OCCASIONAL PAPER No. 280

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Zoological Survey of India

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Edited by the Director, Zoological Survey of India, Kolkata

सत्यमेव जयते

Zoological Survey of India
Kolkata

CITATION

Pal, T.K., Ray, S.K., Talukder, B. and Naik, M.K. 2007. On the Megainvertebrate fauna (Mollusca and Bracchiopoda) of Cenozoic and Mesozoic of Jaisalmer, Rajasthan and their stratigraphic implications. *Rec. zool. Surv. India, Occ. Paper No.*, **280** : 1-40.

Published : December, 2007

ISBN 978-81-8171-180-9

PRICE
Indian Rs. 100.00
Foreign $ 7 £ 5

Published at the Publication Division, by the Director, Zoological Survey of India, 234/4 A.J.C. Bose Road, 2nd MSO Building, Nizam Palace (13th floor), Kolkata 700 020 and printed at Krishna Printing Works, Kolkata - 700 006.

RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA OCCASIONAL PAPER

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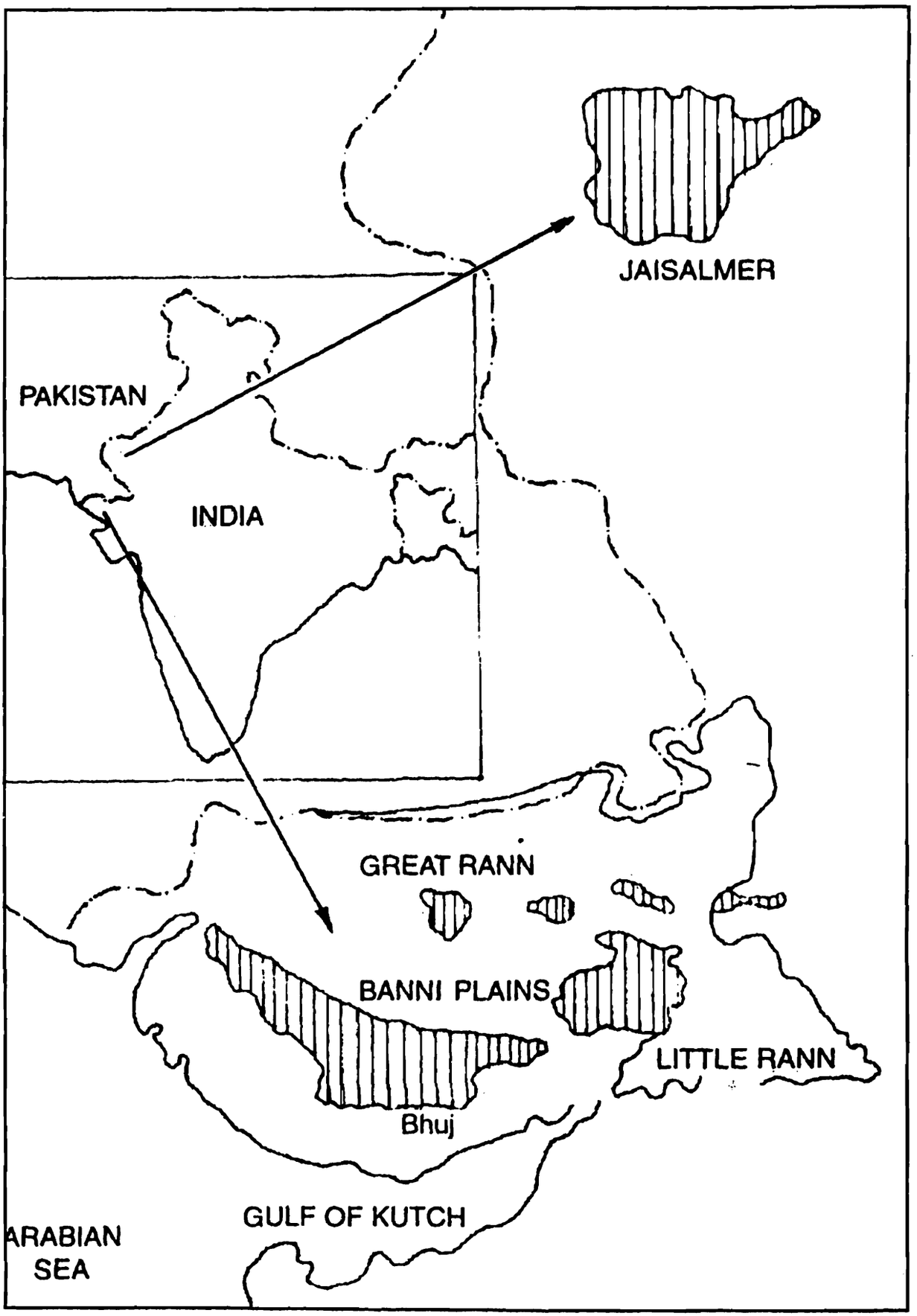
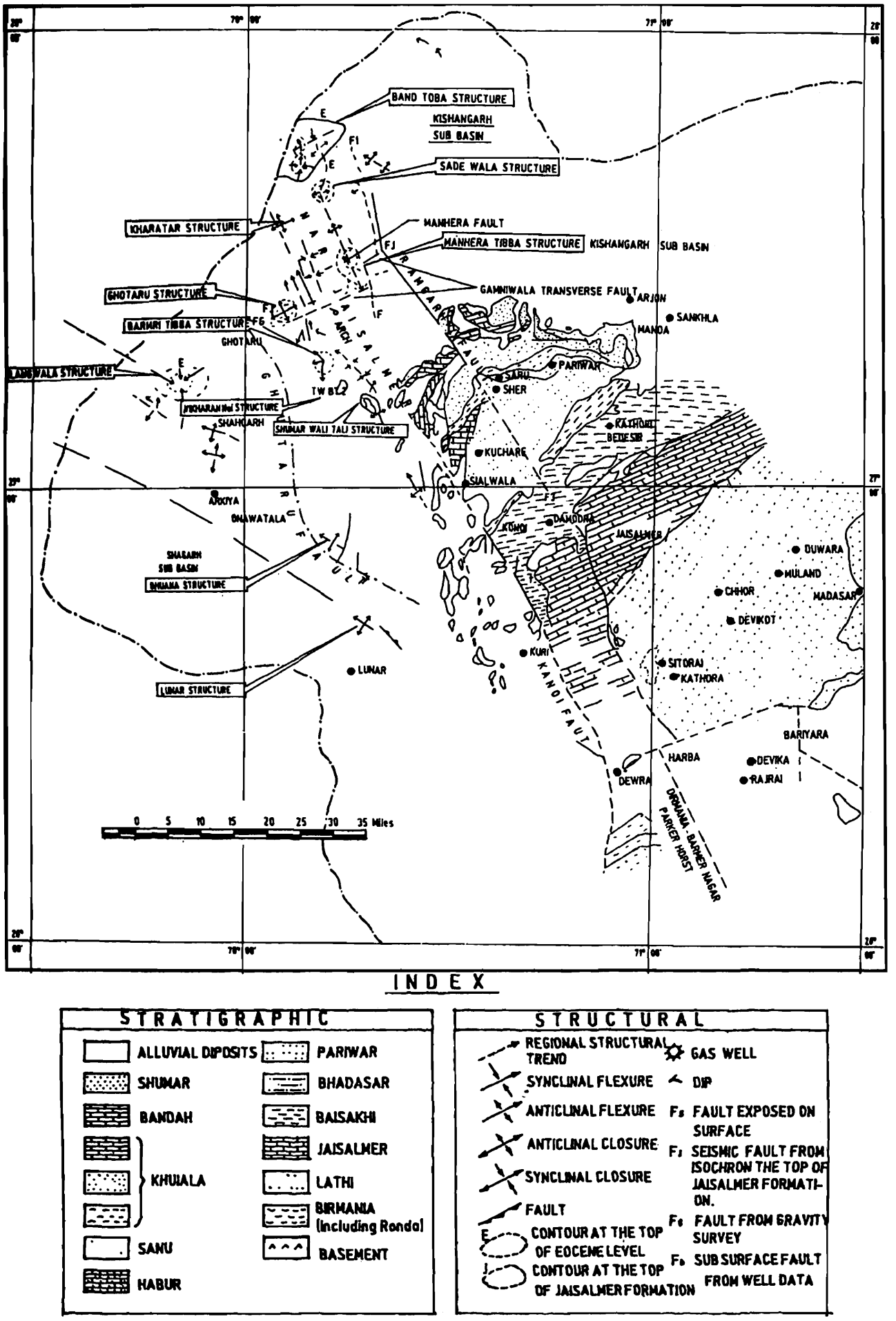
INTRODUCTION

The Mesozoic sedimentary basins along the western border of India has been well known to the geologists for more than a century for their remarkable outcrops and diverse fossil fauna, especially the Cephalopods. In the peninsular India, an important marine transgression occurred during the Jurassic period encompassing areas of Kachchh and Rajasthan (Text-fig. 1). These basins have also received attention in recent times for their unexplored oil reserves. They originated as a result of successive impulses in response to the initiation of rifting phenomenon in the India-Africa plate region of the Gondwana superplate which occurred perhaps near the Triassic-Jurassic boundary. The Jurassic rocks are storehouse of marine fossils. The fossils are well preserved and extensively available. The West Rajasthan shelf has been featured by Dasgupta (1973) as the northern slope of the Indian peninsular shield bounded in the north by the subsurface Delhi-Sargodha ridge, to the east by the western flanks of the Aravalli mountain, to the south the shelf dissected by two prominent uplifted blocks (*viz.*, the Bikaner-Barmer-Nagar Parkar Arch and the Saurasthra peninsula, and to the west the shelf extends up to the Indus basin in Pakistan). There are a number of sedimentary sub-basins within the vast West Rajasthan shelf of which the Jaisalmer basin is the largest (Text-fig. 2).

The early geological investigation on a regional basis for the area around Jaisalmer was carried out by Blanford (1877) and Oldham (1886), followed by La Touche (1911) and many subsequent workers. The initial paleontological investigation in this area was undertaken by Carter (1862). Later on, Blanford (1877) and Oldham (1886) recorded a few animal forms while dealing with the geology of Rajasthan. Subsequently, various groups of fossils including Foraminifera (La Touche, 1902; Vrendenberg, 1907; Heron, 1936; Barooah,1946; West, 1949; Singh 1951 a, b; Singh, 1953 a, b, c; Singh, 1955; Singh, 1957; Subbotina, Dutta & Srivastava, 1960; Chatterji, 1960; Pascoe, H.E., 1963; Poddar, 1963; Richter-Bernburg & Schott, 1963; Siddiquie & Iqbaluddin, 1963; Siddiquie & Bahl,1965; Khosla, 1967; Dave & Chatterjee 1996.), Porifera (Subbotina, Dutta & Srivastava, 1960), Anthozoa (Oldham, 1886), Bryozoa (Subbotina, Dutta & Srivastava, 1960, Shah, 1963), Polychaeta (Gupta, Srivastava & Agarwal, 1966), Ostracoda (Jacob & Sastri, 1950; Jacob *et al.*, 1952; Lubimova *et al.*, 1960; Subbotina, Dutta & Srivastava, 1960, Poddar, 1963; Richter-Bernburg & Schott, 1963), Decapoda (Barooah,1950, Glaessner & Rao, 1960 ; Prasad, 1961; Tiwari, 1962, 1963, 1966), Gastropoda (Blanford, 1877; Oldham 1886; La Touche, 1902; Vrendenberg, 1907; Barooah, 1946; West, 1949; Jacob *et al.*, 1952; Pascoe, 1959, 1963; Subbotina, Dutta & Srivastava, 1960; Misra *et al.*, 1961; Hoffman 1963; Richter-Bernburg & Schott, 1963; Shah, 1963; Tiwari, 1966), Pelecypoda (Blanford, 1877; Oldham, 1886; La Touche, 1902; Vrendenberg, 1907; Barooah, 1946; West, 1949, Pascoe, 1959, 1963; Subbotina, Dutta & Srivastava, 1960; Pascoe, 1963; Hoffman, 1963; Siddiquie & Iqbaluddin, 1963; Shah, 1963;



Text-fig. 1. Location of Mesozoic basins of Kachchh and Jaisalmer (Patterned areas), Western India (after Krishna 1987) (not to scale).



Text-fig. 2. Geological Map showing the structural trends in Jaisalmer and Barmer Districts, Rajasthan (after Dasgupta, 1975).

