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# THE GENUS *UMIAITES* SPATH, 1931 (AMMONOIDEA) FROM THE TITHONIAN (LATE JURASSIC) OF KUTCH, WESTERN INDIA

Sabyasachi Shome and Subhendu Bardhan

## ABSTRACT

Recently collected specimens of *Umiaites* from the latest Jurassic of Kutch, have facilitated a better understanding of this endemic genus. Two previously described species, *Umiaites rajnathi* and *U. Minor*, appear to be conspecific, and the former name is retained. An attempt has been made to characterize the sexual dimorphism between *Proniceras* and *Umiaites*, the latter being the macroconch.

Sabyasachi Shome. Geological Survey of India, 15 Kyd Street, Kolkata – 700 016, India. sabyasachi60@gmail.com

Subhendu Bardhan. Department of Geological Sciences, Jadavpur University, Kolkata – 700 032, India. s_bardhan01@yahoo.co.uk

**KEY WORDS:** Kutch; *Umiaites*; *Proniceras*; Ammonite; Dimorphism; Tithonian

## INTRODUCTION

The Late Tithonian is characterized by a strong provincialism of ammonites. The provincialism is so marked that the Upper Jurassic terminology varies in distinct regions e.g., Portlandian in England, Volgian in Arctic Region and Tithonian in Tethyan and Indo-Pacific regions. The top of the Jurassic may be distinguished from north to south into different realms/provinces like Boreal, Mediterranean and Tethyan, respectively (Callomon 1981a, 1981b). Genus level analysis using different co-efficient methods show persistence of endemism even among the provinces during the Tithonian (Riccardi 1991; Bardhan et al. 2007).

In the present work we have redescribed one of these Late Tithonian endemic genera, *Umiaites*, from Kutch. The genus was based on incompletely preserved rare specimens first described by Spath (1931), who was known for his characteristically brief and subtle descriptions. Moreover, *Umiaites* had not been illustrated and was misspelled in the Treatise (Arkell et al. 1957). Therefore, it is very difficult to compare specimens from other areas with such endemic taxa. The present study redescribes *Umiaites* based on additional specimens along with the types and their precise stratigraphic occurrences. This information allows a better understanding of ontogeny and intraspecific variability within the *Umiaites* population of Kutch, makes it possible to synonymize the two species of Spath (1931), and describes them herein as *Umiaites rajnathi,* which has priority.

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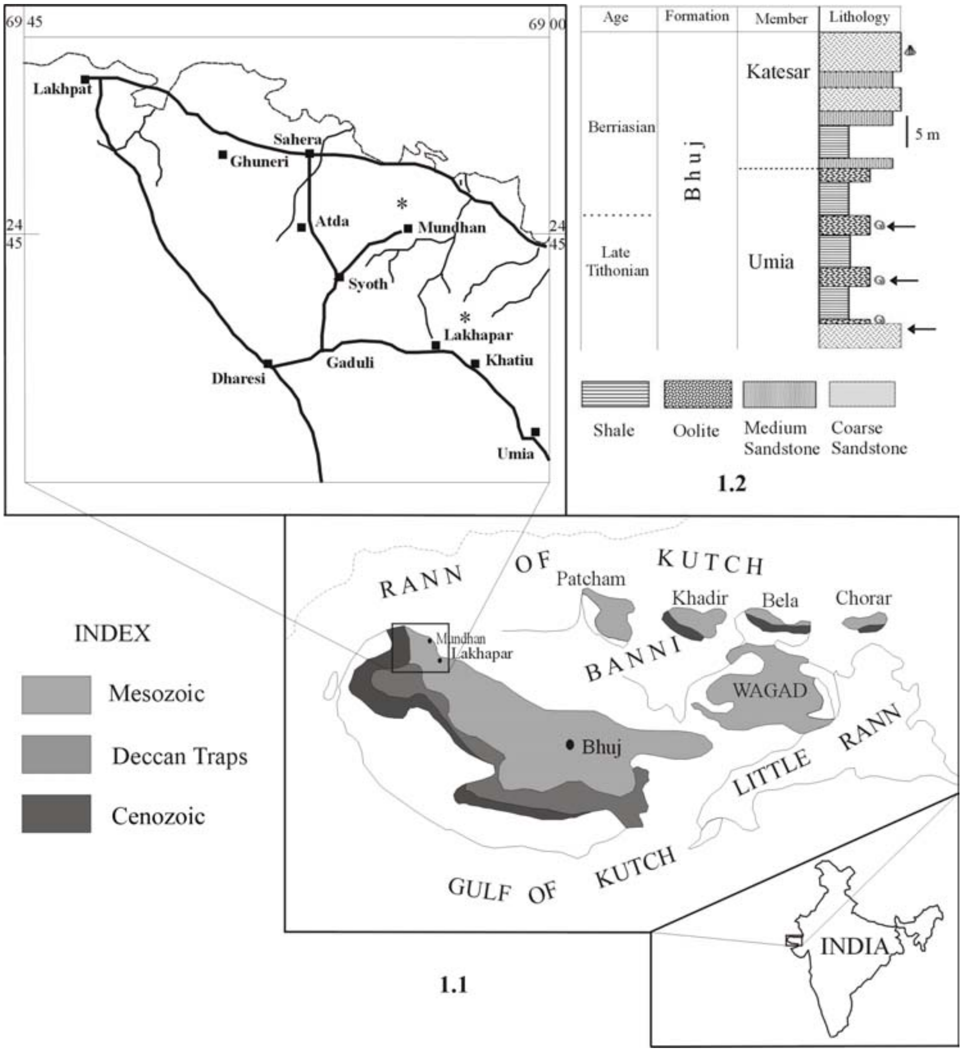


