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The Middle Jurassic *Kheraiceras* SPATH 1924 from the Indian Subcontinent

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India
Middle Jurassic
Biostratigraphy
Correlation

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Kheraiceras SPATH 1924 aus dem Mittleren Jura des Indischen Subkontinents

Zusammenfassung

Kheraiceras SPATH 1924 hat mit Ausnahme des Subboreals nahezu weltweite Verbreitung und ist durch ein Bio-Event (Radiation) insbesondere während des oberen Bathoniums und des unteren Calloviums gekennzeichnet. Solch ein Bio-Event kann die Deutlichkeit der Faunenprovinzen verwischen und über geographische Grenzen hinweg bei der Errichtung eines regionalen chronostratigraphischen Standards und bei interprovinzieller Korrelation hilfreich sein. Die vorliegende Studie behandelt sechs Arten der Gattung *Kheraiceras* aus dem indischen Subkontinent (Kutch, Indien, Belutschistan, Pakistan) drei davon neu. *Kheraiceras cosmopolitum* (PARONA & BONARELLI), *K. bullatum* (D'ORBIGNY), *K. hannoveranum* (ROEMER), *K.* sp. A, B, C (= *Sphaeroceras bullatum* D'ORBIGNY, NOETLING 1896). Das biostratigraphische Potential der Gattung wird untersucht. Drei dimorphe Paare sind bekannt, zwei Mikrokonchen und einem Makrokonch fehlt der entsprechende Partner. Für die Definition der Arten, für Biozonierung und Evolution sind insbesondere die Mikrokonche von Bedeutung.

Abstract

Kheraiceras SPATH 1924 has a near circumglobal distribution except Subboreal and is marked by a "bio-event" (radiation) especially during the Late Bathonian and Early Callovian time. Such "bio-event" may blur the distinction of faunal provincialism and cut across geographic boundaries and thus help in establishing regional standard chronostratigraphy and interprovincial correlation. The present study reports six *Kheraiceras* species from the Indian subcontinent (Kutch, India and Baluchistan, Pakistan) including three new species. They are *Kheraiceras cosmopolitum* (PARONA & BONARELLI), *K. bullatum* (D'ORBIGNY), *K.* cf. *hannoveranum* (ROEMER), *K.* sp. A, *K.* sp. B and *K.* sp. C (= *Sphaeroceras bullatum* D'ORBIGNY, NOETLING 1896). Biostratigraphic potentialities of *Kheraiceras* are also explored. Dimorphism is well understood in the genus, but specific dimorphic pairs are poorly known. At least at three instances, matching of pairs has been firmly established and two other new microconchs and one macroconch still lack their partners. Microconchs are of great help in species discrimination, biozonation and understanding evolution.

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1. Introduction

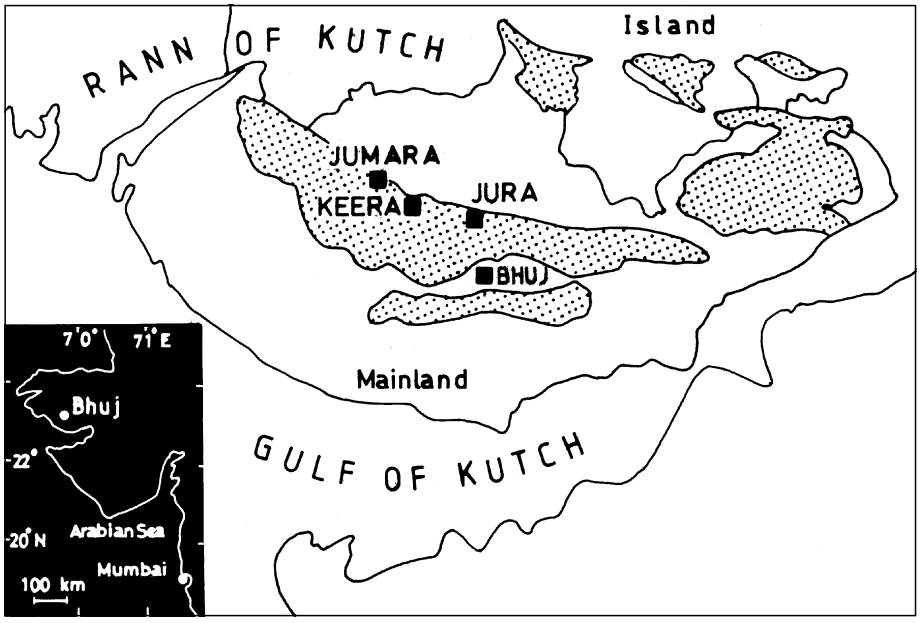
The genus *Kheraiceras* SPATH of the family Tulitidae (BUCKMAN 1921) has a near circumglobal distribution, particularly diverse in the Tethys. Although spanning a longer geologic time (Late Bathonian to Late Callovian, see HAHN [1969, 1971]), *Kheraiceras* is abundant and species-rich between the Late Bathonian and Early Callovian. During this time interval, *Kheraiceras* was distributed in many faunal provinces e.g., along the margins of the Tethys and the Pacific including Indonesia, North and South America (DONOVAN et al., 1981; MANGOLD, 1984; RICCARDI et al., 1989; SANDOVAL et al., 1990; WESTERMANN & RICCARDI, 1979). They are not, however, reported from the Boreal or Subboreal Provinces. This early radiational and migrational event makes *Kheraiceras* biostratigraphically an important taxon. In many places of the world particularly in Europe (e.g., England), the Lower Callovian standard zonations are based mainly on *Macrocephalites* species in the absence of *Kheraiceras* and reineckeiids (CALLOMON et al., 1989). Submediterranean France (CARIOU, 1984) otherwise is dominated by *Kheraiceras* and reineckeiids, and macrocephalitids are rare, thus making inter-provincial chronostratigraphic correlation tentative. Kutch in western India is a place where all these taxa co-exist at some levels in great abundance and diversity. Many *Kheraiceras* species are new, while some precisely-dated forms were not known until recently in Kutch. This provides unique opportunity for further improving the resolution of regional standard biozonations and intercontinental correlation with some degree of confidence.

In the present study, we report six *Kheraiceras* species which include three new forms and two other ones undescribed previously from the subcontinent (for detailed taxonomy see JANA et al., 2000). Dimorphism is now considered very important in understanding evolution within a lineage and must be taken into account in ammonite systematics. Although dimorphism in *Kheraiceras* is evident, we know little about specific dimorphic pairs (for details see BARDHAN et al., 1994). In the present study we have been able to match pairs at three instances. Besides, there are two new microconchs and one macroconch species whose counterparts are still not known. So far *Kheraiceras* are described in the literature mainly by macroconchs and microconchs are often rare. We have found plentiful microconch specimens with well preserved peristome showing apertural modifications, of most of the species described here. This will be of great help in correlation and age determination.