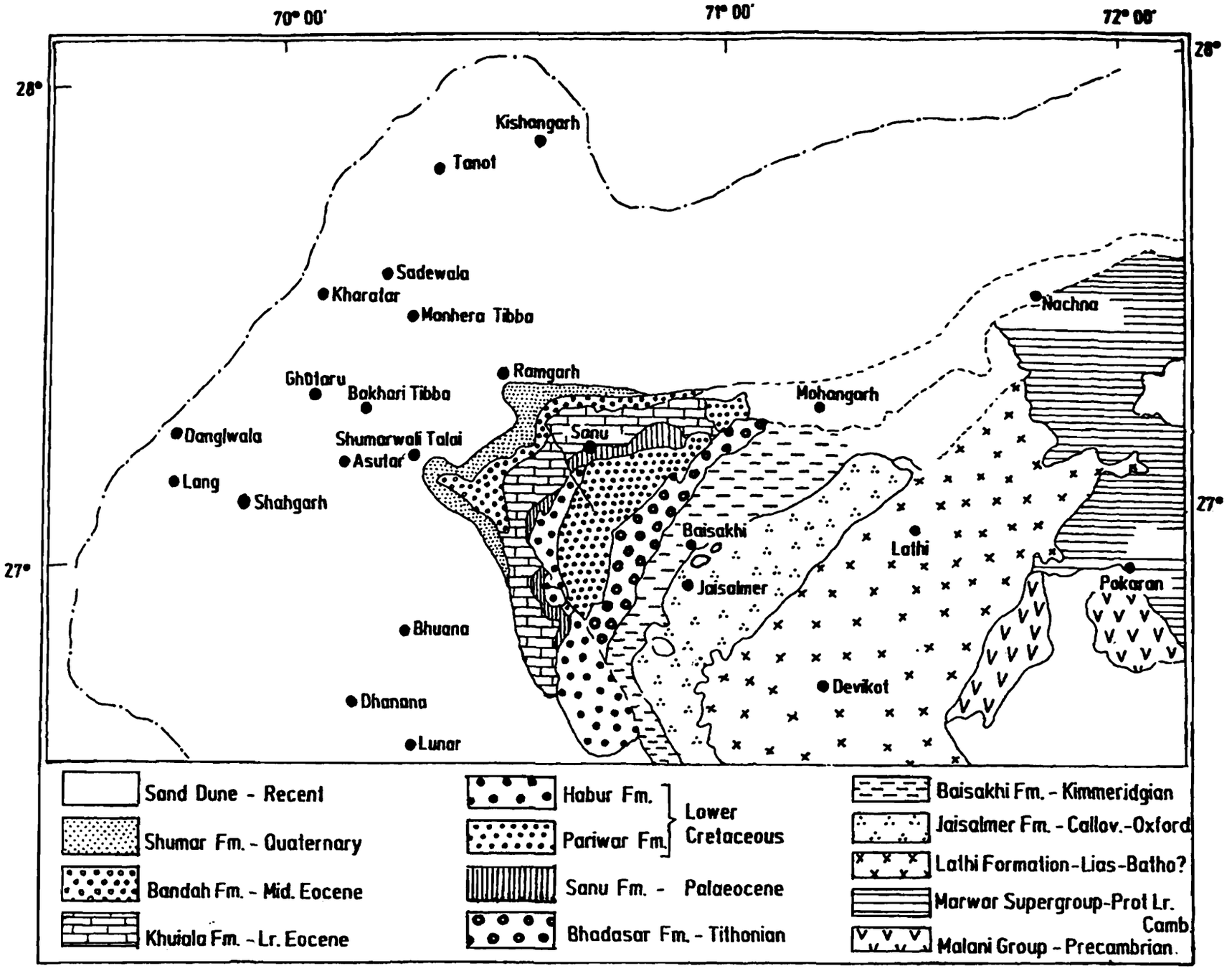
Siddiquie & Bahl, 1965; Tiwari, 1966), Cephalopoda (Carter, 1862; Blanford, 1877; Oldham,1886; Spath, 1933; Sahni & Bhatnagar, 1958; Pascoe, 1959; Richter-Bernburg & Schott, 1963; Shah, 1963; Hoffman, 1963, Chatterjee, 1990), Brachiopoda (Blanford, 1877; Oldham, 1886; Sahni & Bhatnagar, 1955, 1958; Pascoe, 1959; Mishra *et al.*, 1961; Hoffman, 1959), Echinodermata (Blanford, 1877; Fermor, 1931; Barooah, 1946; West, 1949; Ghosh, 1952; Sahni & Bhatnagar, 1955, 1958; Singh, 1955; Subbotina, Dutta & Srivastava, 1960; Tiwari, 1962; Hoffman, 1963; Pascoe, 1963; Gupta, Agarwal & Srivastava, 1967) had attracted attention of the palaeontologists and stratigraphers. However, it was realized that a lot more interesting forms are yet to be recovered from the area. Considering the sedimentary sequences in the Mesozoic and Cenozoic basins of Jaisalmer, field works were carried out by the ZSI in the area for exploration of various animal fossils, and especially the macroinvertebrate fauna. The result of the study has been presented here in the background of the depositional history and rock stratigraphy of the Jaisalmer basin.

STRATIGRAPHY

The Jaisalmer basin encompasses an area of about 30,000 sq. km. and it represents primarily the westerly dipping eastern flank of the Indus shelf (Sinha *et al.*, 1993). Mitra *et al.* (1993) considered that the structural style of this basin is controlled by the wrench fault tectonics as apparent from the dislocation of outcropping stratigraphic boundaries. Tectonically, the basin is divisible into three zones *viz.*, (i) the raised Mari-Jaisalmer Arch extending through the central part of the basin with a NW-SE trend, and flanked by (ii) the synclinal Sahgarh basin to the South and SW and by the (iii) monoclinal Kishangarh sub-basin to the North and NE (Dasguupta,1975). Along the southeastern part of the Mari-Jaisalmer arch, a number of sedimentary formations are exposed. According to Dasgupta(*loc. cit.*) these formations can be grouped into three broad divisions *viz.*, (a) those belonging to Precambrian age, (b) those of Mesozoic-Tertiary age, and (c) those of (?) Subrecent to Recent age (see Text-fig. 3). In the Jaisalmer basin, a somewhat continuous sedimentation from Lias to Lutetian has been noticed.

Mesozoic sequences

Sedimentation, of the Mesozoic sequence, in the region was initiated perhaps during the Permo-Carboniferous and continued at least up to the Middle Jurassic mainly under fluvial and stable deltaic conditions. There are indications of deposition in shallow shelf sea, at least during the Permian and Triassic. Classical Jurassic rift basins opened later perhaps during the Callovian, over the basement rocks that included Permo-Triassic Bhuana Formation and the Liassic Lathi Formation. Opening of the rift basin also marked fresh marine encroachment in the zone. The concept of Mesozoic stratigraphy of Jisalmer basin has undergone certain changes since Oldham (1886), who recognized a five–fold lithostrtigraphic scheme. Dasgupta (1975) moderated ideas placed by earlier workers like, Oldham (1886), Ghosh (1952), Swaminath *et al.* (1959), Narayan (1964) etc. He (*op. cit.*) had put forward a ten-fold stratigraphic framework of the basin (namely, Lathi Formation, Jaisalmer Formation,



Text-fig. 3. Geological Map of Jaisalmer Basin, Rajasthan showing different lithounits (after Dasgupta, 1996)

Baisakhi Formation, Bhadasar Formation, Pariwar Formation, Habur Formation, Sanu Formation, Khuiala Formation, Bandah Formation and Shumar Formation). Krisna (1987) recognized a five-fold stratigraphic scheme of the Mesozoic sedimentation of the area: Lathi Formation, Jaisalmer Formation, Bhadasar Formation, Parihar Formation and Abur Formation. Prasad (2006) considered that the marine Jurassic succession in Jaisalmer area is represented by three Formations *viz.*, Jaisalmer, Baisakhi and Bedesar (=Bhadasar) in ascending order.

A generalized Mesozoic stratigraphy of the Jaisalmer basin (see Text-fig. 4) based on thc surface outcrops and subsurface details (presented by Dasgupta,1975 and later on reviewed by Sigal & Singh, 1980; Dave & Chatterjee,1996; Singh, 1996, 1999) is given hereunder:

Bhuana Formation

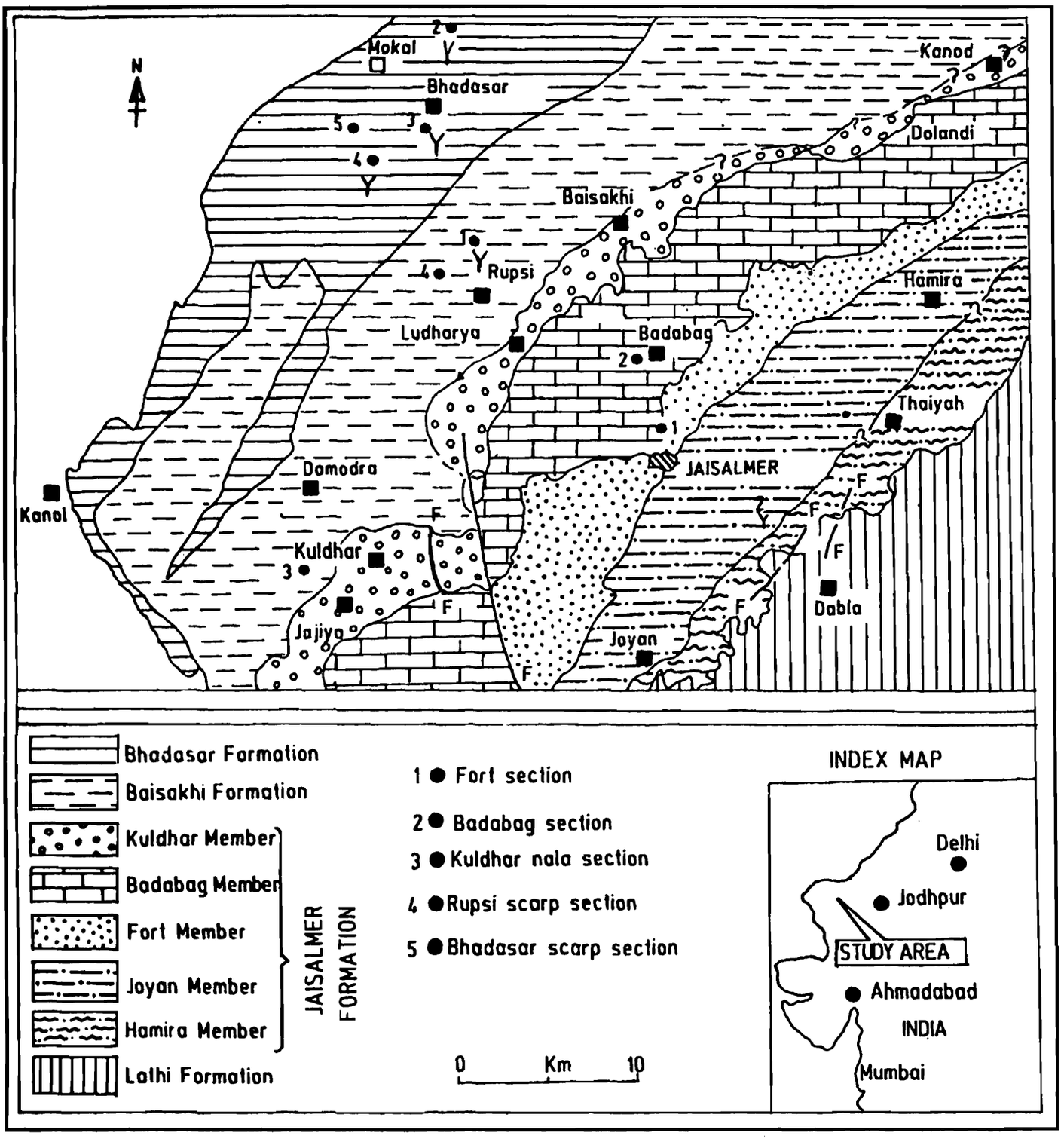
The knowledge about the Formation is based on the subsurface data. Lithologically, this Formation is comprised of greyish white and pinkish grey, medium to fine and some few coarse grained gritty sandstones with intercalations of grey and greenish grey splintery shale of the Triassic age. Occasionally, the rocks contain pyrite, ferruginous claystones and carbonate matters. The Bhuana Formation unconformably overlies the Precambrian rocks (phyllite/schists) and is overlain by the Lathi Formation and/or its equivalents- Goru and Parh Formations. Sedimentary nature of the Formation indicates fluvial and shallow marine palaeoenvironment (Singh, 1996).