**FIGURE 1. 1.1.** Geological map of Kutch with important fossil bearing localities including the areas yielding *Umiaites* (marked by an asterisk) shown in the inset. **1.2.** Stratigraphical section of the *Umiaites* bearing strata (see arrows).

*Umiaites* is similar to *Proniceras* both morphologically (see also Wright et al. 1996) and stratigraphically. Its early stage corresponds well with the adult stage of *Proniceras*, which is a lappeted microconch (e.g., see Imlay, 1939, pl. 18, figs. 5 and 6). It is shown here that these two nominal genera meet many criteria to form a dimorphic pair, *Umiaites* as macroconch and *Proniceras* as microconch.

## GEOLOGICAL SETTING

The marine Mesozic rocks of Kutch range in age from the Bajocian to Aptian and were deposited in a shallow, shelf environment (Biswas 1977; Bose at al. 1988; Fürsich and Oschmann 1993). The thick stack of these Mesozoic sediments has been subdivided into four major formations; Patcham, Chari, Katrol and Bhuj (Rajnath 1932, Mitra et al. 1979), in ascending order, which in turn are subdivided into several members.

The ammonites occur in the Umia Member of the Bhuj Formation of Late Tithonian age (Mitra et al. 1979; Shome et al. 2004; 2005). The Umia Member at Lakhapar and other areas (Figure 1.1) yields a marine assemblage, which was previously assigned to various ages by different workers. Waagen (1875), Rajnath (1932), Spath (1931) and Krishna (1984) advocated a Tithonian age for the Umia Member based on ammonites. There is consensus amongst paleontologists that the upper part of the Umia Member is characterized by Late Tithonian fossils. Fossiliferous units of the Umia Member can be divided into two broad ammonite assemblages. The lower assemblage includes species of *Micracanthoceras* Spath, 1925, *Aulacosphinctes* Uhlig, 1910 and *Virgatosphinctes denseplicatus* (Waagen) group. The assemblage occurs in distinct coarse arenaceous facies. The upper assemblage includes older ammonite taxa along many new ammonite genera (Shome et al. 2004; Shome et al. 2005), which are *Tithopeltoceras* Arkel, 1953, *Corongoceras* Spath, 1925, *Durangites* Burckhardt, 1912, *Himalayites* Uhlig in Boehm, 1904 and *Blanfordiceras* Cossmann, 1907. Here, the characteristic lithology is alternating oolitic sandstone and shale. *Umiaites* is present in both the assemblages. Four bands of oolitic sandstone have been recognized locally, and ammonites are present in all except the topmost one (Figure 1.2). The newly discovered taxa indicate unambiguous Late Tithonian age, but some of them differ from zonal index fossils in Europe (Tavera 1985; Tavera et al. 1986). For example, *Micracanthoceras* is found to have ranged between the *Microcanthum* Zone and the *Durangites* Zone in Spain, which marks the latest Tithonian (Olóriz and Tavera 1983; Tavera et al. 1986). *Tithopeltoceras* is restricted to the *Transitorius* Zone. *Corongoceras* has distinct stratigraphic distributions in different areas. Tavera (1985) and Tavera et al. (1986) described "*Corongoceras"* from the Upper Tithonian *Transitorius* Zone to the lowermost part of the Lower Berriasian *Jacobi* Zone in southern Spain. However, the Lower Berriasian record of "*Corongoceras*" is dubious (Enay personal commun. 2005). *Durangites* is the zonal index for the top of the Tithonian. The presence of *Umiaites* in both assemblages suggests its stratigraphic distribution throughout the Late Tithonian.