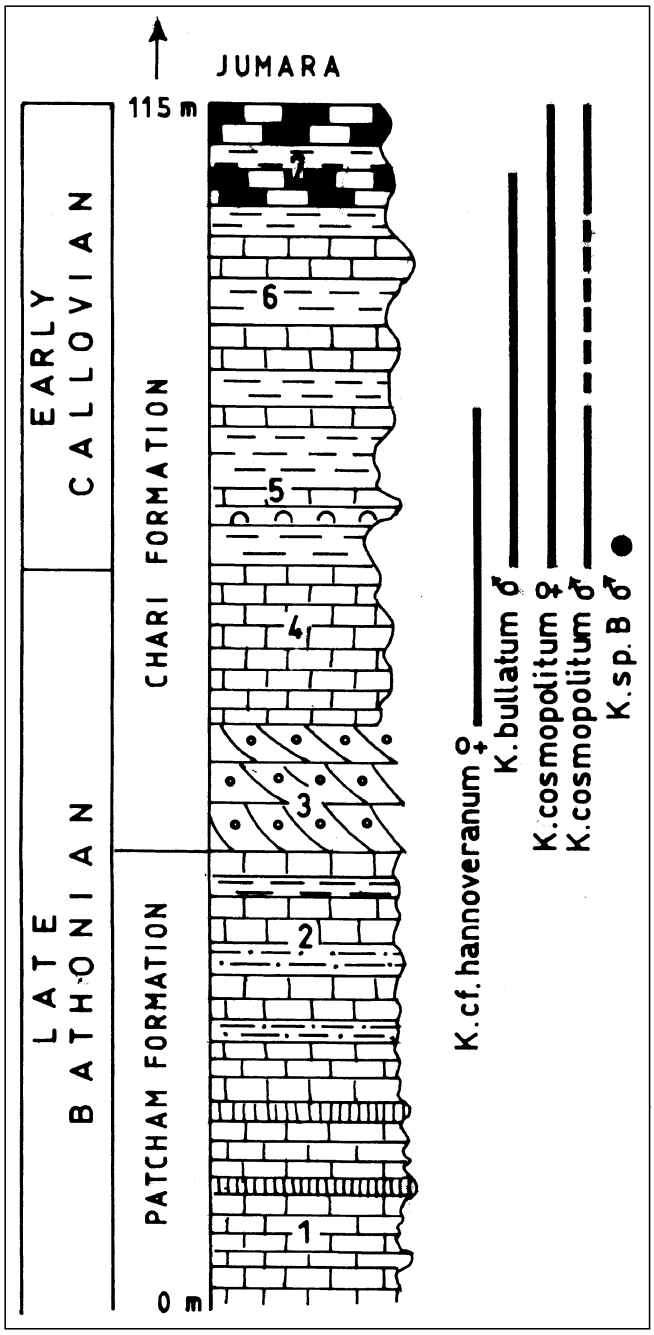
2. Geological Background

The present *Kheraiceras* spp. are recorded from rocks belonging to the Chari Formation spanning the Upper Bathonian to Oxfordian. The beds crop out in several structural domes including the present sections i.e., Jumara, Keera and Jhura (Text-Fig. 1). The Chari Formation, one of the four principal divisions of Kutch Mesozoic (see MITRA et al., 1979; KRISHNA, 1984) is a highly fossiliferous, regionally persistent unit. In Jumara, the type area of the Chari Formation, the older Patcham Formation is partially exposed and the sequence represents a near continuous stratigraphy mainly during the Late Bathonian–Callovian. High resolution facies analysis revealed two different environmental milieus during the deposition of the Patcham and Chari Formations (DATTA, 1992). The Patcham Formation represents sediments of shallow shelf carbonate environment and the Chari Formation represents mid-shelf argillaceous environment (DATTA, 1992; FÜRSICH et al., 1992; FÜRSICH & OSCHMANN, 1993). The Chari Formation constitutes heterolithic facies including shale, sandstone and limestone which is occasionally oolitic. Carbonates, though distributed occasionally throughout the sequence, are frequent in the lower part.

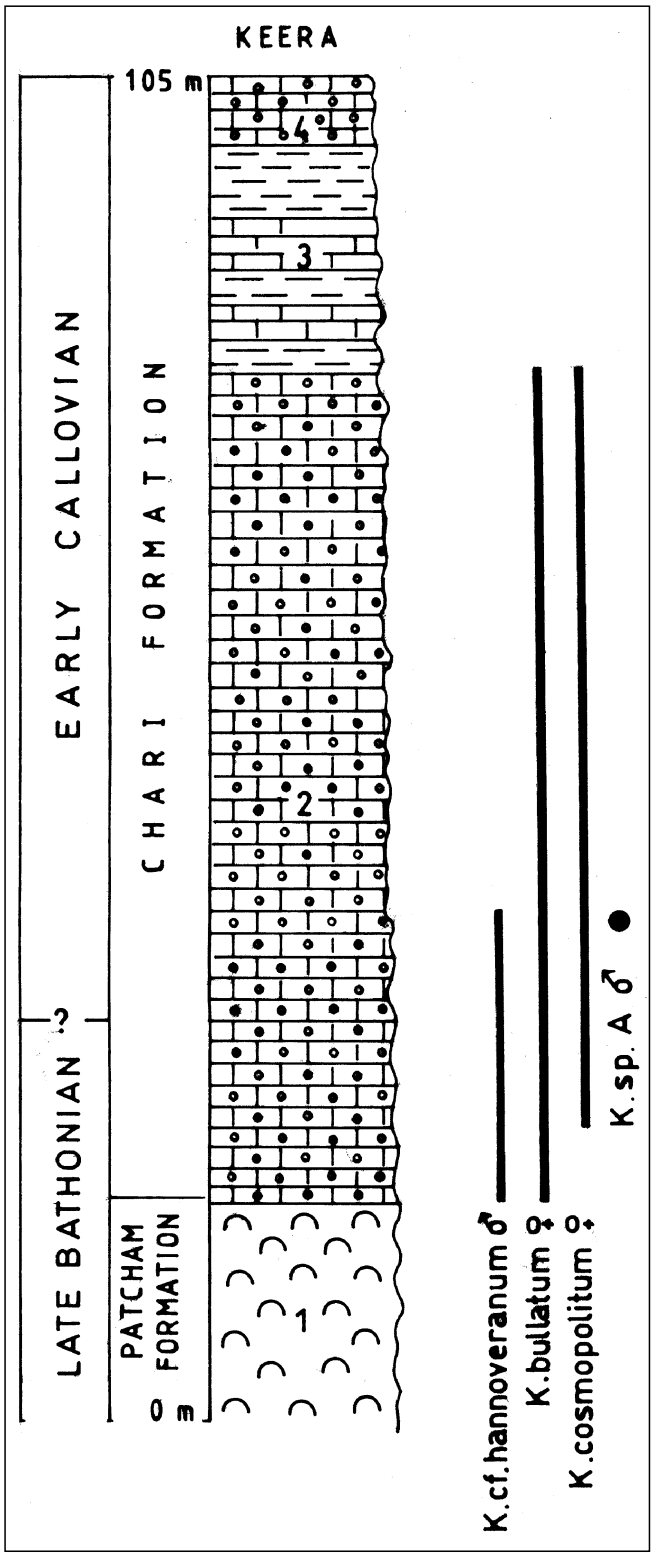
The specimens of the present *Kheraiceras* spp. have been collected from two sections in the mainland of Kutch i.e., Jumara, the type section of the Formation and Keera, the type locality of *Kheraiceras cosmopolitum*. In both areas they are found only in limestone. In Jumara, the specimens come from the Lower Chari Formation i.e., beds 4, 5, 6, and 7 of BARDHAN et al. [1994] (equivalent to beds 10–21 of CARIOU & KRISHNA, 1988) (Text-Fig. 2). These beds are mainly grey shelly limestone (packstone/grainstone) intercalated with greenish to grey shale and white limestone (mudstone/wackestone) of varying thickness. At Keera, specimens come from bed 2 (BARDHAN et al., 1994) and equivalent to bed 1 of CARIOU & KRISHNA (1988) (Text-Fig. 3). It is a 65 m thick golden coloured oolitic limestone (packstone/grainstone) and characterised by chevron and hummocky cross-stratification indicating a high energy environment (for detailed lithologic description and environment of deposition, see DATTA, 1992; BARDHAN et al., 1994).