Lathi Formation

This is the lowermost Formation recognised by Oldham (1886), unconformably overlying rocks of the Malani Group, Marwar supergroup and the Badhaura Formation of the Permo-Carboniferous age. The rock type of the Formation is mainly sandstone, that becomes more argillaceous in the basinal part. Dasgupta (1975) subdivided the Lathi Formation into two members : i) the lower Odania Member and (ii) the upper Thaihat Member. The common rock types of the lower member include white and maroon sandy siltstone, coarse grained, dark ferruginous sandstone and coarse ill-sorted arkosic sandstone grading upwards to whitish sandy siltstone. Most of the arenite beds indicate development of profuse cross bedding and other sedimentary structures. The upper member comprises bands of sandstone and siltstone grading to limestone. The Lathi Formation becomes more than 350m. thick at places. The sedimentary attributes and presence of large fossil woods suggest an overall regressive phase of deposition under the fluvio-deltaic environment, and a shallow marine condition during the later phase of sedimentation. Profuse presence of petrified tree trunks of gymnosperms indicate the existence of forested condition in the geologic past (Pareek, 1979).The palynofossil assemblage has suggested a lower Jurassic age of the Formation (see Dasgupta,1975; Krishna, 1987; Singh, 1996).

Jaisalmer Formation

This Formation conformably overlies the Lathi Foermation. The 'Jaisalmer Limestone' of Oldham, redesignated as the Jaisalmer Formation by Swaminathan *et al.* (1959). It consists



Text-fig. 4. Geological Map of Jurassic rocks of Jaisalmer Basin, Rajasthan (after Dave & Chatterjee, 1996).

of a thick sequence of cream, buff and brown colour, commonly fossil bearing limestone along with oolitic limestone and grayish brown sandstone. The Formation occurs extensively on the surface as well as subsurface. The massive outcrops are seen in Jaisalmer and neighbouring areas. The thickness of the Formation ranges between 120 m in the north and 170m. in the south. However, a thickness of more than 600m. has been recognized by Dasgupta (1975) on the basis of subsurface data. Dasgupta (*op.cit.*) divided the Jaisalmer Formation into five members, namely, (i) Kuldhar Member, (ii) Bada Bag Member, (iii) Fort Member, (iv) Joyan Member, and (v) Hamira Member. Kachhara & Jodhawat (1981, 1999) recognized an additional member, namely, the Jajiya Member. Krishna (1983, 1987) considered the Formation to comprise two members : Jiasalmer Member and Kuldhar Member. The Jaisalmer Formation is the most fossiliferous Jurassic Formation. A shallow marine environment of deposition is indicated by the development of fossil bearing limestone-aranaceous limestone sequence without shale beds (Dasgupta, 1975, Singh, 1996). The fossil assemblage has suggested Callovian-Oxfordian age of the Formation.

Baisakhi Formation

This Formation occurs in a semiarcuate belt, about 10-12 km wide in the north and west of Jaisalmer. The Formation is represented by grey and black gypseous shale, argillaceous sandstone and intraformational conglomerate. The Baisakhi and Bhadasar Formations have been mapped as separate units on the surface, but these could not be separated on the basis of subsurface data. Authors like, Krishna (1987) and Singh (1996) considered these two as a single Formation. The Baisakhi Formation froms prominent outcrops and ridges near Ludharva, Rupsi and Nibh Dungar. This Formation unconformably overlies the Jaisalmer Formation and has been divided by Dasgupta (1975) into three Members: Baisakhi, Ludharva and Rupsi. A continental to marine epineretic environment of deposition has been suggested for Baisakhi Formation by Singh (1996), and Kimmeridgian age has been indicated for this Formation (Dasgupta, 1975, Singh, 1976).

Bhadasar Formation

This Formation overlies the Baisakhi Formation and which was originally described by Oldham (1886) as "Badesir beds" It is represented by ferruginous standstone with thin intercalation of clay beds. Well exposed sections of this Formation occur as a narrow strip near the villages of Bhadasar and Mokal and along Jaisalmer-Ramgarh road. Dasgupta (1975) subdivided the Formation into two Members *viz.*, Kolar Dungar and Mokal. Various foraminifers, corals, ammonites, gastropods and bivalves have been recorded from this Formation. The lithology and fossil assemblages have suggested Tithonian age of the Formation.

Pariwar Formation

Oldham (1886) described the thick aranaceous sequence as the "Parihar beds" and Swaminath *et al.* (1959) as Parihar 'Formation' This Formation is currently used for the rocks which showed presence of Cretaceous fossils. Dasgupta (1975) subdivided the Formation into two Members on lithological consideration: Lower Cretaceous plant fossil bearing lower Member, and the Paleocene fossils in the upper Member. The upper Member was eventually omitted from this Formation. Typical exposures of this Formation occur at the trigonometric hill, south of the Pariwar village. The Formation is well represented both as surface outcrops and in the subsurface, and deposition under regressive environment with intermittent marine influences has been inferred by Sing (1999). According to Dasgupta (1975) and Lukose (1977) the age of the Formation is Lower Cretaceous (Necomian).

Habur Formaton

The original "Abur bed" of Oldham (1886) has been redescribed as "Habur Formation" by Dasgupta (1975). The Formation comprises yellowish arenaceous limestone and marl bands with interfinge ring coquinoidal limestone. The latter contains shells of ammonites and brachiopods in the upper horizon. The Habur Formation extends as 45 km. long, arcuate outcrop, from near Niba in the south, through Sam, Kanoi, and west of Kucheri to Habur and Mohammad-ki-Dhani in the north. A lower Aptian age of the Formation was assigned by Dasgupta (1975).

Goru Formation

This Formation is recorded from the borehole data, found to be homotaxial with the Habur Formation and largely a shaly sequence with sandstone lenses. The Formation has been divided into lower Goru and upper Goru Members on the basis of lithological character and palynological data by the Dasgupta (1975). Sediments of Goru Formation were deposited in an overall transgressive shallow marine environment with short and intermittent regressive cycles (Singh, 1996). Aptian to Cenomanian age has been assigned to the Formation (Bhandari, 1999).

Parh Formation

The upper most Mesozoic sequence is represented by the Parh Formation. No surface outcrop of this Formation has yet been recorded. The contract between the Goru Formation and the overlying Parh Formation is gradational (Dasgupta, 1975). This Formation comprises thick beds of argillaceous limestone with interbeds of calcareous clay, marl and siltstone. Singh (1996) has suggested an open marine depositional environment in middle to outer shelf regime for the Parh Formation.

Tertiary Sequences

The Tertiary sequences in the Jaisalmer basin are represented by Sanu, Khuiala and Bandah Formations (see Text-fig. 5). Geological features about these Formations, characterised by Singh (1999) and Bafna & Dhaka (1999) on the basis of both the surface and subsurface data, are briefed hereunder:

Sanu Formation

This Formation, named after Sanu village, represents the lowermost Tertiary Formation and comprises poorly consolidated beds of profusely cross-bedded, reddish, glauconite sandstone and silty sandstone. The rocks of this Formation overlie unconformably the sandstone bed of Pariwar Formation. It attains the maximum thickness of about 670m. on the surface and Paleocene age has been assigned to this Formation (Singh, 1996).

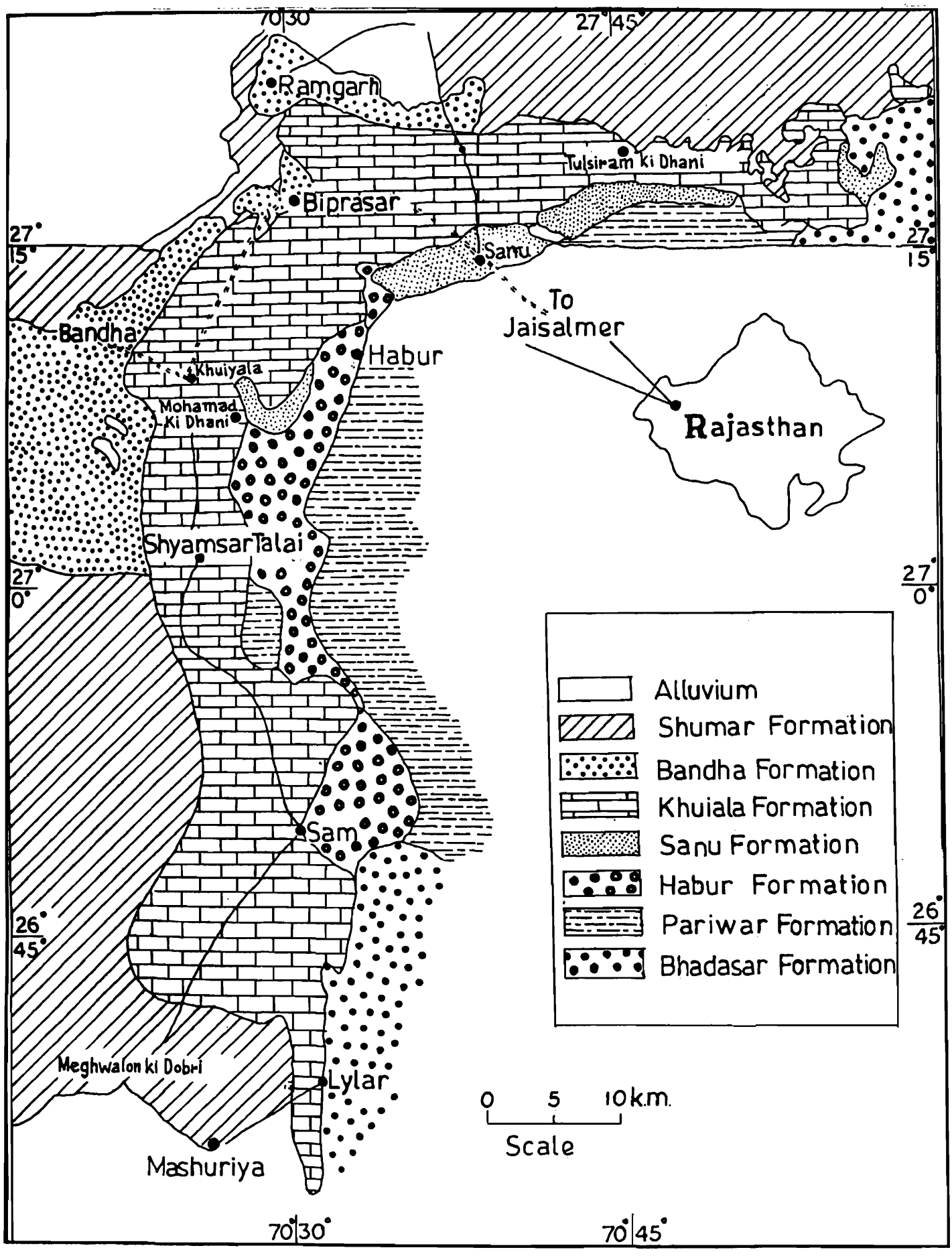
Khuiala Formation

Oldham's (1886) Nummulitic limestone beds actually represented by two different units telescoped into one and these two units are designated as the Khuiala and Bandah Formation by Singh (1984). The upper contact of Khuiala Formation in the surface section with the Bandah Formation is disconformable, while no disconformity is recorded in the subsurface data by Bhandari (1999). The Formation comprises alternation of yellow to yellowish-white calcareous shales/clay, friable and soft as well as hard limestones. Dasgupta (1975) recognized four Members in this Formation, *viz.*, Hingola, Te-Takkar, Sirhera and Khuiala Scarp. Not accepting Dasgupta's arrangement Singh (1984) recognised two Members, *viz.*, Khinsar Shales and Te-Takkar Limestone. The lower part of the Te-Takkar generally comprises alternations of highly argillaceous limestone, foraminiferal beds, and thin shale and clay beds. Its upper part comprises mainly white, soft, chalky limestone and hard compact limestone. Late Paleocene to lower Eocene age of the Formation has been assigned by Singh (1996).