Umia Member sedimentary facies are characterized by repeated cycles of several heterolithic facies such as coarse sandstone and alternating oolitic sandstone and shale. They have been interpreted as multiple transgression-regression couplets (Bose et al. 1988). Fürsich and Pandey (2003) investigated sequence stratigraphy in the Umia Member and recognized the oolitic horizon, which contains time-averaged ammonite assemblage, as the maximum flooding zone. Ammonite shells have variable preservational quality; many of them are internal molds or highly corroded. *Umiaites* specimens also show variable preservation. The associated bivalves occur with a high degree of articulation. According to Fürsich and Pandey (2003), shells accumulated below storm wave-base during slow sedimentation and taphonomic condensation subsequently took place.

All the Tithonian ammonites of Kutch including both endemic and cosmopolitan genera disappeared at this level, precisely within the second oolitic horizon. Elsewhere these genera also died along with many other Tithonian genera. Bardhan et al. (1989; 2007) correlated this regional extinction event with the global mass extinction episode coincident with the Jurassic-Cretaceous boundary (Raup and Sepkoski 1984, but see Hallam and Wignall (1997) for an opposing view).

## SYSTEMATIC PALAEONTOLOGY

Superfamily PERISPHINCTOIDEA Steinmann, 1890 in Steinmann and Doderlein

Family OLCOSTEPHANIDAE Haug, 1910
Subfamily SPITICERATINAE Spath, 1924
Genus UMIAITES Spath, 1931

Type species.- Umiaites rajnathi Spath, 1931

v. 1931. *Umiaites rajnathi* Spath, p.548-549, pl. 91, figs. 10 a-b; pl. 101, fig. 8

v. 1931. *Umiaites minor* Spath, p.549-550, pl. 92, figs. 1 a-b; pl. 102, fig. 6

v. 1994. *Spiticeras* cf. *ducale* (Matheron) Krishna, Pathak, Pandey, p. 333-334, pl.1, fig. 3

**Material.** The present study is based on six specimens including the types (Nos. 16213, 16214; re-illustrated here as Fig. 2.1 – 2.4 and Fig. 2.5 – 2.7) reposited at the Geological Survey of India, Kolkata. Two specimens are broken whorls of phragmocones. G. S. I. type no. 16213 is the holotype. Additional specimens have been collected from 2 km northeast of Lakhapar, western Kutch, and are kept in the museum of the Department of Geological Sciences, Jadavpur University.

**Description.** Shell is large and fully septate. Incomplete specimen (No. 3.1) diameter up to 104 mm; reconstructed diameter of the complete shell is about 160 mm (the presence of. another full revolution is evident from the trace of the umbilical seam of the body whorl (Figure 2.8; Figure 3.1-3.3). Shell is evolute (U/D = 0.39 to 0.56), inflated (W/H = 0.52 to 0.86), and shows wide intraspecific variability. Umbilicus is shallow and wide. Flanks are flat to gently curving; the radius of curvature increases ontogenetically. Whorl overlap is one-fourth of the preceding whorl height. Umbilical shoulder is rounded, and the wall is steeply inclined to overhanging, becoming more rounded

