

ON SOME NEW DISCOVERIES OF SUBFAMILY BULLATIMORPHITINAE FROM THE LOWER CHARI FORMATION OF KACHCHH, WESTERN INDIA

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ABSTRACT

A new microconch species of *B. (B.) densicostatum* is described and illustrated from the Lower Chari Formation in the Jumara Dome, Kachchh, western India. Other occurrences of the species of subfamily Bullatimorphitinae in Kachchh are also discussed and a brief biostratigraphic review of the Patcham Formation in the Jumara Dome is provided.

Key words: Jumara Dome, Kachchh, Lower Chari Formation, Bullatimorphitinae.

INTRODUCTION

The Jumara Dome, in Kachchh (fig. 1), is a prime reference area for the Jurassic Indo-East African faunal province (= Indo-Malagch, Indo-Himalayan or Ethiopian faunal province of authors) (Waagen, 1875; Spath, 1927-33; Raj Nath, 1932; Krishna and Westermann, 1985, 1987; Westermann and Callomon, 1988; Callomon, 1993; Jain, Callomon and Pandey, 1996 and Jain, 1997). It has acquired importance because of its well exposed 437 m thick

Bathonian and Callovian sedimentary sequences assigned to the Patcham and Chari Formations.

Raj Nath (1932) divided the Jumara section into 26 beds from top to bottom. But his description was vague and general in nature. In spite of this, his section has been the basis for various *Macrocephalites* Zones/ Assemblages/ Association, often establishing precise East-West correlation with other faunal realms (Krishna and Westermann, 1985, 1987; Cariou and Krishna, 1988; Krishna and Cariou, 1986,

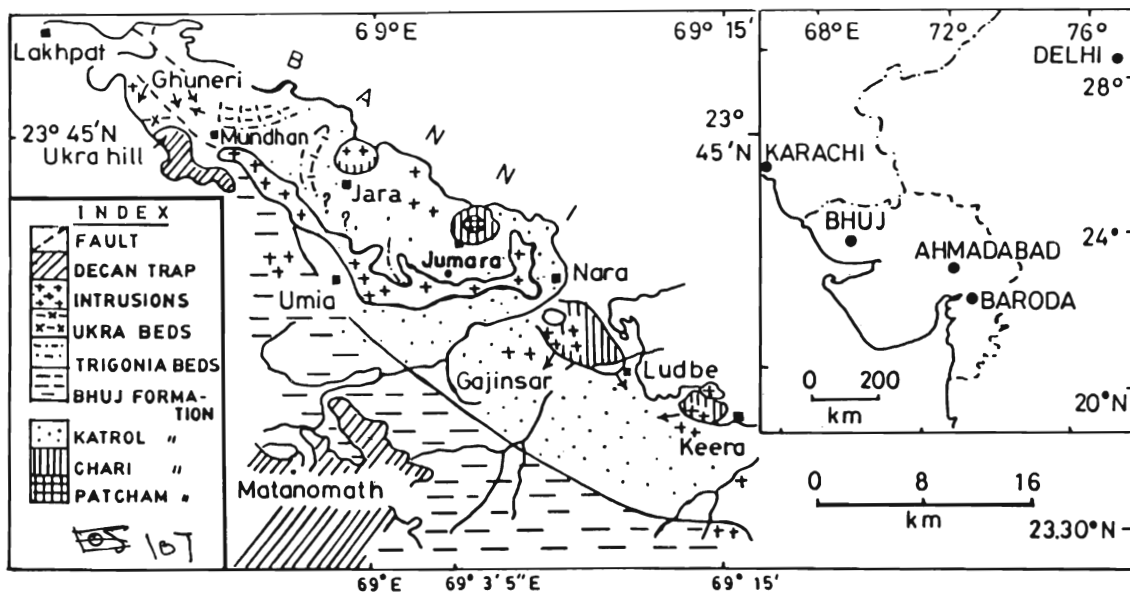


Fig. 1. Map of the Jurassic outcrops in Kachchh, India (modified after Raj Nath, 1932).

Table 1: Litho- and Chronostratigraphic correlation of the beds exposed in the Jumara Dome, as identified by different authors.