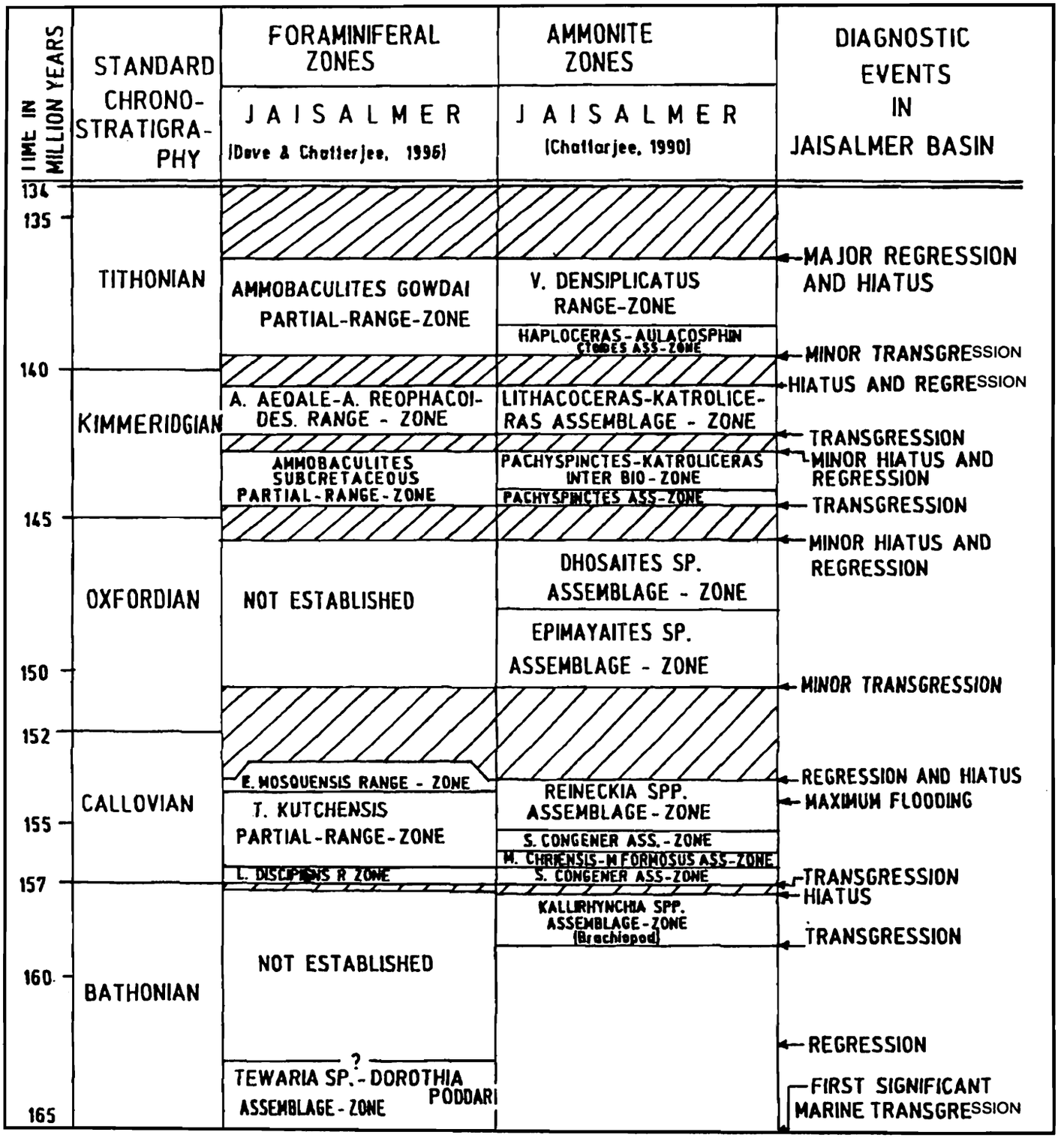
Bandah Formetion

The Formation named after the Bandah village, constitutes the uppermost Tertiary sequence in the Jaisalmer basin. This Formation is represented in surface and subsurface sections, and is comprised of bentonic clay, argillaceous and chalky limestones. The Formation shows graded contact with the underlying Khuiala Formation. Dasgupta (1975) subdivided Bandah Formation into two Members, *viz.*, Bakri Tibba and Habib Rahi Members. Singh (1984) redesignated Habib Rahi as the Batrewala Member. Middle Eocene age of the Formation has been assigned by Dasgupta (1975).

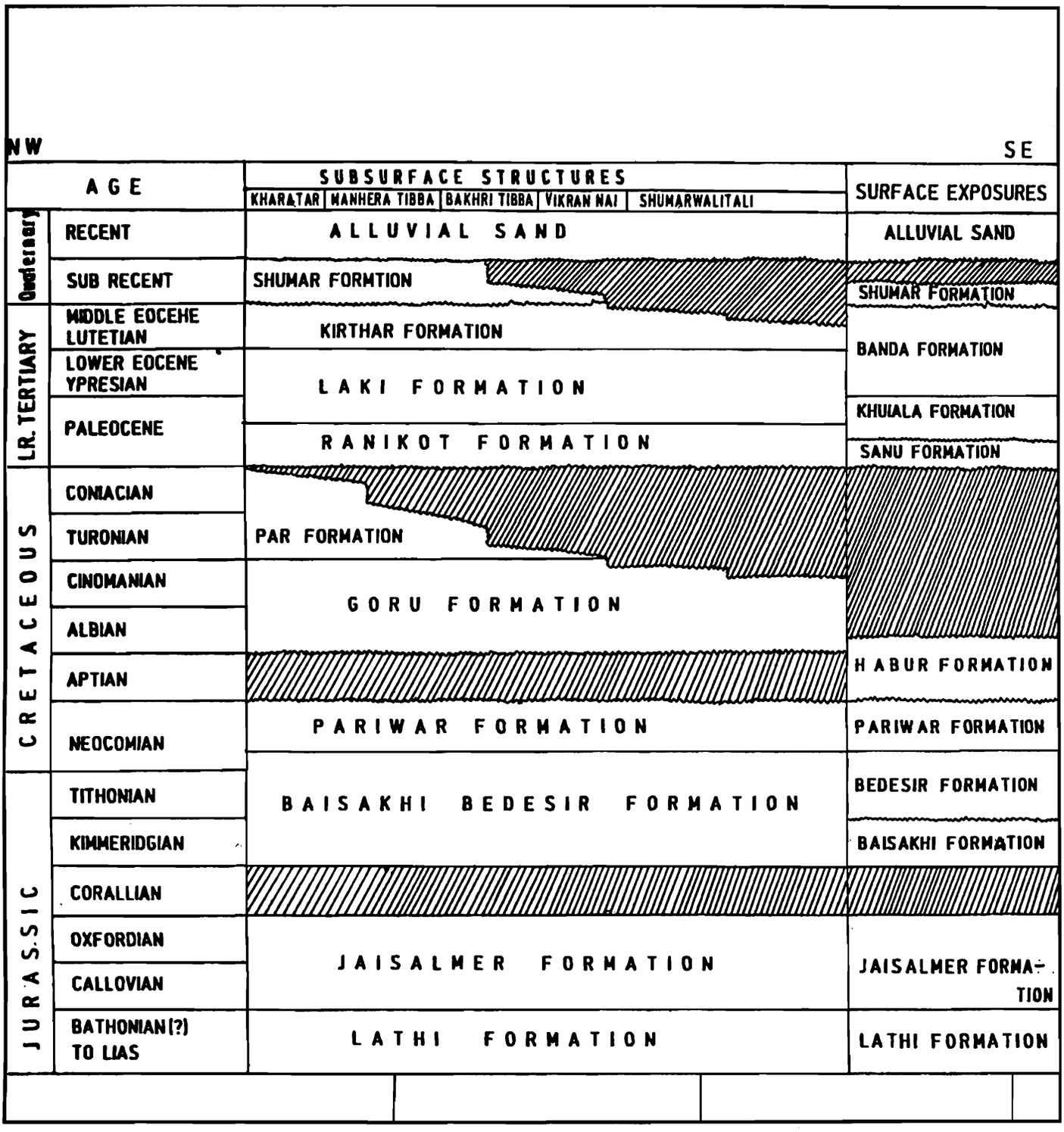
The correlation of surface and subsurface Formations of the Jaisalmer basin (see Text-fig. 7) has been worked out by Dasgupta (*loc. cit.*).



Text-fig. 5. Geological Map showing the Tertiary Formations in the Jaisalmer Basin, Rajasthan (after Bafna & Dhaka, 1999).



Text-fig. 6. Correlation of Benthic Foraminiferal and Ammonite zones in the Jurassic and diagnostic events in the Jaisalmer basin, Rajasthan (after Dave & Chatterjee, 1996).



Text-fig. 7. Stratigraphic correlation of surface and subsurface Formations in the Arch area of the Rajasthan shelf (after Dasgupta, 1975).

SYSTEMATICS

Dr. S. Banerjee & party in 1983 collected much of the material for the present study as a part of the scheme initiated by the ZSI to investigate both extinct and extant fauna of Jaisalmer basin. These material were supplemented by the collection made by M. Naik in 2003 and 2004. Material collected by Dr. K.K. Tiwari and Shri T.R. Mitra were also received for study. The identification of the material was done by the authors, and in the process generous opinion extended by the experts of the Geological Survey of India (GSI) namely, Dr. K. Ayasami, Dr. S. Som and Dr. Debahuti Mukherjee were of great help.

Repository : Palaeozoology Divition, ZSI.

The following abbreviations have been used for the purpose of measurements of different groups of macrofauna :

Gastropods : H-total height; HI-height of last whorl; D-Diameter of last whorl; Ha-height of aperture; Wa-width of aperture; AA-apical angle.

Bivalves : L-length; H-height; I-inflations; BV-both valves; RV-right valve; LV-left valve.

Ammonites : D-diameter; Wh-whorl height; Wt-whorl thickness; Wu-width of umbilicus.

Brachiopods : H-height; W-width; I-inflation.

Phylum MOLLUSCA

Class GASTROPODA

Order ARCHAEOGASTROPODA

Family TROCHIDAE

Genus ***Garramites*** Stephenson, 1941

Garramites sp. (Pl. I, Figs.1, 2)

Material : 2 examples.

Diagnosis : Shell turbiniform, strong convex shaped whorls and convex base, four faint smooth spiral grooves, crenulated angulations on umbilical margin, columellar and outer lip not so thickened.

Measurements : Shell A : H-59·06 mm., L-41.07 mm., Shell B : H-41.06 mm., L-35.05 mm.

Locality : Kapurdi Mine.

Geological age : Cenozoic.

Remarks : Shells partly broken and apertural dimension in 1 example not prominent.

Order CAENOGASTROPODA

Family SUBULITIDAE

Genus ***Subulites*** Hall, 1872

***Subulites* (*Fusispira*)** sp. (Pl. I, Fig. 3, 4)

Material : 1 example.

Diagnosis : Shell fusiform, spire short and curved, whorl flat and round with shallow sutures; aperture narrow, acuminate above and narrow below.

Measurements : H-42.08 mm., L-31.02 mm.

Locality : Kapurdi.

Geological age : Cenozoic.

Remarks : Tip of the shell (whorl) broken.

Class BIVALVIA (PELECYPODA)

Order NUCULOIDA

Family NUCULANIDAE

Genus ***Nuculoma*** Cox, 1940

Nuculoma sp. (Pl. I, Fig. 5, 6, 7)

Material : 5 examples.

Diagnosis : Shell large, heart shaped, taxodont, equivalve with close margin inflated; Opisthogyrate, enrolled umbo; surface bears feeble comarginal ribs, a concave arch between the umbo and the postero-ventral margin

Measurements : A : H-40.07 mm. L-43.01 mm. I-25.04 mm., B : H-54.01 mm. L-40.00 mm. I-35.01 mm., C : H-55.05 mm. L-46.09 mm. I-35.07 mm., D : H-52.04 mm, L-37..01 mm.I-35.01 mm., E : H-34.02 mm. L-25.04 mm. I-21.01 mm.

Locality : Baishaki village, Jaisalmer.

Geological age : Middle Jurassic.

Order MYTILOIDA

Family MYTLIDAE

Genus ***Modiolus*** Lamark, 1799

Subgenus ***Miodiolus*** (s. str.)

Modiolus (Modiolus) sp. (Pl. I, Fig. 8)

Material : 1 example.

Diagnosis : Shell small, modiliform, umbo terminal, dorsal margin small, umbonal carina anterior, rounded and bulged (anterior lobe), separated by an oblique umbonal carina from the main surface.

Measurements : H-42.08 mm., L-31.02 mm.

Locality : Kapurdi.

Geological age : Middle Jurassic.

Remarks : Part of the shell is covered by earth crust.

Order PTERIOIDA

Family PECTINIDAE

Genus ***Chlamys*** Leach, 1815

Subgenus ***Chlamys*** (s. str.)

Chalamys (***Chlamys***) sp. (Pl. I Fig. 9)

Material : 1 example.

Diagnosis : Shell higher than long, anterior auricle longer than posterior one, sculpture of number of striated radial ribs present which diverge anterior to posterior margin, inner margins more or less round shaped.

Measurements : H-22.01 mm., L-20.06 mm.

Locality : Kuldhara river bed.

Geological age : Cenozoic.

Remarks : Shell partly embedded in earth.

Genus ***Camptonectes*** Agassiz, 1864

Subgenus ***Camptochlamys*** Arkell, 1930

Camptonectes (Camtochlamys) sp.

Material : 2 examples.

Diagnosis : Shell orbicular, weak radial striae crossed by concentric laminae giving rise to reticulate pattern of sculpture; distinctly spaced, commarginal lamellae little apart; umbonal region with faint radial striae.

Measurements : Shell A : H-35.05 mm., L-34.05 mm., Shell B : H-53.00 mm., L-broken.

Locality : Kuldhara river bed, 20 km. off Jaisalmer.

Geological age : Jurassic.

Remarks : Shell partly embedded in earth crust.

Genus ***Spondylopecten*** Roeder, 1882

Spondylopecten sp. (Pl. I, Fig. 10)

Material : 1 example.

