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A NEW LATE TITHONIAN AMMONITE ASSEMBLAGE FROM KUTCH, WESTERN INDIA

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ABSTRACT

Kutch was previously believed to be impoverished in the Late Jurassic ammonite diversity. Recent intensive sampling yielded several new records of genera of different taxonomic affinities. Results of this research are presented here, based on the description of *Corongoceras* cf. *lotenoense* , *C.* sp. A; *Himalayites sp.*; *Durangites* cf. *heilprini*, *D.* sp. A and *D.* sp. B; *Tithopeltoceras lakhaparense, Blanfordiceras* sp. A and *Pterolytoceras sutile*. Additionally, we also present a systematic revision of *Micracanthoceras* Spath,1925, *Aulacosphinctes* Uhlig, 1910 and *Umiaites* Spath, 1931. All previously described Kutch species of *Micracanthoceras* have been found to belong to the type species, *M. micrcanthus. Umiaites*. Previously known as endemic only to Kutch, it appears to be the macroconch of the better known *Proniceras* Burckhardt, 1919.

Kutch thus, appears to be taxonomically more diverse than previously assumed during the Late Tithonian

Keywords: Late Jurassic, Tithonian, Ammonite, Kutch, Palaeobiogeography

INTRODUCTION

The Jurassic-Cretaceous transition witnessed major sea-level changes and ammonite turnovers. Ammonite endemism reached its peak during the latest Jurassic, which made interprovincial biostratigraphic correlation difficult. Any new ammonite assemblage described may be important in understanding the Late Tithonian marine scenario. Study of the diversity and biogeographic distribution of the Late Tithonian ammonites is also important because many of them became extinct at the Jurassic-Creataceous boundary (for details see Bardhan *et al.*, 2007), which marks arguably a mass extinction event (Raup and Sepkoski, 1986, but for opposite view see Hallam, 1986; Hallam and Wignall, 1997). Systematic revision and palaeobiogeographical studies of the Late Tithonian ammonites of different provinces have recently been carried out (Fatmi, 1972; Leanza and Olóriz, 1987; Riccardi, 1991; Enay and Cariou, 1997; Cecca, 1999; Olóriz *et al.*, 2000; Yin and Enay, 2004). During the Late Jurassic, major continental shelves of the world experienced fluctuating sea levels (Hallam, 1984) and many marine platforms and basins including Kutch were punctuated by sharp regressive phases (Haq *et al.*, 1987). These local transgressive-regressive couplets were controlled by tectonics. Thus, when India, during the Late Jurassic experienced steep fall in sea level due to regression coupled with the regional tectonics (Biswas, 1991), in Madagascar open marine conditions predominated as suggested by the more complete ammonite sequences (Collignon, 1960; Cecca, 1999). Many of the Tithonian faunal provinces show marked endemism (Cecca, 1999). During eustatic high stands, increased faunal exchanges help in global biostratigraphic correlation (Riccardi, 1991). A latest Tithonian global flooding (Haq *et al.*, 1988; Bardhan *et al.*, 1989) enabled many ammonites to achieve near circum-global distributions.

The present paper considers ammonites of several time-diagnostic genera of the latest Tithonian sampled from a single bed, which were hitherto unknown from the Kutch basin. Their description will be useful for biostratigraphic correlation of the Kutch Tithonian faunal assemblage and biogeographic analysis. They are *Durangites* Burckhardt, 1912; *Corongoceras* Spath, 1925; *Himalayites* Uhlig, 1910; *Tithopeltoceras* Arkell, 1953 belonging to the subfamily Himalayaitinae and *Blanfordiceras* Cossman, 1907 of the Berriasellinae and *Pterolytoceras* Spath, 1927 of the Lytoceratinae. *Durangites* is represented by *D.* cf. *heilprini* Tavera, 1985, *D.* sp. A. and *D.* sp. B; *Corongoceras* by *C.* cf. *lotenoense* Haupt, 1907 and *C.* sp. A; *Himalayites* by *H.* sp.; *Tithopeltoceras* by an endemic *T. lakhaparense* (Shome, Bardhan and De, 2005). *Blanfordiceras* sp. A a fragmentary specimen. Thus it appears that some of the species are endemic into the Indo-Madagascan Province while others have wide biogeographic distribution.

Most previously described species by Spath (1927-33) lack adequate stratigraphic information. We have surveyed all known geological sections that yield Tithonian horizons. Our results indicate that *Micracanthoceras*, *Aulacosphinctes* and *Umiaites* Spath, 1931 have locally long stratigraphic ranges and older collections were made only from the lower assemblage, in association with *Virgatosphinctes* gr. *denseplicatus*. These genera range up into the latest Tithonian, which locally consists of a condensed horizon.

Pterolytoceras Spath, 1927 belongs to the leiostracans, which are believed to be oceanic and cosmopolitan (Westermann, 1990). However, *Pterolytoceras* could have been endemic into the Indo-Madagascan Province (Shome and Roy, 2006).

STRATIGRAPHIC FRAMEWORK

Kutch is famous over the world for its Jurassic ammonites, especially of the Bathonian-Callovian interval. The marine beds of Kutch range in age from the Bajocian to Aptian and were deposited in a shallow shelf environment (Biswas, 1977; Fürsich and Oschmann, 1993). The Mesozoic rocks were first described by Wynne (1872). Waagen (1875) subdivided these rocks into four divisions, viz. Patcham, Chari, Katrol and Umia in ascending order. Subsequent stratigraphic revisions have been made by Rajnath (1932) and Mitra *et al.* (1979). The first three units of Waagen (1875) survived as rock-stratigraphic units and 'Umia' has been relegated to a member within the Bhuj Formation (Fig. 1). The major, comprehensive accounts of Jurassic ammonites of Kutch were given by Waagen (1875) and Spath (1927-33); later, several workers described many new taxa and partially updated the previous ones with a more or less precise stratigraphic control and new data are continuously pouring in.

The Late Tithonian ammonites belong to the Umia Member of the Bhuj Formation which has a limited outcrop only in western Kutch (Fig. 2). The Umia member, whose base is not exposed, underlies the Katesar Member. It is characterised by repetitive cycles of a heterolithic facies dominated by coarse siliciclastic sediments; occasional oolitic sandstone bands with thin layers of mudstone alternate with sharp-based, laterally discontinuous, and hummocky cross-stratified sheet sandstone. The organization of the sedimentary facies has been interpreted as the product of several transgression-regression couplets (Bose *et al.*, 1988). *Micracanthoceras*, *Aulacosphinctes* and *Umiaites* along with *Virgatosphinctes* gr. *denseplicatus* first appear in a very coarse-grained sandstone bed. The bed is also characterized by the presence of abundant oyster shells locally known as the Gryphaea Bed. In the upper part where alternation of oolitic sandstones and shales overly the Gryphaea Bed, the underlying ammonite taxa still continue. Four bands of oolitic sandstone have been recognized locally and ammonites are present in all except the topmost one. However, Krishna (1991) reported Lower Cretaceous *Argentiniceras* from the topmost oolitic horizon. The second band from the top is characterized by the presence of a different ammonite assemblage described below and composed by *Tithopeltoceras, Durangites, Blanfordiceras*, and *Corongoceras* (Fig. 3). All Tithonian ammonites, including both endemic and cosmopolitan genera, disappeared at this level within the second oolitic horizon (Fig. 3). Bardhan *et al.* (1989, 2007) described this fact as a regional mass mortality correlated with a Jurassic-Cretaceous extinction event.

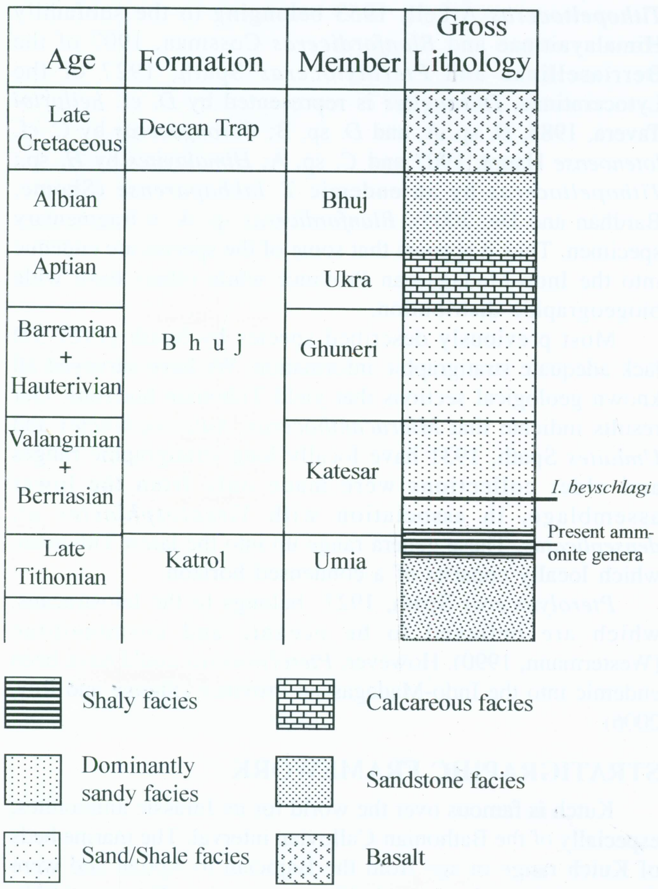

Fig. 1. General stratigraphic succession of the Late Tithonian to Late Cretaceous part of Kutch, India (vertical thickness not to scale) with indication of the stratigraphic position of the ammonite assemblage described in the present paper.