		Raj Nath (1932)			Spath (1927-33)		JK & W* (1987)	Present Work (1998)							
Formation	Age	Bed Nos.	Lithology	Thick-ness (mt.)	Beds	Age	Age	Age	Bed. Nos.	Thick-ness (mt.)	Levels (mt.)				
CHARI	CALLOVIAN	5	Massive sandstone & shales	3	Lower Anceps Beds	CALLOVIAN	MIDDLE CALLOVIAN	MIDDLE CALLOVIAN	C5-C12	21.5	315.5				
		6	Yellow shale band highly rich	3	Upper Rehmanni Beds				-	0.5	294				
		7	Yellow nodular bed (Zeilleria zone)	16.47					Lower Rehmanni Beds	C4	0.5	293.5			
		7a	Shales							C3	5.5	293			
		8	Another fossiliferous band	4.58	Lower Rehmanni Beds				C2-C1	12.5	287.5				
		9	First shelly layer with strong shales over it						?	-	-				
		10	Yellow nodular bed	1.22	Upper Macrocephalus Beds				UPPER BATHONIAN	LOWER CALLOVIAN	LOWER CALLOVIAN	B40-42	2.25	267	
		11	Another nodular yellow bed	3								B39	1	-	
		12	Fe-bed (highly rich in plant fossils also)	2.75								B34-36	2.5	261	
		13	Ferruginous bed	7.32								B32	2.5	255	
		14	Calcareous shelly bed rich in <i>Belemnites</i>	3.66		B26-28	3.5	244.5							
		15	Ferruginous bed	22.9		B25	16	241							
		16	Ferruginous sandstone	1.03		B16	3.5	183.5							
		17	Highly fossiliferous bed	4.27		B14	3.75	157.5							
		18	Calcareous bed	12.8		B12	1.75	-							
		19	Shelly band	113.08		Lower Middle Macrocephalus Beds	B10	6				144.5			
		20	??		B1-9		76.5	121.75							
		21	Green sandy shales	5.49	Lower Macrocephalus Beds	UPPER BATHONIAN	UPPER BATHONIAN	UPPER BATHONIAN	A8	18	48.5				
		22	Cream-coloured nodular limestone —Unconformity—						15.27	Lower Macrocephalus Beds	A7	15.5	30.5		
		23	Craggy sandstone & brown shales								0.15	Coral Beds	A6	9	15
		24	Cream coloured limestone										A5	2.5	6
25	Thin brown calcareous bed	0.15	Coral Beds						LOWER BATHONIAN	UPPER BATHONIAN	UPPER BATHONIAN	A4	0.5	3.5	
26	Yellow calcareous sandy bed											? MIDDLE -	A3	0.5	3
				A2	0.5	2.5									
				A1	2	2									

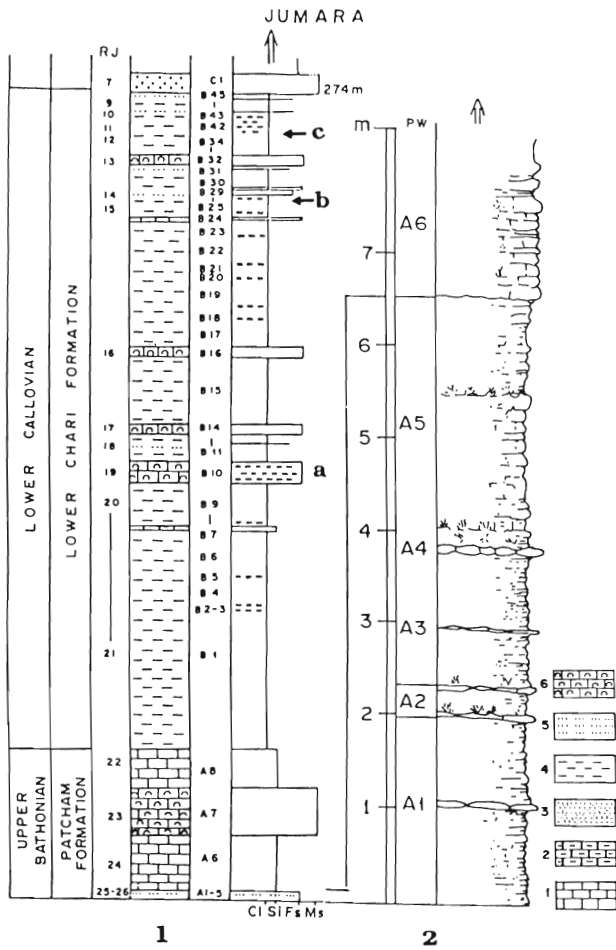


Fig. 2. Stratigraphic section in the Jumara Dome.

Key : 1. ash grey coloured limestone; 2. ironstone; 3. sandstone, occasionally oolitic; 4. shale; 5. siltstone; 6. packstone. Cl: clay; Si: silt; Fs: fine sand; Ms: medium sand. Dark dashes within the section indicates concretion levels. a: *B.(K.) cf. cosmopolitum*, bed no. B10 (RN bed no. 19); b: *B.(B.) densicostatum*, bed no. B27 (RN bed no. 14); c: *B.(K.) cf. bullatus*, bed no. B35 (RN bed no. 12).

1990, 1993). Recently, (Bardhan, Datta, Jana and Pramanik, 1994) in a review of the subgenus *Bullatimorphites* (*Kheraiceras*) clumped several beds together, thus identifying only 15 beds in their 250m thick Jumara section, with no detail description of the beds nor any reference to the Raj Nath's bed numbers. The present author found the Lower Chari sequence alone to be 229 m thick and identified 45 beds (B1-B45) which have been correlated with beds of Raj Nath (1932; see Table 1). For ready reference the present bed numbers have been correlated with those of Bardhan *et al.* (1994) and Raj Nath (1932) (see Table 2).