Diagnosis : Shell suborbicular, inflated, valve convex, slightly fan shaped plicae, co-marginal growth lines are much denser and finer; scalp with a number of strong rounded radial ribs; hinge of right valve with two prominent thick teeth, which fit into corresponding sockets in left valve.

Measurements : H-33.05 mm., L-27.05 mm.

Locality : Kuldhara river bed, 20 km. off Jaisalmer.

Geological age : Middle Jurassic

Remarks : Shell partly embedded in earth crust.

Family POSIDONIIDAE

Genus ***Bositra*** De Gregorio, 1886.

Bositra sp. (Pl. I, Figs. 11, 12)

Material : 7 examples.

Diagnosis : Shell ovoid, auricles poorly developed, low convexity, subequivalve, umbones low; ornamented with fine concentric folds; elongated hinge margin, dorsal angles rounded.

Measurements : Shell A : H-400.00 mm., L-45.05 mm., I-24.08 mm.; Shell B : H-32.00 mm., L-43.09 mm., I-26.09 mm.; Shell C : H-33.08 mm., L-40.02 mm., I-21.03 mm.; Shell D : H-34.09 mm., L-42.07 mm., I 24.02 mm.; Shell E : H-40.06 mm. L-41.01mm, I -25.05 mm.; Shell F : H-30.05 mm. L-35.08 mm. I-20.07 mm.; Shell G : H-29.02 mm. L- 31.05 mm. I-19.00 m.

Locality : Jaisalmer.

Geological age : Jurassic.

Order VENEROIDA

Family MACTROMYIDAE

Genus ***Mactromya*** Agassiz, 1843

Mactromya sp. (Pl. I, Figs. 13, 14)

Material : 2 examples.

Diagnosis : Shell transversely elliptical, outline trigonal, nearly equilateral with strong subequidistant concentric ribs, hinge of right valve with anterior thickening and shallow socket.

Measurements : A : H-31.02 mm. L-43.03 mm. I-22.05 mm.; B : H-27.01 mm. L-34.00 mm. I-15.02 mm.

Locality : Kapurdi.

Geological age : Jurassic.

Order OSTREOIDA

Family PLICATULIDAE

Genus ***Plicatula*** Lamarck, 1801

Plicatula sp. (Pl. I, Fig. 15)

Material : 1 example.

Diagnosis : Shell medium sized, orbicular; right valve highly convex, with somewhat irregular outline, umbonal area rather compressed; shell consists of widely spaced rounded more or less irregular radial ribs, cardinal area small.

Measurements : H-30.06 mm., L-34.06 mm.

Locality : Kuldhara riverbed, 20 km off Jaisalmer.

Geological age : Jurassic.

Order OSTREINA

Family OSTREIDAE

Genus ***Lopha*** Roeding, 1798

Lopha sp. (Pl. II, Fig. 16)

Material : 2 examples.

Diagnosis : Shell irregular in shape, undulated margin, left valve large and thick, right valve comparatively smaller, margin of the valves thrown into a series of folds, subequivalve with similar rib patterns, fairly sharp crested plicae which produce a regular plicate valve commissure, single large adductor impression on the centre of the valve.

Measurements : Not recorded.

Locality : Kuldhara river bed, Jaisalmer.

Geological age : Middle Jurassic.

Remarks : Measurements of the shells were not obtained from broken shells.

Class CEPHALOPODA

Order AMMONOIDEA

Suborder AMMONITINA

Family OPPELIIDAE

Genus ***Sindeites*** Spath, 1925

Sindeites sp. (P. II, Fig. 17)

Material : 1 example.

Diagnosis : Shell medium stout, laterally compressed outer whorl, ribbing sharp and ending in small tubercles.

Measurement : Wt-15.05 mm.

Locality : Kuldhara river bed, Jaisalmer.

Geological age : Upper-Middle Jurassic.

Remarks : Only a part of the shell is recovered.

Family MACROCEPHALITIDAE

Genus ***Nothocephalites*** Spath, 1928

Nothocephalites sp. (Pl. II, Fig. 18)

Material : 2 examples.

Diagnosis : Shell involute, globular, compressed, discoidal, dense ribbing found on outer whorl and gradually folded towards inner half of whorl side; moderately complex suture present.

Measurements : D-91.08 mm., Wt-24.05 mm., Wu-43.07 mm. (n=1)

Locality : Kuldhara river bed, Jaisalmer.

Geological age : Middle Jurassic.

Genus ***Subkossmatia*** Spath, 1924

Subkossmatia sp. (Pl. II, Fig. 19)

Material : 2 examples.

Diagnosis : Large sized, compressed, evolute, discoidal whorl section subelliptical, ribs coarse, rectiradiate, biplicate passing through venter, umbilicus shallow and rounded.

Measurements : D-69.01 mm., Wh-29.05 mm., Wt-27.06 mm., Wu-36.09 mm.

Locality : Kuldhara river bed.

Geological age : Middle Jurassic.

Family MACROCEPHALITIDAE

Genus ***Idiocycloceras*** Spath, 1928

Idiocycloceras sp. (Pl. II, Fig. 20)

Material : 2 examples.

Diagnosis : Shell large, globular, evolute, coarse, biplicate ribs, compressed inner whorl; simple suture.

Measurements : Shell A : Wt- 35.05 mm., Shell B : Wt- 41.06 mm.

Locality : Kapurdi.

Geological age : Middle Jurassic.

Remarks : Only parts of the shell are recovered.

Genus ***Macrocephalites*** Zittel, 1884

Subgenus ***Macrocephalites*** (s. str.)

Macrocephalites (s. str.) sp. (Pl. II, Fig. 21)

Material : 1 example.

Diagnosis : Shell large, involute, umbilicus of moderate diameter, compressed towards inner whorls, ribs rather sharp, outer whorls smooth.

Measurements : D-89.02 mm.,Wt-25.08 mm.,Wu-50.08 mm.

Locality : Kuldhara river bed.

Geological age : Middle Jurassic

Remarks : This is the largest species among the Cephalopoda material collected.

Genus ***Kamptokephalites*** Buckman, 1922

Kamptokephalites sp. (Pl. II, Fig. 22)

Material : 1 example.

Diagnosis : Shell large, involute, globular, coarse, wiry, sharp biplicate ribs, inner whorl gradually becoming smooth, smooth body chamber.

Measurements : D-69.45 mm., Wt-23.05 mm.

Locality : Kuldhara, 20 km. north-west of Jaisalmer.

Geological age : Middle Jurassic.

Genus ***Indocephalites*** Spath, 1928

Indocephalites sp. (Pl. II, Fig. 23)

Material : 2 examples.

Diagnosis : Shell large, inner whorl moderately compressed, cadiocone, ribs strong, outer whorls somewhat laterally compressed, body chambers smooth.

Measurements : D-108.03 mm.Wt-42.05 mm.Wu-51.01.

Locality : Kuldhara river bed.

Geological age : Middle Jurassic.

Famiy REINECKEIIDAE

Genus ***Reineckeia*** Bayle, 1878

Reineckeia sp. (Pl. II, Fig. 24)

Material : 1 example.

Diagnosis : Shell planulate, innermost whorl coronate, large distant primary ribs somewhat bullate, ribbing strong and with lateral tubercles, single row of median lateral tubercles at furcation of ribs.

Measurements : Wt-36.02 mm.

Locality : Kuldhara river bed.

Geological age : Middle Jurassic.

Remarks : Only a part of the shell is recovered.

Genus ***Reineckeites*** Buckman, 1924

Reineckeites sp. (Pl. III, Fig. 25)

Material : 1 example.

Diagnosis : Shell large, stout, planulate, strong biplicate ribbing with lappets, long single row of median lateral tubercles at furcation of rib.

Measurements : Wt-21.06 mm.

Locality : Kuldhara river bed.

Geological age : Middle Jurassic.

Remarks : Only a part of the shell is recovered.

Genus ***Kellawaysites*** Buckman, 1925

Kellawaysites sp. (Pl. III, Fig 26)

Material : 1 example.

Diagnosis : Shell planulate, inner whorls finely ribbed and not coronate, primary ribs long, tubercles absent; outer whorls large, ribbing gradually more distant.

Measerments : Wt-25.06 mm.

Locality : Kuldhara river bed.

Geological age : Middle Jurassic.

Family PERISPHINCTIDAE

Lithacoceras Hyatt 1900

Lithacoceras sp. (Pl. III, Fig. 27)

Material : 1 example.

Diagnosis : Shell large, compressed, involute, constricted; ribbing sharp with fine and as well as dense, biplicate, inner and middle whorls possess triplicate ribbing, tendency to become virgatotome.

Measurements : D-59.05 mm., Wt-16.08 mm., Wu-33.06 mm.

Locality : Kuldhara river bed.

Geological age : Middle Jurassic.

Genus ***Pachysphinctes*** Dietrich 1925

Pachysphinctes sp. (Pl. III, Fig. 28)

Material : 1 example.

Diagnosis : Shell large, stout, inner whorl strongly depressed; ribs regularly biplicate, triplicate ribs scattered on outer whorl surface.

Measurements : Wt-23.05 mm.

Locality : Kuldhara river bed.

Geological age : Upper Jurassic.

Genus ***Alligaticeras*** Buckman, 1923

Alligaticeras sp. (Pl. III, Fig. 29)

Material : 1 example.

Diagnosis : Shell small, planulate, whorls nearly quadrate, constricted, finely ribbed, not modified on body chamber.

Measurements : Wh-12.30 mm.,Wt-13.20 mm.,Wu-36.65 mm., Av-11.10 mm.

Locality : Ludrava, Jiasalmer.

Geological age : Upper Jurassic.

Genus ***Dichotomoceras*** Buckman, 1919

Dichotomoceras sp. (Pl. III, Fig. 30)

Material : 2 examples.

Diagnosis : Shell planulate, with biplicate simple ribs; ribs sharp, distantly arranged, no constrictions.

Measurements : Shell A : Wh-18.00 mm., Wt-15.00 mm.,Wu-25.00 mm., Av-H-17.00 mm., W-16.00 mm.; Shell B : Wh-14.00 mm., Wt-16.00 mm., Wu-21.00 mm., Av-H-12.00 mm., W-18.00 mm.

Locality : Ludrava, Jaisalmer.

Geological age : Upper Jurassic.

Genus ***Klematosphinctes*** Buckman, 1922

Klematosphinctes sp. (Pl. III, Fig. 31)

Material : 2 examples.

Diagnosis : Shell small, with biplicate ribs and long straight narrow lappets, more conspicuous parabolic and less coarsening of ribbing of body chamber.

Measurements : Shell A : WD-13.2 mm., Wt-4.90 mm., Wh-5.00 mm.; Shell B : WD-8.300 mm., Wt-3.60 mm., Wh-3.20 mm.

Locality : Saraswati river bed, Jaisalmer.

Geological age : Upper Jurassic.

Genus ***Paraberriasella*** Donze, 1948

Paraberriasella sp. (Pl. III, Fig. 32)

Material : 1 example.

Diagnosis : Shell medium sized, inner whorls finely ribbed; outer whorl gradually low down, sharp, regularly branched, simple ribbing.

Measurements : Wh-40.00 mm., Wt-22.00 mm., Wu-48 mm., Av-L—23 mm., W-22.00 mm.

Locality : Pahota, Jaisalmer.

Geological age : Upper Jurassic.

Genus ***Aulacosphinctoides*** Spath, 1923

Aulacosphinctoides sp. (Pl. III, Fig. 33)

Material : 1 example.

Diagnosis : Shell medium sized, volute, more sigmoid, sharp biplicatre ribbing, lappets present, body chamber ribbed to the end.

Measurements : Wu- 49.90 mm, Wt- 19.85 mm, Wh- 20.10 mm.

Locality : Saraswati river bed, Jiasalmer.

Geological age : Upper Jurassic.

Family ASPIDOCERATIDAE

Genus ***Parapeltoceras*** Schindewolf, 1925

Parapeltoceras sp. (Pl. III, Fig. 34)

Material : 1 example.

Diagnosis : Shell small, evolute, whorl rounded, sharply ribbed, bifurcating above middle of whorl sides, venter nearly flat.

Locality : Rupsi village, Jaisalmer.

Geological age : Upper-Middle Jurassic.

Family BERRIASELLIDAE

Genus ***Micracanthoceras*** Spath, 1925

Micracanthoceras sp. (Pl. III, Fig. 35)

Material : 8 examples.

Diagnosis : Shell small, evolute, with rounded folds, ribbing in higher relief, tubercles small, tuberculate ribs not flared, secondaries ending in small ventral tubercles.