SYSTEMATIC PALAEONTOLOGY

All materials described here have been collected from a single locality (2 Km north-east of Lakhapar, see Fig. 2) and a stratigraphic horizon (second oolitic band from top, see Fig. 3). Most of the species are represented by fragmentary material, measurements are included in respective descriptions. (D = Shell diameter; U = Umbilical diameter; W = Whorl width and H = Whorl height). Materials are reposited in the Jadavpur University Museum (JUM), Department of Geological Sciences, Kolkata, India. Type specimens refigured are stored in Central Fossil Repository, Geological Survey of India, Kolkata.

Superfamily **Perisphinctoidea** Steinmann, in Steinmann and Doderlein, 1890

Family **Berriasellidae** Spath, 1922

Subfamily **Himalayitinae** Spath, 1925

Callomon (in Donovan *et al.*, 1981) suggested sexual dimorphism between *Micracanthoceras* (M) and *Aulacosphinctes* (m), and *Protacanthodiscus* (M) Spath, 1923 and *Durangites* (m). Recently, Parent (2001) has described dimorphism within *Corongoceras*. In all these genera macroconchs are larger with strong tubercles while microconchs are smaller in size with biplicate ribs having weak or no tubercles at the furcation point, and have prominent ventral furrow. Microconchs thus resemble inner whorls of macroconchs.

Genus ***Corongoceras*** Spath, 1925

Type species: ***Corongoceras lotenoense***, pro *Ammonites köllikeri* Oppel, 1863 (in Haupt, 1907)

Corongoceras cf. *lotenoense* (Spath, 1925) [M]

(Pl. I, figs. a-d)

Hoplites köllickeri Haupt (*non* Oppel), 1907, p. 201, Pl. 9, Figs. 7a-e.

Corongoceras lotenoense Spath, 1925, p.144.

Berriasella (*Corongoceras*) *lotenoensis* Spath – Krantz, 1926, p. 444 (= 1928, transl., p. 28)

Berriasella cf. *koellickeri* (Oppel) Steuer – Weaver, 1931, p.444.

Corongoceras lotenoense Spath var. *fortior* Collignon, 1960, Pl.167, Fig. 687.

Corongoceras cf. *lotenoense* Spath – Helmstaedt, 1969, p. 78.

Corongoceras lotenoense Spath – Leanza, 1980, p. 45, Pl. 6, Fig. 6a, b.

Micracanthoceras (*Corongoceras*) *lotenoense* Spath – Tavera, 1985, p. 176, Pl. 23, Figs 11-13.

Material: Four fragmentary specimens (JUM/L/C/1 to 4). JUM/L/C/1 includes partially preserved adult body chamber and test.

Description: Body chamber partially preserved, large, maximum reconstructed diameter c.110 mm, adult phragmocone diameter about 90 mm. Shell highly evolute (U/D = 0.47), flanks

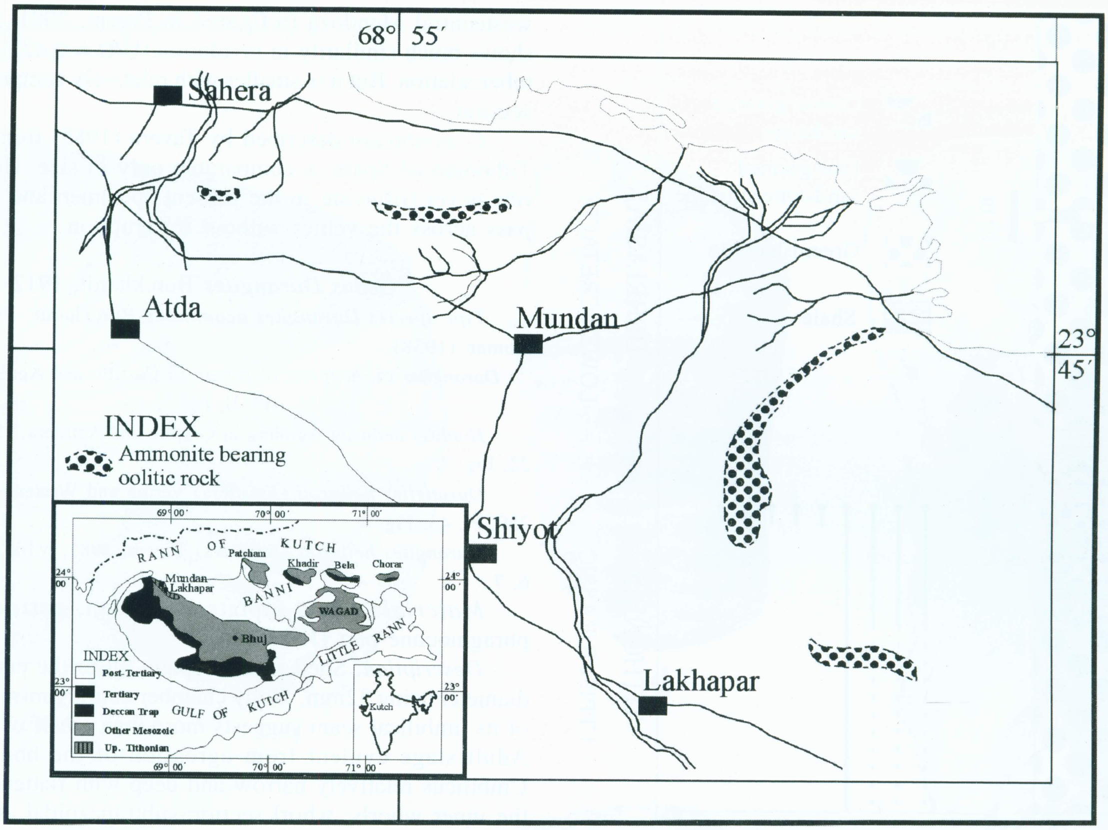

Fig. 2 Locality map showing the studied Tithonian outcrops of northwestern Kutch.

flattened in phragmocone, gently curved in adult body chamber. Whorl depressed in early stage (W/H = 1.6 at 9 mm diameter), compressed (W/H = 0.73) at middle growth stage at 67 mm diameter and at adult phragmocone it is squarish (W/H = 1.07 at 88 mm). Shell strongly and coarsely ornamented. Ribs relatively fine and dense in inner whorls and sharply crested. Primaries rise from the umbilical wall rursiradiately, after crossing the umbilical margin they move rectiradiately and bifurcate on the outer flank. Secondaries are straight, slightly forwardly projected, passing the venter uninterruptedly at least at later stage. Venter broad, gently curved with a broad, shallow sulcus. Two rows of tubercles; one at the furcation point and the other near the mid-ventral sulcus which become stronger at the beginning of body chamber. Outer lateral tubercles remain always stronger than the mid-ventral tubercle. Suture not visible.

Discussion: The present species closely resembles *C. lotenoense*, described from many areas. The main similarity lies in the degree of evolution, being strongly evolute; whorl section being squarish in later stage and the nature of ornamentation. However, the type species shows intraspecific variation with respect to the density of primary ribbing, in the type specimen number of ribs at 20mm diameter is 13. In Spain, density varies with ontogeny, primary ribs are 12 and 14 at 12 mm and 22 mm respectively (see Tavera, 1985, pl. 23, fig. 13a). In one of the present specimen, ribs are 18 at nearly 25 at c.70 mm diameter. The holotype reported from the Upper Tithonian of Cerro Loteno, Argentina is a small septate one (see Parent, 2001, fig.9 a, b) and therefore cannot be compared for adult features. But the specimens described from elsewhere (see Parent, 2001, fig. 9c; Leanza, 1980, pl. 6, fig. 6 a, b) contain partially preserved adult body chamber. In both cases ornamentation is stronger with robust outer lateral tubercles, a feature that also characterize the present specimens. We emphasize that this may be the diagnostic character of the type species. The so far largest specimen of *C. lotenoense* has been described from Neuquen, Argentina (Leanza, 1980, pl. 6, fig. 6a, b). It includes partially preserved body whorl and having a diameter of 54 mm. It may appear that present specimens are macroconchs of same species. Recently Parent (2001) described dimorphism in *Corongoceras* as *C.* cf. *alternans* [M]. The specimens are fragmentary body whorls and lack the characteristic bifurcating ribbing with tubercles at the point of furcation which are present in the type specimen of Gerth (1925) and now reproduce in Parent (2001, fig. 9 D & E).

The type specimen of *C. lotenoense* is also a macroconch according to Parent (2001) and it differs from the present species in having smaller diameter, less denser inner ribs and prorsiradiately projected secondaries.

