HETEROMORPH AMMONITES FROM THE UPPER MAASTRICHTIAN OF PONDICHERRY, SOUTH INDIA

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ABSTRACT. The heteromorph ammonites (Ancyloceratina) from the Upper Maastrichtian Valudavur Formation (Valudayar Group, Antisoceras beds of authors) of Pondicherry, south India are revised in a sequel to the previously published account of the normally coiled Phyloceratina, Lycoceratina and Ammonitina. Twelve species referred to eight genera are recognized, of which Cyrtopycoceras is a new representative of the Polyptychoconulinae. The fauna is of great importance in the development of heteromorph ammonite taxonomy, although a source of great confusion to previous workers. It represents the most diverse Upper Maastrichtian heteromorph assemblage known.

We recently described (Kennedy and Henderson, 1992) the normally coiled ammonites from the Upper Maastrichtian Valudavur Formation (Valudayar Group, Antisoceras beds of authors) of Pondicherry, south India, based on the Kaye and Cunliffe and other collections in The Natural History Museum, London, notably those described by Forbes (1846). In that work we discussed the history of research of these faunas, their stratigraphic context, and age. In this sequel, we describe the heteromorph Ancyloceratina. Fragments, notably of Glyptococeras, were sufficiently common that some early workers referred to what Rajagopalan (1965) termed the Valudavur Formation as the Antisoceras Beds (e.g. Kosmat 1895–8). Specimens of Glyptococeras (Hamites and Antisoceras of nineteenth century workers) from this unit have been a source of confusion since their initial description by Forbes (1846), who referred fragments of the same specimen to different species, as demonstrated by Phillips (1977). D'Orbigny (1847a, 1847b) gave names to a series of fragments from Pondicherry collected by members of the crew of the Bonite from near Valadour in 1837 (Chevalier 1844), and his work was presumably in press when Forbes's work appeared; he subsequently placed several of his Pondicherry species in synonymy with those of Forbes in the Prodome (d'Orbigny 1850). Stoliczka (1866) referred specimens from Pondicherry and other localities at different stratigraphic levels to Forbes's species. Kosmat (1895) clarified certain relationships, but nevertheless increased confusion by referring what have subsequently been shown to be individuals of the same species to different taxa. Shimizu (1935) examined Forbes's types, and introduced a number of new taxa as well as a measure of confusion as to the nature of the types, considering some of Forbes's specimens to be holotypes rather than syntypes. It is to Matsumoto (1959a) that we owe clarification of this taxonomic confusion, and to Phillips (1977) for carefully listing all type and figured specimens. It remains, however, that some specimens have been referred to up to three different species by successive authors, while we ourselves differ from the work of Kosmat in recognizing Diplomococeras cylindraceum (Debrance, 1816) among specimens he referred to Hamites (Antisoceras) rugatius (Forbes, 1846).

Specimens described by Forbes (1846) were collected by C. T. Kaye and C. E. Cunliffe (see Kaye 1840), two amateur geologists on the staff of the Madras Civil Service. Their specimens were donated to the Geological Society of London, and are listed by Blake (1902), having catalogue numbers with the prefix R. They were transferred to the British Museum (Natural History) (now The Natural History Museum, London) in 1911. When first examined by one of us (W. J. K.) many of the figured specimens bore small green labels (and many still do), making them easily
recognizable. Many specimens were glued to labelled boards, and it is these specimens identified with Forbes's, d'Orbigny's or Kosmat's names that are here regarded as the type series of Forbes's species. In the case of the Glyptioceras, the type species, so interpreted, generally consist of several species. In some cases specimens have become separated from boards (from which they were ultimately removed and recatalogued in the 1970s), and some bear notes in L. F. Spath's hand indicating them to be 'types'; a view we have accepted. There remain, however, specimens from the Kaye and Cunliffe Collection that cannot be conclusively shown to be types; we refer to these as possible types in the following account.

We set out below our conclusions as to the identity of the species named by Forbes (1846) and d'Orbigny (1847a), authors of the first accounts of the Pondieherry fauna. Their subsequent history and usage is detailed in the taxonomic part of the work.

Forbes (1846): type species are indicated thus (*):

Ammunites Cardiifer Forbes, 1846 (p. 109, pl. 8, fig. 2) = Indosphaerites cardiifer (Forbes, 1846)*.
Ammunites Papava Forbes, 1846 (p. 110, pl. 7, fig. 5) = Indosphaerites papava (Forbes, 1846).
Ammunites? indicus Forbes, 1846 (p. 114, pl. 8, fig. 9) = Noplosphaerites indicus (Forbes, 1846).
Baculites vagina Forbes, 1846 (p. 114, pl. 10, fig. 4) = Eubaculites vagina (Forbes, 1846).
Baculites teres Forbes, 1846 (p. 115, pl. 10, fig. 5) = Preselliia teres (Forbes, 1846).
Hamites subcompressus Forbes, 1846 (p. 116, pl. 11, fig. 6) = Glyptioceras rugatum (Forbes, 1846).
Hamites tenuliacutatus Forbes, 1846 (p. 116, pl. 10, fig. 8; pl. 11, fig. 3) = Eubaculites tenuliacutatus (Forbes, 1846).
Hamites indicus Forbes, 1846 (p. 116, pl. 11, fig. 4) = Glyptioceras indicum (Forbes, 1846).
Hamites large-scleratus Forbes, 1846 (p. 117, pl. 11, fig. 1) = Glyptioceras large-scleratus (Forbes, 1846).
Hamites rugatus Forbes, 1846 (p. 117, pl. 11, fig. 2) = Glyptioceras rugatum (Forbes, 1846)*.
Hamites nereis Forbes, 1846 (p. 117, pl. 10, fig. 7) = Glyptioceras nereis (Forbes, 1846).
Hamites undulatus Forbes, 1846 (p. 118, pl. 10, fig. 6) = Cyrtopyctoceras undulatus (Forbes, 1846)*.
Psychoceras sphen Forbes, 1846 (p. 118, pl. 11, fig. 5) = Psychoceras sphen (Forbes, 1846)*.

D'Orbigny (1847a):

Baculites ornatus D'Orbigny, 1847a (pl. 3, figs 3–6) = Eubaculites vagina (Forbes, 1846).
Hamites constrictus D'Orbigny, 1847a (pl. 3, figs 7–10) = Psychoceras sphen (Forbes, 1846).
Hamites aculeocostatus D'Orbigny, 1847a (pl. 3, figs 9–10) = Glyptioceras large-scleratus (Forbes, 1846).
Hamites constrictus D'Orbigny, 1847a (pl. 3, figs 11–12) = Glyptioceras rugatum (Forbes, 1846).
Hamites indicus D'Orbigny, 1847a (pl. 3, figs 13–14) = Diplomoceras cylindraceum (Defrance, 1816)?
Hamites simplex D'Orbigny, 1859 (= d'Orbigny, 1847a, pl. 3, figs 15–17) = Diplomoceras rugatum (Forbes, 1846).

To the ten species of Forbes accepted as valid here, we add Diplomoceras cylindraceum (Defrance, 1816), recognized among the syntypes of Hamites rugatus (Forbes, 1846).

This fauna, with twelve species and eight genera, is the most diverse Upper Maastrichtian heteromorph assemblage known.

CONVENTIONS

Repositories of specimens. These are indicated by the following abbreviations:
BMNH: The Natural History Museum, London.
GSC: Prefixes catalogue numbers of the Geological Society of London Collections, transferred to The Natural History Museum (then the British Museum (Natural History)) in 1911.

Dimensions are given in millimetres. The term rib index applies to the number of ribs in a distance equal to the whorl height at the mid point of the interval counted.

Suture terminology. The system of Wedekind (1916), as reviewed by Kullmann and Wiedmann (1970) is used; E, external lobe; L, lateral lobe; U, umbilical lobe; I, internal lobe.
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SYSTEMATIC PALAEONTOLOGY
Suborder ANCYLOCERATINA Wiedmann, 1966, p. 54
Superfamily TURRITITACEAE Gill, 1871, p. 3
Family DIPLOMOCRATIDAE Spath, 1926, p. 81
[= Naoceratinae Spath, 1953, p. 17]
Subfamily DIPLOMOCRATINAE Spath, 1926, p. 81
[= Scalaritinae Ward, 1976, p. 455]
Genus GLYPTOXOCERAS Spath, 1925, p. 30
[= Neohamites Brunnschweiler, 1966, p. 48]

Type species: Hamites rugatus Forbes, 1846, p. 116, pl. 11, fig. 6, by original designation (Spath 1925, p. 30, as Hamites (Antiscoceras) rugatus (Forbes) Kossmat).

GLYPTOXOCERAS RUGATUM (Forbes, 1846)
Plate 1, figs 1–2, 5–16; Plate 2, figs 10–11, 14–29; Plate 3, figs 1–3; Plate 4, figs 2, 12–15; Text-fig. 1a, e.