Measurements : Shell A : Wh- 6.00 mm., Wt- 9.00 mm., Wu- 8.00 mm., Av-L- 5.5 mm., W- 9.00 mm.; Shell B : Wh- 8.00 mm., Wt-10.00 mm., Wu-12.00 mm., Av-L- 9.50 mm., W: 9.00 mm.; Shell C : Wh- 5.00 mm., Wt-10.00 mm.,Wu-10.50 mm, Av-L-9.5 mm., W-9.00 mm., Shell D : Wh- 7.00 mm., Wu-7.00 mm., Av-L-4.00 mm., W-7.00 mm.; Shell E : Wh-8.00 mm., Wt- 8.00 mm., D-28.00 mm.(whorl diameter); Shell F : Wh- 6.50 mm., Wt-9.00 mm.,Wu-10.05 mm.,Av-L-5.00 mm.,W-8.00 mm.; Shell G : Wh-5.50 mm., Wt- 8.00 mm., Wu- 10.00 mm.; Shell H : Wh-15.00 mm., Wt- 23.00 mm., Av-L-12.00 mm., W-17.00 mm.

Locality : Pahota, Jaisalmer

Geological age : Upper Jurassic.

Genus ***Berriasella*** Uhlig, 1905

Berriasella sp. (pl. III, Fig 36)

Material : 2 examples.

Diagnosis : Shell planulate, compressed, with distinct sharp ribbing; venter narrow with smooth band, lappets present, whorls trend to be rounded, sutures present.

Measurements : Shell A : Wh-58.00 mm., Wt-34.00 mm., Wu-79.00 mm., Av-H-23.00 mm.; Shell B : Wh-56.00 mm., Wt-50.00 mm., Wu-78.00 mm., Av-L-60.00 mm. W-48.00 mm.

Locality : Rupsi, Jaisalmer.

Geological age : Upper Jurassic.

Family DESMOCERATIDAE

Genus ***Subsaynella*** Spath, 1923

Subsaynella sp. (Pl. III, Fig. 37)

Material : 6 examples.

Diagnosis : Shell involute, compressed, sides somewhat concevex, venter broadly rounded; dense fine ribs weak on mid sides, stronger and branched and curved forward on outer part.

Measurements : Shell A : Wh-5.00 mm., Wt-4.00 mm., Wu-5.0 mm., Av-L-3.00 mm., W-3.00 mm.; Shell B : Wh-3.00 mm., Wt- 3.00 mm., Wu- 6.50 mm., Av-L-2.00 mm., W-2.50 mm.; Shell C : Wh-7.50 mm., Wt- 5.00 mm., Wu-10.00 mm., Av-L-7.00 mm., W- 5.00 mm.; Shell D : Wh-6.00 mm., Wt- 3.00 mm., Wu-8.00 mm., Av-L-3.00 mm., W-2.00 mm.; Shell E : Wh-5.00 mm., Wt-4.00 mm., Wu-6.00 mm., Av-L-3.00 mm., W-2.00 mm.; Shell F : Wh-3.00 mm., Wt-2.00 mm., Wu-6.00 mm, Av-L-3.00 mm., W-2.00 mm.

Locality : Bhramswar, Jaisalmer.

Geological age : Upper-Middle Jurassic.

Phylum BRACHIOPODA

Class ARTICULATA

Order RHYNCHONELLIDA

Family RHYNCHONELLIDAE

Burmirhynchia Buckman, 1918

Burmirhynchia sp. (Pl. III, Figs. 38, 39)

Material : 3 examples.

Diagnosis : Large sized shell, globose, with many rounded costae, flabellate; beak massive, gibbous, incurved, with a long apex, overhanging a small foramen that hardly touches umbo; ventral sulcus less marked than dorsal fold, fold highest along middle and anteriorly protruding.

Measurements : Shell A : H-51.90 mm., W-56.30 mm.; Shell B : H-48.80 mm, W-48.50 mm.; Shell C : H-41.00 mm., W-45.60 mm.

Locality : Kuldhara river bed, Jaisalmer.

Geological age : Middle Jurassic.

Genus ***Gibbirhynchia*** Buckman, 1917

Gibbirhynchia sp. (Pl. IV, Figs. 40, 41, 42)

Material : 4 examples.

Diagnosis : Shell large, roundly triangular with very high valve thickness; incurved beak; costae strong, angular.

Measurements : Shell A : H-58.00 mm., W-49.00 mm., I-68.00 mm.; Shell B : H-31.00 mm., W-50.00 mm., I-53.00 mm.; Shell C : H-48.00mm., W-43.00mm., I-39.00mm.; Shell D : H-34.00 mm., W-41.00 mm., I-37.00 mm.

Locality : Pahota, Jaisalmer.

Geological age : Middle Jurassic.

Remarks : Three of the 4 examples examined are slightly deformed.

Family BASIOLIDAE

Subfamily DZHANGIRHYNCHINAE

Genus ***Ptychorynchia*** Buckman, 1918

Ptychorynchia sp. (Pl. IV, Figs. 43, 44, 45)

Material : 17 examples.

Diagnosis : Shell small, thickness varies, sometimes subglobular, uniplicate with low and wide fold; costae few- relatively strong; beak small, suberect.

Measurements : Shell J : H-10.00 mm., W-10.00 mm., I-6.00 mm.; Shell K : H-10.00 mm., W-10.00 mm., I-5.50 mm.; Shell L : H-9.00 mm., W-11.00 mm; Shell M : W-12.00 mm., I-8.00 mm.; Shell N : H-9.00 mm., W-12.00 mm., I-7.50 mm.; Shell O : H-10.00 mm., W-11.00 mm., I-I8.00 mm.; Shell P : H-10.00 mm., W-11.00 mm., I-8.00 mm.; Shell Q : H-11.00 mm., W-11.00 mm., I-6.00 mm. Shell R : H-10.00 mm., W-12.00 mm., I-I8.00 mm.; Shell S : H-10.00 mm., W-12.00 mm., I-8.00 mm.; Shell T : H-9.00 mm., W-11.0 mm., I-5.00 mm.; Shell U : H : 12.00 mm., W-11.00 mm., I-5.00 mm.; Shell V : H-9.00 mm., W-10.00 mm., I-6.00 mm.; Shell W : H-9.00 mm., W-10.00 mm., I-6.00 mm.; Shell X : H-9.00 mm.,W-10.00 mm., I-7.00 mm.; Shell Y : H-mm., W-11.0 mm., I-5.00 mm.; Shell Z : H-10.00 mm., W-11.00 mm., I-5.00 mm.

Locality : Bhramswar village, Jaisalmer.

Geological age : Cretaceous Jurassic.

Family WELLERELLIDAE

Genus ***Kallirhynchia*** Buckman, 1917

Kallirhynchia sp. (Pl. IV, Figs. 46, 47)

Material : 9 examples.

Diagnosis : shell medium sized, almost convexiplanate, well developed uniplication, multicostate; beak stout, rather flattened, suberect, rarely incurving, apex short with distinct foramen, elliptical; slightly trilobed median flat fold more or less angulate, dental plates strong and divergent.

Measurements : Shell A : H-10.00 mm., W-12.00 mm., I-8.00mm.; Shell B : H-8.500 mm., W-13.00 mm., I-7.00 mm.; Shell C : H-11.00 mm., W-11.00 mm., I-7.00 mm.; Shell D : H-10.00 mm., W-11.00 mm., I-7.00 mm.; Shell E : H-10.00 mm., W-9.00 mm., I-8.00 mm.; Shell F : H-11.00 mm., W-12.00 mm., I-7.50 mm.; Shell G : H-8.500 mm., W-11.00 mm., I-6.00 mm.; Shell H : H-10.0 mm., W-10.00 mm I-6.00 mm.; Shell I : H-10.00 mm., W-10.00 mm., I-6.50 mm.

Locality : Pahota, Jaisalmer.

Geological age : Middle Jurassic.

Remarks : The two genera *Ptychorhynchia* and *Kallirhynchia* have some overlapping characters but the former has a stratigraphic range from Albian to Bajocian and the latter is found from Bathonian to Early Callovian (D. Mukherjee, pers. com.).

Order TEREBRATULIDA

Family TEREBRATULIDAE

Genus ***Terebratula*** Muller, 1776

Terebratula sp. (Pl. IV, Figs. 48, 49, 50)

Material : 1 example.

Diagnosis : Shell smooth, medium biplicate, convex valves, anterior commissure uniplicate, umbo short; symphytum narrow, commonly concealed; developed pedicel collar, growth line prominent, triangular loop; moderately flattend, transverse band, central bases extending along with edge of outer hinge plates; cardinal process rounded, hinge plate concave, separated from prominent socket ridges by deep slucus.

Measurements : H-33.00 mm., W-24.00 mm., I-23.00 mm.

Locality : Pahota, Jaisalmer.

Geological age : Jurassic.

DISCUSSION

After Vindhyan sedimentation, the major marine transgression took place covering areas of Kachchh (Gujarat) and Rajasthan including Jaisalmer basin in the Jurassic period. Transgressions of minor magnitudes are known also during the Permian period. These events are evident from the well known exposures of Kachchh and Jaisalmer which contain classic cephalopod fauna, along with various other marine invertebrate groups.

The basin of Jaisalmer (as well as Kachchh) originated in response to the rifting episode of the Gondwana superplate. A fracture zone in existence on the western border of the Indian plate was reactivated during the rifting phenomenon. The rifting began around the start of the Permian and proceeded from north to south. The Indian shield already emerged out after an extensive Vidhyan sedimentation north of the Narmada lineament (Krishana, 1987). Around the Triassic-Jurassic boundary a general upheaval took place in most of the axial belt and Indus shelf but the process of sedimentation continues in the Jaisalmer basin.

As far as palaeoecological scenario is concerned the dominant association in Jaisalmer basin represents shelf sedimentation (Krumbein & Sloss, 1963). According to Dasgupta

(1975) the Mesozoic sedimentation started with continental terrigenous rocks derived from the peneplained Precambrian basement in Lias followed by the first marine transgression in Callovian-Oxfordian time. The transgression covered Kachchh, Sanchore, Barmer and Jaisalmer basins along the down-faulted segments of the basement. In late Tithonian, the regressive phase was over. The source of sediments was the basement uplift. In Aptian, the second transgression took place covering the southern and western flanks of the arch. Dasgupta (1973) opined that a phase of igneous activity started in early Palaeocene in the Barmer basin which brought about the most early wide spread Tertiary marine transgression that covered large areas in the Rajasthan shelf. In the Tertiary formations of Jaisalmer basin, cyclical sedimentation, diastems, oxidized beds and the unconformities took place followed by complete withdrawal of marine condition after the Lutetian.

Based on the study of benthic foraminifers, cephalopods and brachiopods Dave & Chatterjee (1996) recognized a number of hiatuses and incident of transgressions-regressions in the Jurassic marine sequence of Jaisalmer basin (see Text-fig. 6). The first significant marine transgression was noticed in the Fort Member represented by *Tewaria -Dorthia* assemblage zone. This transgression was short lived and succeeded by a thick sequence of non-marine sandstone of Fort Member (Fort Sandstone). The next transgression was apparent during the upper Bathonian, represented by a rich assemblage of *Kallirhynchia* in the Badabag limestone (Ghosh, 1990). The Badian-Charian boundary is recognized by a minor hiatus in the Kuldhara Nala. The Callovian transgression was quite pronounced, represented by the diverse foraminiferal assemblage. Extensive flooding took place in the *Epistomina* Range-zone interval corresponding to upper part of *Reineckeia* spp. assemblage zone. Regression and hiatus were noticed over the *Reineckeia* spp. zone. The next transgression was noticed during the Oxfordian. The new Kimmeridgian transgression is represented at Rupsi by the *Pachysphinctes* assemblage. A minor hiatus has been depicted in the middle part of Kimmeridgian. The new upper Kimmeridgian transgression is evident by a suite of *Ammobaculites* spp. The Kimmeridgian-Tithonian boundary is recognized by a hiatus and regression. A short transgression took place during the lower Tithonian, which was succeeded by a major regression and hiatus. This last event is supposed to have eliminated upperTtithonian and a part of Cretaceous in the Jaisalmer basin.

The Jaisalmer Formation is the most fossiliferous Jurassic formation in the region. The deposition of the Formation took place perhaps in a near shore unstable shelf regime. A comparative biostratigraphic assessment of the ammonoid fauna, worked out by Krishna (1987) and Chatterjee (1990), is shown in the Table 1.

On the basis of precise stratigraphic exploration of the ammonoid forms Prasad (2006) proposed 11 biozones and 10 subzones from the Middle to Late Jurassic strata of Jaisalmer area. These zones are *Macrocephalites, Reineckeia, Properisphinctes, Peltoceratoides, Mayaites, Dichotomoceras* (in Kuldhar Member of the Jaisalmer Formation); *Torquatisphinctes* (partly), *Katroliceras* (in the Baisakhi Formation), *Virgatosphinctes, Anavirgatites* and *Substeueroceras* (in the Badesar Formation) in ascsending order. Zones which are faunally well developed have further been subdivided into 10 subzones in ascending order, *viz.*,

Formosus, Lamellosus, Subcompressus (for *Macrocephalites* zone); ***Anceps, Smithi, Ramosa*** (for ***Reineckeia*** zone); ***Alterniplicatus, Kobelliforme*** (for *Torquatisphinctes* zone); ***Mokalensis*** and ***Spitiensis*** (for *Virgatosphinctes* zone) (see Table 2).