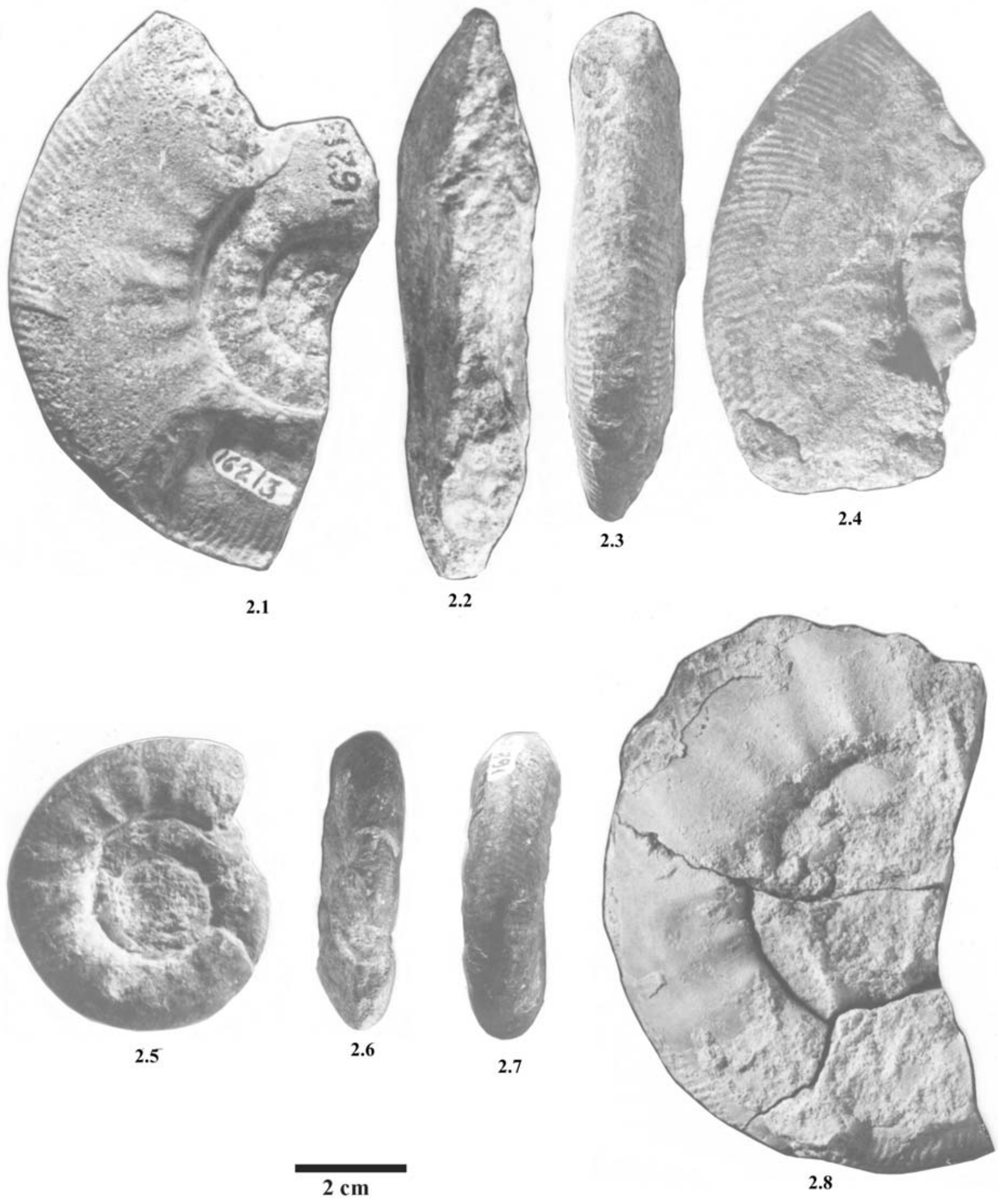


**FIGURE 2. 2.1 – 2.4.** Umiaites ranathi. Holotype, GSI Type No. 16213, lateral, apertural, ventral and lateral views. **2.5 – 2.7.** Umiaites minor. Holotype, GSI Type No. 16214, lateral, apertural and ventral views. **2.8.** Umiaites rajnathi. Specimen No. JUM/L/2, lateral view.