Corongoceras sp. A

(Pl. I, fig. e; Pl. II, figs. a–b)

Material: A fragmentary adult phragmocone (JUM/L/C/5) as internal mould.

Description: Shell large, preserved phragmocone diameter is 123 mm. Trace of umbilical seam of the outer whorl suggests the specimen had at least one more complete whorl. Shell evolute (U/D = 0.46). Flanks rounded; venter wide and broadly curved. Both umbilical and ventrolateral margin rounded, whorl section subtrapezoidal with maximum width on the outer flank. Shell strongly ornate with long primaries, which are sharply crested even on internal mould. Primaries are adorally concave, bifurcate at the ventrolateral margin. Secondaries having almost equal strength, straight or slightly forwardly projected and going over the venter uninterruptedly. Two rows of tubercles

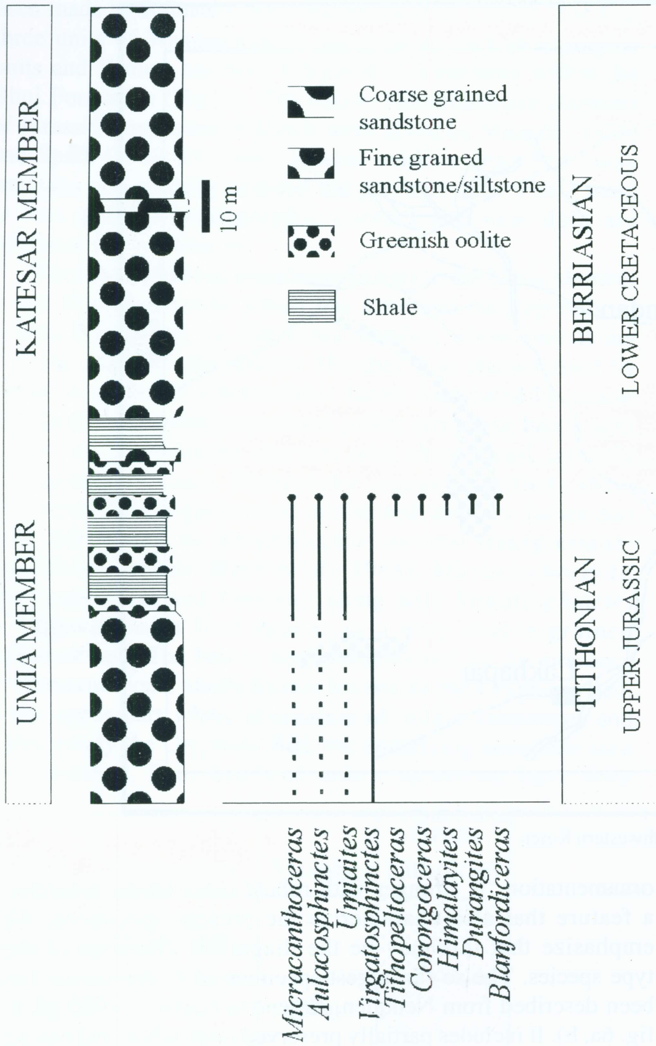

Fig. 3 Studied stratigraphic section showing the distribution of the Late Tithonian ammonites in Kutch (modified after Bardhan *et al.*, 2007).

develop which are equally strong, blunt and spheroidal in nature. One row is situated at the point of furcation and the other near the mid-venter. Mid-venter is marked by a shallow sulcus where secondaries tend to weak. Primaries and secondaries are widely spaced, 14 and 26 respectively per half-whorl, show increasing strength during ontogeny at least in the preserved whorl.

Discussion: The present species is comparable with the macroconch of *C.* cf. *lotenoense*, described here. *C. lotenoense*, however, is larger, having subtrapizoidal whorl section.

Parent (2001, fig. 8K, L) described *C.*cf. *alternans* from the "Upper Tithonian" of Argentina based on two fragmentary body chambers, which are also large and strongly ribbed as our specimens, but they lack lateral tubercles on the point of furcation and having sub-ovate whorl section. The holotype of *C. alternans* described by Gerth (1925) from Arroyo Durazno, westcentral Mendoza (refigured in Parent, 2001, fig. 9 D-E) shows much similarity in involution (U/D = 0.42), ribbing and tuberculation. But it is smaller with relatively compressed whorl section.

C. symbolum described by Tavera (1985) from the Upper Tithonian of Spain is comparable only in size. However, the ribs never trifurcate in the present specimen and secondaries pass across the venter without interruption.

Genus ***Durangites*** Burckhardt, 1912

Type species ***Durangites acanthicus*** Burckhardt, 1912 by SD of Roman (1938)

Durangites cf. *heilprini* (Aguilera in Castillo and Aguilera 1895)
(Pl. II, figs. c-e)

Hoplites heilprini Aguilera in Castillo and Aguilera, 1895, p. 41, Pl. 22, Fig. 7.

Durangites heilprini (Aguilera) Verma and Westermann, 1973, p. 259, Pl. 43, Fig. 4.

Durangites heilprini (Aguilera) Tavera, 1985, p.164, Pl. 18, Figs. 6, 7.

Material: Adult septate specimen, corroded in late phragmocone part (JUM/L/D/1)

Description: Shell small, septate till to the end, preserved diameter being 32mm. Body chamber entirely missing but trace of its umbilical seam suggests more than a half of whorl long. Adult stage evident from egression of the body chamber. Umbilicus relatively narrow and deep with flattened flanks in the inner whorls; whorl section subtrapezoidal at the end of phragmocone. Umbilical and ventrolateral margins gently rounded. Umbilical wall gradually becomes steeper during ontogeny. Ribbing dense (21 primaries and 28 secondaries per half-whorl), sharply crested. Primaries relatively long, furcating high at the outer flank, more or less rectiradiate. Secondaries mostly bifurcating, include intercalatories, which go straight towards the venter in early whorls, but at late phragmocone stage they are slightly flexuous. Secondaries are interrupted at mid-venter in early stage, but are continuous across the venter in late ontogeny. Minute, elongated tubercles may appear on the secondaries near the mid-venter. Venter relatively broad, rounded and sulcate. Suture is not visible.

Discussion: The holotype of the species comes from the Upper Tithonian of Mexico (Castillo and Aguilera, 1895). Verma and Westermann (1973) also described additional specimens from Mexico. The species was later reported from Spain (Tavera, 1985). The species has a characteristic involute shell, rapidly expanding whorl section and dense finer ribbing by which the present identification is well supported. Verma and Westermann (1973) distinguished *D. heiprini* from other Mexican species by its "dense prorsiradiate ribbing, regular ventrolateral tubercles, and abundance of simple ribs". Moreover, tubercles on the secondaries are present near the mid-ventral sulcus and not on ventrolateral margin as they mentioned, and ribs are interrupted near the ventral sulcus in holotype (see Verma and Westermann, 1973; pl. 43, fig. 4 a-c) as well as their specimen (e. g. Pl.56, fig. 5 a, b). Tavera (1985) described many

EXPLANATION OF PLATE I

Figs.a d. ***Corongoceras*** cf. ***lotenoense*** (Spath) [M].

a b, adult with incomplete body chamber, lateral (a), apertural (b) views, JUM/L/C/1.

c d, Broken phragmocone, lateral (c), ventral (d) views, JUM/L/C/2.

e. ***Corongoceras*** sp. A, phragmocone, lateral view, JUM/L/C/5. All X1, bar line represents 2 cm.

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Plate I

species from the same horizon and locality in Spain from where *D. heilprini* also has been reported. *D. heilprini* is distinguished from all other species by its small umbilicus, and somewhat flexuous ribbing.

Durangites sp. A
(Pl. II, figs. f-j)

Material: A single specimen with incomplete body chamber, (JUM/L/D/2).

Description: Shell large, diameter is 63 mm, phragmocone diameter 50 mm and evolute (U/D = 0.42). Whorl overlapping increases during ontogeny – barely in touch in inner whorls, but embracing one-fourth of the preceeding whorl in later stage. Innermost whorl depressed (W/H = 1.31 at diameter 8 mm) and maximum width of the whorl lies towards the outerflank, subsequently shell becomes squarish (W/H = 1 at diameter 16 mm), compressed (W/H = 0.98 at diameter 38 mm) and finally subcircular to ovate. Inner whorls have flattened flanks, which become gradually curved during ontogeny and maximum width at the later part shifted towards the inner flank below the mid-whorl height. Umbilical margin gradual with inclined wall. Coarse ornamentation, but initially may be smooth at least seen in the venter of the nucleus whorl at diameter 4 mm. Primary ribs long, rising from the umbilical wall slightly rursiradiately and then go straight up to the outer whorl where they split into two secondaries. Simple ribs alternate with bifurcating ribs seen at least in the last quarter of the preserved phragmocone. Secondaries slightly curved forward and continue over the ventrolateral margin up to the mid-ventral region where they become interrupted in early ontogeny or become subcontinuous in later stage. Mid-ventral sulcus is prominent, smooth and tabulate in early ontogeny becomes progressively shallow and indistinct. Elongated bullae-like tubercles appear on the secondaries near the sulcus. Number of primaries and secondaries per half-whorl are 23 and 37 respectively.

