

**OCCASIONAL PAPER NO. 247**

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ZOOLOGICAL SURVEY OF INDIA**

**On the Megainvertebrate fauna (Mollusca,  
Brachiopoda, Echinodermata) of Cenozoic and  
Mesozoic of Kachchh, Gujarat and their  
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Kolkata**

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**CONTENTS**

INTRODUCTION .....	1
STRATIGRAPHY .....	3
SYSTEMATICS .....	5
<i>Nerita (Amphinerita)</i> sp. ....	11
<i>Euchrysalis</i> sp. ....	11
<i>Rostellaria</i> sp. ....	12
<i>Lyria (Lyria)</i> sp. A .....	12
<i>Lyria (Lyria)</i> sp. B .....	13
<i>Diastoma</i> sp. ....	13
<i>Eocypraea</i> sp. A .....	13
<i>Eocypraea</i> sp. B .....	14
<i>Zaria</i> sp. ....	14
<i>Natica (Cochlis)</i> sp. ....	14
<i>Ampullella</i> sp. ....	15
<i>Pterygia (s. str.)</i> sp. ....	15
<i>Genota</i> sp. ....	16
<i>Globularia</i> sp. ....	16
<i>Conus</i> sp. ....	17
<i>Ancillus</i> sp. ....	17
<i>Eovasum</i> sp. ....	17
<i>Grammatodon</i> sp. ....	18
<i>Grammatodon (Indogrammatodon)</i> sp. ....	18
<i>Modiolus (Modiolus)</i> sp. ....	19
<i>Chlamys (Argopecten)</i> sp. ....	19
<i>Chlamys (Lyropecten)</i> sp. ....	20
<i>Chlamys (Vertipecten)</i> sp. A .....	20
<i>Chlamys (Vertipecten)</i> sp. B .....	20

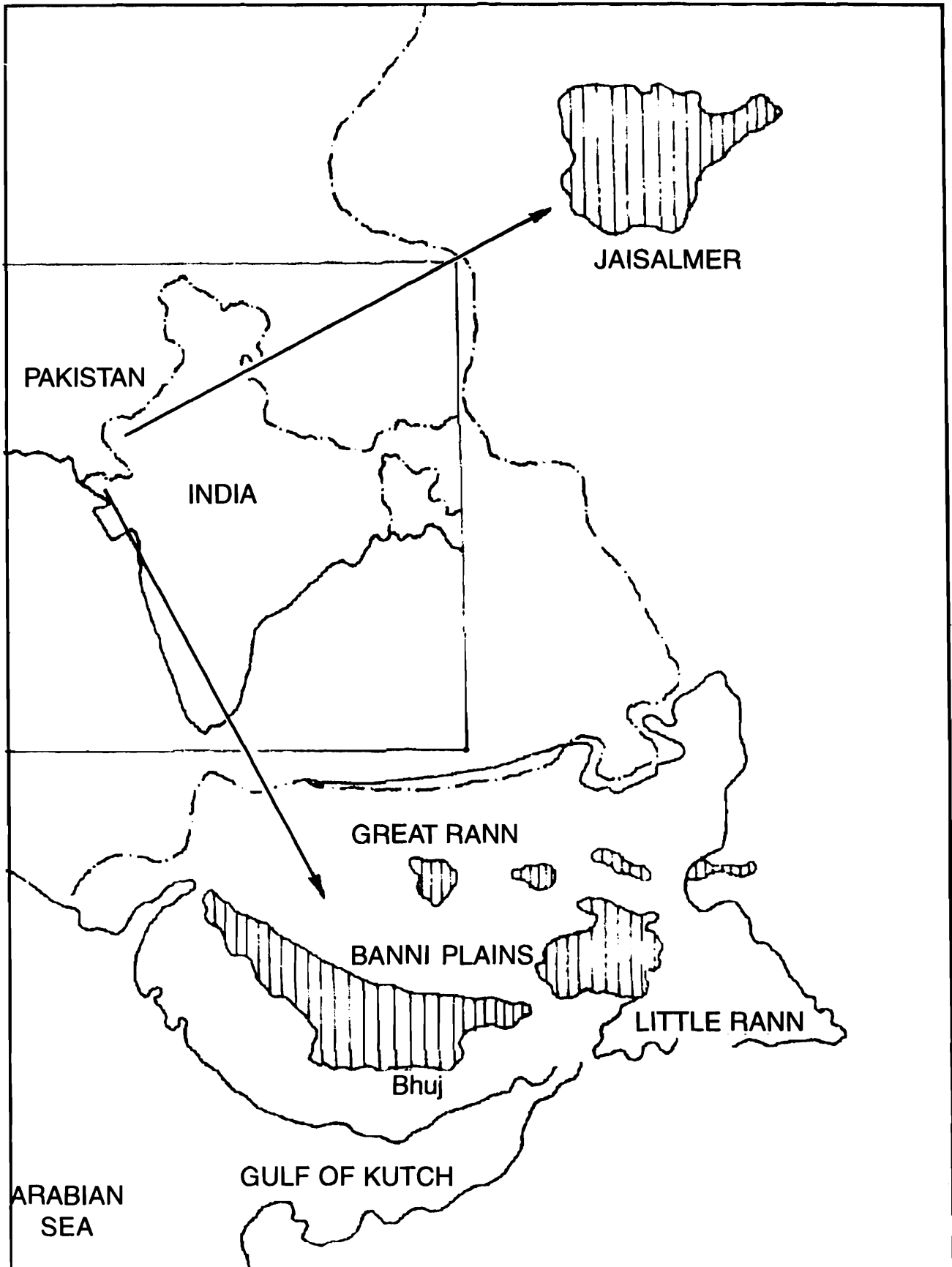
<i>Chlamys (Pecten) sp.</i> .....	21
<i>Spondylus (Corallospondylus) sp.</i> .....	21
<i>Lopha sp. A</i> .....	22
<i>Lopha sp. B</i> .....	22
<i>Pseudocardita sp. A</i> .....	22
<i>Pseudocardita sp. B</i> .....	23
<i>Siliqua sp.</i> .....	23
<i>Polymesuda (Geloina) sp.</i> .....	23
<i>Periglypta sp. A</i> .....	24
<i>Periglypta sp. B</i> .....	24
<i>Hubertoceras sp. A</i> .....	24
<i>Hubertoceras sp. B</i> .....	25
<i>Kinkeleniceras sp. A</i> .....	25
<i>Kinkeliniceras sp. B</i> .....	25
<i>Macrocephalites (s. str.) sp. A</i> .....	26
<i>Macrocephalites (s. str.) sp. B</i> .....	26
<i>Subkossmatia sp.</i> .....	26
<i>Kondiloceras sp.</i> .....	27
<i>Mayaites sp.</i> .....	27
<i>Reineckeia sp.</i> .....	27
<i>Burmirhynchia sp.</i> .....	28
<i>Gen. indet.</i> (Rhynchonellid) .....	28
<i>Kallirhynchia sp.</i> .....	29
<i>Prinocidaris sp.</i> .....	29
<i>Clypeaster sp.</i> .....	30
<i>Clypeaster cf. apertus</i> Duncan & Sladen, 1883 .....	30
<i>Clypeaster cf. monticulifera</i> Duncan & Sladen, 1883 .....	30
<i>Schizaster cf. granti</i> Duncan & Sladen, 1836 .....	30
DISCUSSION .....	31
SUMMARY .....	32
ACKNOWLEDGEMENTS .....	33
REFERENCES .....	33