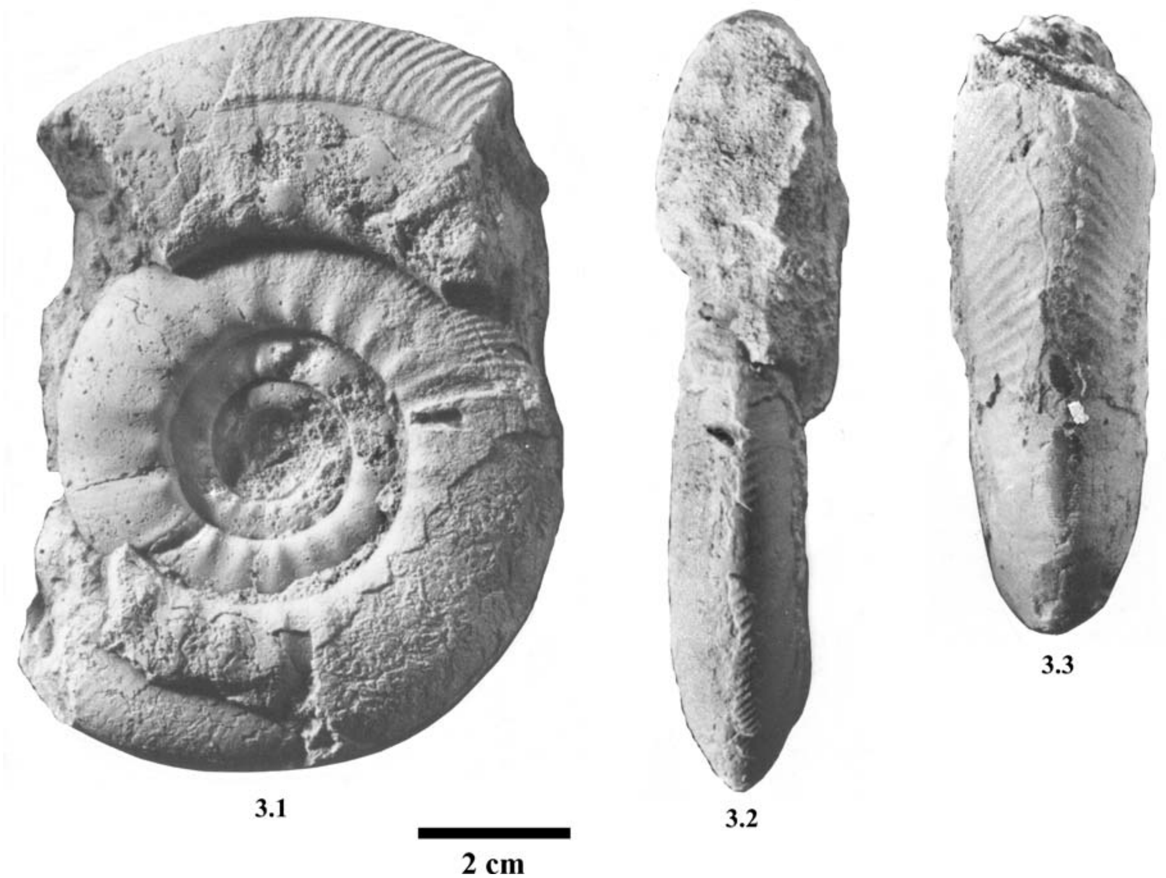


**FIGURE 3.** *Umiaites rajnathi* (JUM/L/1) **3.1 – 3.3.** lateral, apertural, ventral view.

on the outer flank and gradually merging with narrowly arched venter. Shell is marked by a deep adorally concave constriction on the flank, conformable with the primary ribs, but secondaries abut against the posterior end of the constriction. Innermost whorls are obscured by matrix. Primary ribs are seen at 25 mm diameter initially. They appear to be rectiradiate, fine and closely spaced. First constriction is seen at about 30 m diameter. At about 40 mm diameter both primary ribs and constrictions show a rursiradiate pattern. Primaries become increasingly strong and separated. At least two constrictions are present per whorl, and the last constriction is noticed at a phragmocone diameter 100 mm. Whorl section is elliptical with maximum width lying just below the mid-flank. Primary ribs are strong, coarse and distant. They originate from the umbilical wall and rise slightly rursiradiately up to the umbilical margin and then flex forward. Strength of primary ribs decreases posteriorly and below the mid-flank they almost disappear (on internal mold) and a bundle of secondary ribs arises with variable abundance during growth. At 70 mm diameter, three secondary ribs occur with irregularly placed intercalatory ribs. Secondary ribs are fine, closely spaced and sharply crested. Late phragmocone whorl may include six secondary ribs. Upon initiation, secondary ribs bend forward and cross the venter with much adoral projection. This projection is increasingly pronounced during ontogeny. The number of primary and secondary ribs is 10 and 60, respectively, including intercalatory ribs, per half-whorl at 104 mm diameter. Number of primary ribs appears to be more or less uniform in different ontogenetic stages. They become somewhat broad and flat, and secondary ribs become progressively prominent and sharply crested toward the preserved end. This stage may represent an adult phragmocone.

Septal suture moderately complex with trifid, deeply incised, narrow first lateral lobe; first lateral saddle short and relatively wide; the auxiliaries are also equally frilled and deeply indented (see Spath, 1931, pl.101, fig. 8; pl. 102, fig. 6).