Table 2. Correlation of beds of present study with those of Raj Nath (1932) and Bardhan *et al.* (1994).

Present Work	Raj Nath (1932)	Bardhan <i>et al.</i> (1994)
C9-C12		10
C4-C8	5	9
C1-C3		8
B45	8	7
B12-B44	18-9	6
B1-?B11	21-?18	5
A8	22	4
A7	23	3
A6	24	2
A1-A5	25-26	1

This Lower Chari section (beds B1-B45)(fig. 2) is dominated by shales which contains the bulk of the fauna. The Lower Chari beds at Jumara are sandwiched between the resistant white to cream carbonates of the Patcham Formation (Raj Nath's bed nos. 22-26) on the northern flank, and the ridge-forming brown oolitic sandstone of the Middle Chari Formation (Raj Nath's bed no. 5) on the southern flank. The soft beds are shales (often silty, marly or gypsiferous) forming slopes, while hard beds of packstone, ironstone and siltstone crop out as small eroded ridges or hills, never exceeding 10-15m in height. Hard beds which regularly crop out in this shaly sequence are essentially packstones, being poorly sorted and greenish red in colour, reaching up to 6.5m in thickness but usually ranging from 0.50m to 3m. The other hard beds are of siltstone and ironstone. Pale yellow to grey coloured siltstone beds are well sorted, thinly laminated and fine grained, cropping out in different gullies across the dome. Concretions occur throughout the shaly sequence as somewhat resistant concretion beds or as components of shell beds (Jain, 1995; Jain and Pandey, *in press*)

DISCUSSION

All the specimens of the subgenus *Bullatimorphites* (*Kheraiceras*) Spath (Family Tullitidae, subfamily Bullatimorphitinae) so far recorded from the Jumara Dome come from the 229 m thick Lower Chari Formation of the Lower Callovian age. Elsewhere, this subgenus has been found to range from the Upper Bathonian to the Lower Callovian (Callomon, Dietl and Niederhofer,

1992). *Bullatimorphites* (*Bullatimorphites*) has also been recorded in the upper part of the Patcham Formation (Upper Bathonian) of the Jumara Dome (Bardhan and Datta, 1987). In fact, *Bullatimorphites* (*Bullatimorphites*) and *Bullatimorphites* (*Kheraicerias*) overlap in the Upper Bathonian (Westermann and Callomon, 1988), being merely successive segments of the same lineage. The dividing line between the two subgenera is somewhat arbitrary and the retention of the two subgeneric names is an historical convention (Personal communication, Callomon, 1996). Bardhan, *et al.* (1994) treated *Bullatimorphites* and *Kheraicerias* as separate genera, contrary to Westermann and Callomon (1988), who classified *Bullatimorphites* and *Kheraicerias* as transient subgenera of the undivided genus *Bullatimorphites* Buckman, 1921. This approach is also followed in the present work. Both subgenera are dimorphic. Macroconch and microconchs are indicated as [M] and [m] in the usual way.

Both these taxa are potentially important as guide fossils because of their wide geographic distribution and also because of the various stratigraphic ranges of these species (Westermann and Callomon, 1988; Donovan, Callomon and Howarth, 1981).

In the Kachchh basin, the subgenus *Bullatimorphites* is rare and its age has been shown to range from the Middle Bathonian to the latest Upper Bathonian (Pandey and Westermann, 1988). True *Kheraicerias* had so far been reported only from the Lower Callovian sediments.

The known occurrences of the two subgenera are briefly reviewed below.

(A) *Bullatimorphites* (*Bullatimorphites*)

1. *Bullatimorphites* (s.s) n. sp. A. [M], Pandey and Westermann (1988, p. 149, fig 2; see also Pandey and Callomon, 1995, p. 125): This form was recorded from the Gora Dongar (White hills), Pachchham Island, in association with *Procerites* (*Gracilisphinctes*) *arkelli* Collignon and *Clydoniceras triangulare* Pandey and Agrawal. The overlying bed has yielded *P. cf. schloenbachi* (Grossouvre), *P.*

(*Gracilisphinctes*) *arkelli* Collignon, *Micromphalites* (*Clydomphalites*) cf. *clydocromphalus* Arkell, and *Clydoniceras pachchhemense* Pandey and Agrawal. On the strength of this association, a Middle Bathonian age has been advocated (Pandey and Callomon, 1995).

2. *Bullatimorphites* (*Bullatimorphites*) sp. [M], Bardhan *et al.* (1988, p. 24, pl. 1): came from a "cream coloured limestone" of the Patcham Formation of the Jumara Dome about "15 m below the Patcham-Chari boundary" (Table 3). It was found associated with *Macrocephalites triangularis* Spath, *Procerites hians* (Waagen), *Sivajiceras congener* (Waagen) and *Paracenoceras jumarensense* (Waagen). Bardhan, Khan and Bhaumik (1988) did not mention as to where the Patcham-Chari boundary has been drawn.