Text-Fig. 1.
Sketch map of Kutch showing the location of Jumara, Keera and other fossil localities.



Text-Fig. 2.
Stratigraphic section at Jumara.
1 = coral biostrome; 2 = marl/shale alternation; 3 = lenticular green oolitic limestone; 4 = white/cream/brown limestone; 5,6 = shale/limestone alternation; 7 = grey shelly limestone with thin alternating bands of red/white limestone and grey shale. Range chart of different species of *Kheraiceras* is shown.



Text-Fig. 3.
Stratigraphic section at Keera.
1 = Bioclastic grainstone; 2 = golden oolitic limestone; 3 = shale/limestone alternation; 4 = brown oolitic limestone.
Stratigraphic distribution of different species of *Kheraiceras* is shown.

Several standard zonations within the Bathonian–Callovian Stages of Kutch have been attempted and ammonite successions are being continuously revised since SPATH (1927–1933). In recent years, several zonal schemes appear for different sections within mainland of Kutch (MITRA et al., 1979; BARDHAN & DATTA, 1987; KRISHNA & WESTERMANN, 1987; CARIOU & KRISHNA, 1988). Many of these suffer from lack of adequate control of precise stratigraphic and systematic positions of ammonites and other field data. We have been able to collect specimens bed by bed in many areas other than Jumara and Keera. The inconsistency in understanding quick lateral and temporal variation of different sedimentary facies has now been resolved.

We, here, provide a detailed biostratigraphic subdivision up to the level of faunal horizon for the Upper Bathonian – Lower Callovian Stages of Kutch (Table 1). *Kheraiceras* distribution is seen against this background. This is based on species of dominant ammonite families which have wide biogeographic distribution and potential for inter-provincial correlation (Tables 2,3).

Table 1.
The faunal horizons of the Upper Bathonian and Lower Callovian in Kutch, India.

	Faunal Horizon	Other important species	Localities (Bed no.)
XIII	*M. semilaevis*	*Subkossmatia opis, K. cosmopolitum, C. cobra, Collotia oxyptycha*	7d, Jumara; 1b, Jara
XII	*M. formosus*	*Reineckeia tyranniformis, K. cosmopolitum*	7c, Jumara; 1b, Jara; 2e, 3, Keera
XI	*M. (K.) lamellosus*	*K. cosmopolitum*	7b, Jumara; 2e, Keera
X	*M. (K.) dimerus*	*K. bullatum, K. cosmopolitum, C. furcula*	7a, Jumara; 2d, Keera; 1a, Jara
IX	*K. bullatum*	*C. recuperoi, K. cosmopolitum*	6b, Jumara; 2d, Keera
VIII	*M. (I.) diadematus*	*C. recuperoi*	6a, Jumara; 2c, Keera
VII	*Kheraiceras cosmopolitum*	*K. bullatum*, *K.* sp. B	5b, Jumara; 2b, Keera
VI	*M.* (I.) *transitorius*	*M. formosus, M. (K) lamellosus, M. (I) diadematus*	5a, Jumara; 2a, Keera
V	*M. madagascariensis*	*K.* cf. *hannoveranum, S. congener*	4b, Jumara; 23–27 Jhura
IV	*Sivajiceras congener*	*M. madagascariensis, M. (I) chrysoolithicus*	4a, Jumara
III	*M. (Indocephalites) chrysoolithicus*	*S. congener, Choffatia* sp.	2,3, Jumara; 1, Keera
II	*Macrocephalites triangularis*	*Epistrenoceras* sp. A	1b, Jumara; 15, Jhura
I	*Procerites hians*	*M. triangularis, Epimorphoceras decorum*	1a, Jumara

3. Biostratigraphic Subdivision

1) Hians horizon
Procerites hians abundant along with *Macrocephalites triangularis* (f & m). *Epimorphoceras decorum* (single specimen, only the holotype) comes from this horizon.
Reference section: Bed 1a, Jumara.

2) Triangularis horizon
M. triangularis (f & m) dominant, *P. hians* continues. This horizon marks the presence of the typical Late Bathonian genus *Epistrenoceras*.
Reference section: 1b, Jumara; Bed 15 of Biswas (1977), Jhura.

3) Chrysoolithicus horizon
Marked by the first appearance of *M. chrysoolithicus* and *Sivajiceras congener* and by the disappearance of *M. triangularis* and *P. hians*. Other allied species are *Choffatia* sp., (?) *Oxycerites* sp.
Reference section: 2 and 3, Jumara; 1, Keera.

4) Congener horizon
S. congener abundant along with *M. madagascariensis* (f & m) *M. chrysoolithicus* continues along with *Choffatia* sp.
Reference section: 4a, Jumara.

5) Madagascariensis horizon
M. madagascariensis (f & m) dominant along with *S. congener*. First appearance of *Kheraiceras* cf. *hannoveranum*; *M. chrysoolithicus*, *Choffatia* sp. continue.
Reference section: 4b, Jumara; 23–27 (Biswas, 1977), Jhura.

6) Transitorius horizon
Marks the first appearance of plentiful *M. transitorius* (f & m) along with *M. formosus*, *M. diadematus*, *M. lamellosus*. Also marked by the disappearance of *M. madagascariensis* and *S. congener* while *M. chrysoolithicus* continues. *Choffatia* sp. and *K.* cf. *hannoveranum* continue.
Reference section: 5a, Jumara; 2a of Keera.

7) Cosmopolitum horizon
Marks the first appearance of *Kheraiceras cosmopolitum*, *K.* sp. B. and *K. bullatum*. *M. transitorius* sparse while other macrocephalithids continue along with *Choffatia* sp.
Reference section: 5b, Jumara; 2b Keera.

8) Diadematus horizon
M. transitorius and *K.* cf. *hannoveranum* disappear. *M. diadematus* dominant, other macrocephalithids become increasingly dominant. *Choffatia recuperoi* appears. *K. cosmopolitum* continues, *K. bullatum* rare.
Reference section: 6a, Jumara; lower part of 2c, Keera.

9) Bullatum horizon
K. bullatum (f & m) fairly common. Macroconch is found in Keera and microconch in Jumara. Macrocephalithids, *C. recuperoi* and *K. cosmopolitum* continue.
Reference section: 6b, Jumara; lower part of bed 2d, Keera.

10) Dimerus horizon
Both f (magnumbilicatus) and m (dimerus) variants are common. Other macrocephalithids continue along with *K. bullatum* and *K. cosmopolitum*. *Choffatia* aff. *furcula* appears. *C. recuperoi* continues.
Reference section: 7a, Jumara; upper part of bed 2d, Keera; bed 1a, Jara.