**TABLE 1.** Measurements (in mm) of different parameters of *Umiaites rajnathi*.

| Specimen No. | Position | Diameter (D) | Umbilicus (U) | U/D | Height (H) | Width (W) | W/H |
|---|---|---|---|---|---|---|---|
| GSI type no.16213 | Phragmocone | 102 | 42 | 0.41 | 36 | 21 | 0.58 |
| | | 56 | 22 | 0.39 | 21 | 14 | 0.66 |
| | | 26 | 11 | 0.41 | 11 | 8 | 0.72 |
| GSI type no.16214 | Phragmocone | 55 | 23 | 0.42 | 15 | 13 | 0.86 |
| | | 44 | 20 | 0.45 | - | - | - |
| JUM/L/1 | Phragmocone | 104 | 49 | 0.47 | 30 | 22 | 0.73 |
| | | 70 | 33 | 0.47 | 21 | 16 | 0.76 |
| JUM/L/2 | Phragmocone | 111 | 56 | 0.50 | 36 | 24 | 0.66 |
| | | 89 | c.50 | 0.56 | 27 | 22 | 0.81 |
| | | 70 | - | - | 26 | 20 | 0.76 |

**Discussion.** Spath (1931) first described two species of *Umiaites* as *U. rajnathi* and *U. minor*. Both species have been described on the basis of septate specimens, and *U. minor* is based on a monotypic holotype, which is an immature shell. Spath (1931) is known for his excessive subjective splitting which led to an abundance of species names (see e.g., Cariou and Krishna 1981 and Jana et al. 2005). In the present case, Spath (1931) noticed that the inner whorls of *U. rajnathi* closely resembles *U. minor* in nature of ornamentation. Both are equally evolute (U/D is 0.41 and 0.42, respectively, for *U. rajnathi* and *U. minor*). *U. minor*, however, is less compressed than *U. rajnathi* (W/H is 0.86 and 0.58, respectively). Our additional specimens reveal that *Umiaites* population shows wide intraspecific variability with respect to degree of inflation. The type specimens of both *U. rajnathi* and *U. minor* represent two extreme ends and all additional topotypes fall intermediately within the spectrum (Table 1). Therefore, it appears *Umiaites* population in Kutch is a homogenous assemblage which shows continuous variation, a character of a single biological species. *U. rajnathi* and *U. minor* therefore are considered conspecific.

*Umiaites* shows stunning similarities with *Proniceras* in many morphological aspects. They strongly resemble each other in degree of involution (Figure 4.1) and degree of inflation in early whorls (Figure 4.2). They also correspond well in ribbing pattern. The secondary ribs form typical forward projected sinuses, which were described by Spath (1931). Moreover both have strong primary ribs and finer secondary ribs, which are forwardly projected especially on the venter as noted in both versions of Treatise (Arkell et al. 1957; Wright et al. 1996). However, Arkell et al. (1957) described the outer whorl of *Umiaites,* based on the holotype, as having a smooth shell. This description might prompt one to falsely conclude that *Umiaites* has a smooth body chamber. Spath's (1931) illustrated example of the holotype (pl. 41, fig. 10 a, b; here refigured in Figure 4a) is still septate and bears both primary and secondary ribs. However, *Proniceras* is a small genus (the maximum adult size is about 77 mm) and is a lappeted microconch. It has more numerous primary ribs (14 to 17) per half whorl, which are also sharper and stronger. Secondary ribs in *Proniceras* are also relatively few (two to three). Thus, *Proniceras* corresponds well with the early whorls of *Umiaites*.

Krishna et al. (1994) described *Spiticeras cf. ducale* (Matheron) from our collecting horizon and locality of the *Umiaites* in Kutch. *Spiticeras* is compressed, with ribs furcating high up on the sides into numerous secondary ribs, and lacking tubercles. It most closely resembles *Umiaites* and is dissimilar to *Spiticeras* Uhlig, 1903, the latter being coronate with the furcation point lying near the umbilical margin. Recently Yin and Enay (2004) correctly pointed out that the solitary specimen of Krishna et al. (1994) does not belong to *Spiticeras*, assigning it instead to *Proniceras*. However, the specimen is septate, has a diameter of 73 mm (incomplete specimen) and has multiple forwardly projected secondary ribs. Thus, it strongly resembles the present *Umiaites rajnathi* and is synonymised here. The tentative designation by Yin and Enay (2004) illustrates the fact that *Proniceras* is poorly distinguishable from the inner whorls of *Umiaites*, and that *Umiaites* was inadequately known to other workers mainly because of lack of illustration and incorrect description in the early Treatise (Arkell et al. 1957).