Incidentally, the understanding that developed from the study of Kachchh basin depicts that the sediments emerged due to marine transgression-regression cycle, emanated from the break-up of Gondwanaa superplate and was surrounded by East Africa-Madagascar and western India (Fürsich *et al.*, 1991). That newly formed basin served as nursery of evolution of many immigrant fauna that invaded it (Dutta *et al.*, 1996). Rapid diversification of various taxa marked a clear endemism of fauna which constitute "Indo-Madagascan" or "Ethiopian" faunal province (Das *et al.*, 1999). According to Krishna (1987) and Dave & Chatterjee (1996) the Mesozoic (as well as Cenozoic) lithostratigraphic units of Jaisalmer basin show strong homotaxiality with similar units of Kachchh. The succession in this basin is however less thick and somewhat condensed in parts. The ammonoid assemblages are also not as rich as in Kachchh (Krishna, 1987). Sahni & Bhatnagar (1958), based on the study of brachiopod fauna and their excellent preservation, suggested that the stratigraphic sequence in the Jaisalmer basin is likely to yield a rich faunal assemblage. By the way, the records of nature have increasingly been distorted in places due to anthropogenic activities. It has however been realized by us that further investigation on various macroinvertebrate groups in the rock beds of Jaisalmer will be able to bring on record many more newer forms as well as help in characterizing its faunal peculiarities that are different from other parts of the Indo-Madagascan faunal province.

SUMMARY

The Mesozoic sedimentary deposits of Jaisalmer in the West Rajasthan shelf have been well known for their remarkable outcrops and diverse marine fauna of the past geological ages. The Jaisalmer basin, along with the Kachchh basin of Gujarat developed as an extension of the Tethys sea during the separation of Africa and India consequent to the rifting of Gondwana superplate. This rifting phenomenon began probably around Triassic-Jurassic transition period. Different sedimentary formations belonging to Precambrian, Mesozoic-Tertiary and Sub-recent ages are exposed in this basin. Of these, Mesozoic and Tertiary sediments yielded fossils of different marine invertebrate groups. Lithostratigraphically, the Mesozoic rocks have been divided into nine subdivisions and the Tertiary rocks have been subdivided into three subdivisions. The fossils are well preserved and a number of studies have been carried out on them. The studies on the foraminifers, cephalopods and brachiopods were utilized for time diagnosis and lithostratigraphic interrelations. The megainvertebrate fossils explored from this basin have been worked out and that comprise 2 species of Gastropoda, 9 species of Pelecypoda (Bivalvia), 21 species of Ammonoidea and 5 species

of Brachiopoda. The assemblage of the fauna shows Tethyan feature with a degree of regional endemism. The present findings stress upon further intensive studies in this basin for exploration of many more forms so as to characterize its faunal peculiarities that are different from other parts of the Indo-Madagascan faunal province.

ACKNOWLEDGEMENTS

The authors express deep sense of gratitude to the Director, Zoological Survey of India, Kolkata for providing necessary facilities for the project work. They are thankful to Dr. K. Ayasami, Shri D.P. Das, Dr. Debahuti Mukherjee and Dr. S. Som of the Geological Survey of India for support that helped determination of the ammonoid and brachiopod specimens; to Prof. A.K. Jaitly of the Banaras Hindu University for providing pertinent literature. Special thanks are due to Shri Tapan Bhattacharyya of the ZSI who helped in preparation of some text-figures used in this document. They owe to the reviewer of the paper for offering constructive opinions and useful changes for its improvement.

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Table 1. Comparative ammonoid biostratigraphy of Jaisalmer and overlying formations depicted by Krishna (1987) and Chatterjee (1990).

Geological Stage	Ammonoid Taxa Krishna (1987)	Ammonoid Taxa Chatterjee (1990)
Upper Tithonian	?	?
Middle Tithonian	*Virgatosphinctes*	*Virgatosphinctes densiplicatus*
Lower Tithonian	*Pachysphinctes*	*Haploceras, Aulacosphinctoides*
Kimmeridgian	*Torquatisphinctes*	*Lithacoceras, Katroliceras*
Middle Oxfordian	*Mayaites*	*Pachysphincetes, Katroliceras, Dhosaites*
Upper Callovian	?	*Epimayaites*
Middle Callovian	*Callotia gigantean, Reineckeia anceps*	*Reineckeia* sp.
Lower Callovian	*Subkossmatia opis, Macrocephalites semilaevis, M. chariensis, M. madagascarensis*	*Subkossmatia opis, Macrocephalites chariensis, M. formosis, Sivagericas congener*
Upper Bathonian	Approximate boundary	

Table 2. Ammonite biostratigraphic zonation of the marine Jurassic succession of Jaisalmer basin (after Prasad, 2006)

Formation	Member	Zones	Sub Zones	Age
BEDESAR	D	–	–	Post-Tithonian
	C			
	B	Substeueroceras	–	Late Tithonian
	A	Anavirgatites	–	Early Tithonian
		Vigratosphinctes	Spitiensis	
			Mokalensis	
BAISAKHI	Lanela	Katroliceras		Late Kimmeridgian
	Ladorva	Torquatisphinctes	Kobelliforme	Early Kimmeridgian
	Rupsi		Alterneplicatus	
JAISALMER	K	Dichotomoceras	–	Late Oxfordian
	U			
	L	Mayaites	–	Middle Oxfordian
	D	Peltoceratoides	–	Early Oxfordian
		Properisphinctes	–	? Late Callovian
	H	Reineckeia	Ramosa Smithi	Middle Callovian
	A		Anceps	
	R	Macrocephalites	Sub compressus	Early Callovian
			Lamellosus	
			Formosus	

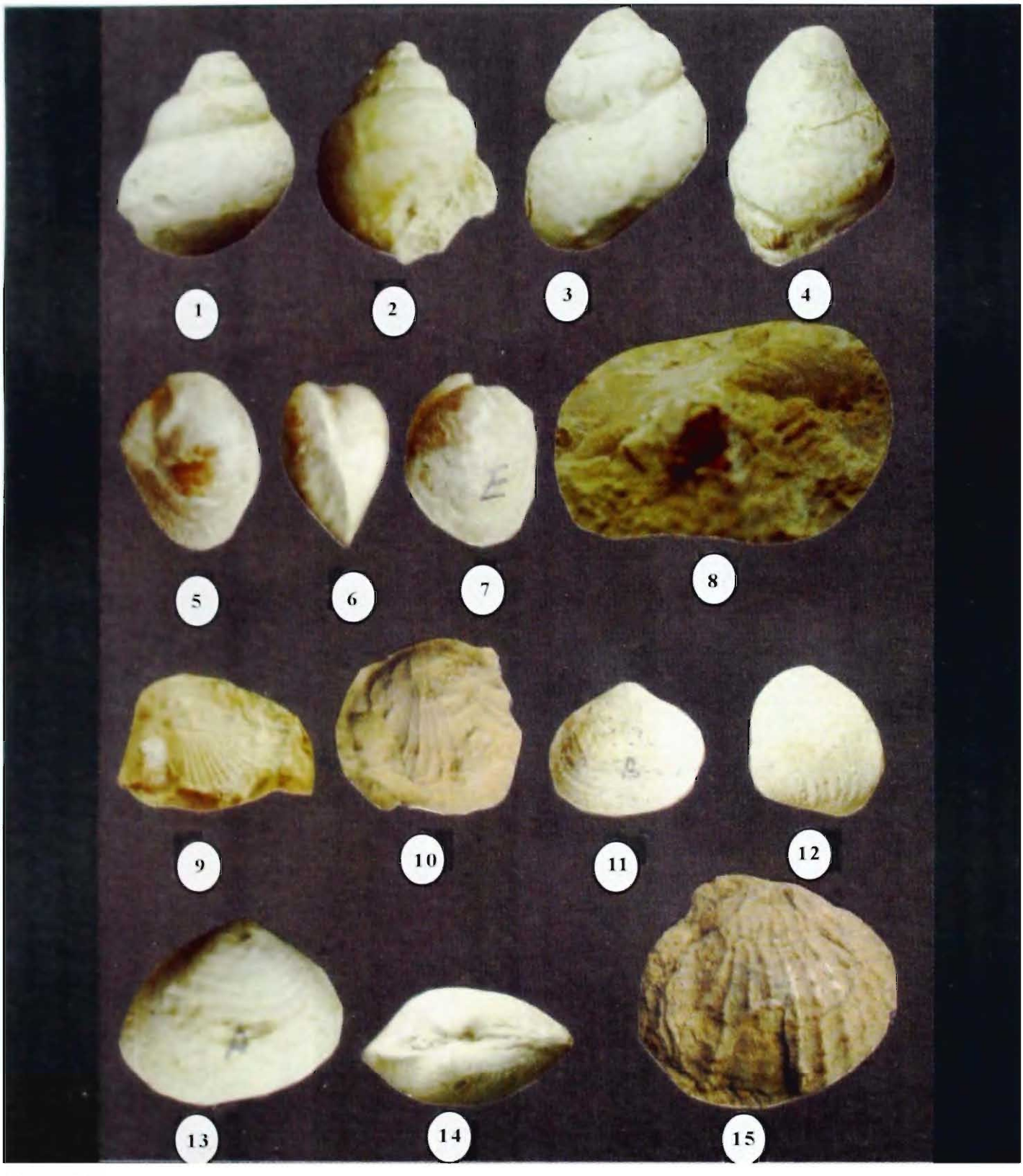

PLATE I. Figs. 1-15 1-2. *Garamites* sp., Cenozoic; IVP 479; 1. Adapertural view (0.86x); 2. Apertural view (0.87x); 3-4. *Subulites* sp., Cenozoic; IVP 481; 3. Adapertural view (1.02x); 4. Apertural view (1.00x); 5-7. *Nuculoma* sp., Middle Jurassic; IVP 482; 5. External view of left valve (0.80x); 6. Side view; (0.75x) 7. External view of right valve (0.80x); 8. *Modiolus* sp., Middle Jurassic; IVP 483; External view of left valve (0.91x); 9. *Chalamys* sp., Cenozoic; IVP 484; External view of left valve (1.13x); 10. *Spondylopecten* sp., Middle Jurassic; IVP 487; External view of left valve (1.02x); 11-12. *Bositra* sp., Jurassic; IVP 488; 11. External view of left valve (0.68x); 12. External view of right valve (0.70x); 13-14. *Mactromya* sp., Jurassic; IVP 495; 13. External view of right valve (1.25x); 14. Side view (1.00x); 15. *Plicatula* sp., Jurassic; IVP 497, External view of left valve (1.0x).