Discussion: *Durangites* sp. A is larger than *D.* cf. *heilprini* described above. Besides, it has a wide umbilicus and lacks flexuous ornamentation. Tavera (1985) described *D. apertus* (pl. 18, figs. 14, 15) which is similar in size and involution. In both species flanks are curved and possess long rectiradiate primaries. However, in *D. apertus*, venter bears prominent tubercles on body chamber which are more conspicuous in early stage of the present species.

Durangites sp. B
(Pl. III, figs. a-c)

Material: A single specimen, adult, nearly complete (JUM/L/D/3).

Description: Shell almost complete, 85mm in diameter, and body chamber is three-fourths whorl long. Strongly evolute (U/D = 0.44), perisphinctoid coiling and compressed (W/H = 0.70). Whorl section sub-elliptical, maximum width lies near the umbilical margin. Flank flattish to curved. Ventre broad and flattened. Sharp, densely spaced straight ribs divide on the upper middle part of the flank and form sharp edges at the ventrolateral margin. Ribs interrupted on mid-venter by a prominent sulcus. Small elongated bullae-like tubercles appear on the ribs near the sulcus at the early growth stage, but at later stage ribs go across the flattened venter.

Discussion. It is similar with *D.heilprini* in the fine and dense ribbing, but present species is larger, more evolute and lacks flexuos adult ribbing. *D.* sp. A is also large and has similar ribbing pattern, but *D.* sp. B is more compressed, relatively widely sulcate and has perisphinctoid coiling.

The only specimen of the present species may resemble similar sized species of *Andalusphinctes* or *Moravisphinctes* of Tavera (1985) in degree of involution , inflation and dense ribbing in inner whorls (Enay, pers. Com., 2008). Closer study, however, reveals the similarities are superficial. Both *Andalusphinctes* and *Moravisphinctes* have diagnostic characters like polygirate ribbing and constricted whorls (see Tavera, 1985) which are lacking in the present species. Moreover, the prominent mid-ventral sulcus of the present species is flanked by feeble tubercles which is a generic character of *Durangites* not found in species of the two former genera.

Genus ***Tithopeltoceras*** Arkell, 1953

Type species ***Aspidoceras moriconii*** Meneghini 1885; by OD

Tithopeltoceras lakhaparense Shome, Bardhan and De

Tithopeltoceras lakhaparensis, Shome, Bardhan and De, 2005, p. 620, fig. 1.

(Pl. III, figs. d-f)

Remarks: Largest species in the genus represented by its holotype only (for detailed description, see Shome *et al.*, 2005). *Tithopeltoceras* has been previously described from the region 30° North of the palaeoequator in the Mediterranean Province (Arkell, 1956; Arkell *et al.*, 1957). Stratigraphic distribution of different species of *Tithopeltoceras* show narrow range and is restricted in the Subbetic Zone to the uppermost Tithonian (Enay, 1973; Olóriz and Tavera, 1979; Olóriz and Tavera, 1982).

Genus ***Micracanthoceras*** Spath, 1925
Type species ***Ammonites microcanthus*** Oppel, 1863
Micracanthocras cf. *microcanthum*
(Oppel, 1863 in Zittel, 1868)
(Pl. IV, figs. a-g)

Ammonites microcanthus Oppel in Zittel, 1868, p. 93, Pl. 17, Figs. 3-5.

Perisphinctes occultefurcatus Waggen, 1875, p. 195, Pl. 50, Figs. 4a, b.

Perisphinctes eudichotomus Waggen, 1875, p. 197, Pl.55, Figs. 5a – c.

Aulacosphinctes occultefurcatus (Waggen) Uhlig, 1910, p. 348.

Aulacosphinctes eudichotomus (Waggen) Uhlig, 1910,p. 348.

Himalayites microcanthus (Oppel) Uhlig, 1910, p. 139.

Micracanthaceras microcanthum (Oppel) Spath, 1925, p.144.

Micracanthoceras aff. *microcanthum* (Oppel) Spath, 1931, p. 543, Pl. 92, Figs. 3a, b.

EXPLANATION OF PLATE II

Fig.a,b ***Corongoceras*** sp. A, lateral (a), and ventral (b) views, JUM/L/C/5.

c,e ***Durangites*** cf. ***heilprini*** (Aguilera). Adult phragmocone, lateral (c), apertural (d), and ventral (e) views, JUM/L/D/1.

f,j ***Durangites*** sp. A. Shell with partly preserved body chamber, lateral (f), apertural (g) and ventral (h) views, JUM/L/D/2; i, j. inner whorl of the same specimen. Note smooth venter of the missing nucleus whorl (i), ventral (j) views. All X1, bar line represents 2 cm.


a
b
c
d
e
f
g
h
i
j

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Plate III

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EXPLANATION OF PLATE III

Fig.a c, ***Durangites*** sp. B. Nearly complete specimen, lateral (a), apertural (b) ventral and (c) views, note elongated tubercles near ventral sulcus, JUM/L/D/3.

d,f. ***Tithopeltoceras lakhaparense*** (Shome, Bardhan and De). Adult phragmocone, lateral (d), apertural (e) and ventral (f) views, JUM/L/T/1/02. All X1, bar line represents 2 cm.

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Plate IV

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EXPLANATION OF PLATE IV

Fig.a,c, ***Micracanthoceras*** cf. ***microcanthum*** (Oppel) [M]. Fully septate, lateral (a), apertural (b) and ventral (c) views, JUM/L/M/1. d g, ***Micracanthoceras*** cf. ***microcanthum*** [m].

d,e. Adult with body chamber, lateral (d), apertural (e) views, JUM/L/M/2. f g, Adult phragmocone, note trace of body chamber, lateral (f), ventral (g) views, JUM/L/M/3. All in X1, bar line represents 2 cm.

Micracanthoceras brightoni Spath, 1931, p. 544, Pl. 101, Figs. 6, 11a, b.

Aulacosphinctes occultefurcatus (Waggen) Spath, 1931, p. 542, Pl. 83, Fig. 3; Pl. 95, Fig. 10; Pl. 100, Figs. 6a, b.

Himalayites (*Micracanthoceras*) *microcanthum* (Oppel) Roman, 1936, p. 22, Pl. 4, Fig. 6.

Himalayites (*Micracanthoceras*) *microcanthus* (Oppel) Linares and Vera, 1966, Pl. 5, Fig. 2.

Himalayites (*Micracanthoceras*) *microcanthus* (Oppel) Sapunov, 1977, Pl. 5, Fig. 3.

Micracanthoceras (*Micracanthoceras*) *micracanthum* (Oppel) Tavera, 1985, p. 169-175, Pl. 21, Figs. 1-4, Pl. 22, Figs. 1-6.

Micracanthoceras (*Micracanthoceras*) cf. *brightoni* (Spath), Tavera, 1985, p.175, Pl. 21, Fig. 5.

Material: Three macroconchs (JUM/L/M/1, JUM/L/M/4 and JUM/L/M/5) and two microconchs (JUM/L/M/2 and JUM/L/M/3).

Description: Microconchs are small, diameter of a full grown specimen is 62 mm, with maximum adult phragmocone diameter about 51 mm, evolute (U/D = 0.48) and depressed (W/H = 1.09); whorl section rectangular. Body chamber more than a half whorl long. Ribs strong, distant; consist of secondaries and intercalatories. Venter strongly sulcate. Minute tubercles appear at furcation point and near sulcus.

Macroconch represented by adult phragmocones (diameter being 104 mm). Trace of body chamber suggests more than half whorl long. Involution (U/D = 0.51) and inflation (W/H = 1.15) are similar to what is seen in associated microconch. Ornamentation is also similar and mid-ventral sulcus is shallow to indistinct.

Remarks: Both Waagen (1875) and Spath (1931) (in Spath 1927-33) described *Micracanthoceras* and *Aulacosphinctes* from Kutch. The specimens were collected from different beds. Present material includes specimens of both genera from the upper assemblage (Fig. 3) where they co-occur with time-diagnostic Late Tithonian genera such as *Durangites*, *Corongoceras* and *Tithopeltoceras*. *Micracanthoceras* includes large shell with strong ornamentation with respect to *Aulacosphinctes* which includes smaller shells with similar or identical inner whorls. Recently, Callomon in Donovan *et al.* (1981) proposed sexual dimorphism between *Micracanthoceras* and *Aulacosphinctes* (see above).

Genus **Himalayites** Uhlig in Böhm, 1904

Type species **Himalayites treubi** Uhlig in Bohm, 1904 by SD Douvillé, 1912

Himalayites sp. A

(Pl. V, figs. a – b)

Material: Incomplete body chamber with remains of phragmocone (JUM/L/H/1).