Table 3. Litho-biostratigraphy at Jumara (Modified after Jain *et al.* 1996)

Beds	Lithology	Faunal Elements	Mts.
Chari Formation			
B1	Soft, fine-grained shales, lowest part not exposed.	<i>M. madagascariensis</i> [M], <i>M. transitorius</i> [M], <i>M. elephantinus</i> [M] <i>M. subcompressus</i> [m], <i>M. dimerus</i> [m].	
—contact not seen—			
Patcham Formation			
A6-A8	Raj Nath's bed nos. 22-24, Lower <i>Macrocephalus</i> Beds of Spath		
A8	Sponge bed. White, well-bedded limestone with alternating bands of hard micrite	<i>Choffatia</i> spp. [M], <i>M. triangularis</i> [M], <i>M. subcompressus</i> [m], <i>M. dimerus</i> [m], <i>Sivajiceras congener</i> [M and m], <i>M. transitorius</i> [M], <i>M. madagascariensis</i> [M] <i>Paracenoceras jumarensense</i> , abundant sponges, rhynchonellids and terebratulids with rare corals and some bivalves.	18
A7	Light brown echinoderm packstone. Cross-bedded and hard (sandstone of several authors; Raj Nath's bed no. 23) — sharp boundary—	<i>Choffatia</i> spp., <i>M. triangularis</i> [M], <i>S. cf. congener</i> [m] and rare bivalves.	12

A6	White to cream, fine grained micritic limestone	<i>M. dimerus</i> [m], <i>M. triangularis</i> [M], <i>M. transitorius</i> [M], <i>M. subcompressus</i> [m], <i>S. congener</i> [M and m] and <i>Choffatia</i> sp., <i>Parapatoceras tuberculatum</i> , <i>Parapatoceras</i> sp. with abundant corals and some rhynchonellids and terebratulids.	14
A4-A5	Coral Beds, Raj Nath's bed no. 24-25, Patcham Coral Bed of Spath		
A5	Fine grained micritic limestone with abundant corals forming shell beds (Upper Diverse Coral Beds of Jain <i>et al.</i> 1996)	<i>Procymatoceras</i> cf. <i>intumescens</i> , <i>Procerites</i> cf. or aff. <i>hodsoni</i>	2.5
A4	Hard calcarenitic, biomicritic limestone (Yellow Bed; Lower Diverse Coral Bed of Jain <i>et al.</i> 1996)	<i>Procerites</i> cf. or aff. <i>hodsoni</i> , <i>M. triangularis</i> [M and m], <i>M. madagascariensis</i> [M], <i>Siemiradzka</i> cf. or aff. <i>verciacensis</i> , <i>S. congener</i> [M], <i>Procerites hians</i> [M], <i>Indocephalites transitorius</i> [M], <i>Reineckeia</i> sp. [M], <i>Parapatoceras distans</i> , <i>Homoeoplanulites</i> sp. juv., abundant bivalves, brachiopods and gastropods with echinoid ossicles and <i>Belmnites</i>	0.1-2
A1-A3	Raj Nath's bed no. 26 (Patcham Shelly limestone of Spath)		
A-3	Soft marly limestone	few bivalves	1.5
A2	Marly limestone with packstone interbeds	<i>M. madagascariensis</i> [M], abundant corals dominated by <i>Microsolena</i>	0.5
A1	Marls or soft micritic limestone —lower beds not exposed—	few bivalves	1-2

There are thus only two possibilities for the proper stratigraphic position of this taxon: either it came from the Sponge bed, the Raj Nath's bed no. 22; the bed no. A8 of present work) which is the topmost unit of the Patcham Formation (about 18m thick), or from the limestone beds underlying the prominent ridge-forming echinoderm packstone in the core of the dome, about 30m below the true Patcham-Chari boundary (Raj Nath's bed no. 24; bed no. A6 of present work). Bardhan *et al.*'s 1988 specimen, except for its small size, closely resembles *B. cf. hannoveranus* Roemer (1911, p1. 8, fig 1; Hahn 1971, p1. 6, fig. 3) from the Upper Bathonian

Oxycerites orbis Zone of Germany and with *B. cf. hannoveranus* (Mangold 1971, figs. 96-97) from the Upper Bathonian *Prohcticoceras retrocostatum* Zone of the Southern Jura.

Thus, in Kachchh, *Bullatimorphites* (*Bullatimorphites*) has been found so far to range from Middle Bathonian to Upper Bathonian.