1846 Hamites subcompressus Forbes, p. 116, pl. 11, fig. 6.
1846 Hamites rugatus Forbes, p. 117, pl. 11, fig. 2.
1846 Hamites nereis Forbes, p. 117, pl. 10, fig. 7.
1847a Hamites acuticostatus d’Orbigny, pl. 3, figs 11–12 only.
1847a Hamites acuticostatus d’Orbigny, pl. 3, fig. 15–17 (non d’Orbigny, 1842).
1850 Hamites subcompressus Forbes; d’Orbigny, p. 216.
1850 Hamites rugatus Forbes; d’Orbigny, p. 216.
1850 Hamites nereis Forbes; d’Orbigny p. 216.
1861 Hamites rimosus Sowerby?: Binkhorst, p. 34, pl. 56, figs 2–4; pl. 5c, fig. 1.
1866 Antiscoceras rugatum Forbes; Stoliczka, p. 178, pl. 85, figs 10–13.
1866 Antiscoceras subcompressum Forbes; Stoliczka, p. 179, pl. 85, fig. 7.
1866 Antiscoceras indicum Forbes; Stoliczka, p. 181 (pars), pl. 85, figs 3–5 only.
1866 Antiscoceras nereis Forbes; Stoliczka, p. 182, pl. 85, figs 17–18.
1866 Antiscoceras sp?: Stoliczka, p. 179, pl. 85, fig. 19.
1871 Antiscoceras rugatum Forbes; Griesbach, p. 63, pl. 3, fig. 4.
1890 Hamites rectoscutellatus Seunens, p. 229, pl. 9, fig. 6.
1895 Hamites (Antiscoceras) subcompressus Forbes; Kossmat, p. 145 (49), pl. 19 (5), figs 10–12.
1895 Hamites (Antiscoceras) rugatus Forbes; Kossmat, p. 146 (pars), non pl. 19 (5), figs 7–9 (= G. indicum, D. cylindraceum).
1895 Hamites (Antiscoceras) sp.; Kossmat, p. 148 (52).
1895 Hamites (Antiscoceras) nereis Forbes; Kossmat, p. 148 (52).
1903 Antiscoceras subcompressus Forbes; Whiteaves, p. 338, pl. 45, fig. 1.
1906 Hamites (Antiscoceras) subcompressus Forbes; Woods, p. 339, pl. 43, fig. 2.
1925 Glyptoxoceras cf. rugatum (Forbes); Spath, p. 30, pl. 1, fig. 4.
1930 Diplomoceras (Hamites) sp. Wetzel, p. 90.
1930 Glyptoxoceras brasilienne Maury, p. 184, pl. 11, fig. 6.
1935 Glyptoxoceras rugatum (Forbes); Shimizu, p. 273, text-figs 1–9.
1935 Glyptoxoceras subcompressum (Forbes); Shimizu, p. 272, text-fig. 12.
1940 Glyptoxoceras cf. rugatum (Forbes); Spath, p. 47, pl. 1, fig. 4.
1952 Diplomoceras? subcompressum (Forbes), 1845; Usher, p. 110, pl. 29, fig. 3.
1959a Glyptoxoceras rugatum (Forbes); Matsumoto, p. 169.
1959a Glyptoxoceras subcompressum (Forbes); Matsumoto, p. 169.
1962 Diplomoceras (Glyptoxoceras) cf. subcompressum (Forbes); Wiedmann, 1928, pl. 12, figs 1–2.
1966 Glyptoxoceras indicum (Forbes, 1845); Brunnschweiler, p. 44, pl. 6, figs 1–3; text-fig. 28.
1966 Glyptoxoceras circulare Shimizu, 1935; Brunnschweiler, p. 46, pl. 6, figs 4–6; text-fig. 29.
1966 Glyptoxoceras nipponicum Shimizu, 1935; Brunnschweiler, p. 46, pl. 6, figs 7–9; text-fig. 30.
1966 Glyptoxoceras bullarense Brunnschweiler, p. 47, pl. 6, fig. 10; text-fig. 31.
1966 Neohamites girarosus Brunnschweiler, p. 48, pl. 7, figs 1–2; text-fig. 32.
1966 Neohamites rugatus (Forbes, 1846); Brunnschweiler, p. 49, pl. 7, figs 4–6; text-fig. 33.
1966 Neohamites cardinalis Brunnschweiler, p. 51, pl. 7, figs 7–9; text-fig. 35.
1966 Neohamites largelaticulus (Forbes, 1846); Brunnschweiler, p. 51, pl. 1, fig. 8; pl. 8, figs 3–6; text-
fig. 36.
1966 Neohamites sooufousi Brunnschweiler, p. 53, pl. 8, fig. 2; text-fig. 37.
non 1966 Diploceras aff. subcompressum Forbes; Collignon, p. 6, pl. 457, fig. 1861.
non 1969 Glyptoxoceras subcompressum Forbes subsp. ensiforme Collignon, p. 41, pl. 529, figs 2084–2085.
non 1976 Glyptoxoceras subcompressum (Forbes); Ward, p. 456, pl. 1, figs 1–3; text-fig. 3.
non 1976 Diploceras (Glyptoxoceras) subcompressum (Forbes, 1843); Klinger, p. 80, pl. 34, fig. 6.
1977 Neohamites subcompressus Kennedy, text-fig. 34, pl. 7, fig. 36.
non 1982 Diploceras (Glyptoxoceras) subcompressum (Forbes, 1846); Immel et al., p. 26, pl. 9, figs 4–5;
pl. 10, fig. 7; pl. 11, fig. 4.
1986a Glyptoxoceras cf. subcompressum (Forbes, 1846); Kennedy, text-fig. 39–41.
1986a Glyptoxoceras cf. circularis Shimizu, 1935; Kennedy, text-fig. 42–43.
1987 Glyptoxoceras cf. circularis Shimizu, 1935; Kennedy, p. 180, pl. 4, figs 1–3; pl. 26, figs 7, 10–12;
15.
1987 Glyptoxoceras cf. subcompressum (Forbes, 1846); Kennedy, p. 179, pl. 26, figs 1–6, 8–9, 13–14,
19–21.

types. Lectotype, here designated, is BMNH CS1110, the original of Forbes 1846 (pl. 11, fig. 2), GSC R10499.
The lectotype, here designated, of Hamites subcompressus Forbes, 1846, is shown in Plate 1, figures 12–16. It
is broken into three parts (Pl. 1, fig. 16). The middle fragment (A), as noted by Phillips (1977, p. 125), GSC
R10491, is the original of Kosmat (1895, pl. 19(5), fig. 10), and possibly the original of Forbes (1846, pl. 11,
fig. 6). The apical fragment (B) corresponds with Forbes's plate 11, figure 4a, c, the figured syntype of
Hamites indicus. Fragment C was never figured. The lectotype, here designated, of Hamites novus Forbes, 1846
plate 10, figure 7, is BMNH CS1109, GSC R10502. In each case lectotypes are designated because Forbes cited
the 'dimension of largest specimen', indicating that he possessed more than one of each species. The holotype
of Glyptoxoceras circularis Shimizu, 1935 (text-figs 10–11) is BMNH CS1112. Possible paratypes of
Hamites subcompressus are BMNH CS1112, the original of Kosmat (1895, pl. 19(5), fig. 4c = GSC R10497;
Pl. 2, fig. 10), and BMNH CS1103, the original of Kosmat (1895, pl. 19(5), fig. 11; Pl. 1, fig. 9, herein). Topotypes
BMNH CS1125 (Pl. 1, fig. 5), CS1131 and CS1139 are possible syntypes of Hamites indicus that belong to the
present species, as are BMNH CS1120–5122 (Pl. 1, figs 10–11; Pl. 4, fig. 2), syntypes of Hamites undulatus
Forbes, 1846; and BMNH CS1098–5109, which are syntypes of Hamites largelaticulus Forbes, 1846 (Pl. 3, figs
1–3; Pl. 4, figs 13–15 (all ex Kaye and Curllie Collection). Other topotypes are BMNH C4049 (5 fragments,
no history), C6650 (12 fragments, no history); CS109 (history uncertain, the original of Shimizu 1915, figs 6–9),
CS114–5116 (no history), BMNH C24201 (4 fragments, ex Kaye Collection), CS1126–5129 (ex Geological
Society Collection), and C242 (ex Kaye Collection). All are from the Valudavar Formation of Pondicherry,
south India.

EXPLANATION OF PLATE 1

Figs 1–2, 5–16. Glyptoxoceras rugatum (Forbes, 1846), 1–2, BMNH CS1110, GSC R1049, the lectotype, the
original of Forbes (1846, pl. 11, fig. 2). BMNH CS1125, a possible syntype of G. indicum. 6, BMNH C24202.
7, BMNH CS1116, 8, BMNH CS1139, a possible syntype of G. indicum. 9, BMNH CS1103, a syntype of
Glyptoxoceras subcompressum figured by Kosmat (1895, pl. 19(5), fig. 11a–b). 10, BMNH CS1120, a
syntype of C. undulatum. 11, BMNH CS1122, a syntype of C. undulatum. 12–16, BMNH CS1100, a specimen
broken into 3 fragments, of which A is GSC R10491, the original of Kosmat (1895, pl. 19(5), fig. 10), and
possibly Forbes (1846, pl. 11, fig. 6), and thus a possible syntype of G. subcompressum. B is probably the
original of Forbes (1846, pl. 11, fig. 4), and a syntype of G. indicum. C was never figured by Forbes.
Figs 3–4. Glyptoxoceras indicum (Forbes, 1846), BMNH CS1111, GSC R10500, a syntype of G. rugatum,
the original of Kosmat (1895, pl. 19(5), fig. 7a–b).
All from Pondicherry, south India. Figs 1–9, 12–16, ×1; figs 10–11, ×3.
TEXT-FIG. 1. Suture lines. A, E, Glyptoceras rugatum (Forbes, 1846), BMNH C51110 and C51112 respectively. B, Diplomoceras cylindraceum (Deffrance, 1816), BMNH C51102. C, D, Eubaculites vagina (Forbes, 1846), BMNH C2597 and C51148 respectively. F, Glyptoceras largesculptum (Forbes, 1846), BMNH C4005.

Description. The early growth stages are shown by a series of evenly ribbed and occasionally constricted fragments down to whorl heights of as little as 3 mm. They vary from compressed to subcircular in cross section and are slightly curved, defining obtuse or acute angles, or straight. The same shapes characterize the largest fragments, indicating a planispiral shell, polygonal in outline, and made up of straight shafts connected by obtuse or acute angles. The lectotype of Hamites rugatus (Forbes 1846, pl. 11, fig. 2) is a wholly septate fragment consisting of two diverging shafts linked by a curved sector (Pl. 1, figs 1–2). It has a maximum preserved whorl height of 198 mm, and a whorl breadth to height ratio of 0.87; the rib index is 8, the ribs blunt, somewhat weakened on the dorsum but strengthening progressively across the flanks, and strong and transverse on the venter. They are prostriate and archaeomarginal at the smallest and largest diameters preserved, but marked rursiadiate on the curved sector. The lectotype of Hamites subcompressus Forbes, 1846 (Pl. 1, figs 13–16) is a curved body chamber, 150 mm long. The whorl section is compressed oval, with flattened subparallel flanks and a broadly rounded dorsum and venter. The costal whorl breadth to height ratio is 0.73, and the rib index varies between 7 and 8. The ribs are relatively weak and transverse on the dorsum, but strengthen across the flanks, where they are feebly prostriate, and on the venter, where they are transverse. The ribs are distinctly narrower than the interspaces, but show some variation, being blunter on the internal mould than where shell is preserved. The holotype of Glyptoceras circulare Shimizu, 1935 (Text-figs 10–11; Pl. 4, fig. 12) is a broken, straight shaft 95 mm long, with a circular cross section, embedded in matrix. The style of ribbing is, as far as visible, like that of the lectotype of subcompressus, with a rib index of six. Suture (Text-fig. 1A, E) with moderately incised, bifid lobes and saddles.

Discussion. We regard Hamites rugatus, H. nereis and H. subcompressus of Forbes (1846) as synonyms, and as first revising authors select the name rugatus for the species. Also regarded as
conspicuous is *G. circulare*, and some of the syntypes of *Hamites indicus* of Forbes. The characteristic features of the species are the polygonal coiling, relatively large size, and rib density. When compared with other species in the Pondicherry fauna, *Glyptoceras tenuisulcatum* (Forbes, 1846) has an initial helix, and much finer ribbing that is oblique on the venter of the shaft, rather than being transverse (Pl. 2, figs 2, 6, 8, 30). *Glyptoceras largesulcatum* (Forbes, 1846) (Pl. 3, figs 4–9; Pl. 4, figs 16–18) has very distant, annular ribs, and is only known as straight shafts. *G. indicum* (Forbes, 1846) (Pl. 1, figs 3–4; Pl. 2, figs 1, 3–5, 7, 9, 12–13) has a quite different coiling, with an initial helix, and oval planispiral later whorls, being adult at a much smaller size (Pl. 1, figs 3–4). When these species are removed from the Pondicherry fauna, the numerous remaining fragments form a species that is variable in whorl section and ribbing density, but of similar coiling and ribbing style. *Hamites nervis* (Forbes, 1846) (Pl. 2, figs 10–11), referred to *Pseudoxybeloceras* by some authors, is a pathological *rugatium* in which ventral ribbing is interrupted, as a result of non-lethal injury to the mantle margin (Pl. 2, fig. 10).

Of species from Pondicherry illustrated by d’Orbigny (1847a), one of the specimens of *Hamites acuticostatus* (pl. 3, figs 11–12) may belong here; it is shown as being 40 mm long, with a compressed whorl section, and rib index of 4. The second specimen illustrated by d’Orbigny (pl. 3, figs 9–10) seems to be a *G. largesulcatum*. The *Hamites simplex* of d’Orbigny from Pondicherry (pl. 3, figs 15–16) is a curved fragment 30 mm long, and is clearly *G. rugatium*.

