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ON SOME AMMONOIDEA, PELECYPODA (MOLLUSCA), BRACHIOPODA AND REPTILIAN FOSSILS FROM JURASSIC OF KUTCH, GUJARAT

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INTRODUCTION

The Ammonoidea have been extinct long back but their shells in fossilized forms are seen in all the continental areas and many oceanic islands. Numbers of specimens are well preserved and their significance as a basis for lithostratigraphic interrelation has long been recognized by the palaeontologists. Hence, existing information on this group is sizeable one. The understanding about this group has eventually developed through the study of their shells and enclosing rock matrices, and occasionally of a few preserved opercula. The shells of ammonoids are comparable with those of extinct *Nautilus*, which are considered to be a close relative of the former. The nautiloids and ammonoids constitute the Subclass Terebranchiata. They were widespread in the past but are now represented by several species of the Genus *Nautilus* only. Most ammonoids had a relatively long centre of gravity. However, some forms with body chambers about a volution in length may have been able to invert themselves.

The ancient Terebranchiates lived in the oceans and the seas over the globe and most of the known fossil forms have been recovered from the rocks, which represent shallow water marine deposits. In the Ordovician, they were an eminent group of animals. They continued to thrive in the Silurian, and in early Devonian the ammonoids evolved from the nautiloids. Throughout the Mesozoic period ammonoids were more abundant than the nautiloids. However, at the end of the Mesozoic period the former became extinct and the latter one survived with less occurrence. The ammonoids are excellent stratigraphic indices and the marine strata of late Palaeozoic and the Mesozoic are marked with their representatives. The ammonoids are characteristically tightly coiled in a plane and symmetrical, with a bulbous calcareous protoconch, septa forming angular sutural flexures, and a small marginal siphuncule.

Studies on marine Mesozoic succession of Kutch have brought on record diverse molluscan forms of which ammonoids are prevalent. The first comprehensive work on ammonoid was carried out by Waagen (1873–75) and it was elaborated subsequently by Spath (1927–33). Later on, considerable works have come out on the rock stratigraphy and biostratigraphy of

Kutch (Nath, 1932; Agrwal, 1958; Biswas, 1977; Kanjilal, 1978; Mitra *et al.*, 1979; Krishna, 1984; Bardhan *et al.*, 1988; Singh, 1989; Bardhan *et al.*, 1994a, 1994b; Halder & Bardhan, 1996a, 1996b, 1997 etc.). However, it is presumed that a lot more interesting forms are yet to be recovered from this area. The identification of ammonoids requires a careful approach as many individuals of the same population may exhibit considerable variability in their morphological features. Otherwise, a multiplicity of names or misallocation of names would result out of a non-conservative approach. Exact naming of the species have therefore, not been done in this study but the characters of different forms with illustrations are provided for record and understanding of the others.

The present account incorporates the result of a study of a collection of ammonoids, pelecypods and reptilian fossils from Kutch region of Gujarat State (see Map). Their significance in intercontinental correlation is also indicated herein.

STRATIGRAPHY

Lithologically the Jurassic rocks of Kutch have been divided into four subdivisions *i.e.*, Patcham, Chari, Katrol and Bhuj Formations in ascending order and these range from Bathonian to Aptian ages (Waagen, 1873; Nath, 1932; Mitra *et al.*, 1979; Krishna, 1984; Table 1). The Chari Formation, one of the important units of Mesozoic Kutch, is thick, persistent and exposed throughout the Kutch mainland (Nath, 1932; Biswas, 1977; Mitra *et al.*, 1979). It crops out into several structural domes and attains a maximum thickness of 204 m. (Datta, 1992). It ranges in ages from the Callovian to the Late Oxfordian and with its lower boundary extended into the Late Bathonian (Datta *et al.*, 1996; Halder & Bardhan, 1996). The Chari Formation supports a rich biota in places where the full sequence is exposed (Halder & Bardhan, 1997). Its lithologies include mainly shale, sandstone and limestone which were deposited in a warm shallow marine environment (Datta, 1992; Fürsich & Oschmann, 1993). Upper part of the beds contain diverse fossils, in which ammonites are represented by *Macrocephalites madagascariensis* Lemoine, *Indocephalites chrysoothicus* (Waagen), *Sivajiceras congener* (Waagen), etc. Besides, numerous bivalves, brachiopods, corals and sponges characterize this zone (Halder & Bardhan, 1997). Judging from the ammonite association, especially *Macrocephalites* spp., the beds can be assigned an age range from Upper Bathonian to Lower Callovian (Krishna & Westermann, 1987; Datta *et al.*, 1991; Table 2).