(B) *Bullatimorphites* (*Kheraiceras*)

1.B. (*Kheraiceras*) *cosmopolitum* Parona and Bonarelli [M] and [M]

- a. Keera, Golden Oolite - Waagen (1875), [M] only. Precise locality unknown.? *Madagascariensis* Zone (Holotype).
- b. Keera, Golden Oolite - Krishna, Cariou, and Enay (1988), [M] only. *Madagascariensis* Zone.
- c. Keera, Golden Oolite - Bardhan *et al.* (1994), [M] and [m] *Madagascariensis* Zone.
- d. Jumara, Raj Nath's bed nos. 5-7 Bardhan *et al.* (1994), [M] only, [Middle and Upper *Macrocephalus* Zones of Spath (1933); from 2 (*Madagascariensis*) to 6 (*Semilaevis*) *Macrocephalites* Associations of Krishna and Westermann (1987)].
- e. Jumara, *Macrocephalus* Zone - Spath (1931), [m] only. Callovian. Precise locality unknown.
- f. Jumara, Raj Nath's bed no 19 - Present Collection, [M] only [Middle and Upper *Macrocephalus* beds of Spath (1933)].

Bardhan *et al.* (1994) recorded *B. (Kheraiceras)* as spanning the entire Middle and Upper *Macrocephalus* beds of Spath [Their bed nos. 5-7; Raj Nath's bed nos. 8-21(see Table 2); Krishna and Westermann's *Macrocephalites* Assemblage 2 to 6 (*Madagascariensis* to *Semilaevis* Zones)]. In fact Bardhan's bed no. 7 (of upper Lower Callovian age) underlies the ridge-forming brown oolitic sandstone of the southern flank which has yielded typical lower Middle Callovian forms. Lithologically, Raj Nath's bed no. 5 (sandstone ridge) includes Bardhan's bed nos. 8-10 (*Semilaevis* Zone). The present author has, how-

ever, not recorded any specimen from such a high horizon. Elsewhere, *B. (Kheraicerias)* has been found to range from Upper Bathonian to Lower Callovian (Westermann and Callomon, 1988; Sandoval, Westermann and Marshall, 1990) but in Kachchh this subgenus has only been reported from the Lower Callovian sediments. Its upper limit in Kachchh is much higher than that of in Europe.

REPOSITORY

All the specimens are lodged at the repository of the Department of Geology, University of Rajasthan, Jaipur- India.

SYSTEMATIC PALAEOONTOLOGY

Superfamily Perisphinctaceae Steinmann, 1890

Family Tulitidae Buckman, 1921

Genus Bullatimorphites Buckman, 1921

Subgenus Kheraicerias Spath, 1924

(Type Species : *Sphaeroceras cosmopolitum* Parona and Bonarelli, 1897)

Systematic remarks: Bardhan *et al.* (1994) considered their *Kheraicerias ex. gr. platystoma* (Reinecke) as a junior synonym of *K. cosmopolitum* (Parona and Bonarelli) as also the species reported by Krishna *et al.* (1988). Pandey and Westermann (1988) have already considered Kanjilal's (1988) *K. probullatum* as an inflated variant of *M. formosus* (Sowerby).

Bullatimorphites (Kheraicerias) cf. *cosmopolitum* Parona and Bonarilli [M]

(Pl. I, figs. 1-3)

Material: One nearly complete specimen (Ju/9/273).

Description: Shell almost complete, moderately involute, depressed with coarse and dense ornamentation. There are 26 primaries and 64 secondaries per whorl. These ribs are more closely spaced at the phragmocone which increases gradually near the end of the phragmocone. The primaries, arising from below the umbilical seam, are slightly rursiradiate. At the indistinct ventrolateral margin, they become slightly prorsiradiate and cross the broad venter with a very slight convexity. Just after the end of the

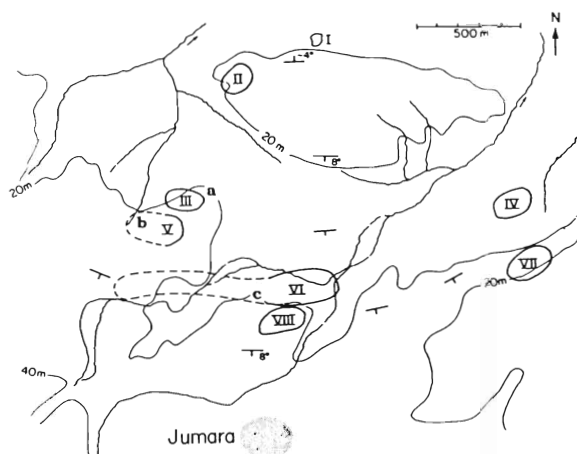


Fig. 3 Topographic contour map of the Jumara Dome. Krishna and Westermann's (1987) fossil localities indicated by enclosing circles. a: *B.(K.) cf. cosmopolitum*; b: *B.(B.) densicostatum*; c: *B.(K.) cf. bullatus*.

phragmocone a single constriction is present, which follows the ribbing pattern. Umbilical smoothening starts at this point and gradually increases with increasing shell diameter. The primaries are long, dividing variably from the lower third of the flank height to the middle, into 2 or 3 secondaries and show alternate pairing. Single ribs are also present. The ventrolateral margin is gradational and becomes indistinct with increasing diameter. Umbilical shoulder is broad with a sloping umbilical wall at initial stages but, with increasing shell diameter, becomes wide and steep. Phragmocone measures 35 to 40mm with the body chamber occupying 3/4 of the last whorl. Approximated maximum shell diameter is 55mm.