Description: Shell small in size, reconstructed diameter is about 55mm. Widely umbilicate (U/D = c. 0.45), whorl section depressed (W/H = 1.12). Flanks highly convex rounded with both umbilical and ventrolateral margins. Penultimate whorl partly exposed, showing fine and dense secondary ribs. In the outer whorl, primary ribs rise from the steep umbilical wall and cross the flank with a gentle forward projection where they split into two equally strong secondaries which show forward projection. Secondaries cross the ventrolateral margin and become weak or fade off. In the point of furcation there is a rounded, blunt tubercle on internal mould. The beginning of the body chamber is marked by a constriction and reinforcement of the tubercles. Secondaries show much forward projection from the beginning of body chamber. Venter wide, gently convex with a smooth band. Secondaries, may occasionally bear small tubercles.

Discussion: Uhlig (1910) described several forms of *Himalayites* from the Upper Tithonian of Spiti in Himalayas. We have recently made a systematic revision of this material stored in Geological Survey of India, Kolkata and shown that the genus is strongly dimorphic (Shome and Bardhan, 2007).

Many of the adult features of the microconchs make resemblance with the inner whorls of larger ones (see *H. siedeli* Uhlig 1910, p. 140 and *H. stolizkai* Uhlig, 1910, p. 146; refigured here in Pl. V, fig. c, d and e. The present form which is only 55 mm diameter with incompletely preserved adult body whorl is a microconch.

H. hyphasis (Blanford in Uhlig, 1910; refigured in Pl. V, fig. f and g) closely resembles *Himalayites.* sp. A in having similar diameter, ribbing pattern and whorl outline. Ribs weakens in both species at the mid-venter. Primaries are also essentially bifurcating. The main difference lies in that the present species has relatively stronger tubercles and ribs more widely spaced.

H. ventricosus from Spiti (Uhlig, 1910, pl. 38, fig. 4 a-d, refigured here in Pl. V, fig. h) is similar to *H.* sp. A in degree of involution and inflation. Both have mid-ventral sulcus marked in early stage and obsolete in body chamber. Microconchiate ontogeny is clearly recognizable in *H. ventricosus.* Inner whorls are flattened, less inflated and ornamented with fine non-tuberculate ribs and bifurcating secondaries. In late phragmocone stage ribs become stronger with incipient tubercles and beginning of body chamber is marked by the sudden change in whorl section (from compressed to depressed). Body chamber exhibits two to three secondaries per bundle but dominated by simple ribs. The notable differences with *H.* sp. A are that it has very weak tubercles at the mid-flank and some secondaries are three per bundle on adult body chamber. Collignon (1960, pl.174, fig. 749) described a specimen as *V. ventricosus*. It has bifurcating ribs on the partially preserved adult body chamber. Tubercles are stronger from the end-phragmocone stage and the species has highly curved shell with wide venter. Thus it strongly resembles the present species, and they could be conspecific.

Several small species of *Himalayites* have also been described from Spain (Tavera, 1985). They broadly resemble the present species in having depressed whorl section, evolute shell with broad venter. *H. coroniformis* and *H. cortazari*, however, have denser ribbing (3 to 4 secondaries per single primary rib) and primaries are relatively more closely spaced.

EXPLANATION OF PLATE V

Fig.a,b. ***Himalayites*** **sp. A.** Phragmocone with partly preserved adult body chamber, lateral (a), ventral (b) views, JUM/L/H/1.

c,d. ***Himalayites seideli*** . Near complete specimens, microconchs, lateral and ventral views, GSI Type No. 9996.

e. ***Himalayites stoliczkai***, ventral view, GSI Type No. 9988.

f,g ***Himalayites hyphasis*** (Blandford), ventral views, GSI Type No. 9989 and 9990 respectively.

h. ***Himalayites ventricosus***, ventral view, GSI Type No. 9991, bar line represents 2 cm.

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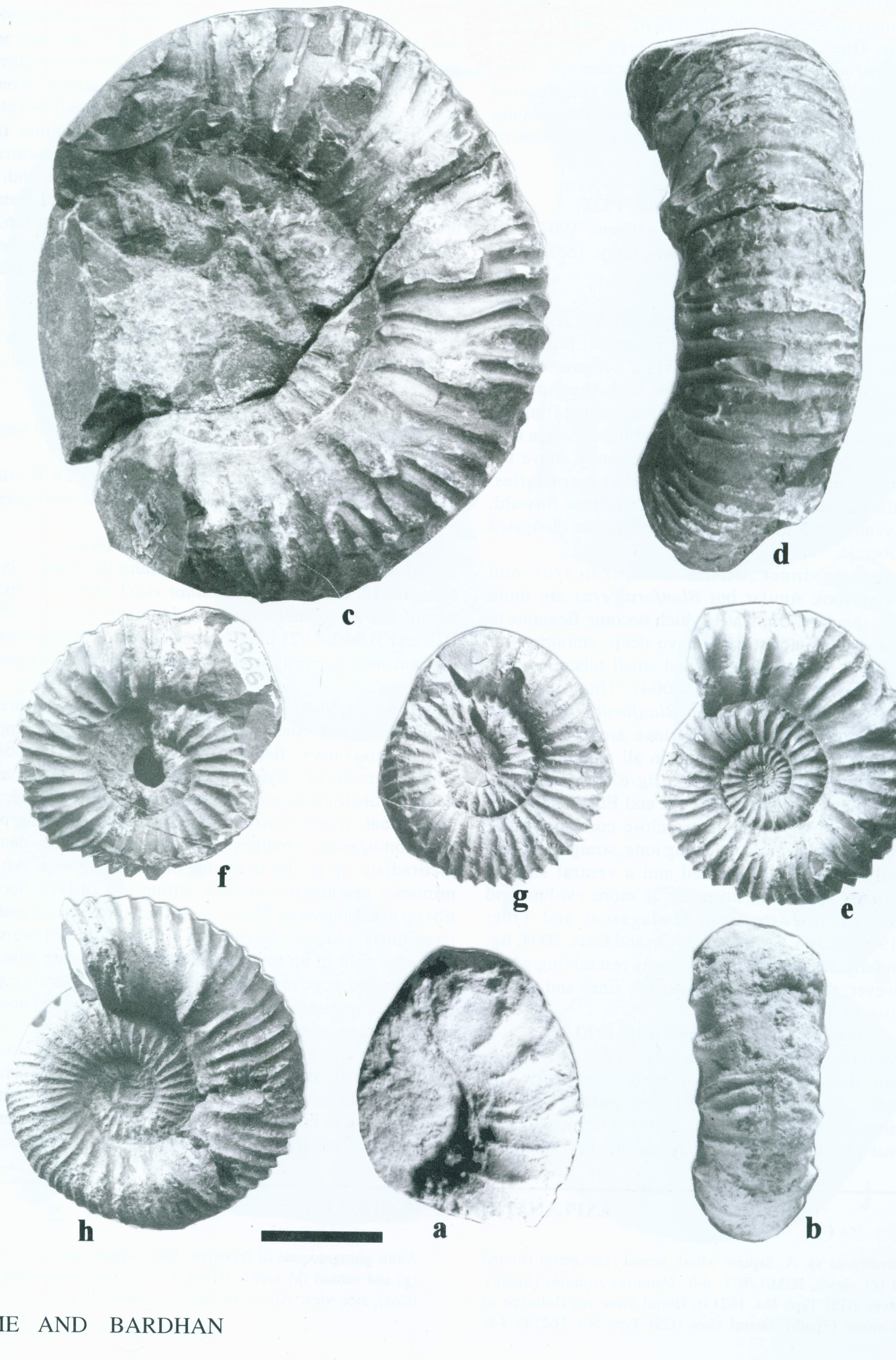
Plate V



Moreover, tubercles situated on the furcation point migrate towards the outer-flank during ontogeny.

Enay and Cariou (1997) also recognized the larger specimens of *Himalayites* as macroconch as well as the larger specimen figured in Zittel (1870, pl. 17, fig. 1 and 2) as *A. microcanthus* (the lectotype of the type species of *Micracanthoceras microcanthum* is Zittel's another specimen, Zittel 1870, pl. 17, fig. 3). Enay and Cariou (1997) emphasized that true Indo-SW Pacific *Himalayites* have inner flank sloping down to the umbilical margin and ribs posses a single row of tubercles on the inner flank.

Subfamily **Berriasellinae** Spath, 1922

Genus ***Blanfordiceras*** Cossmann, 1907

Type species ***Ammonites wallichi*** Gray, 1832.

?*Blanfordiceras* sp. A

(Pl. VI, figs. a – c)

Material: An incomplete phragmocone (JUM/L/B/1).

Description: Evolute, septate whorl fragment. Flanks are slightly curved with broad flat venter. Whorl compressed (W/H = 0.75), and subovate. Umbilicus wide with sharp margin and steep wall. Primary ribs are relatively long, rising from the umbilical wall rursiradiately and from the umbilical margin they take sharp forward turn and then run rectiradiately above the mid-flank where primary ribs split into two secondaries. Secondary ribs are also straight and project further forward, reaching the ventral area where they end in a minute elongated bullae-like tubercle.