Table 1. Lithostratigraphic divisions of Jurassic of Kutch (modified from Krishna *et al*, 1983).

Lithostratigraphic Unit	Age
Bhuj Formation	Upper Tithonian – Aptian
Katrol Formation	Kimmeridgian – Lower to Middle Tithonian
Chari Formation	Upper Bathonian – Upper Oxfordian
Patcham Formation	Bajocian – Bathonian

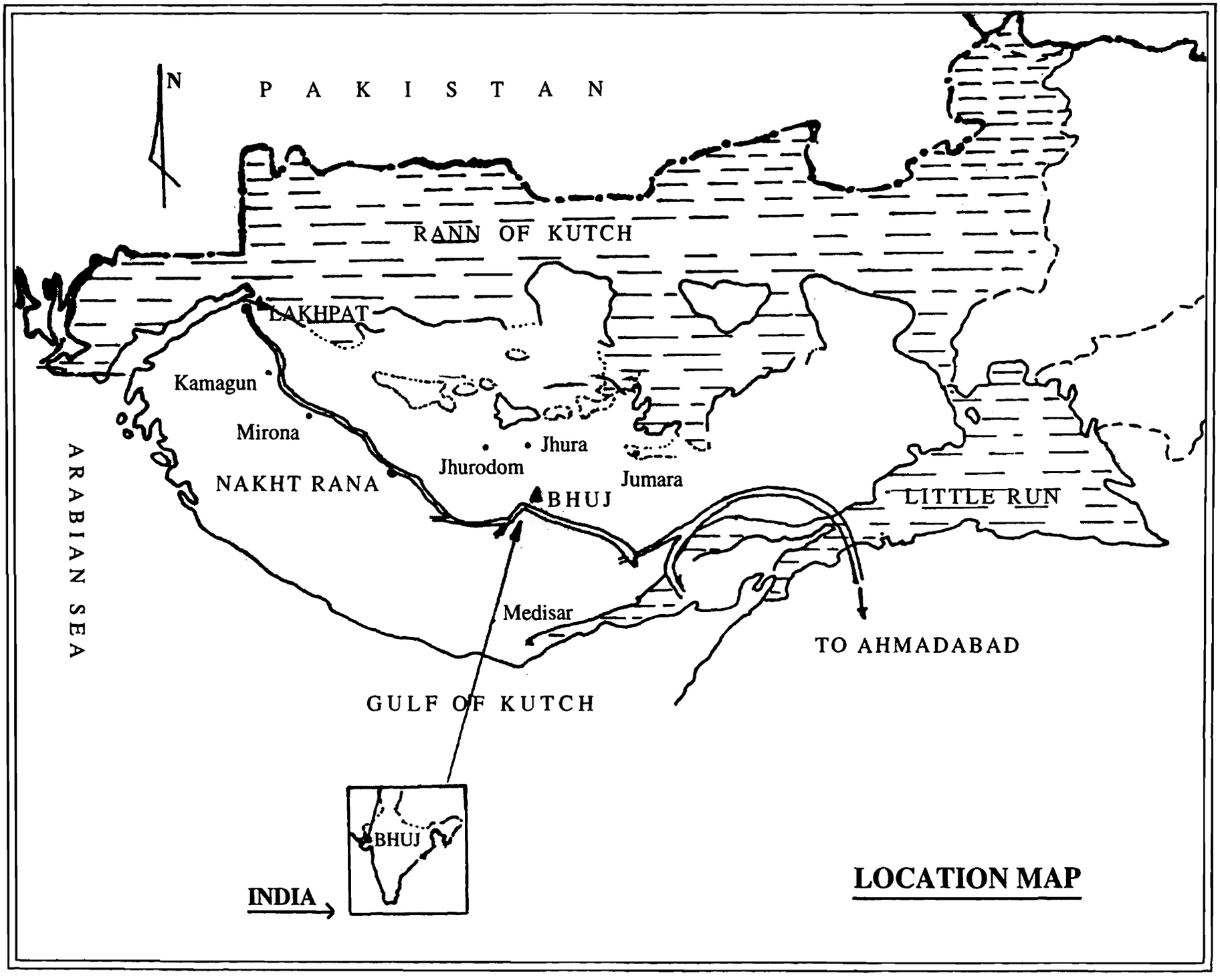
N
P A K I S T A N
RANN OF KUTCH
LAKHPAT
Kamagun
Mirona
NAKHT RANA
Jhurodom
Jhura
Jumara
BHUJ
LITTLE RUN
ARABIAN SEA
Medisar
TO AHMADABAD
GULF OF KUTCH
BHUJ
INDIA
LOCATION MAP