11) Lamellosus horizon
Abundant *M. lamellosus* (f & m) while other macrocephalithids continue. *K. bullatum* disappears. *Choffatia recuperoi*, *K. cosmopolitum* continues.
Reference section: 7b, Jumara; 2e, Keera.

12) Formosus horizon
Acme of large, full-grown *M. formosus*. Both variants i.e., *chariensis* and *formosus* abundant. *Reineckeia tyrraniformis, R. anceps* appear. Other macrocephalitids, *K. cosmopolitum* and *C. recuperoi* continue.
Reference section: 7c, Jumara; 1b, Jara; 2e and 3, Keera.

13) Semilaevis horizon
First appearance of *M.* semilaevis. *M. formosus*, *M. lamellosus* and *K. cosmopolitum* continue. *Subkossmatia opis, Choffatia cobra* and *Collotia oxyptica* appear. *R. tyranniformis, R. anceps* and *C. recuperoi* continue.
Reference section: 7d, Jumara; 1b Jara.

Table 2.
Zonation of the Bathonian and Callovian Stages in Kutch, India and its correlation with the East Pacific and Madagascar scale.

AGE	KUTCH			EAST PACIFIC				MADAGASCAR
					ARGENTINA	NORTH CHILE	SOUTH MEXICO	
	ZONE	SUBZONE	FAUNAL HORIZON	ZONE	FAUNAL HORIZON	FAUNAL HORIZON	FAUNAL HORIZON	ZONE
LOWER CALLOVIAN	FORMOSUS	SEMILAEVIS	M. semilaevis	PROXIMUM			Hecticoceras boginense	PATINA
		FORMOSUS	M. formosus					CHARIENSIS
			M. lamellosus	BODENBENDERI				
							Rehmannia Asso.	
		DIADE-MATUS	M. dimerus				Clydoniceras inflatum Asso.	
			K. cf. bullatum					
			M. diadematus	VERGARENSIS				
		TRANSI-TORIUS	Kheraiceras cosmopolitum					
			M. transitorius					
U. BATHONIAN	CHRYSOO-LITHICUS	MADAGAS-CARIENSIS	M. madagascariensis	STEINMANNI	Stehnocephalites gerthi	Choffatia jupiter	Lilloettia-Neuqueniceras Association	
			Sivajiceras congener					
		CHRYSOO-LITHICUS	M. chrysoolithicus					
	TRIAN-GULARIS	TRIAN-GULARIS	Macrocephalites triangularis		(Choffatia aff. acqualis)	(Epistrenoceras) (Prohecticoceras blanazense)	(Epistrenoceras)	TRIANGULARIS
		HIANS	Procerites hians					

Table 3.
Zonation of the Bathonian and Callovian Stages in Kutch, India and its correlation with the zones of France, England and Germany.

AGE	KUTCH			FRANCE			ENGLAND			GERMANY		
	ZONE	SUBZONE	FAUNAL HORIZON	ZONE	SUBZONE	FAUNAL HORIZON	ZONE	SUBZONE	FAUNAL HORIZON	ZONE	SUBZONE	FAUNAL HORIZON
LOWER CALLOVIAN	FORMOSUS	SEMILAEVIS	M. semilaevis	GRACILIS	PATINA	H. kiliani	CALLOVIENSE	ENODATUM	S. enodatum	CALLOVIENSE	ENODATUM	M. tumidus
						H. boginense			S. enodatum			
									S. enodatum			
		FORMOSUS	M. formosus		MICHALSKII	Hecticoceras (Chanasia) michalskii		CALLOVIENSE	S. micans		CALLOVIENSE	Sigaloceras calloviense
									Sigaloceras calloviense			
							KOENIGI	GALILAEII	K. galilaeii		KOENIGI	K. (Gowerianus) galilaeii
			M. lamellosus		LAUGIERI	R. (R.) laugieri		CURTILOBUS	K. trichophorus			H. (Chanasia) descicum
									Cadoceras tolype			R. (R.) laugieri
									K. curtilobus			M. sp. nov. E
					PICTAVA	Reineckeia (T.) pictava		GOWERIANUS	K. gowerianus			M. macrocephalus
					REHMANNI	Rehmannia rehmanni			K. metorchus			Reineckeia (T.) tyrannа
		DIADEMATUS	M. dimerus	MACROCEPHALUS	PRAHECQUENSE	K. prahecquense	HERVEYI	KAMPTUS	M. kamptus	MACROCEPHALUS	KAMPTUS	K. (Goweric) sp. nov. A
			K. cf. bullatum						M. kamptus			
			M. diadematus		BULLATUS	Kheraiceras bullatus		TEREBRATUS	M. herveyi			C. sp. nov.E. quenstedti
									M. terebratus			K. (Gow.) toricelli
		TRANSITORIUS	Kheraiceras cosmopolitum					KEPPLERI	M. terebratus		MACROCEPHALUS	C. suevicum
			M. transitorius						Macrocephlites verus			Cadoceras quenstedti
									Kepplerites keppleri			Kepplerites keppleri
UPPER BATHONIAN	CHRYSOOLITHICUS	MADAGASCARIENSIS	M. madagascariensis	DISCUS	DISCUS	Clydoniceras discus	DISCUS	DISCUS	Homoeoplanulites crisphinctoides	DISCUS		
			Sivajiceras congener						Clydoniceras discus			
		CHRYSOOLITHICUS	M. chrysoolithicus		HOLLANDI	C. hollandi		HOLLANDI			HOLLANDI	
	TRIANGULARIS	TRIANGULARIS	Macrocephalites triangularis	RETROCOSTATUM	RETROCOSTATUM	Prohecticoceras retrocostatum	ASPIDOIDES or ORBIS			ASPIDOIDES	ASPIDOIDES	
					BLANAZENSE	P. blanazense					PARADOXUS	
		HIANS	Procerites hians			Procerites mirabilis					DENSECOSTATUS	

4. Systematic Palaeontology

Family: Tulitidae BUCKMAN 1921
Subfamily: Bullatimorphitinae CALLOMON, DIETL & NIEDERHÖFER 1992
Genus: *Kheraiceras* SPATH 1924

Kheraiceras cosmopolitum (PARONA & BONARELLI 1895) f & m

(Pl. 1, Figs. 1–4)

It is an endemic form spanning the entire Lower Callovian and recently described in detail (BARDHAN et al., 1994). Shell is sphaeroconic with highly inflated phragmocone (width : height = 2.8) and extremely depressed body chamber. It resembles some depressed variants of *K. bullatum* from other areas (e.g., SANDOVAL et al., 1990, Pl. 9, Fig. 1a–c), but the nature of dimorphism differs. Both macro- and microconch not only have a much inflated phragmocone and depressed aperture but also have a more aberrantly coiled body chamber than those of *K. bullatum*. Beginning of body chamber is marked by a whorl contraction and peculiar umbilical uncoiling which follows first a straight centrifugal line and then turns suddenly inwards with a U-turn. The microconch has relatively coarse, distant and less numbered secondary ribs than that of *K. bullatum*. The macroconch has feeble primaries which die out rapidly on the outer whorl.