We refer a number of non-Indian records to *G. rugatium* on the basis of coiling style, ribbing and age (see synonymy), but reject small fragments that are significantly older where the coiling style is unclear, believing them to be unidentifiable as to genus in some cases. Thus fragments from the Upper Maastrichtian of the Maastricht area, described as *Hamites retinula* by Binkhorst (1861) are referred to *G. rugatium* (see also Kennedy 1987), as is *G. recticostatus* (Saimes, 1890) from the Upper Maastrichtian of southeastern France, and *G. brasiilense* (Maury, 1930), from Brazil. Study of more than 100 Glyptoceras from the Upper Maastrichtian Miria Formation of western Australia (to be described elsewhere), has convinced us that *G. indicum*, *G. circulare*, *G. nipponicum*, and *G. bullarensis*, *Neohamites giralensis*, *N. rugatus*, *N. carabidensis*, *N. largesulcatum*, and *N. soufoulii* of Bruchweiler (1966) represent but a single form, conspecific with *Glyptoceras rugatium*.

The *Glyptoceras subcompressum* of Ward (1976, p. 456, pl. 1, figs 1–5; text-fig. 3) and Ward and Westermann (1976, text-figs 1–3) has a quite different, ellipsoidal coiling when compared to the Pondicherry material, with an initial helix with its axis of coiling at 90° to that of the planispiral whorls; it is of late Santonian or early Campanian age.

**Occurrence** Maastrichtian of south India, Brazil, Chile (?), Western Australia, northern Spain, south-east France, and the Maastricht area in the Netherlands and Belgium.

*Glyptoceras indicum* (Forbes, 1846)
Plate 1, figs 3–4; Plate 2, figs 1, 3–5, 7, 9, 12–13

1846 *Hamites indicus* Forbes, p. 116 (pars), non pl. 11, fig. 4 (= *G. rugatium* (Forbes, 1846)).

1847a *Hamites indicus* Forbes; d’Orbigny, pl. 3, figs 13–14 (= *Diplomoceras cylindraceum* (Defrance, 1816)).

1850 *Hamites indicus* Forbes; d’Orbigny, p. 215.

1866 *Anticeras indicum* Forbes sp.; Stoliczka, p. 181 (pars), non pl. 85, figs 1–5.

1866 *Anticeras tenuisulcatum* Forbes; Stoliczka, p. 177 (pars), pl. 85, fig. 14 only.

1895 *Hamites (Anticeras) rugatius* Forbes; Kossmat, p. 145 (49) (pars), pl. 19 (5), fig. 4a–c.

1906 *Hamites (Anticeras) indicus* Forbes; Woods, p. 340, pl. 44, fig. 2.

1921 *Diplomoceras? indicum* Forbes sp.; Spath, p. 256, p. 23, fig. 5.

1935 *Glyptoceras indicum* (Forbes); Shimizu, p. 272.

1954 *Glyptoceras*; Wright and Matsumoto, text-fig. 5.

1959a *Glyptoceras indicum* (Forbes, 1846); Matsumoto, p. 167, pl. 41, figs 2–6; text-fig. 80.
non 1966 Glyptospiraceras indicum (Forbes, 1846); Brunnschweiger, p. 44, pl. 6, figs 1-3; text-fig. 25 (= G. rugatum).
non 1969 Diplomoceras indicum Forbes octosulcatum subsp. nov. Collignon, p. 45, pl. 530, fig. 2090.
non 1976 Diplomoceras (Glyptospiraceras) indicum (Forbes), 1845; Klinger, p. 79, pl. 34, figs 3, 5.
1977 Glyptospiraceras indicum; Kennedy, text-fig. 31, 11-12.
non 1982 Diplomoceras (Glyptospiraceras) indicum (Forbes, 1846); Immel et al., p. 26, pl. 10, figs 5-6.

Types. The lectotype, by the subsequent designation of Matsumoto (1959a, p. 167), is BMNH C51113, the original of Kossmat (1895, pl. 19 (5), fig. 4), GSC R10496. Paralecotypes include a part of the lectotype of *G. rugatum*, BMNH C51100, the original of Forbes (1846, pl. 11, fig. 4a, c); BMNH C51111, the original of Kossmat (1895, pl. 19 (5), fig. 7a-b), GSC R10500, referred to Kossmat to *G. rugatum*: Possible paralecotypes are BMNH C51130, C51132-51134, C51136. C51138 that belong to the present species; other possible paralecotypes are referred to *G. rugatum* and *G. largesulcatum* under these species; all from the Valadavur Formation of Pondicherry, south India. Topotypes are BMNH C4050 (2 fragments), C51117, and C82502-82503 (ex Marsham Collection).

Description. The early whorls (Pl. 2, figs 1, 4-5, 7, 9) are in the form of a very low helix, with a total diameter to the spire of 22 mm, the translation rate being very low. The whorl section is circular at this stage, with coarse, blunt ribs, separated by somewhat wider interspaces, and a rib index of 6-7. Ribs are weak on the inner whorl face, feebly prorsiradiate, strengthening and strongly rursiradiate on the upper whorl face, strongest and markedly prorsiradiate on the outer whorl face and weakened and feebly convex on the lower. The lectotype (Pl. 2, figs 3, 12-13) is 35 mm long, entirely body chamber, consisting of the external mould of a smaller, straight shaft, connected by a strongly curved portion to a longer, straight shaft. The maximum preserved whorl height is 7 mm, the whorl section circular, the rib index 7. Ribs are strong, sharp and narrower than the interspaces. They are feebly prorsiradiate on the flanks of the shaft, and pass straight across the venter, but change to markedly rursiradiate on the hook. BMNH C51111 (Pl. 1, figs 3-4) is more complete, consisting of the displaced fragments of straight shaft, a curved sector and a second, shorter, straight shaft, the whole forming an asymmetric U. The specimen is partly crushed, but where well preserved, has a maximum whorl height of 12 mm, and a whorl breadth to height ratio of 0.46. The ribbing style is comparable to that of the lectotype; feebly prorsiradiate on the smaller shaft, becoming markedly rursiradiate on the hook and large shaft, but the rib index, 9, is slightly higher on the final shaft. There is a prominent constriction and terminal collar at the aperture, suggesting the specimen to be adult.

Discussion. Forbes (1846, pl. 11, fig. 4a-c) figured only a fragment of what has been subsequently designated the lectotype of *G. rugatum* to illustrate the species *indicus*. Stoliczka (1866, pl. 85, figs 1-5) used the name, but none of his figured specimens belong to the species as defined here. Kossmat (1895) pointed out that the specimen figured by Forbes as *indicus* was identical to Forbes's *Hamites subcompressus* (they were shown by Phillips (1977, p. 124) to be based on bits of the same specimen), and figured a syntype of Forbes's *indicus* (1895, pl. 19 (5), fig. 4a-b; pl. 2, figs 3, 12-13) as well as

EXPLANATION OF PLATE 2

Figs 1, 3-5, 7, 9, 12-13. Glyptospiraceras indicum (Forbes, 1846). 1. BMNH C51134, a possible paralecotype. 3, 12-13, BMNH C51113, GSC R10496, the lectotype, the original of Kossmat (1895, pl. 19 (3), fig. 4a-b). 4. BMNH C51133, a possible paralecotype. 5, 7. BMNH C51138, a possible paralecotype. 9, BMNH C51116, a possible paralecotype.

Figs 2, 6, 8, 30. Glyptospiraceras tenasulcatum (Forbes, 1846). 2. BMNH C51107, a paralecotype. 6, BMNH C51135, a paralecotype. 8, BMNH C51106, a paralecotype. 30. BMNH C51104, GSC R10493, the original of Forbes (1846, pl. 10, fig. 8).

Figs 10-11, 14-29. Glyptospiraceras rugatum (Forbes, 1846). 10-11. BMNH C51109, GSC R10502, the lectotype of *Hamites nereis* Forbes (1846, pl. 10, fig. 7). 14-15. BMNH C4049, the original of Shimizu (1935, text-figs 6-9). 16. BMNH C51112, R10497, a paralecotype, the original of Kossmat (1895, pl. 19 (5), fig. 4c). 17-19. BMNH C4049. 20-22. BMNH C4049. 23. BMNH C51114. 24. BMNH C51115. 25-27. BMNH C4049. 28. BMNH C51131. 29. BMNH C51128.

All from the Valadavur Formation, Pondicherry, south India. All x1.
a syntype of Forbes’s *rugatum* (Kossmat 1895, pl. 19 (5), fig. 7; Pl. 1, figs 3–4) which we identify with *Glyptoxooxerus indicum*. Shimizu (1935) considered Forbes’s figured specimen to be the holotype of *indicum*, but Matsumoto (1959a, p. 167) correctly recognized (following Kossmat 1895, p. 145 (49)) that *Hamites indicus* of Forbes was based upon a number of syntypes, and designated BMNH C51113, the original of Kossmat 1895 (pl. 19 (5), fig. 4a–b; pl. 1, figs 3–4) as lectotype. So defined, *G. indicum* is a distinctive species, characterized by the presence of an initial helix, followed by a single elliptical whorl, beautifully illustrated by examples from the Maastrictian of California (Matsumoto 1959a, pl. 41, figs 2–6). This coiling style immediately separates *G. indicum* from *G. rugatum* and *G. tenuisulcatus*, while *G. tenuisulcatus*, with similar coiling, has a much higher rib index, the ribs oblique on the venter of shafts rather than transverse, and reaches a much larger size (Pl. 2, figs 2, 6, 8, 30).

The *Glyptoxooxerus indicum* of Brunswiezer (1966, p. 44, pl. 6, figs 1–3; text-fig. 28) is *G. rugatum*. *Diplomoceras indicum acutiusculatum* Collignon, 1969 (p. 45, pl. 30, fig. 2090), from the Lower Campanian of Madagascar, is based on a straight shaft 80 mm long, a coiling style quite unlike that of *G. indicum*. The Santonian–Campanian fragments from Zululand and Pondoland (Woods 1906, pl. 44, fig. 2; Klinger 1976, pl. 34, figs 3, 5) are indeterminate. The *Diplomoceras (Glyptoxooxerus) indicum* of Iimmel et al. (1982, pl. 10, figs 5–6) from the Santonian of Austria are of uncertain affinities in our view, being densely ribbed curved fragments only. The *Glyptoxooxerus subcompressum* of Ward and Westermann (1976, text-figs 1–3) and Ward (1976, pl. 1, figs 1–5; text-fig. 3) consists of an initial helix, followed by one and a half elliptical whorls, rather as in *G. indicum*, but the plane of coiling of the helix is 90° to that of the late whorls.

**Occurrence.** Maastrictian of south India and California.

*Glyptoxooxerus tenuisulcatus* (Forbes, 1846)

Plate 2, figs 2, 6, 8, 30; Text-fig 2a

1846 *Hamites tenuisulcatus* Forbes, p. 116, pl. 10, fig. 8; pl. 11, fig. 3.
1850 *Ancyxooxerus tenuisulcatus* Forbes; d’Orbigny, p. 214.
1855 *Ancyxooxerus tenuisulcatus* Forbes sp.; Stoliczka, p. 177, pl. 85, figs 14–16.
1895 *Hamites (Ancyxooxerus) tenuisulcatus* Forbes; Kossmat, p. 147 (51), pl. 19 (5), figs 5–6.
1959a *Hamites (Ancyxooxerus) indicus* Forbes; Matsumoto, p. 168.
1977 *Diplomoceras tenuisulcatus* (Forbes); Phillips, p. 49.
1979 *Glyptoxooxerus cf. indicus* (Forbes, 1846); Birkeland, p. 55.

**Types.** The lectotype, by the subsequent designation of Matsumoto (1959a, p. 168), is BMNH C51104, the original of Forbes (1846, pl. 10, fig. 8), GSC R10493. Parallectotypes are BMNH C51107, the original of Forbes (1846, pl. 11, fig. 3a–b); BMNH C51105, the original of Forbes (1846, pl. 11, fig. 3c–e); GSC R10495; BMNH C51106, the original of Kossmat (1895, pl. 19 (5), fig. 5a–b); GSC R10494; BMNH C51108 (4 specimens), and C51135, all from the Valadodar Formation of Pondicherry, South India (ex Day & Cunliffe Collection). BMNH C82504 is a topotype (ex Marsham Collection).