Table 2. Stratigraphic distribution of different ammonites in Kutch (modified from Halder & Bardhan, 1997).

Age	Zone
Oxfordian	*Mayaites maya*
Upper Callovian	*Peltoceras ponderosum*
Middle Callovian	*Subgrossouvria aberrans*
	Reineckeia reissi
Lower Callovian	*Macrocephalites formosus*
	Macrocephalites chrysoolithicus
Upper Bathonian	*Macrocephalites triangularis*

STRATIGRAPHIC DISTRIBUTION AND SIGNIFICANCE OF FOSSIL FAUNA

The marine Jurassic sequence of Jhura revealed the existence of rich microfaunal assemblage confined to Patcham and Chari Formations. There is no record of Foraminifera from Katrol Formation. The microfauna is dominated by Foraminifera with representation of ostracods, bryozoans, holothurians, echinoids and minute gastropods (Mandwal & Singh, 1989).

Ammonoids are commonly used as index fossil, because of their widespread occurrence, easy recognition and stable evolution. Many of the 'Faunal zones' recognized in the intercontinental correlation are based on these fossils. Generally, ammonoids evolved from the nautiloids, but intermediate forms are insufficiently known. In recent years however the knowledge of ammonoids has increased considerably (Arkell *et al.*, 1978).

SYSTEMATICS

Class CEPHALOPODA

Order AMMONOIDEA

Suborder AMMONITINA

Family MAYAITIDAE

Genus ***Mayaites*** Spath

1. ***Mayaites*** sp. I

Plate A; Fig. 1.

Measurements : Shell diameter–85 cm.; Umbilical diameter–31 cm.; Apertural Height–5.50 cm.; Apertural Width–2.84 cm.

Characters : Giant inflated; coarse-ribbed homeomorphs of *Macrocephalites*, with smooth outer whorl.

Material examined : India : Gujarat : Dist. Kutchch : Jhura, 1 ex., 05.05.2000, Coll. M. K. Naik (ZSI, Calcutta).

Geological age : Oxfordian.

2. ***Mayaites*** sp. II

Plate A; Fig. 2.

Measurement : Shell diameter–40 cm.; Umbilical diameter–5.9 cm.; Apertural height–6.5 cm.

Characters : Inflated, outer whorl smooth, inner whorl with moderately strong ribbing.