Kheraiceras bullatum (D'ORBIGNY 1846) f & m

(Pl. 1, Figs. 5–6)

Macroconch shell medium sized, maximum diameter being about 60 cm. Body chamber ellipticonic, phragmocone relatively less depressed (W/H = 1.04 to 1.8) than that of *K. cosmopolitum*. Umbilicus is narrow with distinct margin and steeper wall. Flanks unlike those of *K. cosmopolitum* may be wide, flat to gently curved. Width of body chamber contracts maximum at middle part from where it gradually increases while whorl height shows negative allometry with increasing diameter. Ribbing dense and fine in inner whorls, relatively coarse and distant, and restricted to the venter of the adult body chamber. The microconch resembles macroconch in many features, but smaller (f : m = 1.42) with modified aperture. Peristome with slightly flared collar followed immediately by terminal constriction. Ribs prominent, continue till the end.

The macroconchs of the present form are closely allied to the type specimens of *K. bullatum* (D'ORBIGNY) (see ARKELL, 1954, Text-Fig. 34). *K. bullatum* in Europe as well as in S. America is now known from the Late Bathonian and spans up to the Early Callovian (RICCARDI et al., 1989; SANDOVAL et al., 1990). Up the sequence there is a distinct phyletic size decrease as experienced in Kutch as well as in France (see also KRISHNA & CARIOU, 1990). Our smallest adult macroconch variant comes from the highest level of the stratigraphic range of the species. The smaller adult size of the Kutch form may actually represent transient of younger stratigraphy or may be due to geographic variation.

The microconch resembles the macroconch of *K. bullatum* of both Kutch and European forms. In Kutch, both dimorphs come from coeval stratigraphic horizons, but significantly, they are mutually exclusive in geographic localities. While all macroconch specimens come from different levels at Keera within the Golden Oolite, the microconchiate forms are found only at Jumara in different horizons. This may perhaps imply sexual segregation. *Ammonites microstoma* D'ORBIGNY (see ARKELL, 1954, Text-Fig. 35) has a less depressed phragmocone than the present microconch and has gradual Bullatimorphites-like uncoiling of the body chamber.

Recently SANDOVAL et al. (1990) established a dimorphic pair of *K. bullatum* from the Upper Bathonian of Mexico. They described *Bomburites microstoma* as the possible microconch which differs from D'ORBIGNY's form, but strongly resembles the Kutch variant. One specimen (Pl. 9, 3a–c) in fact, appears to be identical.

Kheraiceras cf. *hannoveranum* (ROEMER 1911) f & m

(Pl. 1, Figs. 7–9)

Macroconch with less inflated (W/H = 1.4) phragmocone and less contracted body chamber. Observed maximum shell diameter being 100 mm. Shell coarsely ornate on body chamber, secondaries broad, distant and convex aborally. The microconch replicates the macroconch except being smaller (f : m = 2). Aperture missing. Both primaries and secondaries are coarse, distant and are present till to the end.

It can be distinguished from other species of *Kheraiceras* by its coarsely ornate form, sutural pattern and nature of dimorphism. The present species is morphometrically intermediate between highly depressed *K. cosmopolitum* and relatively compressed *K. bullatum*.

The present Kutch form resembles the lectotype of European *K. hannoveranum* from the Upper Bathonian, Orbis Zone of Germany in having less inflated phragmocone and persistence of strong, coarse ribbing to the end. JAIN et al. (1996) also compared one of the variants (Pl. 1, Fig. 8; see also BARDHAN et al. [1988, Pl. 1, Figs. a–c]) of the present Kutch form with *K.* cf. *hannoveranum* (ROEMER 1911, Pl. 8, Fig. 1; HAHN 1971, Pl. 7, Fig. 3) and *K.* cf. *hannoveranum* (MANGOLD 1970, 303 Figs. 96–97, cited in JAIN et al., 1996) from the Upper Bathonian Retrocostatum Zone of Southern Jura. CALLOMON (1993) even showed a resemblance of the Kutch specimen with *B. costatus* ARKELL (LISSAJOUS, 1923, p. 18, Fig. 2). But according to him the European form is larger and comes from an earlier zone, while the present form spans the Late Bathonian and the earliest Callovian. However, their close affinity to *K. hannoveranum* is evident and their smaller adult size may be due to geographic variation as well as to younger stratigraphic age, since phyletic size decrease is found in many species of *Kheraiceras*. *K. suevicum* (ROEMER, Pl. 7, Fig. 21) which CALLOMON (1993) compared with one of the present macroconchiate forms (Pl. 1, Fig. 8), has a comparable size and similar nature of ribbing to the present microconch. Recently SANDOVAL et al. (1990) described it as a microconch and synonymised it with *Bomburites microstoma*, microconch of *K. bullatum* from Mexico.

The finding of an adult microconch is very significant. It is strongly ornate on the outer whorl and ribbing continues to the end without loosing strength. Unfortunately, we are not aware of any microconchiate forms of *K. hannoveranum* described so far. *K. bullatum* is also a closely comparable form but the macroconch of the present species differs from that of *K. bullatum* described here by its relatively larger adult size, less contracted body chamber and retention of course, distant ribbing throughout the last whorl. In *K. bullatum*, both in Europe and Kutch, ribs are finer, restricted mainly to the venter and disappear at the end. Moreover, the number of secondaries in this species

is higher than that of *K.* cf. *hannoveranum*. Remarkably, these differences are also observed at the microconchiate level.

Kheraiceras sp. A m

(Pl. 1, Fig. 11)

Small, diameter being about 30 mm. Strongly involute inner whorls, phragmocone highly inflated (W/H = 1.8). Aperture missing. Body whorl highly contracted, barely touches the penultimate whorl. Ribs very fine, dense, 34 on first half of outer whorl.

This unique specimen has been recorded from the lower horizon of Bed 2 Keera, which also yields microconchs of *K.* cf. *hannoveranum*. The present form is very distinct and shows no affinity to other microconchiate forms from Kutch or the Callovian of Europe. Surprisingly it strongly recalls the holotype of much older *Bullatimorphites uhligi* (POPOVICI-HATZEG) (see ARKELL, 1954, Text-Fig. 36).

Both have characteristic fine, dense ribbing persisting on the body chamber and involute inner whorls. *K.* sp. A however is characterized by *Kheraiceras*-like aberrantly coiled outer whorl and the holotype of *B. uhligi* has incomplete body chamber.

Kheraiceras sp. B m

(Pl. 1, Fig. 12)

Small sized with phragmocone less depressed and evolute; highly contracted body chamber, width shows negative allometry during ontogeny. *Bullatimorphites*-like gradual uncoiling of umbilical seam. The aperture is marked by a deep constriction and preceded by a flared collar not well discernible in internal mould.

This species is from the basal part of a bed (5, Jumara) immediately above the Bathonian–Callovian boundary in Kutch. It is comparable with some European species e.g., *Ammonites microstoma* D'ORBIGNY refigured by ARKELL (1954, Text-Fig. 35) resembles the present form especially with respect to the nature of uncoiling, less depressed, evolute inner whorls and presence of deep terminal constriction. *A. microstoma* is now considered to be a microconch of *K. bullatum* (WESTERMANN & RICCARDI, 1979; WESTERMANN & CALLOMON, 1988).