**Description.** The earliest stages are in the form of a low loose helix, with a low translation rate (Pl. 2, figs 2, 6, 8) and a slightly compressed, subcircular whorl section. Ornament is of very fine, delicate ribs, with a rib index of 14. The ribs are weak on the inner whorl face, but strengthen on the juncture of inner and upper whorl faces, are concave on the upper, markedly prorsiradiate on the outer, sweeping back and markedly concave across the lower whorl face. These helices can be linked, via BMNH C41105, to the lectotype (Pl. 2, fig. 30) which is a shaft and part of a helicoidal whorl, in all 94 mm long. The whorl breadth to height ratio is 0.9 at the greatest whorl height preserved, and the rib index 15 or 16. The ribs are very fine, sharp and narrower than the interspaces. They are transverse to feebly concave on the dorsum, sweeping forwards and markedly prorsiradiate on the flanks, and markedly oblique on the venter, rather than transverse. Suture florid, with deeply incised bifid elements (Text-fig. 2b).

**Discussion.** Matsumoto (1959a) thought tenuisulcatus might be a Diplomoceras, but the helicoidal whorls indicate, rather, that it is a *Glyptoxooxerus*. Diplomoceras have psychoceratid early growth stages (Matsumoto 1984, p. 31, pl. 8, fig. 3; Matsumoto and Miyaiuchi 1984, p. 68, pl. 27, fig. 2;
text-fig. 2. Suture lines. A, Indospirites carilloi (Forbes, 1846), BMNH C51090. B, Glyptoceras

tenuisulcatum (Forbes, 1846), BMNH C51105. C, Fresvilia perpusca (Forbes, 1846), BMNH C41505.
D, Phyllotyphloceras zigr (Forbes, 1846), BMNH C41502.

Glyptoceras tenuisulcatum differs from all other described Glyptoceras in the very
fine ornament, markedly prorsiradiate on the flanks, and oblique, rather than transverse on
the venter, as well as its retention of helicoid coiling to a much larger size than D. indicum, the other
species in which helices are known.

Occurrence. Maastrichtian of south India and Denmark.

Glyptoceras largesulcatum (Forbes, 1846)

Plate 3, figs 4-9; Plate 4, figs 16-18; Text-fig. 1d

1846 Homites large-sulcatus Forbes, p. 117, pl. 11, fig. 1.
1847a Homites acutioratus d'Orbigny, pl. 3, figs 9-10 only.
1850 Homites indicus Forbes, d'Orbigny, p. 215 (pars).
1866 Antoceras large-sulcatum Forbes, Stoliczka, p. 180, pl. 85, figs 8(?)—9.
1895 'Homites (Antoceras) largesulcatus Forbes; Kosmat, p. 147 (31).
1959a Glyptoceras(?) largesulcatum (Forbes); Matsumoto, p. 169.
non 1966 Neohomites largesulcatus (Forbes, 1846); Brunnscheier, p. 52, pl. 1, fig. 8; pl. 8, figs 3–6; text-
fig. 36 (= G. rugatum).
non 1969 Glyptoceras largesulcatum Forbes; Collignon, p. 46, pl. 530, fig. 2091.
1977 Neohomites largesulcatus (Forbes, 1846); Phillips, p. 124.
Types. Lectotype, here designated, is BMNH C51094, the original of Forbes (1846, pl. 11, fig. 1), GSC R10498; paratypes are BMNH C51095—51099; BMNH C51098—51099 are G. rugatum (Pl. 3, figs 1—3; Pl. 4, figs 13—15). All are from the Valadavur Formation of Pondicherry, south India (ex Kaye and Coinche Collection). Topotypes are BMNH C24200 (ex Kaye Collection), and C4051.

Description. The lectotype (Pl. 3, figs 4, 8—9), is a straight body chamber fragment 54 mm long, with a maximum preserved whorl height of 23.5 mm. The whorl section is a compressed oval, with a costal and intercostal whorl breadth to height ratio of 0.84. There are 4—5 ribs in a distance equal to the whorl height, in profile, the interspaces are symmetrically concave, and terminate at the sharp rib crests, a very distinctive ornament indeed. The ribs are slightly weakened and concave on the dorsum, feebly prorsiradiate on the flanks and strengthened slightly and transverse on the venter. BMNH C51095 (Pl. 3, fig. 7) is also a straight body chamber fragment, 54.5 mm long, with a costal whorl breadth to height ratio of 0.91, and an intercostal whorl breadth to height ratio of 0.93. The rib index is 4.5 to 5. BMNH C51096 (Pl. 4, figs 16—18) is 80 mm long, with a rib index of 5. BMNH C51097 (Pl. 3, fig. 6) is 36.5 mm long, with a rib index of 5. A topotype, BMNH C4051, shows the suture (Text-fig. 1d), which is moderately incised, with broad-stemmed bifid lobes and narrower-necked bifid saddles.

Discussion. The Geological Society of London catalogue lists only one specimen under Hamites largesulcatus, and this is designated lectotype above. There are, however, five other specimens in The Natural History Museum collections, labelled, in L. F. Spath’s hand, ‘Diplomoceras (cotypes of Hamites largesulcatus Forbes)’. In the absence of the original boards to which the specimens were glued, as well as the original labels, these are taken to be syntypes, as Forbes refers to both straight and curved specimens, including what is clearly BMNH C51098 (Pl. 3, figs 1—3) ‘the most curved specimen bearing two oval varices’ (Forbes 1846, p. 117). This specimen and paralectotype C51099 (Pl. 4, figs 13—15) are referred to G. rugatum.

One of the specimens of Hamites acuticostatus d’Orbigny, 1847a (pl. 3, figs 9—10) has a circular whorl section, is 27 mm long, with a whorl height of 15 mm, and a rib index of 3. It appears to belong to the present species. The other fragment illustrated as acuticostatus has a compressed whorl section and rib index of 4, and seems to be a G. rugatum.

The distant, sharp ribbing, with symmetrical interspaces distinguishes G. largesulcatus from all other species of the genus.

Occurrence. As for types.

**Genus Diplomoceras Hyatt, 1900, p. 571**

[= Eudiplomoceras Brunhesweiler 1966 p. 18]

**Diplomoceras cylindraceum** (Defrance, 1816)

Plate 6, figs 1—3; Text-figs 1b, 3

1816 *Hamites cylindraceus* Defrance, p. 160.

1847 *Hamites indicus d’Orbigny*, pl. 3, figs 13—14.

1895 *Hamites (Aniosoceras) rugatum* Forbes sp.; Koosmat, p. 146 (50) (pars), pl. 19 (5), figs 8—9 only.

1980 *Diplomoceras sp., cf. D. notabile* Whiteaves; Matsumoto and Morozumi, p. 23, pl. 16, fig. 3.

1981 *Diplomoceras cf. notabile* Whiteaves; Matsumoto, p. 291, pl. 47, fig. 8; pl. 48, fig. 5.

**EXPLANATION OF PLATE 3**

Figs 1—3. *Glyptosoceras rugatum* (Forbes, 1846), BMNH C51098, one of the syntypes of *Hamites largesulcatus* Forbes, 1846.

Figs 4—9. *Glyptosoceras largesulcatum* (Forbes, 1846). 4, 8—9, BMNH C51094, GSC R10498, lectotype, the original of Forbes (1846, pl. 11, fig. 1). 5, BMNH C24200, a topotype. 6, BMNH C51097, a paralectotype. 7, BMNH C51095, a paralectotype. All from the Valadavur Formation, Pondicherry, south India. All ×1.
KENNEDY and HENDERSON, *Glyptoxoceras*
Type. Neotype, designated by Kennedy (1987, p. 183, pl. 24, figs 1–3), is no. 10511 in the collections of the Institut Royal des Sciences Naturelles de Belgique, from the Upper Maastrichtian Nekum or Meerssen Chalk of St. Pietersberg, Maastricht, The Netherlands.

Description. BMNH C51102 (Pl. 6, figs 1–3), the original of Kossmat (1895, pl. 19 (5), fig. 9), a syntype of *Homites rugatus* Forbes, 1846, is an initially slightly curved, thereafter straight shaft, 180 mm long, with a whorl breadth to height ratio of 0.86 at the smaller and 0.85 at the larger end, where the maximum preserved
whorl height is 28 mm. The flanks are broadly and evenly rounded, the dorsum and venter more narrowly so, with an oval whorl section. The specimen is partially septate. Ornament is subdued on the mould, but sharp where shell is preserved. The rib index is 12-13, the ribs transverse on dorsum and venter and varying from feebly rursiradiate to feebly prorsiradiate on the flanks, and only slightly weaker on dorsum than venter. Where well-preserved, they are narrower than the interspaces, with blunt crests. BMNH C51101 (Text-fig. 3; the original of Kosunat 1895, pl. 19 (3), fig. 8) is a wholly septate fragment of a shaft and part of the curved sector, with a maximum preserved whorl height of 40 mm on the shaft close to the curved sector, where the rib index is 14-15, the ribs markedly inclined on the flank. The whorl breadth to height ratio cannot be determined. Even larger is an unregistered fragment of a straight shaft, with a whorl height of more than 50 mm.

Suture (Text-fig. 1b) with deeply incised symmetrically bifid lobes and saddles.

Discussion. Kennedy (1987) described a suite of more than 70 specimens from the type area in The Netherlands, as well as a smaller suite of well-preserved specimens from the Calcaire à Bacculites of Manche, France (Kennedy 1986a). Kennedy and Summesberger (1986) redescribed the type material of Hamites happeanus Hauer, 1847 (p. 75), a synonym, and Kennedy and Summesberger (1987) described material from Lvov in the Ukraine, showing the variety lvovensis of Mikhailov (1951) to be based on crushed specimens of D. cylindraceum. These workers considered D. cylindraceum to be a widely varying species in terms of whorl breadth to height ratio and rib index, encompassing both Diplomoceras notabile Whiteaves, 1903 (p. 335, pl. 44, fig. 4), originally described from British Columbia, and D. lambi Spath, 1953 (p. 17, pl. 2, figs 1-3), originally described from Antarctica. Olivero and Zinsmeister (1989) in seeming ignorance of the description of the neotype of cylindraceum, as well as other toptype material, held D. lambi, D. notabile and a new species, D. maximum Olivero and Zinsmeister, 1989 (p. 629, text-figs 2.5, 4.1-4.5, 5.1-5.4) to be different from D. cylindraceum. According to these authors, the diagnostic features of these species include: D. lambi, circular whorl section and rib index of 13-20; D. notabile, compressed whorls, and slight sutural difference; D. maximum, circular whorl section, rib index ranges from 9 to 13, average 11-12. For D. cylindraceum they quote Kennedy (1986b) and Kennedy and Summesberger (1986) as indicating a rib index of 11-13. In fact material from The Netherlands (Kennedy 1987) has whorl breadth to height ratios of 0.77-1.02, and a rib index of 13-17 at whorl heights of 55-60 mm, and up to 20 or more in the largest fragment.