Discussion: In inner whorls *Blanfordiceras* and *Durangites* may look similar but *Blanfordiceras* are more sharply ribbed, regularly biplicate (which become flexuous in adult stage) and characteristically have deep, smooth mid-ventral sulcus with regularly developed small tubercles near the ventral sulcus (Yin and Enay, 2004). Thus, we have tentatively placed this specimen in *Blanfordiceras*. Some species of the Indo-Madagascar Province are comparable. The type species, *B. wallichi* is found in all adjoining areas like Madagascar (Collignon, 1960, pl. 166, fig. 679), Spiti (Uhlig, 1910, pls. 29, 30 and 31) and Tibet (Yin and Enay, 2004, fig. 7.3-7.7). The present specimen shows close correspondence with early whorls of *B. wallichi* in having long, straight primary ribs, forwardly projected bifurcated and a ventral smooth band. The present specimen, however, is more evolute and compressed. *B. acuticosta* from Madagascar and Tibet (Collignon, 1960, pl. 166, fig. 682, 683; Yin and Enay, 2004, fig. 10.3) has similarly curved flanks and closely resembling whorl section. However, the present specimen has finer and denser ribs than those of *B. acuticosta*.

Family **Olcostephnidae** Haug, 1910

Subfamily **Spiticeratinae** Spath, 1924

Although dimorphism is not well known in the Spiticeratinae, it has been well recognized in the Olcostephaninae (see Wright *et al.*, 1996). Microconchs of *Olcostephanus* Neumayr, 1875 and *Jeannoticeras* Thieuloy, 1965 are strongly ornamented and lappeted. Macroconchs have bundled secondaries while adult microconchs have three to four secondaries thus retaining the ribbing pattern of early growth stages of macroconchs. In Spiticeratinae, for example, many species of *Spiticeras* Uhlig, 1910 have lappeted peristome (see Arkell *et al.*, 1957). They have smaller adult size and are strongly tuberculate and resemble inner whorls of many large forms which are clearly macroconchiate adults. However, definite dimorphic pair at genus or species level is yet to be established. Nature of dimorphism in both subfamilies appears to be similar. Microconchs are strongly ornamented and lappeted and ornamentation continue up to the end. They resemble inner whorls of macroconchs (a typical feature of dimorphism in Jurassic ammonites, see Callomon, 1963). An attempt has been made to recognize sexual dimorphism between *Umiaites* (M) and *Proniceras* (m) (see Shome and Bardhan, communicated).

Genus ***Umiaites*** Spath, 1931 (in Spath 1927-33)

Type species Umiaites rajnathi Spath, 1931

Umiaites rajnathi Spath, 1931

(Pl. VI, figs. d – h)

Umiaites rajnathi Spath, 1931, p. 548, Pl. 91, Figs. 10 a-b; Pl.101, Fig. 8

Umiaites minor Spath, 1931, p. 549, Pl. 91, Figs. 1 a-b; Pl. 102, Fig. 6

Spiticeras cf. *ducale* (Matheron) Krishna, Pathak and Pandey, 1994, p. 333, Pl. 1, Fig. 3.

Umiaites rajnathi, Shome and Bardhan, (in press).

Material: Four specimens including the types (GSI Type Nos. 16213 and 16214). *U. minor* (GSI Type No. 16214) is considered as a synonym. Two additional topotypes (JUM/L/U/1 and JUM/L/U/2) have been included. The holotype is an internal mould, the largest specimen (JUM/L/U/1) preserves some test.

Remarks: Shell large, fully septate. Maximum preserved diameter 104 mm. Shell strongly evolute and highly compressed with flat to convex flanks. Umbilical shoulder rounded while wall being steeply inclined to overhanging. Deep adorally convex constriction present. Primary ribs are strong, coarse and distant, rising from the umbilical wall. Ribbing patterns show ontogenetic changes. Primary ribs are fine, dense and rectiradiate up to the diameter of about 40 mm. After that primaries become increasingly strong and distant. Secondary ribs up to a diameter of 70 mm are trifurcating with intercalatories irregularly placed. At the end of the adult phragmocone primaries split in up to six secondaries. Secondary ribs always bend forward or go over the venter with much adoral projection. Number of primaries and secondaries per half whorl are 10 and about 60 respectively.

Pronicers strongly resembles *Umiaites* in many morphological characteristics. They are strongly evolute and show a negative allometry in degree of inflation. *Proniceras*, however, is less compressed. Similarity of their ornamentation is noticed by Arkell *et al.* (1957) and Wright *et al.* (1996). Adult

EXPLANATION OF PLATE VI

Fig.a,c. ***Blanfordiceras*** sp. A. Septate whorl, lateral (a), ventral (b) and apertural (c) views, JUM/L/B/1. d-h, *Umiaites rajnathi* (Spath). (d) Holotype (GSI Type No. 16213), lateral view. (e) Holotype of *Umiaites minor* (Spath), lateral view (GSI Type No. 16214). f-h, Adult phragmocone of topotype, fully septate, lateral (f) Apertural (g) and ventral (h) views, JUM/L/U/1. (i,j) *Megacucculaea eminens* (Cox), side view. All in X1, bar line represents 2 cm.

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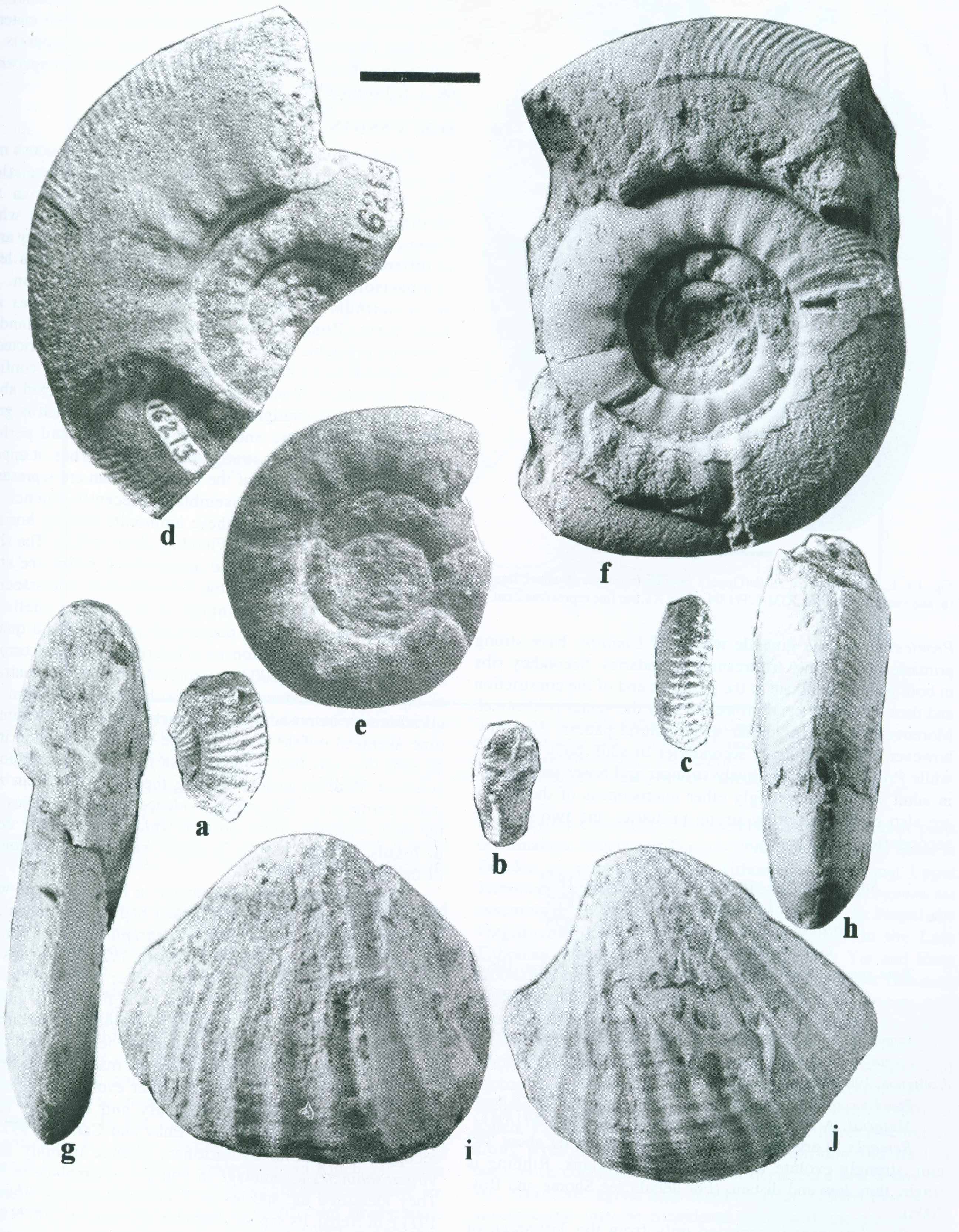
Plate VI