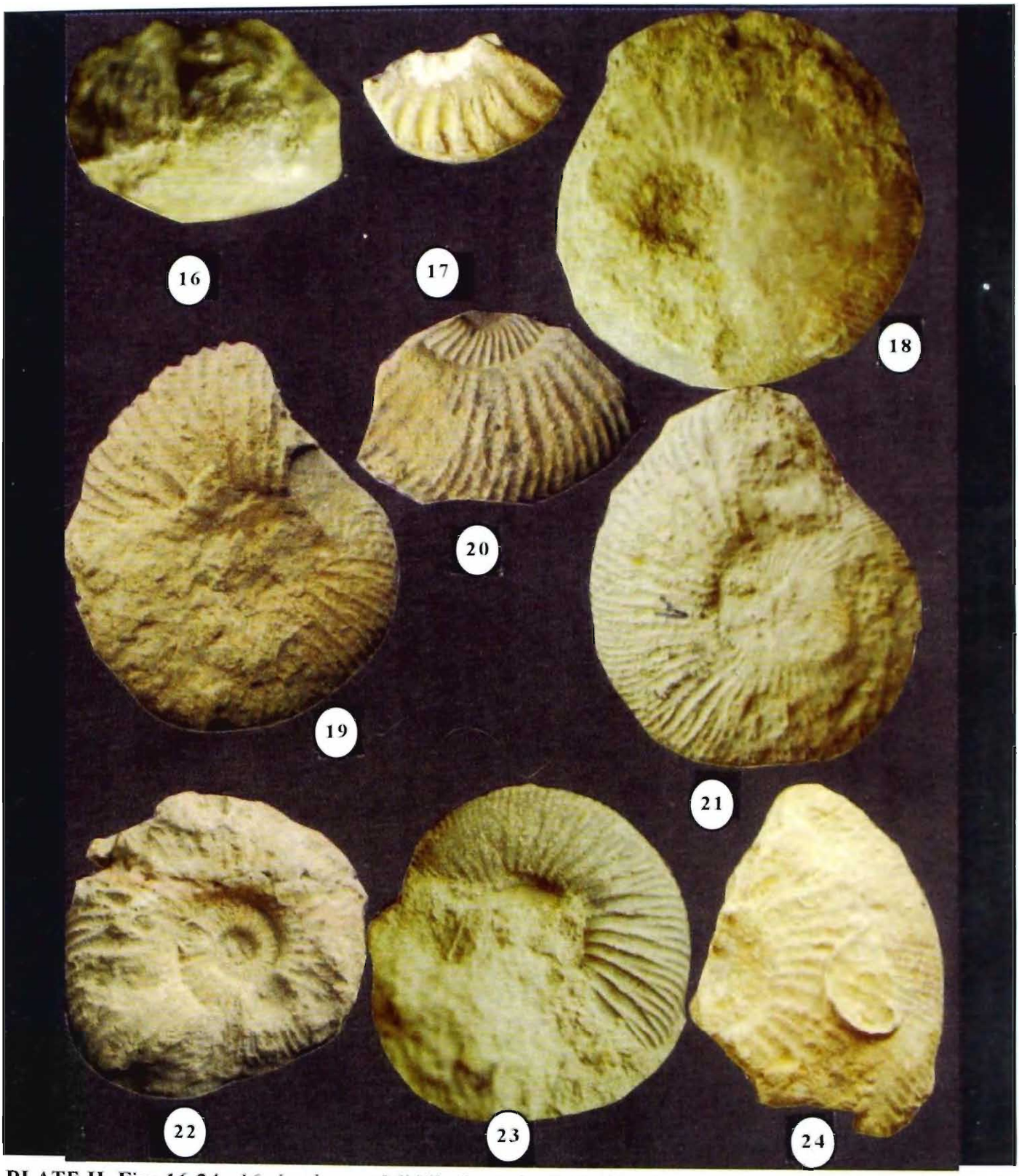

PLATE II. Figs.16-24 : 16. *Lopha* sp.; Middle Jurassic; IVP 498; External view of left valve (0.95x); 17. *Sindeites* sp.; Middle Jurassic; IVP 500; Lateral view (0.86x); 18. *Notocephalites* sp.; Middle Jurassic; IVP 501; Lateral view (0.83x); 19. *Subcosmatia* sp.; Middle Jurassic; IVP 503; Lateral view (1.11x); 20. *Idiocycloceras* sp.; Middle Jurassic; IVP 505; Lateral view (0.59x); 21. *Macrocephalites* sp.; Middle Jurassic; IVP 507; Lateral view (0.83x); 22. *Kamtokephalites* sp.; Middle Jurassic; IVP 508; Lateral view (0.82x); 23. *Indocephalites* sp.; Middle Jurassic; IVP 509; Lateral view (0.58x); 24. *Reineckeia* sp.; Middle Jurassic; IVP 510; Lateral view (0.70x).

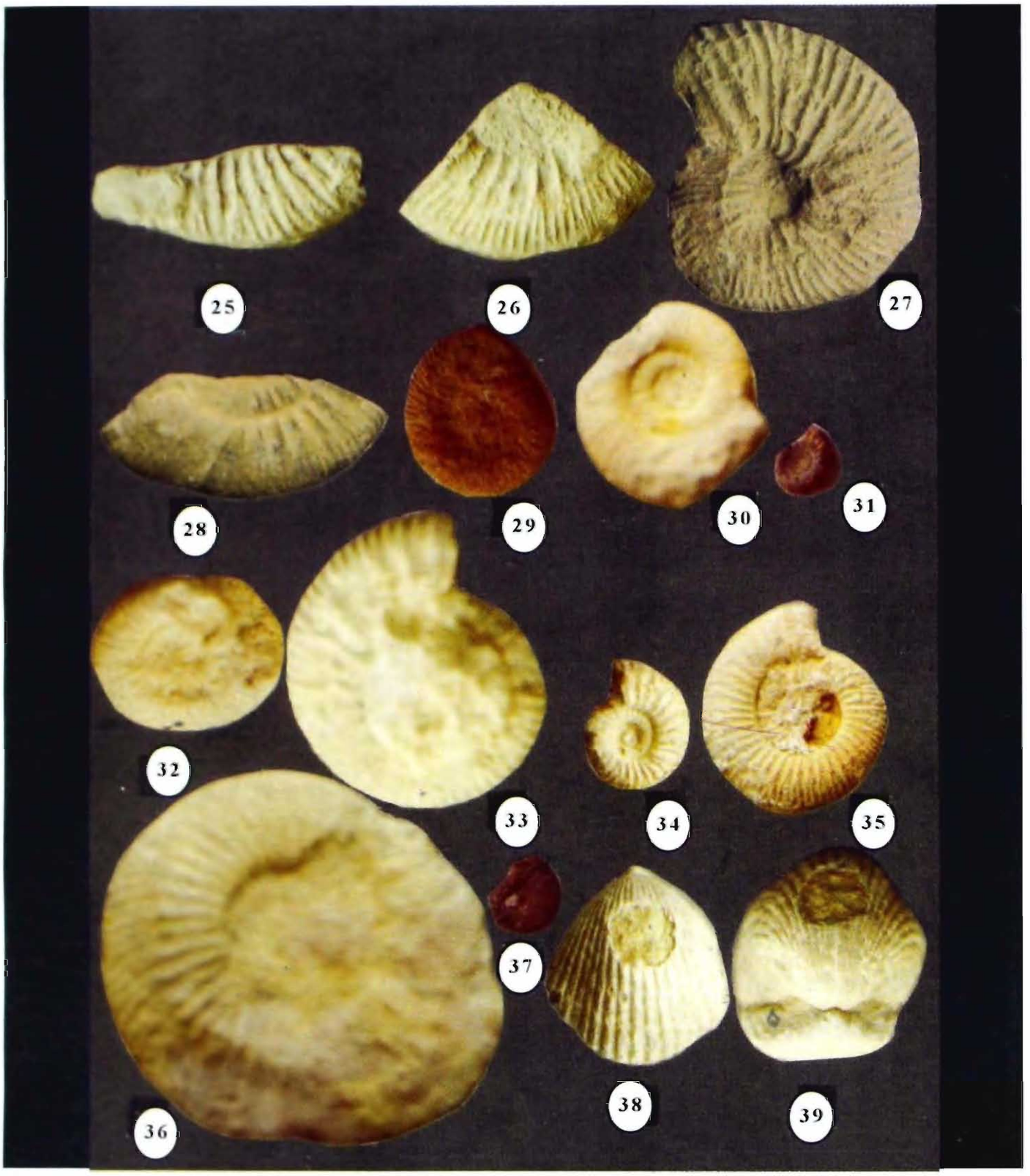

PLATE III. Figs.25-39 : 25. *Reineckeites* sp.; Middle Jurassic; IVP 511; Lateral view (0.77x); 26. *Kellawaysites* sp.; Middle Jurassic; IVP 512; Lateral view (0.81x); 27. *Lithacoceras* sp.; Middle Jurassic; IVP 513; Lateral view (1.02x); 28. *Pachysphinctes* sp.; Middle Jurassic; IVP 514; Lateral view (0.79x); 29. *Alligaticeras* sp.; Middle Jurassic; IVP 515; Lateral view (1.03x); 30. *Dichotomoceras* sp.; Middle Jurassic; IVP 516; Lateral view (1.03x); 31. *Klemptosphinctes* sp.; Middle Jurassic; IVP 518; Lateral view (1.33x); 32. *Paraberriasella* sp.; Middle Jurassic; IVP 519; Lateral view (1.81x); 33. *Aulacosphinctoides* sp.; Middle Jurassic; IVP 520; Lateral view (1.31x); 34. *Parapeltoceras* sp.; Middle Jurassic; IVP 521; Lateral view (1.42x); 35. *Micracanthoceras* sp.; Middle Jurassic; IVP 522; Lateral view (1.83x); 36. *Berriasella* sp.; Middle Jurassic; IVP 530; Lateral view (0.87x); 37. *Subsaynella* sp.; Middle Jurassic; IVP 532; Lateral view (0.80x); 38-39. *Burmirhynchia* sp.; Middle Jurassic IVP 538; 38, Ventral view., (0.86x); 39. Anterior view (0.88x).

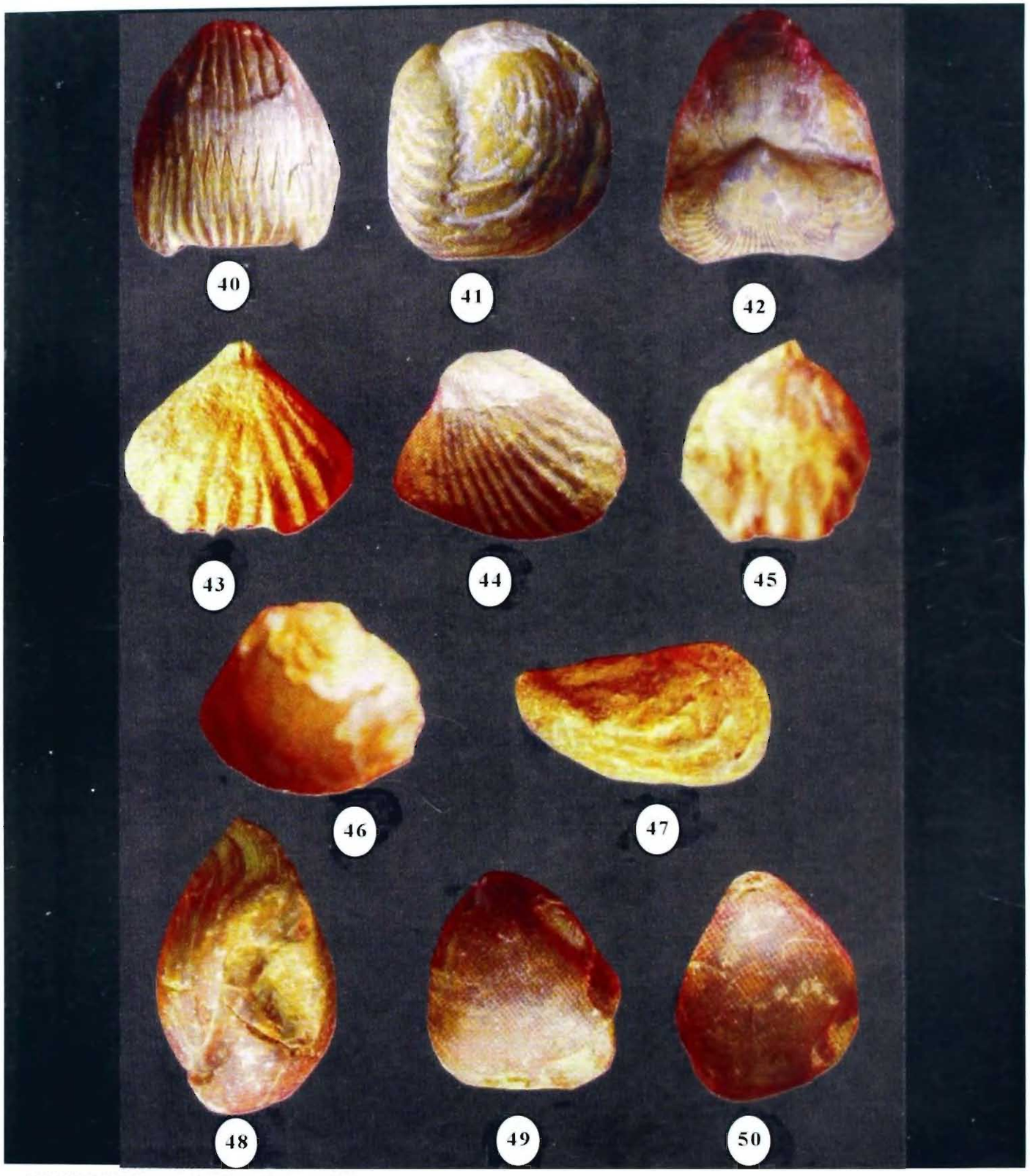

PLATE IV. Figs. 40-50 : 40-42. *Gibbirhynchia* sp.; Middle Jurassic; IVP 541; 40. Dorsal view (0.80x); 41. Side view (0.80x); 42. Anterior view (0.94x); 43-45. *Ptychorynchia* sp.; Middle Jurassic; IVP 545; 43. Dorsal view (3.01x); 44. Side view (3.00x); 45. Ventral view (3.01x); 46-47. *Kallirhynchia* sp; Middle Jurassic; IVP 562; 46. Dorsal view (4.05x); 47. Side view (4.56x); 48-50. *Terebratula* sp.; Middle Jurrassic; IVP 571; 48. Side view (1.83x); 49. Dorsal view (1.36x); 50. Anterior view (1.42x).