Text-figure 4 plots the whorl breadth to height ratio of type material of all these species, additional specimens from The Netherlands, the Calcaire à Bacculites of the Cotentin Peninsula in France, and the Indian examples. The whorl section of the neotype of D. cylindraceum and the holotype of D. notabile are both compressed. Whiteaves (1903) gives a ratio of 0.81 at the smaller and 0.84 at the larger end of the holotype. The rib index is 15, so that the specimen falls within the range of D. cylindraceum. The types of D. lambi in the collections of The Natural History Museum have a whorl breadth to height ratio of 0.95 to 1.06, overlapping that of D. cylindraceum, as does the rib index of 13, 14 and 17. The larger suite described by Olivero and Zinsmeister (1989) with a rib index of 13-20 and circular cross section also overlaps with the toptype assemblage and other European material. There are thus no grounds for separating these species in our view. D. maximum cannot be differentiated from D. cylindraceum on whorl section, showing a whorl breadth to height ratio that varies from 0.79-1. The rib index is as low as 7 in specimens with a whorl height of 10 mm, but varies up to 15 at a whorl height of 16 mm, and is generally between 10 and 13 in larger specimens. To us it appears to be no more than the paucicostate part of a population which clearly overlaps with European material. Indeed, the plot of rib index versus whorl height in Olivero and Zinsmeister (1989) shows what is to us an arbitrary separation between D. maximum and D. lambi; taken together, the overlap with European D. cylindraceum is even more obvious. We see no grounds for treating all of the forms discussed here as anything more than a variable D. cylindraceum.

Hamites indicis d’Orbigny, 1847a (pl. 3, figs 13-14) is shown as a 22 mm long fragment with a compressed whorl section and feebly prorsiradiate narrow, straight flank ribs, the rib index being 14, and may well be a juvenile D. cylindraceum.
TEXT-FIG. 4. Plot of whorl breadth versus whorl height for selected specimens referred to *Diplomoceras cylindraceum* (Deffense, 1816).
**Occurrence.** Where well dated, this species is Maastrichtian, ranging to the very top of the stage. There are records from South India, Japan, Alaska, British Columbia, California, Chile, the Antarctic Peninsula, Western Australia, Madagascar, Zululand (South Africa), the USSR, Italy, northern Spain, France, Belgium, the Netherlands, Germany, Denmark, Poland, Austria, Bulgaria, and, possibly, New Zealand, Greenland and Brazil. A slightly lower appearance in the Upper Campanian, is suggested by records from Japan (Matsumoto and Morozumi 1980; Matsumoto 1984, Matsumoto and Miyachi 1984).


**Genus POLYPHYCOSERAS** Spath, 1923, p. 16

[— Neozychoceras Anderson, 1958, p. 189]

Type species. *Psichoceras siphon* Forbes, 1846 (p. 118, pl. 11, fig. 5), by original designation.

*Phyllophycocoseras siphon* (Forbes, 1846)

Plate 4, fig. 7; Plate 5, figs 18–32; Text-fig 20

1846 *Psichoceras siphon* Forbes, p. 118, pl. 11, fig. 5.
1847a *Hamites constrictus* d’Orbigny, pl. 3, figs 7–8.
1850 *Psichoceras siphon* Forbes; d’Orbigny, p. 215.
1850 *Hamites constrictus* d’Orbigny, p. 215.
1866 *Psichoceras siphon* Forbes; Stoliczka, p. 194, pl. 90, figs 5–9.
1895 *Hamites (Psichoceras) siphon* Forbes sp.; Kossmat, p. 150 (54).
1953 *Phyllophycocoseras siphon* (Forbes); Spath, p. 19, pl. 11, fig. 7.
1958 *Neozychoceras bryani* Anderson, p. 189, pl. 72, fig. 5.
1965 *Phyllophycocoseras siphon* (Forbes); Howard, p. 386, pl. 11, fig. 1.
1970 *Phyllophycocoseras siphon* (Forbes); Henderson, text-fig. 7b.
1977 *Phyllophycocoseras siphon*; Kennedy, text-fig. 3120.
1986 *Phyllophycocoseras sp.* Stannage, p. 200, pl. 15, figs 3; text-fig. 22.
1989 *Phyllophycocoseras*; Kennedy, text-fig. 18f.

Types. Lectotype, by the subsequent designation of Howard (1965, p. 386) is BMNH C51153, the original of Forbes (1846, pl. 11, fig. 5b), GSC R10510; paratypotypes BMNH C51154 is the original of Forbes (1846, pl. 11, figs 5k, e), GSC R10506; paratypotype BMNH C51155 is the original of Forbes (1846, pl. 11, figs 5e, j), GSC R10507; paratypotype BMNH C41507 is probably the original of Forbes (1846, pl. 11, fig. 5d); unfigured paratypotypes are BMNH C41503, C51165–51161, all from the Valadavur Formation of Pondicherry, south India (ex Kaye and Cuniff collection). Topotypes are BMNH C3521, and 24199. The holotype of *Hamites constrictus* d’Orbigny, 1847 (pl. 3, figs 7–8), is MNHP R982 (Pl. 5, figs 19–20), also a topotype of *P. siphon*.

**Description.** The earliest developmental stages are shown by BMNH C51155 and 51160 (Pl. 5, figs 18, 24), which consist of minute subparallel shafts in tight contact, linked by narrowly curved sections, where shafts are separated by a tear-shaped opening; the shell is smooth, but for prorsiradiate growth lines. BMNH C51161 is a similar fragment (Pl. 5, fig. 19), but much larger. BMNH C51154 (Pl. 5, fig. 23) is the same size and shape as BMNH C51161, with a circular cross section and feeble ornament of low, broad, feeble prorsiradiate ribs, and a single constriction. If, as seems likely, these are correctly interpreted as successive growth stages of the same form (rather than of macro- and microconchs), then the shell consisted of four closely adpressed subparallel shafts, the first three and part of the fourth being septate. The lectotype (Pl. 5, figs 31–32) is the best-preserved of the adult specimens, and is 107 mm long. The whorl section is subcircular, slightly compressed at the apical end, and consists of a slightly curved shaft and short recurved crozier. The whorl breadth to height ratio is 0.83 at the mid-point of the shaft, but becomes markedly depressed and reeniform on the final curved sector. Ornament on the shaft is of low, broad, distant, rounded ribs; the rib index is two. Ribs are weak and transverse on the dorsum, straight and feebly prorsiradiate on the flanks, and strong and transverse across the venter. The ribs weaken, narrow and crowd on the final section of the shaft and the initial part of the hook, disappearing altogether on the final section of the hook, where they are replaced by crowded growth lines. The final, adult aperture appears to have been flared and trumpet-shaped, as suggested by BMNH.
C41503. Suture (Text-fig. 2n) greatly simplified with narrow-stemmed, bilid saddles with only minor indentations; lobes have narrow necks, with apsated, bilid lateral elements and a larger median element, entire in L and U.

Discussion. Hamites constrictus d’Orbigny, 1847a (pl. 3, figs 7–8) is based on a Pondicherry specimen of P. sipho (Pl. 5, figs 27–28). The holotype of Neocystochitida bryani Anderson, 1958 (p. 189, pl. 72, fig. 5) is based on a small smooth form with psycoceratid coiling like the early stages of the present species, and said, by Anderson, to be of Maastrichtian age; it is a possible synonym, as is the Phylloptychoceras sp. of Stinnesbeck (1986, p. 200, pl. 15, fig. 3; text-fig. 22), from the Maastrichtian of Chile.

Occurrence. Maastrichtian of south India and, possibly, Chile and California, and the Biscay region of France and Spain.

Genus CYRTOPTYCHOCERAS nov.

Derivation of name. Kyrios (Greek), curved; psychos (Greek), fold; and keros (Greek), horn.

Type species. Hamites undulatus Forbes, 1846 (p. 118, pl. 10, fig. 6).

Diagnosis. Small, whorl height less than 4 mm before aperture; consisting of a single endogastrically curved shaft; whorl section circular, ornamented by low, broad, straight prorsiradiate flank ribs that are transverse on the venter. Apertural region expanded into a smooth, trumpet-shaped section succeeded by constrictions, and terminal linguoid ventral process.

Discussion. Shape and style of ribbing, plus apertural modifications correspond to those of Polyptychoceratinae, as in Phylloptychoceras described above. It differs from all other genera assigned to the subfamily in consisting of a single, curved shaft, rather than several subparallel ones. It differs from all known Diplomoceratinae in rib style and form of aperture. There are closer similarities to Baculitidae, but the transverse ribbing on dorsum and venter, with no development of dorsal and ventral rostra throughout ontogeny is a differentiating feature from genera such as Fresevilia Kennedy, 1986a, and species such as Baculites columna Morton, 1834.

Occurrence. Upper Maastrichtian Valudavar Formation of Pondicherry, south India.

Cyrtoptychoceras undulatus (Forbes, 1846)

Plate 4, figs 1, 3–6, 8–11

1846 Hamites undulatus Forbes, p. 118, pl. 10, fig. 6.
1855 Hamites undulatus Forbes; d’Orbigny, p. 216.
1866 Antiloceras undulatum Forbes; Stoliczka, p. 177, pl. 85, fig. 6.
1895 Hamites (Antiloceras) undulatus Forbes sp.; Kossmat, p. 148 (52).
1977 Hamites undulatum (Forbes); Phillips, p. 54.

EXPLANATION OF PLATE 4

Figs 1, 3–6, 8–11. Cyrtoptychoceras undulatum (Forbes, 1846). 1, BMNH C51124, a paralectotype. 3, BMNH C51119, a paralectotype. 4, 6, 8–9, 11, BMNH C51118, GSC R10563, the lectotype, the original of Forbes (1846, pl. 10, fig. 6). 10, BMNH C51123, a paralectotype.


Fig. 7. Phylloptychoceras sipho (Forbes, 1846). BMNH C51159, a paralectotype.

Figs 16–18. Glyptoceras largesulcatum (Forbes, 1846). BMNH C51096, a paralectotype.

All from the Valudavar Formation, Pondicherry, south India. Figs 6–7, 11–18, x1; figs 1–5, 8–11, x2.
KENNEDY and HENDERSON, Cryiptychoceras, Phyloptychoerat, Glyptoxoceras
Types. Lectotype, here designated, is BMNH CS1118, the original of Forbes (1846, pl. 10, fig. 6), GSC RI0503. Paratypes are BMNH CS1119, CS1123 and CS1124; paratypes BMNH CS1121 (Pl. 4, fig. 2), BMNH CS1122 (Pl. 1, fig. 11) and CS1120 (Pl. 1, fig. 10) are G impressions. All are from the Valdavador Formation of Pondicherry, south India (ex Kaye and Cunliffe Collection).

Description. The lectotype (Pl. 4, figs 4–6, 8–9, 11) is an incomplete body chamber 46 mm long, with the adult aperture preserved. The greater part of the specimen is slightly curved, curvature increasing towards the adult aperture, with the ventral convex and dorsum concave in profile. The whorl section is circular, and expands very slowly. Ornament is of low, broad, blunt ribs, as wide as, or narrower than the interspaces. The ribs are transverse on the dorsum, feebly pronotquadrate on the flanks, and somewhat strengthened and transverse on the venter. The rib index is 2.

The whorl expansion rate increased markedly on the final sector before the aperture and ornament is lost, leaving a 4 mm smooth section of shell, which terminates at a broad, deep constriction, pronotquadrate on the flank, and transverse on the venter, with a narrow, sharp adapical collar-rib. Beyond the collar, there is a further sector of shell, preserved on the ventral and ventrolateral regions only. It bears a series of weak ribs, the terminal one defining a broad lingual ventral apertural process (Pl. 4, figs 4, 5, 8, 9). BMNH CS1119 is a series of near-straight sections of body chamber (Pl. 4, fig. 3). BMNH CS1124 (Pl. 5, fig. 1) shows the ventral ornament, BMNH CS1123 (Pl. 4, fig. 10) may show that of the dorsum, but is very small. None of the specimen show the suture.

Discussion. See under genus.

Occurrence. As for types.