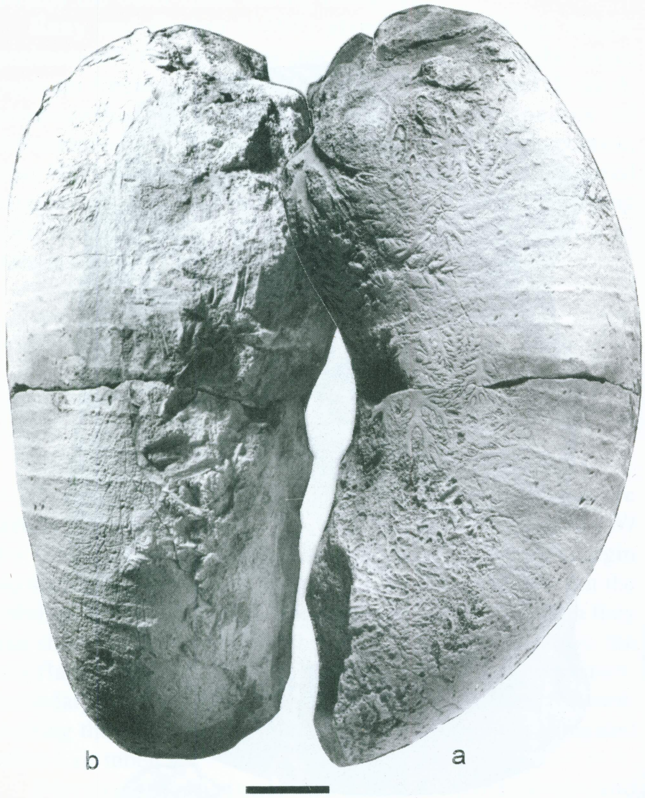


Fig. 4 a b, *Pterolytoceras sutile*(Oppel). Septate fragment of whorl, lateral (a) and ventral (b) views, JUM/L/P/1/04. All in X1, bar line represents 2 cm.

Proniceras and the juvenile whorls of *Umiaites* have strong primaries and mainly trifurcating secondaries. Secondary ribs in both genera terminate at the posterior end of the constriction and their forwardly bend projection over the venter is identical. Moreover, both have similar septal sutural pattern. *Umiaites*, however, has multifurcate secondaries in adult body chamber while *Proniceras* has relatively stronger and fewer secondaries in adult whorl. Interestingly other microconchs of the family are also characterized by strong primaries and two to three secondaries (see above).

Superfamily **Lytoceratoidea** Neumayr, 1875
Family **Lytoceratidae** Neumayr, 1875
Subfamily **Lytoceratinae** Neumayr, 1875
Genus ***Pterolyticeras*** Spath, 1927
Type species ***Ammonites exoticum*** (Oppel in Zittel 1863)
Pterolytoceras sutile (Oppel, 1863)
(Fig. 4a,b)

Ammonites sutile Oppel in Zittel, 1863, p. 76. Pl.12. Figs. 1-5.

Pterolytoceras sutile Oppel var. *madagascariensis* nov. var. Collignon, 1960, Pl. 139-140, Figs 529-531.

Pterolytoceras sutile Shome and Roy, 2006, p. 57-64, Figs. 4 a – b.

Material: A fragmentary phragmocone (JUM/L/P/1/04).

Remarks: Large, maximum preserved diameter about 245 mm, strongly evolute with highly convex flank. Ribbing is single, thin, low and distant. (For details see Shome and Roy, 2006).

Pterolytoceras is reported only from the Tithonian of Madagascar, NW Pakistan, Spiti Himalaya and presently from Kutch. In Madagascar it is distributed throughout the Tithonian (Collignon, 1960) in Pakistan *Pterolytoceras* occurs in Tithonian beds of the Chichali Formation (Fatmi, 1972). Uhlig (1910) reported *Pterolytoceras* from Chidamu beds of the Spiti Shale. Pathak and Krishna (1993) also mentioned the presence of *Pterolytoceras* in the Chidamu beds and assigned their material the Late Tithonian age. The present find also supports its Tithonian age as it co-occurs with *Durangites*, *Corongoceras*, etc. (cf. Tavera, 1985; Shome *et al.*, 2004).

DISCUSSION

Kutch ammonite fauna includes several genera which may be useful for interprovincial biostratigraphic correlation. *Durangites* characterizes the latest Tithonian in the Mediterranean Tethys (Olóriz and Tavera, 1982) while *Corongoceras* and *Micracanthoceras* are found in many areas at different levels within the Late Tithonian. Species level comparison, however, provides better resolution. *M. microcanthum* ranges through the *Simplisphinctes* and *Transitorius* Zones of the Primary International Standard Chronostratigraphic Scale, while *C. lotenoense* is restricted to the *Simplisphinctes* Zone and *Durangites heilprini* is confined to the *Durangites* Zone. The cf./aff. species described above occur in a single stratigraphic level in Kutch, which is green coloured, glauconitic and oolitic sandstone, and perhaps represents a condensed stratigraphic horizon. Thus, it appears that three standard zones of the Late Tithonian are represented by the Kutch ammonite assemblage. Recently, Fürsich and Pandey (2003) recognized these ammonite-bearing horizons as the product of Maximum Flooding Zone (MFZ). The shells are highly time averaged and accumulated below the storm wave base during times of slow sedimentation. The associated bivalves show high percentage of articulated shells and ammonites show varying degrees of preservational quality. Many of the ammonites consist of internal moulds or corroded. Fürsich and Pandey (2003) interpreted the shell concentration as taphonomic condensation due to biogenic alteration. The question may be raised that how much time elapsed within this time averaged oolitic bed. From the faunal association it can be said that this bed includes taxa of three Late Tithonian zones of Mediterranean including the latest Tithonian zonal index *Durangites*. The crucial evidence, however, comes from the next overlying oolitic horizon which is practically devoid of fossils. Krishna (1991), however, reported *Argentiniceras* of the Lower Berriasian.

The lower ammonite assemblage in Kutch is found within coarse siliciclastic facies (Gryphaea bed as mentioned), and dominated by *Virgatosphinctes* gr. *denseplicatus* with ancillary occurrence of *Microcanthoceras* (Spath, 1927-33). At this level *Virgatosphinctes* spp. are smaller in size; macroconchs have diameter rarely exceeding 300 mm (= *V. broili-raja* group of Enay and Cariou, 1997). The *Virgatosphinctes* assemblage continues up to the top of the condensed level studied in this paper, where they show differences e. g., macroconchs become very large exceeding 600 mm diameter even at phragmocone stage. Moreover, they are coarsely and distantly ribbed (taxonomic revision underway). Enay and Cariou (1997) also recognized a similar evolutionary change in body size of *Virgatosphinctes* assemblage in younger assemblage in Nepal. They identified the species as *V. adranosamontae* (Lemoine, 1911). In Nepal, its septate diameter also reaches 500-600 mm. Lectotype of the species comes from Madagascar and many larger forms of Kutch strongly resemble the lectotype (see