Dimensions : All dimensions are in millimeters.

D = Diameter, H = Whorl height, W = Whorl width and U = Umbilicus. Figures in parenthesis are dimensions expressed as percentage of the total diameter.

Sp. no.	D	H	W	U	W/H
Ju/9/273	at 35	23(66)	35(100)	c4(11)	1.52
	at 45	31(69)	44(98)	3.6(8)	1.43

Remarks: Relative proportions place this specimen close to the macroconch holotype of *K. cosmopolitum*, though stratigraphically, the present

specimen occurs at a much higher level in the Jumara Dome (at the top of the *Formosus* Zone of middle to upper Lower Callovian age) as compared to the type locality in the Keera Dome, in the *Madagascariensis* Zone of lower Lower Callovian age.

Interestingly, the ribbing pattern of the present specimen is also close to one of the Bardhan's illustrated microconch specimens [(1994, fig. 3(12-13)] recorded from the Jumara Dome just below the sandstone ridge (their bed no. 7, *Semilaevis* Zone).

The present specimen also closely resembles *Bullatimorphites* (*Kheraicerias*) *bullatus* [M] but differs from the latter by its small size and in possessing spindle-shaped inner whorls.

However, in view of the present specimen's somewhat differing morphological and stratigraphical position and its closeness to *Bullatimorphites* (*Kheraicerias*) *cosmopolitum* it is here identified as *B. (K.) cf. cosmopolitum* Parona and Bonarelli.

Occurrence and Age: Raj Nath's bed no. 19 (bed no. B10 of the present work), near Locality III of Krishna and Westermann, 1987; Fauna F (*Chrysoolithicus* Zone of Callomon, 1993).

Bullatimorphites (*Kheraicerias*) *cf. bullatus* Parona and Bonarelli [M]

(Pl. I, figs. 4-5)

Material: One specimen (Ju/9/272) with a complete phragmocone.

Description: The intermediate whorl of the phragmocone at 31mm diameter is sphaeroconic, moderately involute and depressed, with a broadly rounded whorl section. Phragmocone measures 55mm. in diameter. The maximum approximated diameter is of 70mm. The ribbing, visible on the intermediate whorl is moderately dense (24 primaries per whorl), slightly coarse and subdued. Distinct primaries arise from below the rounded umbilical margin. They are straight, prorsiradiate with radial arrangement. Single ribs are also present. Primaries strictly bifurcate, which is so characteristic of subgenus *Kheraicerias*. The branching is variable, from below the inner third to the middle of the flank height. A single constriction is also present, which follows the prorsiradiate ribbing pattern. Maximum whorl height

is just outside the rounded umbilical margin. Umbilicus small, deep, with vertical umbilical walls. At the smallest diameter, visible, the ventrolateral margin is broad and gradational but with increasing shell diameter the venter becomes wider and slightly tabulate to moderately flat.

Dimensions:

Sp. no.	D	H	W	U	W/H
Ju/9/272 at	32	19(61)	30(97)	4(13)	1.58
End of phrag.	55	33(60)	52(95)	4.7(9)	1.67

Remarks : The ribbing pattern is similar to that of the ultimate septate whorl of *Bullatimorphites* s.s. (Pandey and Westermann, 1988) from the Shell Limestone, WNW of Sadhara, Gora Dongar, Pachchham Island of Middle Bathonian age. Primaries in both the cases are long, straight, slightly prorsiradiate and radial.

The other comparable form is *Kheraicerias cosmopolitum* (Parona and Bonarelli [M]), but in spite of closely similar ornamentation, *K. cosmopolitum* is considerably more evolute (at comparable diameters of 27-34mm, U/D ratio is 25-26%; at 50-57mm it is 14.5% to 22%: see also Bardhan *et al.*, 1994) and more depressed (at diameters of 27 to 34 mm: T/H ratio is 2.3 to 2.6 at 50-57mm it is 1.9 to 2.7), though one of the Bardhan *et al.*'s specimen (Jum/K/4) has closely similar T/H ratio (1.48) but again it is also a very evolute form (U/D = 25 at 56mm).

As compared to *B. (K.) bullatus*, the phragmocone in the present specimen is equally depressed and similarly involute (see Westermann, 1958; Hahn, 1971; Sandoval, 1983 and Sandoval *et al.*, 1990) (see fig. 4 for comparison of whorl section). The present specimen also matches closely with the description of the nucleus of *B. (K.) bullatus* by Westermann (1958).

Sandoval's specimen of *B.(K.)* sp. 2 (1983, fig. 149; whorl section D) is also a close match for the present specimen as also is *B. (K.) bullatus* of Sandoval *et al.* (1990), though the former is measured at the beginning of the body chamber and the latter at the body chamber.

Intrestingly, *B.(K.) cosmopolitum* has often been considered as morphologically close to *B. (K.) bullatus* (Krishna *et al.*, 1988).