Family BACULITIDAE Gill, 1871, p. 3

[= Eubaculinae Brunswiecker, 1966, p. 24]

Genus EUBACULITAE Spath, 1926, p. 80

[= Giraudites Brunswiecker 1966, p. 33; Eubaculitidae Brunswiecker 1966, p. 36; Cardabites Brunswiecker 1966, p. 38]

Type species. Baculites vagina var. oostaciensis Stoliczka, 1866 (p. 199, pl. 90, fig. 14, 11), by original designation.

Eubaculites vagina (Forbes, 1846)

Plate 5, figs 10–13; Plate 7, figs 1–18; Plate 8, figs 1–12; Plate 9, figs 1–13; Plate 10, figs 1–3; Text-fig. 1c, r

1846 Baculites vagina Forbes, p. 114, pl. 10, fig. 4.

non 1844 Baculites vagina Forbes; Darwin, p. 216 [= E. carinatus (Morton, 1834)].

1847a Baculites vagina d'Orbigny, pl. 3, figs 3–6.

1850 Baculites vagina Forbes; d'Orbigny, p. 215.

1866 Baculites vagina Forbes; Stoliczka, p. 198 (pars), pl. 91, figs 1–6; non var. oostaciensis, p. 199, pl. 90, figs 14–15.

1895 Baculites vagina Forbes (a) Typische Form; Kossmat, p. 155 (59), pl. 19 (5), fig. 17.

non 1897 Baculites vagina Forbes; Kossmat, pl. 6, fig. 4 [= E. carinatus (Morton, 1834)].

1899 Baculites vagina Forbes; Crick, p. 78, pl. 17, fig. 5.

1907 Baculites vagina Forbes var. caudiformis Paulcke, p. 11, pl. 16, fig. 5a–c.

1907 Baculites vagina Forbes; Boule et al., p. 45 (65), pl. 8 (15), fig. 3.

non 1923 Baculites vagina Forbes; Spengler, p. 54, pl. 4, fig. 9.

non 1924 Baculites cf. vagina var. oostaciensis Stoliczka; Crick, p. 140, pl. 9, figs 4–5 [= E. carinatus (Morton, 1834)].

non 1924 Baculites cf. vagina var. simplex Kossmat; Crick, p. 140, pl. 9, figs 6–7 [= E. carinatus Morton, 1834].

1924 Baculites cf. vagina Forbes; Crick, p. 130, pl. 9, figs 1-3 [= E. carinatus (Morton, 1834) and E. latericarinatus Brunswiecker, 1966].

1925 Baculites vagina Forbes; Diener, p. 63 (pars).
non 1926 Eubaculites vagina (Forbes); Spath, p. 80.
non 1930 Bucalites vagina (Forbes); Wetzeli, p. 90, pl. 10, figs 3-4 [= E. carinatus (Morton, 1834)].
non 1931 Bucalites vagina Forbes; Bouse, p. 20, pl. 2, figs 6-10.
non 1936 Bucalites vagina Forbes var. vanhookeri Venzo, p. 116 (58), pl. 10 (6), figs 11-12 [= Bucalites vanhookeri].
non 1940 Eubaculites vagina (Forbes); Spath, text-fig. 1a [= E. carinatus (Morton, 1834)].
non 1966 Eubaculites vagina (Forbes); Brunnschweiler, p. 29, pl. 1, fig. 7; pl. 2, figs 1-14; text figs 12-14.
1971 Eubaculites vagina Forbes; Collignon, p. 15, pl. 645, fig. 2391.
1977 Bucalites vagina; Kennedy, text-fig. 31. 1-3.
1980 Eubaculites vagina (Forbes); Kennedy and Klinger in Klinger et al., p. 299, text-fig. 5a-c.
1987 Eubaculites vagina (Forbes); Kennedy, p. 194.
1989 Eubaculites; Kennedy, text-fig. 171-i.

Types. Lectotype, here designated, is BMNH C49726, the original of Forbes (1846, pl. 10, fig. 4). GSC RIO488; paralectotypes are BMNH C5140-5150, from the Valudavur Formation of Pondicherry, south India. There are also the following topotypes: BMNH C2582, C77593-77598 (ex Kaye Collection); C2583, C77567-77369; C77590 (ex Marsham Collection); C2597 (ex Forbes Collection); C26299-26300 (ex Spath Collection); C77599-77600.

Dimensions. Wb Wb:Wh Wb Wh Dorsum Venter Rib index
BMNH C51144 7.8 11.8 0.66 4.8 (61-5) 10 (12-8) Smooth
BMNH C51151 11.6 15.7 0.70 6.3 (57-3) 20 (18-2) Smooth
BMNH C51145 21.5 — — 9.1 (—) 4.1 (—) 3
BMNH C51149 15.0 23.6 0.64 10.4 (60-0) 30 (12-7) 3
BMNH C77594 16.5 23.7 0.62 11.5 (71-5) 40 (24-2) Smooth
BMNH C51142 16.0 22.8 0.67 11.8 (68-8) 4.4 (27-5) Smooth
BMNH C51140 16.6 25.8 0.64 10.4 (62-6) 3.2 (19-2) 2
BMNH C51148 19.3 26.7 0.72 16.3 (84-4) 51 (19-1) 25
BMNH C51143 19.2 28.2 0.68 13.2 (66-2) 3.2 (16-2) 2
BMNH C51147 19.0 29.2 0.65 17.0 (89-5) 30 (15-8) 2
BMNH C26300 21.4 30.0 0.71 17.0 (79-4) 3.8 (18-8) 2
BMNH C51141 21.4 30.6 0.69 14.9 (70-6) 3.6 (17-1) 2
BMNH C9762 21.5 32.0 0.67 16.0 (74-4) 54 (16-9) 3
BMNH C51146 — 36.0 — 19.1 (—) 9.2 (—) —
BMNH C77953 26.5 38.8 0.69 19.0 (71-7) 5.5 (20-8) 2
BMNH C51140 32.6 50.0 0.64 24.5 (77-6) 8.7 (27-2) 3

(measurements were taken at the larger end of the specimen; width of dorsum and venter, expressed as a percentage of whorl breadth are shown in parentheses)

Description. The whorls expand quite rapidly, and the shell is slightly curved. The whorl section is compressed, the whorl breadth to height ratio varying between 0.6 and 0.73. The dorsum is broad and flattened, the venter narrow and tabulate, with sharp or narrowly rounded edges. In feebly ornamented varieties the whorl section is the more compressed, dorsal flanks are divergent, the mid-flank region rounded, and the outer flanks convergent. In strongly nodate varieties the whorl section is less compressed, the inner flanks flattened and divergent, with maximum breadth at the mid-lateral tuberole and with flattened to feebly concave ventral flanks in costal section. The venter is distinctly tabulate from as little as 9 mm whorl height, the only smaller specimens seen being poorly preserved, but with a narrowly rounded venter at a whorl height of 8 mm. A wide range of variation in ornament is attributed to the species. At one extreme (Pl. 5, figs 10-13; Pl. 7, figs 4-9, 10-12; Pl. 8, figs 10-12) are variants ornamented by growth lines only. These are sharp on the shell surface (e.g. Pl. 5, fig. 10), but subdued on the mould (Pl. 5, fig. 12). They are broadly convex over dorsum, sweep back across the dorsolateral region, are markedly concave on the dorsal half of the flank, but projected strongly forwards on the ventral half, to intersect the line of the venter at an acute angle. They flex back and are convex over the juncture of flank and venter, passing straight across the venter. Stronger ornament takes the form of broad, ill-defined ribs on the dorsal half of the flanks that strengthen into a feebly mid-lateral node, as in BMNH C2582 and C77567.
In specimens such as BMNH C77994 (PL 7, figs 13–15), ornament is better differentiated, with a rib index of 2–3.5. The ribs are distant, low and transverse on the dorsal half of the flank, and strengthen into a crescentic mid-lateral tubercle, but decline on the outer flank. As ornament strengthens, a second, dorsolateral tubercle develops, a condition well illustrated by the lectotype (PL 7, figs 16–18), with a rib index of 3. As well as this variation between individuals, ornament changes, generally strengthening, as size increases (PL 7, figs 1–3, 13–18; PL 8, figs 1–9). A notch of the tabulate venter may develop (PL 7, fig. 16; PL 8, fig. 3), producing an undulate profile to the shell margin but is of variable development within and between individuals. In coarsely ornamented individuals, the dorsolateral tubercle is markedly elongated parallel to the margin of the shell (e.g., BMNH C26300), and the dorsolateral margin undulate in profile (PL 9, fig. 13); a broad rib links to the lateral tubercle, which varies from crescentic and oblique (BMNH C7795; PL 9, figs 1–2) to elongated parallel to the length of the shell (BMNH CS1141; PL 8, fig. 5). The largest specimen seen (BMNH CS1140; PL 10, figs 1–3) has a whorl height of 49.5 mm, a whorl breadth to height ratio of 9:6, and a rib index of 5. A marked concavity occupies the ventral part of the flanks, and strengthened growth lines – or ribs – link dorsolateral and mid-lateral tubercles, and extend to the ventrolateral margin. One fragment, BMNH CS1146 (PL 9, figs 9–10), shows the aperture, with short dorsal and long ventral rostrum.

Suarae (Text-fig. 1c, f) with very broad E with broad shallow median saddle; E/L narrower, bifid. L broader than E/L and bifid. L/U much broader than other saddles, U of intermediate width. All saddles are broad-based, and lobes E, L and U have wide necks.

**Discussion.** The diagnostic features of the type assemblage of *E. vagina* are the presence of a tabulate venter from an early stage, and binodose ornament on the flanks of a shell that is slightly curved, with a moderately high expansion rate. When compared with other species, these differ as follows:

*Eubaculites carinatus* (Morton, 1834, p. 4, pl. 15, fig. 1; holotype is no. 72866 in the collections of the Academy of Natural Sciences, Philadelphia; Text-fig. 5a–c), originally described from the Maastrichtian Prairie Bluff Chalk of Wilcox County, Alabama, has the tabulate venter of the present species, but a flank ornament of concave ribs only, without tubercles. The name *carinatus* has priority over *Baculites tippaensis* Conrad, 1856 (p. 334, pl. 35, fig. 27) and *B. spilimba* Conrad, 1858 (p. 335, pl. 35, fig. 24), originally described from the Owl Creek Formation of Tippah County, Mississippi; and *Baculites lyelli* d’Orbigny 1847a (pl. 1, figs 3–7), originally described from Chiquitana Island, Chile among others (see Kennedy 1987, p. 195 for an extensive synonymy).

*Eubaculites laevirhynchus* (Morton, 1834, p. 44, pl. 13, fig. 10, synotypes are nos 72868–72869 in the collection of the Academy of Natural Sciences, Philadelphia; Text-fig. 50–k) originally described from the Maastrichtian Prairie Bluff Chalk of Alabama, is known in that region as fragments with whorl heights of up to 17.5 mm. The dorsum is flattened, with a dorsolateral node

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**Explanation of Plate 5**

Figs 1–3. *Indosceptylites pavana* (Forbes, 1846). BMNH CS1092, GSC R10480, holotype, the original of Forbes (1845, pl. 7, fig. 2).

Figs 4–9. *Indosceptylites callidus* (Forbes, 1846). 2, 6, BMNH CS1089, the original of Forbes (1846, pl. 8, fig. 2c). 7–9, BMNH CS1091, paralectotype.

Figs 10–13. *Eubaculites vagina* (Forbes, 1846). BMNH CS1142, a paralectotype; 10, shows the shell surface; 12, the internal mould.

Figs 14–17. *Fresnillia tere* (Forbes, 1846). BMNH CS1152, GSC R10490, holotype, the original of Forbes (1846, pl. 10, fig. 5).