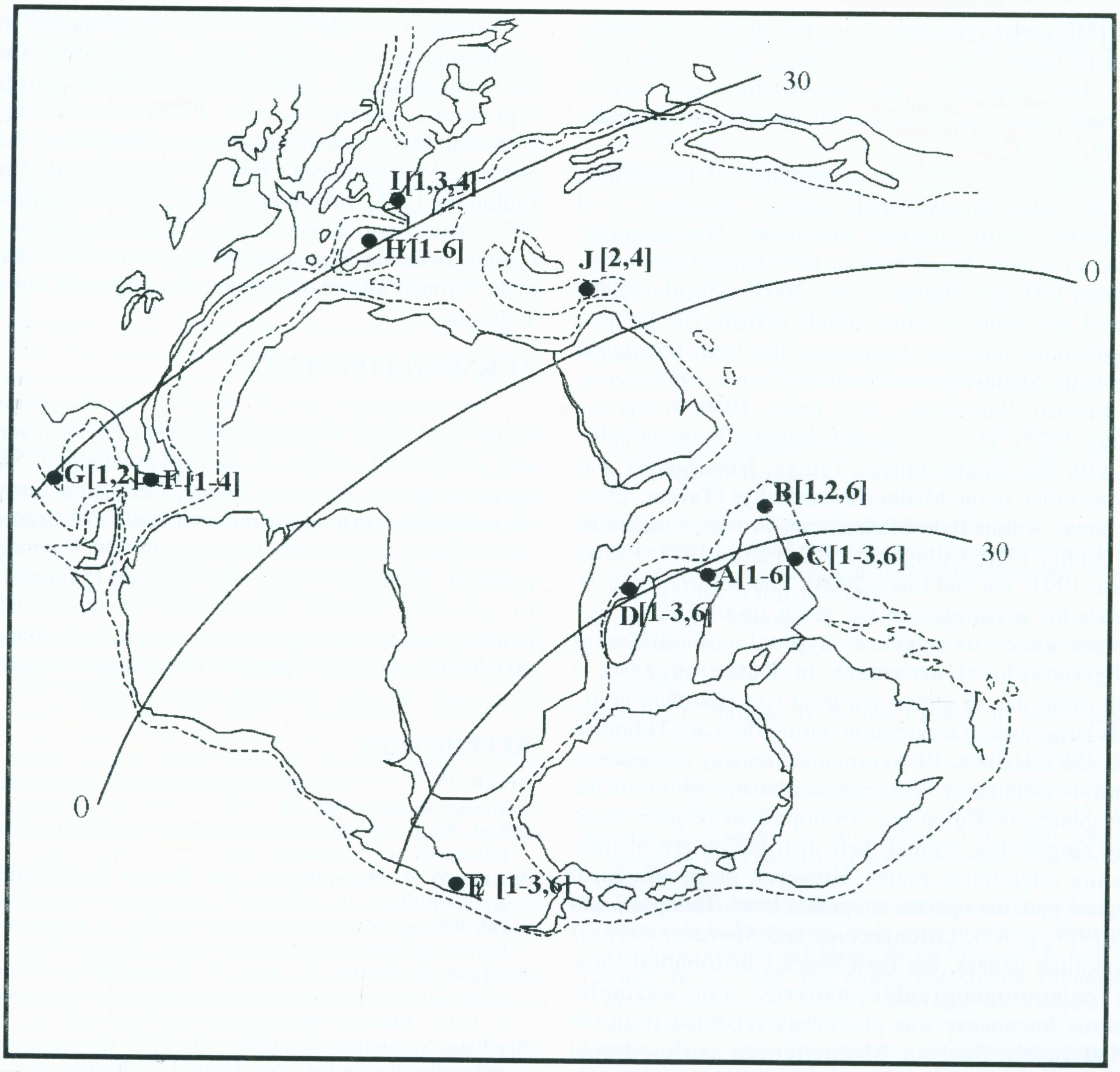


Fig. 5 Biogeographic distribution of the genera considered here. The base map is modified after Enay and Cariou, 1997. A = Kutch; B = North-West Pakistan; C = Himalayas; D = Madagascar; E = Southern South America; F = Cuba; G = Mexico; H = Southern Spain (Mediterranean); I = SE France; J = Turkey. 1 = *Micracanthaceras* [M]-*Aulacosphinctes* [m]; 2 = *Himalayites*; 3 = *Corongoceras*; 4 = *Durangites*; 5 = *Tithopeltoceras*, 6 = *Blanfordiceras*. Sources are Bardhan *et al.* (2007) and references therein; Enay *et al.* (1998); Enay and Geyssant (1975).

Spath, 1931; Enay and Cariou, 1997). This kind of evolutionary change within *Virgatosphinctes* lineage has also been noticed in NW Pakistan (Fatmi, 1972) and Madagascar (Collignon, 1960).

Virgatosphinctes is widely distributed (cf. Enay and Cariou, 1997), but *V.* gr. *denseplicatus* is considered to be essentially perigondwanan (Verma and Westermann, 1972; Enay and Cariou, 1997). From literature it appears that *Virgatosphinctes* shows high interspecific diversity and the genus is long ranging (spaning Lower to Upper Tithonian). According to Olóriz and Tintori (1990), the subfamily Virgatosphinctinae and especially the genus *Virgatosphinctes* lacks taxonomic consistency which results in assigning different names to morphologically similar assemblages in different areas. In the Indo-Madagascan Province, *V.* gr. *denseplicatus* is clearly excessively splited. Spath (1931) described 6 species of *Virgatosphinctes* from Kutch and Uhlig (1910) reported 23 species from few localities in Spiti. There are many reports of *V. denseplicatus* from different stratigraphic horizons in Himalayan region. Krishna *et al.* (1982) and Krishna (1983) reported *Virgatosphinctes* spp. below the Late Tithonian *Himalayites-Corongoceras* assemblage from different parts of Himalaya. Olóriz and Tintori (1990) dated the Spiti Shale in Zanskar as uppermost Lower Tithonian – lowermost Upper Tithonian on the basis of *Virgatosphinctes-Aulacosphinctes* assemblage following Krishna *et al.* (1982). In Nepal the *Virgatosphinctes* assemblage is reported from the Late Tithonian (Enay and Cariou, 1997). Recently Yin and Enay (2004) reported *V. denseplicatus* from Lower to Upper Tithonian of Tibet and found that *Blanfordiceras wallichi* occurs well above it. In Himalayas, *Virgatosphinctes* assemblage co-occurs mostly with endemic species and hence dating is sometimes become tentative notwithstanding the inaccessibility and tectonic disturbance which disrupt the continuity of succession (Gaetani *et al.*, 1985; Olóriz and Tintori, 1990). In Kutch, *V.* gr. *denseplicatus* is abundant in the lower assemblage along with *Micracanthoceras microcanthum* and its last occurrence coincides with the first occurrence of *Durangites*. We, therefore, agree with Krishna *et al.* (1996) that *V.* gr. *denseplicatus* may be considered along with the present find of other taxa to demarcate Jurassic-Cretaceous boundary in Kutch. Pending systematic revision of *Virgatosphinctes* population (MS under preparation) we refrain from assigning new names to larger forms of the younger *Virgatosphinctes* assemblage, but it appears to be a distinct form and may be used as a zonal index for the latest Tithonian in whole Indo-Madagascan region.

The present Late Tithonian assemblage of Kutch also shows complex palaeobiogeographic patterns. At generic level it shows affinity with different provinces. For example, *Tithopeltoceras* is now found both in the Mediterranean (30° N) and Kutch (30° S). Shome *et al.* (2004) considered the occurrence of the genus in same latitude perhaps can be used as a palaeolatitude indicator. *Durangites* has been previously reported from the Mediterranean Province (Tavera, 1985; Cecca, 1999) and Mexico (Burckhdart, 1919; Imlay, 1939; Verma and Westermann, 1973). *D.* cf. *heilprini* suggests biogeographic affinities with the Mediterranean Tethys. *Himalayites* was previously recorded in the MediterraneanTethys (Tavera, 1985) and many areas within Indo-Madagascan Province including Himalaya (Uhlig, 1910; Collignon, 1960; Fatmi, 1972; Pathak and Krishna, 1993; Yin and Enay, 2004). The occurrence of *H.* sp. A extends the occurrence of the genus up to Kutch.

The presence of genera typical of different palaeobiogeographical provinces in Kutch suggests a migrational event due to global sea level rise (Bardhan *et al.*, 2007). This large scale transgression during the Late Tithonian (Haq *et al.*, 1987; Hallam, 1988) promoted seaway connections among various isolated or semi-isolated basins. Many of the immigrant genera in Kutch are cosmopolitan or have wide geographic ranges (Fig. 5) and their distribution are of little use in tracing migrational routes. However, biogeographical and ecological patterns operate at species level (Campbell and Valentine, 1977, p. 47). *Corongoceras* and *Micracanthoceras* are cosmopolitan genera, but their species distribution show different paleobiogeographic patterns. For example, *Corongoceras lotenoense* was previously recorded from the Andes, Madagascar, Subbetic Mediterranean and the Nepal Himalayas (Collignon, 1960; Matsumoto and Sakai, 1983; Haupt, 1907; Enay and Cariou, 1999). It has now been collected in the uppermost Tithonian horizons in Kutch as *C.* cf. *lotenoense* described above (see also Shome *et al.*, 2004). A very narrow strait is thought to have opened up between South Africa and India which would have enabled faunal exchange between Kutch and Andean basin (Termier, 1952; Enay, 1972). *C. lotenoense* from the Andes reached Madagascar, Kutch and Himalaya (Riccardi, 1991), while younger, larger forms of *Virgatosphinctes* reached the Andean regions (Bardhan *et al.*, 2007). Bivalve distribution also supports the appearance of South African corridor. *Megacucculea* (Pl. VI, figs. i, j), for example, which is thought to be endemic to the Indo-Madagascan area (Cox, 1940; Shome *et al.*, 2004), reached the Andean Province through this narrow corridor (see also Riccardi, 1991).

Blanfordiceras and *Spiticeras* are two typical genera of other areas of Indo-Madagascan Province (e.g. Madagascar, NW Pakistan, Himlayas) and the Andean Province (Gerth, 1925; Leanza, 1945; Leanza, 1981). *Himalayites*, is another typical Himalayan genus, which also has been reported from the Mediterranean Tethys (Tavera, 1985). We have already suggested (Bardhan *et al.*, 2007) that the absence of these genera in Kutch might be due to collection failure. The present find of *Blanfordiceras* sp. and *Himalayites* in Kutch has confirmed our speculation.

Umiaites is endemic to Kutch, including two macroconch morphospecies (*U. rajnathi* Spath and *U. minor* Spath), which could be conspecific. *Umiaites* [M] and *Proniceras* [m] perhaps represent a dimorphic pair. *Proniceras* during the Late Tithonian had a paleobiogeographic distribution including the Subbetic Mediterranean (Tavera, 1985), Mexico (Imlay, 1939, Callomon, 1993), Argentina (Leanza, 1945), Baluchistan (Fatmi, 1972; Fatmi and Zeiss, 1994), Nepal Himalayas (Enay and Cariou, 1997) and Madagascar (Collignon, 1960). Thus like many other forms it also shows southward migration during the Late Tithonian.

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