Kheraiceras sp. C (= *Sphaeroceras bullatum* D'ORBIGNY, NOETLING 1896)

(Pl. 1, Fig. 10)

This species was described by NOETLING (1896) from the Upper Bathonian of Baluchistan. We recently inspected the only specimen kept at the repository (Type No. 2915) of the Geological Survey of India, Calcutta. The specimen is a hypermorphic giant, unusually large for the genus. It has an involute and cadiconic phragmocone (W/H = 2.7). The body chamber is in bare contact with the preceding whorl. Complete shell with 158 mm diameter. Both whorl height and width show positive allometry during late ontogeny. Primary ribs are prominent up to the end of the phragmocone, secondaries coarse, distinct and persist up to 3/4 of last whorl where they become obsolete and are restricted to the venter. NOETLING (1896) and ARKELL (1952) considered it to be conspecific with *Kheraiceras bullatum* of Europe. Recently, PANDEY and WESTERMANN (1988), and WESTERMANN and CALLOMON (1988) described it as *K.* cf. *bullatum*. Admittedly, it closely corresponds to the European form and *K. bullatum* is known from the Upper Bathonian of both Europe and South America (e.g., RICCARDI et al., 1989). But the adult size difference between them is remarkable and the Baluchistan form has coarse and distant secondaries. If they were conspecific, it would be the first Late Bathonian *K. bullatum* recorded from the Indian subcontinent. *K. bullatum* in both Europe and India shows phyletic size decrease with the advent of time and larger size of the Baluchistan form may be regarded as the older transient of the species.

5. Age and Correlation

The only species described from outside Kutch is *"Sphaeroceras bullatum"* D'ORBIGNY from the Polyphemus Limestone, Mazardrik, Baluchistan (NOETLING, 1896). Judging from the faunal association which includes the *Macrocephalites triangularis* "group", *Clydoniceras baluchistanense* (SPATH) and *Choffatia (Homoeoplanulites)* (SPATH), a Late Bathonian age of the species is certain (see also WESTERMANN & CALLOMON, 1988).

K. cf. *hannoveranum* appears in the Madagascariensis Subzone, Chrysoolithicus Zone (= upper Lower Macrocephalus Zone [SPATH 1933]) in the mainland of Kutch and continues up to the base of Transitorius Subzone of the succeeding Formosus Zone. *M. madagascariensis* is a large, involute species with highly variable whorl sections. It resembles *M. verus* BUCKMAN (= *M. macrocephalus* ZITTEL) of Europe (WESTERMANN & CALLOMON, 1988). The European form first appeared in the lowest faunal horizon, Bullatus Subzone in Submediterranean France (CARIOU, 1984) and Faunal Horizon II of Subboreal Province (CALLOMON et al., 1989a; CALLOMON et al., 1989b). We, therefore, in a previous attempt with others (DATTA et al., 1996) securely placed Madagascariensis Subzone at the Bathonian/Callovian boundary. Besides, the possible ancestor of *madagascariensis* i.e., *triangularis* comes from the immediately underlying Triangularis Zone and is widely believed by many of having a pre-Callovian affinity (BHAUMIK et al., 1993; CALLOMON, 1993; DATTA et al., 1996). In the absence of any time-diagnostic ammonite taxa, the precise age determination could not, however, be conclusively made. But recently, new record of *Epistrenoceras* BENTZ, co-occurring with *M. triangularis* now resolves the long-standing age problem (KAYAL & BARDHAN, 1998). *Epistrenoceras* is an excellent marker for correlation as it is known only from Upper Bathonian horizons throughout the world (TORRENS, 1980; DIETL, 1982; WESTERMANN et al., 1984).

The present species i. e., *K.* cf. *hannoveranum* strongly resembles *K. hannoveranum* of Europe where the latter is considered as an important taxon of the middle Late Bathonian. Thus judging from this viewpoints the age of Madagascariensis Subzone can also be assigned to the Late Bathonian. However, unlike in Europe, this species continued further into the lowest Callovian in Kutch.

SPATH (1925) described *Kheraiceras* ? *stansfieldi* (Plate 1, Fig. 2a, b) from the "Lower Callovian", Macrocephalus Zone of Madagascar. It is similarly depressed and has similar ribbing like *K.* cf. *hannoveranum*. Interestingly, it is recorded from the same locality and horizon from where *Macrocephalites madagascariensis* also comes.

K. hannoveranum is restricted to the Tethys and its margin including Europe and India. SANDOVAL et al. (1990) reported *"Bullatimorphites (Kheraiceras) bullatus"* from the Upper Bathonian Steinmanni Zone of South Mexico (Table 2). One specimen (Plate 9, Fig. 4a–c) appears to be coarsely ornate with widely spacing ribbing and less inflated phragmocone. Body chamber is also less contracted. More important is that ribbing persists till to the end of

body chamber without any loss of strength. The body chamber is less aberrantly coiled and hence inner whorls are well exposed with relatively wide umbilicus. Thus it closely resembles the coeval Indian *K.* cf. *hannoveranum* of the present study.

Kheraiceras cosmopolitum, which is the most abundant, spans the entire Formosus Zone (Middle and Upper Macrocephalus Zones, SPATH, 1933) (DATTA, 1992). This zone can be approximately correlated with the Lower Callovian Macrocephalus and Gracilis Zones of France (see also KRISHNA & WESTERMANN, 1985, 1987). *K. bullatum* (D'ORBIGNY) has a similar lower limit but lasted briefly in Kutch and persisted up to the top of Diadematus Subzone, i.e. Dimerus Faunal Horizon (Table 3). *M. dimerus* which is the characteristic ammonite of this level, is equivalent to *M. kamptus* of England (CALLOMON, 1993). KRISHNA & CARIOU (1990) also mentioned (not illustrated) the species from the same level at Keera and correlated it with the upper Herveyi Zone of Europe, Bullatus Subzone of France. *K.* cf. *bullatum* is also reported from the East Pacific Faunal Province. Here, it appears in the lower part of Steinmanni Zone (= upper part of the Retrocostatum Zone or coeval Aspidoides Zone of Europe) and is associated with *Epistrenoceras histricoides* indicating Late Bathonian age (SANDOVAL et al., 1990). In Argentina it continues into the Vergarensis Zone (RICCARDI et al., 1989, Fig. 2) which is equivalent to lower part of the Macrocephalus Zone of Submediterranean France. *K. cosmopolitum*, however, continued further in Kutch and persisted up to the top ofthe Semilaevis Subzone. In the upper part of the Formosus Subzone it occurs with *Reineckeia anceps* (REINECKE) (= *R. indosabauda* PARONA & BONARELLI of SPATH) (KAYAL, pers. comm., 1999). This early appearance of *Reineckeia* in Kutch has been overlooked by many earlier workers (e.g., KRISHNA & WESTERMANN, 1985; KRISHNA & CARIOU, 1986, 1990; CARIOU & KRISHNA, 1988) but not by WAAGEN (1875) and SPATH (1927–33).

The Indian "type specimen" of *"R. indosabauda"*, described by WAAGEN as *Perisphinctes rehmanni* comes from his Macrocephalus shales (= bed 3, above the Golden Oolite of Keera, which also yields *M. formosus*). The holotype of SPATH's (1927) *R. tyranniformis* also interestingly comes from the Golden Oolite of Keera. Here, these two species co-occur with *K. cosmopolitum* and *Macrocephalites* spp. which belong to the Formosus Subzone (middle to upper part of the Dimerus Zone of CARIOU & KRISHNA, 1988). One of us (S.B.) with others (BARDHAN & KAYAL, to be communicated) collected quite a sizeable number of specimens belonging to these two reineckeiid species from the same level at Keera and the equivalent levels at Jumara and Jara. In a recent report JAIN et al. (1996) brings down the lower stratigraphic range of *Reineckeia* in Kutch even up to the Late Bathonian.