It is interesting to note that similar large forms of *B. (K.) bullatus* have also been recorded in Europe in the *Herveyi* Zone of early Lower Callovian age (Callomon, 1993). The present specimen supports this contention.

The earliest record of *B.(K.) bullatus* in Kachchh (though so far neither described nor illustrated) comes from the lowest bed of the Golden Oolite, bed 1g of Krishna and Cariou (1990) at Keera. According to them it belongs to their *Madagascariensis* Zone. But in one of their earlier papers (Krishna *et al.*, 1988), they indicate that this bed belongs to their *Chrysoolithicus* Zone which has rightly been confirmed by Callomon's (1993)

discussion on the stratigraphic occurrence of the subfamily Bullatimorphitinae in Kachchh.

Thus, it appears that *B.(K.) bullatus* in Kachchh ranges through the entire *Madagascariensis* Zone and into the *Semilaevis* Zone (from lower to upper Lower Callovian).

Occurrence and Age: Bed no. B35 (Raj Nath's bed no. 12), Lower Chari Formation, Lower Callovian, NW of the village of Jumara, near locality VI of Krishna and Westermann (1987).

Thus, specimens of *Kheraiceras* have so far been recorded in Kachchh only from the Lower Chari Formation (Lower Callovian).

Bullatimorphites (Bomburites) densicostatum
n. sp. [m]

(Pl. I, figs. 6-9)

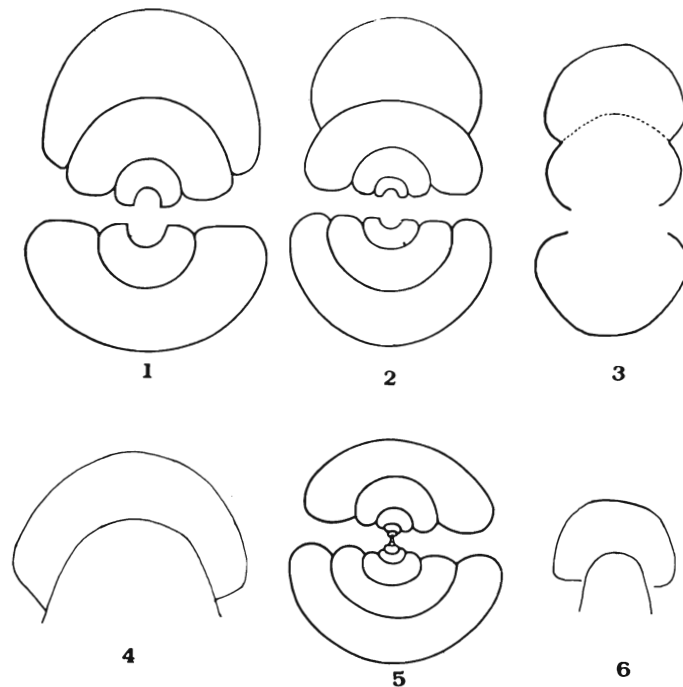


Fig. 4. Compare whorl sections of *Bullatimorphites (Kheraiceras)* (1-5) and *Bullatimorphites (Bullatimorphites)* (6) with that of the present specimens (in pl I, figs. 3 and 5). 1. *B. (K.) bullatus*, Hahn, 1971, fig. 12a at 68mm 2. *B. (K.) bullatus*, Quenstedt, 1887, pl. 78, fig. 30 (redrawn from Hahn, 1971, fig. 12 b) at 64mm, 3. *B.(K.)* sp. 2, Sandoval, 1983, fig. 149; whorl section D at 84mm 4. *B. (K.) bullatus*, Sandoval, *et. al.*, 1990, pl. 9, fig. 1b at 64mm. 5. *B. (K.) cosmopolitum*, Bardhan *et al.* 1994, fig. 4 at 57mm. 6. *B. (B.)* s.s., Pandey and Westermann, 1988, fig. 2(4) at 43mm.

Material: Holotype, Ju/9/271, nearly complete microconch.

Diagnosis: Shell small, involute, subsphaeroconic, elliptically coiled and densely ribbed with a hook-shaped, contracted body chamber.

Description: Shell small, involute, subsphaeroconic and elliptically coiled. Body chamber hook shaped, depressed, contracting towards aperture and partially covering the umbilicus. Venter convex, merging smoothly with flanks with maximum width near the sharp umbilical edge. Body chamber ornamented with very fine and dense ribs (8 primaries per 4mm at 18mm diameter) arising from the umbilical edge. The ribs become thicker (4 primaries per 4mm) towards the aperture. There are 38 primaries and 88 secondaries per whorl at the maximum diameter of 28mm.

Primaries are long, mostly bifurcating, rarely trifurcating on the ventrolateral region. Secondaries cross the venter with slight convexity towards the aperture and at places show alternate pairing. Suture line is poorly visible at 20 mm, marking boundary between phragmocone and body chamber.