Material examined : India : Gujrat, Dist. Kutch, Habo Dom. 1 ex., 20.iv.2000 Coll. M. K. Naik (ZSI, Kolkata)

Geological age : Upper Oxfordian.

3. ***Mayaites*** sp. III

Plate A; Fig. 3.

Measurement : Shell diameter–50 cm.; Umbilical diameter–4.8 cm.; Apertural height–5 cm.; Apertural width–5.6 cm.

Characters : Inflated; with coarse, sharp, radiating ribbing on inner whorl, outer whorl smooth.

Material examined : India : Gujarat, Dist. Kutch, Sonaichelly River beds. 1 ex., 22.4.2000 Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Upper Oxfordian.

4. ***Mayaites*** sp. IV

Characters : Giant, inflated, with smooth outer whorl.

Material examined : India : Gujarat, Dist. Kutch, Keera. 1 ex., 21.iv.2000 Coll. M. K. Naik (ZSI, Kolkata)

Geological age : Upper Oxfordian.

5. ***Mayaites*** sp. V

Plate A; Fig. 4.

Characters : Inflated, outer whorl smooth, with coarse ribbing on inner whorl, ribs less sharp on upper edge.

Material examined : India : Gujarat, Dist. Kutch, Sonaichelly river beds, Keera sites. 14.4.2000

Geological age : Upper Oxfordian.

6. ***Mayaites*** sp. VI

Plate B; Fig. 1.

Measuremenst : Shell diameter–17.9 cm.; Umbilical diameter–6.7 cm.; Apertural height–5.4 cm.

Characters : Inflated, outer whorl smooth, inner whorl with compressed ribs.

Material examined : India : Gujarat, Jhura Gram, 7 km. from Jhura, 1 ex., 17.4.2000 Coll. M. K. Naik (ZSI, Kolkata)

Geological age : Upper Oxfordian.

7. ***Mayaites*** sp. VII

Plate B; Fig. 2.

Measurement : Shell diameter–7.4 cm.; Apertural width–4cm.; Apertural height–2.9 cm.

Characters : Inflated, outer whorl smooth, smaller specimen.

Material examined : India : Gujarat, Dist. Kutch, Nakhatrana. 10.iv.2000 Coll. M. K. Naik (ZSI, Kolkata)

Geological age : Upper Oxfordian.

8. ***Mayaites*** sp. VIII

Plate B; Fig. 3.

Measurement : Umbilical diameter–7.3 cm.; Apertural height–3.7 cm.

Characters : Inflated, outer whorl smooth, smaller specimen.

Material examined : India : Gujarat (Jhura in Kuchch Dist.) 1 ex., 22.iv.2000., Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Upper Oxfordian (Dhosaoolite rock).

Family MACROCEPHALITIDAE

Genus ***Macrocephalites*** Zittel

9. ***Macrocephalites*** sp.

Plate B; Fig. 4

Measurements : Shell diameter–4.8 cm.; Umbilical diameter–1.5 cm.; Apertural height–2 cm.

Characters : Large to gigantic whorls quadrate in cross section; Juvenile and middle whorls sharply ribbed, with sudden change at adult whorl to strong coarse, distant, ridge or wedge shaped primaries; peristome simple, no constrictions.

Material examined : India : Gujarat, Dist. Kutchch, Jhura, 1 ex., 03.02.1999 Coll. M. K. Naik (ZSI, Calcutta).

Geological age : Upper Oxfordian.

Family PERISPHINETIDAE

Genus ***Perispihinctes*** Waagen

10. ***Perisphinctes*** sp. I

Plate C; Fig. 1.

Measurement : Shell diameter–3.6 cm.; Umbilical diameter–1.6 cm.; Apertural height–1.8 cm.

Material examined : India : Gujarat, Dist. Kutch, Jhura Camp, 1 ex., 07.ii.1999, Coll. M. K. Naik (ZSI, Kolkata).

Characters : Small, whorls quadrate, finely ridged.Small, whorls quadrate, finely ribbed.