## REMARKS

*Umiaites* belongs to the subfamily Spiticeratinae, which also includes other genera including *Spiticeras* and *Proniceras*. Spiticeratinae are found in Indo-Madagascar, Caribbean provinces, and in

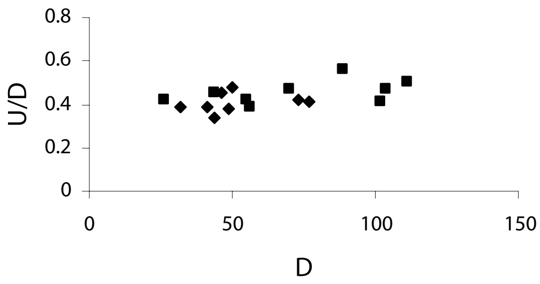


Fig. 4.1

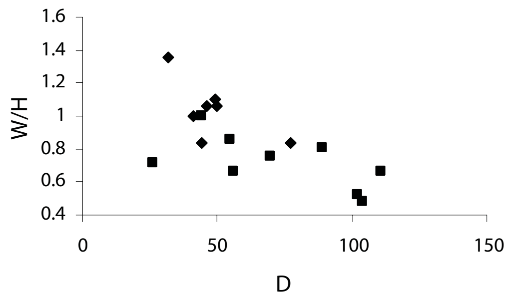


Fig. 4.2

**FIGURE 4. 4.1** Bivariate analysis involving degree of involution (U/D) vs. shell diameter of *Umiaites* (solid square) and *Proniceras* (solid diamond) of the world. Note similar degree of involution. **4.2.** Bivariate analysis involving degree of inflation (W/H) vs. shell diameter of *Umiaites rajnathi* and different species of *Proniceras*. Note scatter of points of early whorls of *U. rajnathi* correspond with those of *Pronicers* spp. Sources other than present study materials are Krishna et al. (1994), Imlay (1939), Collignon (1960) and Wright et al. (1996).

south and central Europe (Wright et al. 1996). *Umiaites* is so far known only from Kutch and is considered to be endemic. We have already mentioned the close correspondence between adult *Proniceras* and intermediate-sized *Umiaites*. *Proniceras* is a small genus and distributed in all major faunal provinces except the Andean (Arkell et al. 1957). Imlay (1939, pl. 18, figs. 5 and 6) reported one species from Mexico, *P. scorpionum* which bears an unmistakable lappet. As the microconch affinity is established, the possible macroconch requires investigation.

Dimorphism is not well known in Spiticeratinae, although in the descendant subfamily Olcostephanitinae it has been firmly established (Wright et al. 1996). Both in *Olcostephanus* Neumayr, 1875 and *Jeannoticeras* Thieuloy, 1965 microconchs are smaller, lappeted and strongly ornamented, with notably strong primary ribs. Secondaries in *Olcostephanus* microconchs are three to four in number, whereas they are numerous in macroconchs.

In Spiticeratinae, genera like *Negreliceras* Djanelide, 1922 and *Kilianiceras* Djanelide, 1922 are large, tuberculate and have also strong primaries and numerous fine secondaries. They appear to be macroconchs. Many species of *Spiticeras*, however, have a lappeted peristome (see Arkell et al. 1957), smaller adult size and are strongly tuberculate up to the end, resembling inner whorls of larger macroconchiate forms, a typical feature of ammonite dimorphism (see Callomon 1963; 1981b). Moreover, bituberculate stage in *Spiticeras* is suppressed compared to *Kilianiceras*. However, definite dimorphic pair recognition at the genus or species level is still elusive. Nature of dimorphism in both subfamilies appears to be more or less similar; microconchs being strongly ornamented and lappeted, and ornamentation continuing up to the end. They resemble inner whorls of macroconchs. Dimorphism has now become a very reliable tool in tracing phylogenies, "for it makes it possible to predict what a hitherto unrecognized or undiscovered dimorph might look like." (Callomon 1981b, p. 260). The same nature of dimorphism found in olcostephaniid phylogeny can also be observed between *Umiaites* and *Proniceras*.