Dimensions:

Sp no.	D	H	W	U	W/H
Ju/9/271	26	14.1(54)	18(69)	4.5(17)	1.3
at	23	13.5(59)	21(910)	4.1(18)	1.5

Remarks: As compared to the present specimen, the microconch of *B.(K.) cosmopolitum* is more involute, depressed with coarser and less dense costation at the same diameter. Secondaries in the former become indistinct near the aperture. The present specimen resembles Spath's *K. aff. cosmopolitum* (1931, pl. 96 figs. 8a-b) in its W/H ratio, but the latter form is larger and coarse ribbed with gradually fading primaries near the terminal constriction at the aperture. The primaries in Spath's specimen are shorter and somewhat more subdued. In fact, the Spath's form appears to be more closely allied to Hahn's *Bullatimorphites (Bomburites) suevicus* (1971. pl. 8, fig. 8) from the Upper Bathonian *Aspidoides* Zone of the S.W. Jura than to microconch specimens of *Kheraicerias cosmopolitum* (Bardhan *et al.*, 1994). The former was originally figured by Quenstedt (1887, pl. 78

fig. 5) as *Ammonites microstoma*. Sandoval *et al.* (1990, p. 133) treated it as a junior synonym of *Bullatimorphites (Bomburites) microstoma* (Orbigny). The Spath's specimen also closely resembles the holotype of *Bomburites devauxi* (De Grossouvre) but the former is less depressed.

Bomburites Arkell (1952; Arkell, Kummel and Wright, 1957) (without lappets), like the present specimen, also has a relatively involute shell with highly inflated whorls, a sudden contraction and an eccentric body chamber. The present specimen differs from the former in possessing a dense and fine ribbing pattern but lacks an eccentric *Bullatimorphites*-like outer whorl.

The present specimen thus, on account of its fine and dense ribbing pattern, does not match with any of the species of *B. (Kheraicerias)* Spath hitherto described.

Occurrence and Age: The specimen came from Bed no. B27 of Present work (= Bed No. 14 of Raj Nath; Locality V of Krishna and Westermann, 1987), Lower Chari Formation, North-west of the village of Jumara, Kachchh, W. India.

CONCLUSIONS

Bullatimorphites (Bomburites) densicostatum n. sp. appears to be morphologically closer to the European forms of the subgenus than to any of the illustrated Kachchh specimens (Spath, 1931; Bardhan *et al.*, 1994). This small and finely ribbed form points to a shift from the earlier known coarsely ribbed "conservative" subgenus *Bullatimorphites (Kheraicerias)*. No phylogenetic conclusions have been drawn.

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EXPLANATION OF PLATE

Plate I

- 1-3. *Bullatimorphites (Kheraicerias) cf. cosmopolitum* Parona and Bonarelli [M], Lower Callovian, Jumara, Kachchh, Ju/9/273, bed no. 19 of Raj Nath, Natural Size.
1. Lateral view.
 2. Ventral view.
 3. Lateral view.
- 4-5. *Bullatimorphites (Kheraicerias) cf. bullatus* [M], Lower Callovian, Jumara, Kachchh, Ju/9/272, bed no. 12 of Raj Nath, Natural Size.
4. Lateral view.
 5. Apertural view.
- 6-9. *Bullatimorphites (Bomburites) densicostatum n. sp.* [m]. Jumara, Kachchh, Ju/9/271, bed no. 14 of Raj Nath, x 2 magnification.
6. Lateral view.
 7. Opposite Lateral view.
 8. Ventral view.
 9. Apertural view.



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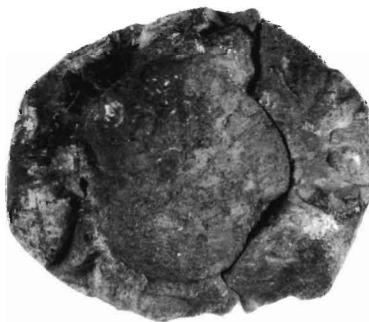
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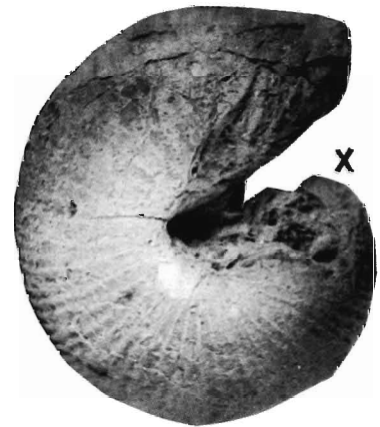
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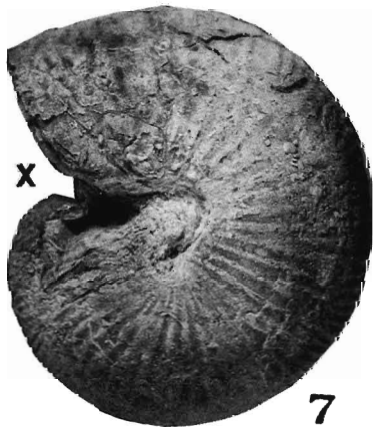
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