Geological age : Oxfordian.

11. ***Perisphinctes*** sp. II

Plate C; Fig. 2.

Measurements : Shell diameter–5.4 cm.; Umbilical diameter–2 cm.; Apertural height–2.6 cm.

Characters : Whorls quadrate, inner and middle whorls moderately sharply ribbed.

Material examined : India : Gujarat, Dist. Kutch, Keera, 5.2.1999, Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Oxfordian.

12. ***Perisphinctes*** sp. III

Plate C; Fig. 3.

Measurements : Umbilical diameter–3.5 cm.; Apertural width–1.5 cm.; Apertural height–1.8 cm.

Characters : Whorls round to depressed, ribbing normal to modified, venter smooth before septation.

Material examined : India : Gujarat, Dist Kutch, Jhura Camp., 7.2.1999, Coll. M. K. Naik (ZSI, Kolkata)

Geological age : Oxfordian.

13. ***Perisphinctes*** sp. IV

Plate C; Fig. 4.

Measurement : Shell diameter–1.9 cm.

Characters : Ribs remaining close and fine but less distinct on outer whorls, peristome simple.

Material examined : India : Gujarat, Dist Kutch, Jhura, 5.5.2000, Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Oxfordian.

Family ASPIDOCERATIDAE

Genus ***Peltoceras*** Waagen

14. ***Peltoceras*** sp.

Plate D; Fig. 1.

Measurements : Umbilical diameter–4.6 cm.; Apertural height–1.6 cm.; Apertural width–1.5 cm.

Characters : Evolute, whorls hardly overlapping; ribs strong, bifurcating or trifurcating on ventral margin, venter nearly flat, outer whorl with two rows of massive lateral tubercles.

Material examined : India : Gujarat, Dist. Kutch, Jhuragram, 1 ex., 8.5.200. Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Upper Oxfordian.

Family MACROCEPHALITIDAE

Genus ***Eucycloceras*** Spath

15. ***Eucyloceras*** sp.

Plate D; Fig. 3.

Measurements : Umbilical diameter–6.4 cm.; Apertural height–2.5 cm.

Characters : Involute, compressed; ribbing fine and dense on inner whorls, becoming distant and feeble on outer whorls, especially on venter; sutures simple.

Material examined : India : Gujarat, Dist. Kutch, Jhuragram, 1 ex., 5.v.2002, Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Upper Oxfordian

16. **Coquina**

Composite fossil fragment

Gastropod and Bivalvia

Characters : Composite fossil fragment rock constructed with Gastropoda and Bivalvia shells. Composing various colour; mainly with red and rock colour. Lying on superficial layer.

Material examined : India : Gujarat, Dist. Kutch, Jhura Camp. 1 ex., 8.ii.1999.

Geological age : Presumably Upper Oxfordian.

Family MAYAITIDAE

Genus ***Epimayaites*** Spath

17. ***Epimayaites*** sp. I

Plate D; Fig. 4.

Measurements : Shell diameter–34 cm.; Umbilical diameter–10.4 cm.; Apertural height–5.3 cm.

Characters : Ribbing projected on venter, sutures simpler than in *Mayaites*

Material examined : India : Gujarat, Dist. Kutch, Jhuragram, 1 ex., 10.ii.99, Coll. M. K. Naik (ZSI, Kolkata)

18. ***Epimayaites*** sp. II

Plate E; Fig. 1.

Characters : Ribbing projected on venter, sutures simpler than in *Mayaites*; species appear to be transitional from *Pachyceras.*

Material examined : India : Gujarat, Dist. Kutch, Keera. 1 ex., 7.2.99. Coll. M. K. Naik (ZSI, Kolkata).

19. ***Epimayaites*** sp. III

Plate E; Fig. 2.

Measurements : Shell diameter–9 cm.; Apertural width–6.5 cm.; Apertural height–3 cm.

Characters : Inflated, coarse-ribbed on outer whorls.