It is also interesting to note that first *Reineckeia*, like in Europe, appeared in Kutch at a level after the disappearance of *Kheraiceras bullatum*. This level judging by its macrocephalitid association may be correlated with the middle part of the Gracilis Zone including Michalskii Subzone of CARIOU (1984). Recently KRISHNA & CARIOU (1990) recorded *Hecticoceras michalskii* presumably from this level.

Finally, *K. cosmopolitum* disappeared at the top of the Semilaevis Subzone where all the Kutch macrocephalitids also ended. This corresponds to the Patina Subzone of the Gracilis Zone of France (see also KRISHNA & CARIOU, 1990) and Faunal Horizon XVII, Enodatum Subzone, Britain (CALLOMON et al., 1989).

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Plate 1

Figs. 1–4: ***Kheraiceras cosmopolitum*** **(PARONA & BONARELLI) f. & m.**
- Fig. 1: Mostly internal mould with incompletely preserved adult body chamber, lateral view. Holotype f, Type No. 2009, from the Golden Oolite of Keera, Bed 2.
- Fig. 2: Adult specimen with last quarter of body chamber missing, f. From bed 5, Jumara, JUM/J/5, lateral view.
- Fig. 3: Young, phragmocone, internal mould f; note extremely depressed whorl section, apertural view. From Bed 2, Keera.
- Fig. 4: Almost complete specimen m. From Bed 7, Jumara, JUM/J/6, lateral view.

Figs. 5–6: ***Kheraiceras bullatum*** **(D'ORBIGNY) f. & m.**
- Fig. 5: Adult with almost completely preserved body chamber, f. Mostly internal mould, from Bed 2, Keera, JUM/K/12, lateral view.
- Fig. 6: Adult with terminal constriction preserved near the flank, m. From Bed 6, Jumara, JUM/J/12, lateral view.

Figs. 7–9: ***Kheraiceras*** **cf.** ***hannoveranum*** **(ROEMER) f. & m.**
- Fig. 7: Almost complete adult specimen f., other side damaged. From Polyphemus Limestone, Mazar Drik, Baluchistan, kept in Indian Museum, Calcutta, no. H. 48.607, lateral view.
- Fig. 8: Adult with last 1/3 of the body chamber missing, f. From Bed 4, Jumara, JUM/P-2, lateral view.
- Fig. 9: Almost completely adult aperture missing, m. From Bed 2, Keera, JUM/K/7, lateral view; note presence of coarse, distant ribbing to the end.

Fig. 10: ***Kheraiceras*** **sp. C f.**
Complete adult specimen.
Polyphemus Limestone, Mazar Drik, Baluchistan, kept in repository Geological Survey of India, Calcutta, no. 2915, lateral view.

Fig. 11: ***Kheraiceras*** **sp. A m.**
Adult with almost completely preserved body chamber.
Bed 2, Keera, JUM/K/16, lateral view.

Fig. 12: ***Kheraiceras*** **sp. B m.**
Adult with lappet, Bed 5, Jumara, JUM/J/15, lateral view.

All Figures 88 % of natural size

References

ARKELL, W.J., 1952–54: The English Bathonian ammonites. – Palaeontographical Society, 106–107 (3–4), 73–128, London.

BARDHAN, S. & DATTA, K., 1987: Description and stratigraphic distribution of *Kheraiceras* SPATH, 1924 in Kutch, India. – Mesozoic Research, **1**, 147–150.

BARDHAN , S., DATTA, K., JANA, S.K. & PRAMANIK, D., 1994: Dimorphism in *Kheraiceras* SPATH from the Callovian Chari Formation, Kutch, India. – Journal of Paleontology, **68**(2), 287–293.

BARDHAN, S., DATTA, K., KHAN, D. & BHAUMIK, D., 1988: Tulitidae genus *Bullatimorphites* from Upper Bathonian Patcham Formation, Kutch, India. – Newsletters on Stratigraphy, **20**, 21–27.

BHAUMIK, D., DATTA, K., JANA, S.K. & BARDHAN, S., 1993: Taxonomy and intraspecific variation of *Macrocephalites formosus* (SOWERBY) from the Jurassic Chari Formation, Kutch, Western India. – Journal of Geological Society of India, **42**, 163–179.

BISWAS, S.K., 1977: Mesozoic rock-stratigraphy of Kutch, Gujarat. – Quarternary Journal of Geological, Mining and Metallurgical Society of India, **49**, 1–51.

BUCKMAN, S.S., 1909–30: Type Ammonites. – 790 p., Wheldon and Wesley, London.

CALLOMON, J.H. 1993: On *Perisphinctes congener* WAAGEN, 1875, and the age of the Patcham Limestone in the Middle Jurassic of Jumara, Kutch, India. – Geologische Blätter von N-Bayern, **43**, 227–246.

CALLOMON, J.H., DIETL, G. & NIEDERHOFER, H.J., 1989a: Die Ammonitenfaunen-Horizonte im Grenzbereich Bathonium–Callovium des Schwäbischen Juras und deren Korrelation mit W-Frankreich und England. – Stuttgarter Beiträge zur Naturkunde, Serie B, **148**, 1–13.

CALLOMON, J.H., DIETL, G. & PAGE, K.N., 1989b: On the ammonite faunal horizons and standard zonations of the Lower Callovian Stage in Europe. – In: ROCHA, R.B. & ZEISS, A. (eds.): 2nd International Symposium on Jurassic Stratigraphy, Lisboa 1987, **1**, 359–376; Lisboa.

CALLOMON, J.H., DIETL, G. & NIEDERHÖFER, H.J., 1992: On the true stratigraphic position of *Macrocephalites macrocephalus* (SCHLOTHEIM, 1813) and the nomenclature of the standard Middle Jurassic "Macrocephalus Zone". – Stuttgarter Beiträge zur Naturkunde, B, **185**, 1–65.

CARIOU, E., 1984: Biostratigraphic Subdivisions of the Callovian Stage in the Subtethyan province of ammonites, correlations with the Subboreal zonal scale. – In: MICHELSEN, O. & ZEISS, A. (eds.): International Symposium on Jurassic Stratigraphy (I.U.G.S.), **1**, 315–326, Erlangen.

CARIOU, E. & KRISHNA, J., 1988: The Tethyan Reineckeiinae of Kachchh and Jaisalmer (West India): Systematic, biostratigraphic and biogeographic implications. – Palaeontographica (A), **203**, 149–170.

DATTA, K., 1992: Facies, fauna and sequence: an integrated approach in the Jurassic Patcham and Chari Formations, Kutch, India. – Unpublished Ph.D. dissertation, Jadavpur University, Calcutta, 167 p.

DATTA, K., BHAUMIK, D., JANA, S.K. & BARDHAN, S., 1996: Age, ontogeny and dimorphism of *Macrocephalites triangularis* SPATH – the oldest macrocephalitid ammonite from Kutch, India. – Journal of Geological Society of India, **47**, 447–458.