Figs 18–22. *Phylopythochoerus simpus* (Forbes, 1846). 18, BMNH CS1155, 19, BMNH CS1161, a paralectotype; 20, BMNH CS1159, a paralectotype (see also PL 4, fig. 7). 21–22, BMNH CS1159, a paralectotype; 23, BMNH CS1154, GSC R10506, a paralectotype, the original of Forbes (1846, pl. 11, fig. 5b, c). 24, BMNH CS1160, a paralectotype; 25–26, BMNH CS1156, a paralectotype. 27–28, MNHP R982, the holotype of *Hamites constrictus* d’Orbigny, 1847, 29–30, BMNH 24199, a tepolecype. 31–32, BMNH CS1153, GSC R10504, the lectotype, the original of Forbes (1846, pl. 11, fig. 5).

All from the Valadavur Formation, Pondicherry, south India. Figs 1–2, 10–17, 20–23, 25–32, ×1; figs 3–9, 18–19, 24, ×2.
KENNEDY and HENDERSON, Indoscaphites, Eubaculites, Fresvilia, Phylloptychoceras
elongated parallel to the length of the shell, linked by a low broad rib to a similarly elongated but obliquely placed mid-lateral tuberole that gives rise to delicate prorsiradiate riblets and striae, which also intercalate. The rib index is 2. This is similar to the ornament of *E. vagina*, but the venter of *E. labyrinthicus* is fastigate rather than broadly tabulate, immediately differentiating the two species.

*Eubaculites ootacodensis* (Stoliczka, 1866) (= *Baculites vagina* Forbes var. *Ootacodensis* Stoliczka, 1866, p. 199, pl. 90, figs 14, 715) (lectotype, designated by Kennedy 1987, p. 195 in the original of Stoliczka 1866, pl. 90, fig. 14, shown here as Text-fig. 51–59), originally described from Ootacoed, south India, has a binodose lectotype with fastigate venter, which separates it from *E. vagina* (see Kennedy 1987, p. 194 for a synonymy). *E. simplex* (Kossmat, 1895) (= *Baculites vagina* Forbes var. nov. *simplex* Kossmat, p. 156 (60), pl. 19 (5), figs 13–b, nov. 14a–b (= *E. carinatus*) (lectotype, designated by Kennedy 1987, p. 195, is the original of Kossmat 1896, pl. 19 (5), fig. 13; Text-fig. 60–f), from Arriyalur, south India, has a completely smooth lectotype, with a narrowly rounded, fastigate venter, immediately separating it from *E. vagina*. Kennedy (1987, p. 194) thought *simplex* to be a synonym of *E. ootacodensis*, but study of large collections from Western Australia show, rather, that it is the senior synonym of *Eubaculiceris compressus* Brunnschweiler, 1966 (p. 36, pl. 4, figs 15–17; pl. 5, figs 1–3; text-fig. 21), *E. fastigiatum* Brunnschweiler, 1966 (p. 37, pl. 5, figs 7–9; text-fig. 22), *Cardiabites tabulatus* Brunnschweiler, 1966 (p. 38, pl. 5, figs 12–15; text-fig. 23), and
Cardabites seminaturn Brunnschweiler, 1966 (p. 38, pl. 5, figs 16–21; text-fig. 24). The Australian material has both fastigate and narrowly tabulate venters, and feeble undulations on the flank of some specimens. The venter of tabulate variants is always much narrower than in smooth variants of E. vagina.

Eubaculites latelcarinatus (Brunnschweiler, 1966, p. 33, pl. 3, figs 13–14; pl. 4, figs 1–5; text-figs 17–18), of which Girallites quadririncatus Brunnschweiler, 1966 (p. 33, pl. 4, figs 11–14; text-fig. 20) and Eubaculites ambindensis Collignon, 1971 (p. 18, pl. 646, fig. 2393) are synonyms (see revision in Klinger (1976), and Klinger and Kennedy (in Klinger et al. 1980, p. 296, text-figs. 2–4, 5d)), is characterized by a lack of flank ornament and a broad tabulate venter. Lack of ornament alone distinguishes it from ribbed and tuberculate specimens of E. vagina, and large collections of latelcarinatus from Zululand never show significant flank ornament, although the venter may
become notched, so that the species and populations seem distinct enough. More difficult is the distinction between E. latecarinatus and the smooth Eubaculites in the Pondicherry fauna (Pl. 5, figs 10–13; Pl. 7, figs 4–9, 10–12; Pl. 8, figs 10–12; Pl. 9, figs 9–10; see also Stolzcek 1866, pl. 91, fig. 1 (Text-fig. 6a–c, g–i), and pl. 91, fig. 2 (Text-fig. 6j–l; the latter feebly binodose at the larger end), and the question as to whether or not these smooth individuals should be segregated as E. latecarinatus rather than being referred to E. vagina. Some E. latecarinatus at least have a much more compressed whorl section than the smooth Pondicherry forms, which also lack the pronounced corrugated venter of South African specimens (e.g. Klinger and Kennedy in Klinger et al. 1980, fig. 4) and their dorsal grooves and median ridge (Klinger and Kennedy in Klinger et al. 1980, fig. 30). On balance, given the apparent transition from smooth to ribbed and tuberculate individuals in the Pondicherry assemblage (not seen in South African and Australian E. latecarinatus), we treat them as a single species, admitting however, that some smooth individuals of E. vagina are morphologically inseparable from some E. latecarinatus.

Occurrence. Maastrichtian of Pondicherry, south India, and Madagascar. Zululand representatives (Klinger 1976) may be better referred to E. labrynthicus (Morton, 1834).

Genus Fresvillia Kennedy, 1986b, p. 61

Type species. Fresvillia constricata Kennedy, 1986b (p. 62, pl. 14, figs 39–42; text-fig. 10a).

Fresvillia teres (Forbes, 1846)

Plate 5, figs 14–17; Text-fig. 2c

1846 Buculites teres Forbes, p. 115, pl. 10, fig. 5.
1850 Buculites teres Forbes; d’Orbigny, p. 215.
1866 Buculites teres Forbes; Stolzcek, p. 197 (pars), pl. 99, fig. 12 only, non fig. 13 [not a baculitid].
1897 Buculites teres Forbes; Kosmat, p. 64.
1897 Buculites teres Forbes; Speth, p. 16.
1958 Buculites (?) aff. B. teres Forbes; Spath, p. 163, figs 5–6; text-figs 82a–c, 83.
1966 Buculites (?) teres Forbes; Stinneman, p. 204.

Types. The holotype, by monotypy, is BMNH C51152, the original of Forbes (1846, pl. 10, fig. 5), GSC R10490, from the Valadavur Formation of Pondicherry, south India (ex Kaye and Cunliffe Collection). Topotypes are BMNH C2586, and C41304–41305, removed by L. F. Spath from the type series of Phylopychoceras sipho.

Description. The holotype is a fragment 46.5 mm long, septate throughout, and retaining partially exfoliated shell material. The shell is straight, slowly expanding, with a circular whorl section. Ornament is of low, broad ribs. These are weakest on the dorsum, which they cross in a broad convexity. They strengthen on the dorsolateral area, sweep back and are markedly concave across the middle of the flank, sweeping forwards and

EXPLANATION OF PLATE 6

Figs 1–3. Diplomoceras cylindraceum (Defrance, 1816). BMNH C51102.
Figs 4–6. Indoscutifites canaliculifer (Forbes, 1846). BMNH C5109, GSC R10480, lectotype, the original of Forbes (1846, pl. 8, fig. 2a–b).
Figs 7, 8. Hypolocifites’ indicus (Forbes, 1846). BMNH C51093, GSC R10489, the original of Forbes (1846, pl. 8, fig. 9).
All from the Valadavur Formation, Pondicherry, south India. All ×1.
KENNEDY and HENDERSON, Diplomoceras, Indoscaphites, Hoploscaphites?
straight on the ventral flanks, strengthening and crossing the venter in a broad convexity, where they are scale-like, and separated by narrow interspaces. Both ribs and interspaces are ornamented by delicate growth lines and striae, and fine riblets are developed in the outer flank. The course of the ornament thus defines a short, blunt, dorsal rostrum, and a longer, blunt ventral one. Suture (Text-fig. 2c) baculitid, with triangular, moderately incised bifid lobes and saddles.

**Discussion.** F. teres differs from the type species, F. constrictus Kennedy, 19866 (p. 62, pl. 14, figs 39–42; text-fig. 10a) from the Upper Maastrichtian Calcaire à Baculites of Manche, France, which lacks the well-differentiated ribbing of F. teres, and has constrictions. Baculites loides Brunnschweiler, 1966 (p. 23, pl. 1, figs 1–3; text-fig. 8) may be a Frensilina, but the (worn) suture is simple in Brunnschweiler’s figure. It differs from F. teres in having a compressed whorl section and widely separated, narrow ribs; it is perhaps closer to ‘Baculites’ columna’ Morton, 1834 (p. 44, pl. 19, fig. 8), first described from the Maastrichtian Prairie Bluff Chalk of Alabama (see also Stephenson 1941, p. 405, pl. 76, figs 1–4; and Matsumoto 1959b, p. 161, pl. 30, fig. 1; pl. 34, fig. 4; pl. 43, fig. 4; text-figs 80–81), which also has narrow, distant ribs and a much simpler suture than F. teres. So too does ‘Baculites’ venticus’ Stinnerbeck, 1986 (p. 203, pl. 9, fig. 4; pl. 10, figs 3–6; text-fig. 23a–e), where the suture is even more simplified, and more polytychoceratid than baculitid.

**Occurrence.** Maastrichtian of south India and California.

Superfamily Scaphitaceae Gill, 1871, p. 3
[nom. transl. Wright and Wright, 1951, p. 13, ex Scaphitidae Gill]

Family Scaphitidae Gill, 1871, p. 3
[Subfamily Scaphitinae Gill, 1871, p. 3]

**Genus Hoploscaphites** Nowak, 1911, p. 565
[= Merescaphites Arabekian, 1976, p. 523 (nom. nud.)]

**Type species.** Ammonites constrictus J. Sowerby, 1817, p. 189, pl. A, fig. 1, by original designation.

**Hoploscaphites** (?) indicus (Forbes, 1846)

**Plate 6, figs 7–8**

1846 **Ammonites indicus** Forbes, p. 114, pl. 8, fig. 9.

1859 **Ammonites indicus** Forbes; d’Orbigny, p. 213.

1890 **Holococeras indicum** Forbes; Kossnati, p. 35 (142).

1925 **Kossmatoceras indicum** Forbes; Diener, p. 98.

1977 **Hoploscaphites indicum** (Forbes); Phillips, p. 96.

**Type.** Holotype; by monotypy, is BMNH C51093, the original of Forbes (1846, pl. 8, fig. 9), GSC R10489, from the Valadavwar Formation of Pondicherry, south India (ex Kaye and Cudilli Collection).

**Description.** The holotype is a body chamber fragment 52 mm long, with traces of a spar-filled nucleus preserved in the dorsal impressed zone. Coiling appears to have been moderately involute, with the whorls in

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**EXPLANATION OF PLATE 7**

Figs 1–18, *Baculites saginatus* (Forbes, 1846), 1–3, BMNH C77569, 4–6, BMNH C51144, a paralectotype, 7–9, BMNH C77568, 10–12, BMNH C75369, 13–15, BMNH C77594, 16–18, BMNH C49762, GSC R10488, the lectotype, the original of Forbes (1846, pl. 10, fig. 4).