Material examined : India : Gujarat, Dist. Kutch, Jhura Camp, 1 ex., 14.4.2000, Coll. M. K. Naik (ZSI, Kolkata)

Geological age : Upper Oxfordian.

20. ***Epimayaites*** sp. IV

Plate E; Fig. 3.

Character : Small, with lappets, inner whorls with strong ribbing.

Material examined : India : Gujarat, Dist. Kutch, Jhura Camp. 1 ex., 22.iv.2000, Coll. M. K. Naik (ZSI, Kolkata)

Geological Age : Oxfordian.

Genus ***Pleurocephalite*** Buckman

21. ***Pleurocephalites*** sp.

Plate E; Fig. 4.

Measurements : Shell diameter–19 cm.; Umbilical diameter–5.2 cm.; Apertural height–2.4 cm.

Characters : Involute, globular, sharply ribbed with moderately complex structures which typically differ from those of Tulitidae in having slender, pointed 2nd lateral lobe with single central main stem (transition from bifid type of 2nd lateral lobe being seen in *Moricisiceras*). Body chamber smooth in many genera but seldom markedly contracted or eccentric; peristome never collared, flared or constricted. Depressed to cadicone, strongly ribbed to end of adult umbilical wall.

Material examined : India : Gujarat, Dist. Kutch, Habodom, 5.5.2000, Coll. M. K. Naik (ZSI, Kolkata)

Distribution : Kutch Region, Gujarat. Other occurrences : North Africa, Kenya, Baluchisthan.

Geological age : Upper Oxfordian.

Class PELECYPODA (Bivalvia)

22. **Oyester shell**

Plate F; Fig. 1.

Measurement : Shell diameter–6.2 cm.; Apertural Width–5 cm.; Apertural Height–2.5 cm.

Characters : Impression clear and prominent, ray-like structure, back portion suture-like, overall shape semiround. Inner whorls as in *Kossmaticeras* but more inflated, outer whorls with more or less flat parallel sides and broad fastigate venter and with regular tuberculate ribs, ribs coarsen suddenly on body chamber.

Material examined : India : Gujarat, Dist. Kutch, Jhura dom. 1 ex., 13.iv.2000., Coll. M. K. Naik (ZSI, Kolkata)

Geological age : Presumably Upper Oxfordian.

23. **Oyester shell**

Measurements : Shell diameter–4.2 cm.

Characters : Crystal formation on the fragment portion ribbed with wave like structure, back portion suture like and outline of shell orbicular.

Material examined : India : Gujarat, Dist. Kutch, Jhura Camp, 1 ex., 15.4.2000, Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Presumably Upper Oxfordian.

24. **Oyester shell**

Plate F; Fig. 3.

Measurement : Specific measurement not recorded.

Characters : Strong chomata and several strong, continuous and moderately narrow radial ribs on valve, moderately prominent umbo.

Material examined : India : Gujarat, Dist. Kutch, Habodom. 1 ex, 15.4.2000, Coll. M. K. Naik (ZSI, Kolkata)

Geological age : Presumably Upper Oxfordian.

Phylum **BRACHIOPODA**

Class ARTICULATA

Order PALAEOTREMATA

Family TERIBRATULIDAE

Genus ***Terebratula*** Bruguiere

25. ***Terebratula*** sp.

Plate D; Fig. 2.

Measurements : Umbilical diameter–3.4 cm.; Apertural height–1.5 cm.

Characters : Tortorise shaped back portion oval, wavy mouth portion curved towards lower side; upper side deep spotted with bird's beak-like structure.

Material examined : India : Gujarat : Dist. Kutch, Jhura, 1 ex., 07.v.2002, Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Upper Oxfordian.

Phylum CHORDATA

Class REPTILIA

Subclass ANAPSIDA

Order CHELONIA

26. **Ulna of Chelonian**

Plate F; Fig. 2.

Measurements : Length–19 cm.; width–1.4 cm.