*Proniceras* resembles intermediate-sized *Umiaites*, and both have common synapomorphic characters. For example, they share strong primary ribs, non-tuberculate shell and truncation of secondaries at the posterior end of the constriction, and similar septal sutural pattern. *Proniceras*, as with other microconchs of the family, is characterized by relatively stronger and fewer secondaries. Secondaries in *Umiaites* are generally finer and multifurcate in the adult phragmocone, but the ribbing pattern in inner whorls includes three secondaries. Morphometrically, the two genera also bear strong resemblance (Figures 4.1 and 4.2).

However, one point, which goes against the establishment of dimorphism between *Umiaites* and *Proniceras*, is the non-overlaping palaeobiogeographic distribution. *Umiaites* is endemic to Kutch while *Proniceras* is quasicosmopolitan. The objections raised against the disparity of distribution of two different sexes are well known in ammonite dimorphism. The sex ratio of ammonite macroconch and microconch varies in considerably; it may be 1:100 toward either sex (see for details in Callomon 1981b). But unlike Callomon's observation microconchs dominate Spiticeratinae assemblages. *Proniceras* and *Spiticeras* are not only widely distributed but are abundant locally or provincially (see for example Collignon 1960; Enay and Cariou 1997). Callomon (1981b) emphasized that it is very difficult to refute dimorphism unless the sample size comprises hundreds of adult specimens. The highly variable sex ratio is constrained by many factors, including biased collection, differential preservation and most importantly, migratory differences between the sexes and sexual segregation, which predominate in the living cephalopod community (see also Westermann 1990). Either variant can therefore occur to the total exclusion of others (Projeta and Gordon 1987). The Late Tithonian ammonite assemblage of Kutch was previously known by sparse genera (Spath 1931). Many new genera have been recently described (Shome et al. 2004, 2005; Shome and Roy 2006). Therefore, the discovery of *Proniceras* from Kutch may be a matter of time.

A literature search, however, reveals that *Umiaites* and *Proniceras* are not geographically mutually exclusive. Imlay (1939, pl. 18, figs. 1-3) described one *Proniceras* species, *P. jimulcense* from Mexico. The species is larger than the preserved diameter of 77 mm (a nearly complete whorl is missing). The ornamentation strikingly resembles the variocostate nature of *Umiaites* i.e., strong primaries and finer, denser secondaries, which include numerous intercalatory ribs. Moreover, its inner whorl corresponds with the adult *Proniceras scorpionum* described by Imlay (1939, pl. 18, figs. 5-6). Interestingly, they come from the same horizon and locality. Enay and Cariou (1997) recently mentioned large fragmentary specimens of the macroconch of *Proniceras* from Nepal, where the latter genus is particularly abundant in a single horizon. Photographs of *Proniceras* macroconch (Enay personal commun. 2005) strongly resemble the holotype of *Umiaites rajnathi* (Figure 4.1). This holotype is septate and bears both primary and secondary ribs until to its preserved end as with the *Proniceras* macroconch. Undescribed specimens of *Proniceras* macroconch has been reported from the Early Microcanthum Zone of southern Spain (Enay and Geyssant 1975). They appear to be adult with peristome preserved (Enay personal commun. 2005). Unfortunately, they can not be compared with the Kutch specimens, because body whorls are missing in the latter. However, they resemble adult *Proniceras* microconch.

One of the criteria for dimorphism is the parallel evolution of the two sexual variants (see Callomon 1963; 1981b). We also note that extinction is another attribute, which should show parallelism between the two variants. Remarkably, Proniceras and Umiaites evolved during the Late Tithonian and became extinct at the Jurassic-Cretaceous boundary, which is arguably a period of mass extinction (Bardhan et al. 2007). Le Hegarat, 1973 reported Proniceras from the Berriasian, but for Tithonian termination of the genus see Wright et al. 1996. Other members of the subfamily Spiticeratinae such as Spiticeras, Negreliceras, etc. occur above the Jurassic-Cretaceous boundary.

## CONCLUSIONS

The genus *Umiaites* was poorly known from the Tithonian of Kutch. A detailed taxonomic revision of the genus has been done, and its precise stratigraphic position has been established. *Umiaites* is a macroconch, but its microconchiate counterpart has yet to be identified in Kutch. *Proniceras* has been considered as the possible microconch but the dimorphs do not have overlapping palaeobiogeography. The reasons for this conclusion have been discussed in detail. Similar stratigraphic distribution and contemporaneous extinction has been considered important in establishing dimorphism, and there is growing evidence that dimorphism is apparent in the assemblages of many genera. Our interpretation of the published literature suggests that the macroconch of *Umiaites* occurs, but was not recognised, in *Proniceras* assemblages reported from different regions.

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