All specimens from the Valadavwar Formation, Pondicherry, south India. All ×1.
contact, although the body chamber itself has what might be interpreted as an eccentric umbilical seam. The whorl section is depressed, with a rounded-rectangular cross section, the whorl breadth to height ratio 2:24, the greatest breadth at mid-flank. The umbilicus is deep, with a rounded wall merging with a broadly rounded umbilical shoulder. The flanks are flattened, the ventrolateral shoulders broadly rounded, and the broad venter flattened. Ornament consists of fine, sharp ribs, narrower than the interspaces. Most ribs arise at the umbilical seam, are initially weak, but strengthen to the umbilical shoulder, where a few bifurcate, and at least one bears a tiny tubercle. The ribs are variably prosiradial on the flank, and there are rare bifurcations and intercalations low on the flank. Groups of three or four ribs converge on, and are linked at horn-like ventral clavi (of which only two survive on the fragment), with about five nontuberculate ribs between the clavi. This bunching of ribs at clavi produces marked irregularities in rib spacing on the outermost flanks and ventrolateral shoulder. The ventral clavi are linked across the venter by four or five looped ribs, the adapical ones being concave, the adapertural ones being convex on the shoulders, before passing straight across the venter. They occasionally bifurcate, and show minor irregularities where they approach the ventral tubercles.

Little can be made of the fragmentary inner whorl, other than the outline of a tangential section. This suggests rather more compressed phragmocone whorls, with similar ribs to the body chamber and ventral tubercles. No trace of the suture survives.

Discussion. The fragmentary holotype, with its fine, sharp, looped ribs and depressed whorl section stands apart from the other scaphitids in the Pondicherry fauna. In general style, the ornament is closest to certain late Campanian Hoploscaphites which, although much older, have the same basic style of ribs and tubercles, as in Hoploscaphites ikosfatesis Birkelund, 1965 (p. 102, pl. 24, figs 1-4; pl. 25, figs 1-2; pl. 26, fig. 1; text-figs 59, 93, 121, 3), or various forms illustrated by Schüller (1871, pl. 27, figs 5-7). However, the depressed whorls and very distant nodes of H. indicus distinguish it from all of these.

Occurrence. As for type.

Genus Indoscaphites Spath, 1953, p. 14

Type species. Ammonites cunliffei Forbes, 1846, p. 109, pl. 8, fig. 2, by original designation.

Indoscaphites cunliffei (Forbes, 1846)

Plate 5, figs. 2, 6-9; Plate 6, figs 4-6; Text-fig. 2a

1846 Ammonites Cunliffei, p. 109, pl. 8, fig. 2.
1850 Ammonites Cunliffei Forbes; d’Orbigny, p. 213.
1865 Ammonites Cunliffei Forbes; Stoliczka, p. 97, pl. 50, fig. 3.
1898 Scaphites Cunliffei Forbes sp.; Kossmat, p. 31 (138).
1907 Scaphites Cunliffei Forbes; Periniquaque, p. 124 (pars), pl. 4, figs 36-40, non figs 41-42
[= I. pavana]; figs A-C on the explanation of pl. 4; text-figs 42-44, non text-fig. 45
[= I. pavana].
1911 Acanthiscaphites Cunliffei Forbes; Nowak, p. 565.
1916 Hoploscaphites Cunliffei; Nowak, p. 66.
1925 Acanthiscaphites Cunliffei Forbes; Diener, p. 205.
non 1921 Scaphites Cunliffei Forbes sp., Van Hoepen, p. 28, pl. 5, figs 5-7.
1953 Indoscaphites cunliffei (Forbes); Spath, p. 14.
1977 Indoscaphites cunliffei; Kennedy, text-fig. 31.7-8.
1977 Indoscaphites cunliffei (Forbes); Phillips, p. 99.
1989 Indoscaphites; Kennedy, text-fig. 17e.

EXPLANATION OF PLATE 8

Figs 1-12. Eubaculites vagina (Forbes, 1846), 1-3, BMNH CS1149, a paratype; 4-6, BMNH CS1141, a paralectotype; 7-9, BMNH C1297, 10-12, BMNH CS1145, a paralectotype. All from the Valladraur Formation, Pondicherry, south India. All ×1.
Types. Lectotype, here designated, is BMNH C51090, the original of Forbes (1846, pl. 8, fig. 2a-b, d-i, GSC R10477. Paralectotypes are BMNH C51089, the original of Forbes (1846, pl. 8, fig. 2c), GSC R10478, and BMNH C51091, all from the Vadamavir Formation of Pondicherry, south India (ex Kaye and Cunliffe Collection).

Dimensions. D Wb Wh Wh:Wh U
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<tr>
<td>BMNH C51090</td>
<td>05 (100)</td>
<td>12-2 (34-9)</td>
<td>12-9 (36-9)</td>
<td>0-95</td>
</tr>
<tr>
<td>at c</td>
<td>23-8 (100)</td>
<td>90 (37-8)</td>
<td>11-4 (47-9)</td>
<td>0-79</td>
</tr>
<tr>
<td>BMNH C51091</td>
<td>10-2 (100)</td>
<td>61 (59-8)</td>
<td>4-3 (42-1)</td>
<td>1-41</td>
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Description. The lectotype is a complete adult, the paralectotypes are juveniles. All retain traces of original shell material. The early growth stages are moderately involute, with a rounded whorl section and faint constrictions, plus an ornament of low, irregular ribs and growth striae only. By a diameter of 6.5 mm, the distinctive ornament of the species has appeared. This consists of weak, distant umbilical bulke (six or seven per half whorl at a diameter of 10.5 mm in BMNH C51089) connected by low, rounded, straight to feebly concave prorsiradiate ribs to stronger conical ventrolateral horns, the ribs broadening as they cross the flanks. The ventrolateral horns are linked across the venter by a low, broad convex rib or ribs, while there are low, variable and irregular intercalated ribs, growth lines and grooves between tuberculate groups; some ribs show a trace of an outer ventrolateral node. By this ontogenetic stage the whorl section has become progressively more compressed, the sides flattened, with greatest breadth at the umbilical tubercle, the venter very broad and rounded. The somewhat larger paralectotype, BMNH C51089 (Pl. 5, figs 7–9) shows a comparable ornament at a maximum preserved diameter of 15 mm, although there are low intercalated ribs extending to mid-flank, and distinct looping of ventral ribs and striae between the ventrolateral tubercles.

The lectotype (Pl. 6, figs 4–6) is septate to a diameter of approximately 21 mm, with two-thirds of a whorl of body chamber. The ornament of the phragmocone is as described above. The body chamber shows markedly eccentric, scaphitoid coiling, although the whorls remain in contact. The umbilical seam becomes distinctly undercut, with a sharp umbilical shoulder. The umbilical bulate become sharper and more pronounced and are progressively deflected forwards as size increases. The broad, simple ribs of the phragmocone give way to groups of much finer, sharper, irregularly developed strongly flexed prorsiradiate ribs and striae which occasionally bifurcate around mid-flank where intercalatories are inserted. They link in groups to the ventral tubercles, which are irregularly developed and disappear before the adult aperture is reached. The ribs are convex across the venter and variably developed, both linking tubercles and intercalating.

On the last sixth of a whorl before the aperture, beyond the last ventral tubercle, the ventral and ventrolateral ribbing strengthens markedly, with many ribs branching. The aperture itself is simple and entire.

The suture line (Text-fig. 2a) is relatively simple, with asymmetrically bifid E/L and L/U; L is deep and asymmetrically trid. Here the umbilical chamber shows a distinct umbilical shoulder, the umbilical chamber becomes much deeper, and the umbilical chamber is much more pronounced and is progressively deflected forwards as size increases. The broad, simple ribs of the phragmocone give way to groups of much finer, sharper, irregularly developed strongly flexed prorsiradiate ribs and striae which occasionally bifurcate around mid-flank where intercalatories are inserted. They link in groups to the ventral tubercles, which are irregularly developed and disappear before the adult aperture is reached. The ribs are convex across the venter and variably developed, both linking tubercles and intercalating.

On the last sixth of a whorl before the aperture, beyond the last ventral tubercle, the ventral and ventrolateral ribbing strengthens markedly, with many ribs branching. The aperture itself is simple and entire.

The suture line (Text-fig. 2a) is relatively simple, with asymmetrically bifid E/L and L/U; L is deep and asymmetrically trid.

Discussion. The coarseness of flank ribs and development of strong ventrolateral horns immediately distinguishes this species from _I. producta_ (Forbes, 1846), discussed further below. Spath (1953, p. 14) thought there were morphological transitions between _Indoscaphites_ and _Hoploscaphites_ of the _quadrangularis_ group, but these are a much larger US Western Interior scaphitid stock, referred to _Jeletskytes_ Ricardi, 1983, and bear no resemblance to the present form.

Occurrence. Maastrichtian, south India and Tunisia.

Explanation of Plate 9

Figs 1–13. _Eubaculites vagina_ (Forbes, 1846). 1–2, BMNH C7759, 3–5, BMNH C77597, 6–8, BMNH C73567, 9–10, BMNH C51146, a paralectotype. 11–13, BMNH C77292. All from the Vadamavir Formation, Pondicherry, south India. All ×1.
Indoschopitites pavana (Forbes, 1846)

Plate 5, figs 1, 3-5

1846 Ammonites Pavana Forbes, p. 110, pl. 7, fig. 5.
1850 Ammonites Cunfilej Forbes; d’Orbigny, p. 213.
1865 Ammonites Pavana Forbes; Stoliczka, pp. 90, 98.
1898 Schopitites Pavana Forbes sp.; Kosmat, p. 31 (138).
1907 Schopitites Cunfilej Forbes; Pervinquié, p. 124 (pars), pl. 4, figs 41-42 only; text-fig. 45 only.
1953 Indoschopitites pavana (Forbes); Spath, p. 14.
1977 Indoschopitites pavana (Forbes); Phillips, p. 100.

Type. Holotype, by monotypy, is BMNH C51092, the original of Forbes 1846 (p. 110, pl. 7, fig. 5), GSC RB0480, from the Valdavvar Formation of Pooncherry, South India (ex Kaye and Culiffe Collection).

Description. The holotype is only 12 mm in diameter, with half a whorl of body chamber, and retains much of the original shell material. Coiling is moderately involute, ammonitic rather than scaphoid. The earliest whorls visible are compressed and rounded, but as diameter increases they become even more compressed and flat-sided. Ornament is present from the smallest diameters visible. It consists of approximately sixteen low, broad, flexuous, prorsisradiate primary ribs on the outer whorl. Initially simple, they branch on the inner flank as size increases, and are accompanied by similarly flexuous growth striae. At the largest diameters preserved, these are almost falcoid; feebly concave and prorsisradiate on the inner flank, convex at mid-flank, and concave on the ventrolateral shoulder, where they bear small ventral clavi. The clavi are connected across the venter by a low convex rib or ribs, striae and growth lines, which also occur between ribs. The suture, which is imperfectly exposed, is little inclined, and not of Indoschopitites type.

Discussion. The holotype of Indoschopitites pavana is easily separated from Indoschopitites culfilejii of similar size (Pl. 5, figs 2, 6-9), where the whorl section is broader, tubercles stronger, and ribs distant and straight, rather than crowded and flexuous. The style of ventral ornament is of the same basic type, as in the coiling, and the two species are certainly congeneric. Some authors (e.g. Pervinquié 1907) have regarded them as conspecific, but we have studied all the available specimens, including those from Tunisia; there are no intermediate forms.

Occurrence. Maastrichtian of southern India and Tunisia.

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EXPLANATION OF PLATE 10

Figs 1-3. Eubaculites sagina (Forbes, 1846). BMNH C51140, a paralectotype; Valdavvar Formation; Pondicherry, south India, ×1.
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