Characters : Mineralized limb bone with both heads well preserved, broad and considerably curved along the length.

Material examined : India : Gujarat, Jhura in Kuchch Dist., 1 ex., 9.2.1999, Coll. M. K. Naik (ZSI, Kolkata).

Geological age : Not ascertained.

DISCUSSION

Terrestrial rocks of Jurassic age occur in the upper zone of Gondwana series. In the northwestern India, in the Jurassic area of Kutch, nearshore shallow water sediments of Callovian to Tithonian age contain a quite rich fauna of ammonoids (Spath, 1927–33) and bivalves (Cox, 1940). This fauna originated perhaps at the southern margin of the Tethys and as expected, the Tithonian fauna show a strong relationship with the fauna of Spiti shale of Himachal Pradesh (Berggren *et al.*, 1979). Further, close relationships exist between the early Late Jurassic ammonoid fauna of Kutch and those of the southern Europe. The Kutch Section shares many other genera with Europe and much areas of the Tethys. Spath (*loc. cit.*) mentioned that more than two-thirds of the described ammonoids of Kutch were known from that zone only and cautioned about exaggerated taxonomic splitting of the material. This may also be a reason for such a high figure of species from Kutch only. The Jurassic of Kutch belong to the East African-Madagascan-Peninsular Indian epicontinental sea, which had evolved since Callovian time from the Arabian-Madagascan seaway. In the Upper Oxfordian, the Mayaitidae, which were homeomorphic with the older Macrocephalitidae are confined to the East African-Indonesian Region. The Tithonian of Madagascar has close faunal affinity with Kutch (Berggren, *loc. cit.*). Enay (1973) reviewed the zoogeography of Tithonian ammonoid fauna and indicated the difficulties in taxonomic separation of the Perisphinctaceae. A close relationship between the Jurassic cephalopod (Ammonoidea and Nautiloidea) fauna of Kutch and Europe has also been indicated by Halder & Bardhan (1997).

Extensive occurrence of the ammonoids in Kutch region was earlier reported by Spath (*loc. cit.*). The samples collected during our study are generally comparable in shape, size and other features mainly with the European types. They are also not identical with the Middle Oxfordian specimens described from Saudi Arabia. Tetrabranchiate cephalopods are characteristically tightly coiled in a plane and symmetrical, with a bulbous calcareous protoconch, septa that form angular sutural flexures, and a small marginal siphuncle. The material dealt with here perhaps come from a younger horizon. The recent collections from Kutch region representing the period of Bathonian and Callovian time show some differences in relative adult size and ventral modifications.

Some Oxfordian species and their structures are marked both by size variation and ventral differentiation. The Prolecantina, a relatively small suborder of discoidal Palaeozoic ammonoids, are especially important because they represent the stock from which all Mesozoic forms arose. Presumably, the group evolved from the prolobitids during the Devonion time. Members of this suborder have much more stratigraphic value in the Mississippian than in the later Palaeozoic. Characteristically, the sutures form a large number of lobes, which were added progressively in the umbilical region. The siphuncle in ammonoids is of lesser taxonomic significance. However, at maturity it becomes marginal in position and serves to differentiate the ammonoids from the nautiloids. Moreover, it helps in differentiating the ammonoids into two suborders.

SUMMARY

The ammonoidea, a close relative of nautiloidea, have been extinct but their exoskeletons are preserved in many areas of the world. Owing to their well preservation they have been utilized by the palaeontologists for lithostratigraphic interrelations. Ammonoids were more numerous during the Mesozoic. The Mesozoic rocks of Kutch region of Gujarat were explored recently and the Ammonoidea, Bivalvia, Brachiopoda and a vertebrate fossil material in these rocks have been worked out. The result of this study, in the background of stratigraphy of rock formation, is presented in this paper. The material of ammonoids are representing Bathonian and Callovian time with some ventral modification and size differences.

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