DIETL, G., 1982: The real stratigraphic position of *Ammonites aspidoides* OPPEL (Ammonoidea, Middle Jurassic) of the locus typicus. – Stuttgarter Beiträge zur Naturkunde Serie B, **87**, 1–21.

DONOVAN, D.T., CALLOMON, J.H. & HOWARTH, M.K., 1981: Classification of the Jurassic Ammonitina. – In: HOUSE, M.R. & SENIOR, J.R. (eds.): The Ammonoidea, Systematic Association, Special Volume, London, **18**, 101–155.

FÜRSICH, F.T., OSCHMANN, W., SINGH, I.B. & JAITLY, A.K., 1992: Hardgrounds, reworked concretion levels and condensed horizons in the Jurassic of Western India: Their significance for basin analysis. – Journal of the Geological Society, London, **149**, 323–331.

FÜRSICH, F.T. & OSCHMANN, W., 1993: Shell beds as tools in basin analysis: the Jurassic of Kachchh, Western India. – Journal of the Geological Society, London, **150**, 169–185.

HAHN, W., 1969: Die Perisphinctidae STEINMANN (Ammonoidea) des Bathonium (Brauner Jura) in Südwest-deutschen Jura. – Jahreshefte des Geologischen Landesamts von Baden – Württemberg, **11**, 29–86.

HAHN, W., 1971: Die Tulitidae S. BUCKMAN, Sphaeroceratidae S. BUCKMAN und Clydoniceratidae S. BUCKMAN (Ammonoidea) des Bathonium (Brauner Jura) in Südwest-deutschen Jura. – Jahreshefte des Geologischen Landesamts von Baden – Württemberg, **13**, 55–122.

JAIN, S., CALLOMON, J.H. & PANDEY, D.K., 1996: On the earliest known occurrence of the Middle Jurassic ammonite genus *Reineckeia* in the Upper Bathonian of Jumara, Kachchh, Western India. – Paläont. Z., **70**, 129–143.

JANA, S.K., BARDHAN, S. & SARDAR, S.K., 2000: *Kheraiceras* SPATH (Ammonoidea) – new forms and records from the Middle Jurassic sequence of Indian Subcontinent. – Paleontological Research, **4**(3), 205–225.

KAYAL, A. & BARDHAN, S., 1998: *Epistrenoceras* BENTZ (Ammonoidea) from the Middle Jurassic of Kutch (Western India): a new record and its chronostratigraphic implication. – Canadian Journal of Earth Sciences, Ottawa, **35**, 931–935.

KRISHNA, J., 1984: Current status of the Jurassic stratigraphy of Kachchh, Western India – In: MICHELSEN, O. & ZEISS, A. (eds.): International Symposium on Jurassic Stratigraphy, Erlangen, **3**, 731–742.

KRISHNA, J. & CARIOU, E., 1986: The Callovian of Western India: new data on the biostratigraphy, biogeography of the Ammonites and correlation with Western Tethys (Submediterranean Province). – Newsletters on Stratigraphy, **17**(1), 1–8.

KRISHNA, J. & CARIOU, E., 1990: Ammonoid faunal exchanges during the Lower Callovian between the Indo-East-African and Submediterranean Provinces: Implications for the long distance East-West Correlations. – Newsletters on Stratigraphy, **23**(2), 109–122.

KRISHNA, J. & WESTERMANN, G.E.G., 1985: Progress report on the Middle Jurassic ammonite zones of Kachchh, West India. – Newsletters on Stratigraphy, **14**, 1–11.

KRISHNA, J. & WESTERMANN, G.E.G., 1987: Faunal association of the Middle Jurassic ammonite genus *Macrocephalites* in Kachchh, West India. – Canadian Journal of Earth Sciences, **24**, 1570–1582.

LISSAJOUS, M., 1923: Etude sur la Faune du Bathonien des Environs de Macon. – Travaux des Laboratories de la Faculté des Sciences, Lyon, **3**, 273 p.

MANGOLD, C., 1970: Stratigraphie des Étages Bathonien et Callovien du Jura méridional. – Docum. Lab. Géol. Fac. Sci. Lyon, **41**.

MANGOLD, C., 1984: Report of the Bathonian Working Group. – In: MICHELSEN, O. & ZEISS, A. (eds.): International Symposium on Jurassic Stratigraphy, Erlangen, (I.U.G.S.), **1**, 67–76.

MITRA, K.C., BARDHAN, S. & BHATTACHARYA, D., 1979: A study of Mesozoic stratigraphy of Kutch, Gujarat with a special reference to rock-stratigraphy and biostratigraphy of Keera dome. – Bulletin of Indian Geologists' Association, **12**, 129–143.

NOETLING, F., 1896: Fauna of the Kellaways of Mazar Drik. – Palaeontologia Indica, Series **16**, 1, 1–22.

PANDEY, D.K. & WESTERMANN, G.E.G., 1988: First record of Bathonian *Bullatimorphites* (Jurassic, Ammonitina) from Kachchh, India. – Journal of Paleontology, **62**, 148–150.

RICCARDI, A.G., WESTERMANN, G.E.G., & ELMI, S., 1989: The Middle Jurassic Bathonian–Callovian Ammonites Zones of the Argentine-Chilean Andes. – Geobios, **22**(5), 553–597.

ROEMER, J., 1911: Die Fauna der Aspidoides-Schichten von Lechstedt bei Hildesheim. – Inaugural-Diss. Univ. Göttingen, 64 S., Gîttingen.

SANDOVAL, J., WESTERMANN, G.E.G. & MARSHALL, M.C., 1990: Ammonite fauna, stratigraphy and ecology of the Bathonian–Callovian (Jurassic) Tecocyunca Group, South Mexico. – Palaeontographica, A, **210**, 93–149.

SPATH, L.F., 1925: Jurassic Cephalopoda from Madagascar. – Bulletins of American Paleontology, **11**(44), 6–29.

SPATH, L.F., 1927–33: Revision of Jurassic cephalopod fauna of Kachh (Cutch). – Palaeontologia Indica, New Series **9**, Memoir 2(1–6), 1-945.

TORRENS, H.S., 1980: Bathonian correlation chart. – In: COPE, J.C.W.: A correlation of Jurassic rocks in the British Isles, Part two: Middle and Upper Jurassic, Geological Society, London, Special Report No. **15**, 21–45.

WAAGEN, W., 1875: Jurassic fauna of Kutch, the Cephalopoda. – Palaeontologia Indica, Series **9**, Memoir 1, 1–247.

WESTERMANN, G.E.G. & CALLOMON, J.H., 1988: The Macrocephalitinae and associated Bathonian and Early Callovian (Jurassic) ammonoids of the Sula Islands and New Guinea. – Palaeontographica, (A) **203**, 1–90.

WESTERMANN, G.E.G. & RICCARDI, A.G., 1979: Middle Jurassic ammonoid fauna and biochronology of the Argentine-Chilean Andes, Part II: Bajocian Stephanocerataceae. – Palaeontographica (A), **164**, 85–188.

WESTERMANN, G.E.G., CORONA, R. & CARRASCO, R., 1984: The Andean Mid-Jurassic *Neuqueniceras* Ammonite Assemblage of Cualac. – Geological Association of Canada, Special Paper **27**, 99–112, Ottawa.

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