## INTRODUCTION

The Kachchh basin is famous world over for its thick pile of marine sediments ranging in age from Triassic to Recent (with a few stratigraphic breaks) and entombing invertebrate fauna. Especially, the marine Jurassic sequences of Kachchh have been the centre of attraction for more than a Century for their extensive outcrops and a rich biota including molluscan fauna and which were worked out by earlier workers (Blanford, 1877; Waagen, 1873-75; Spath, 1924, 1927-33, 1935; Rajnath, 1932 etc.). In the peninsular India, an important marine transgression took place during the Jurassic Period encompassing areas of Kachchh and Rajasthan (Text-Fig.1). These basins have also received considerable attention from the geologists for their possible oil reserves.

The Mesozoic basins along the western margin of the Indian plate incorporate Narmada, Cambay, Saurashtra, Kachchh and Sanchore basins in Gujarat; Barmer, Jaisalmer and Bikaner-Nagaur basins in Rajasthan; and Lower and Upper Indus basins in Pakistan. These basins originated as a result of successive tectonic impulses commensurate with the rifting phenomenon along India-Africa plate margins of the Gondwana superplate which began perhaps near the Triassic-Jurassic boundary (Krishna, 1987). The Kachchh basin is somewhat EW-trending protected bay. The basin is bounded by Radhanpur- Barmer ridge to the east side, by Delhi-Aravalli basement ridges to the north, and Saurashtra peninsula to the south.

Wynne (1872) pioneered the detailed geological investigation on a regional scale for the area around Kachchh. The initial palaeontological investigation in this area was undertaken by Waagen (1873-75), Kitchin (1900, 1903), followed by Spath (1927-33, 1935), Cox (1940, 1952) and many subsequent workers (Kanjilal, 1978a, Jaitly & Singh, 1980, 1983b, Pandey, Singh & Agrawal, 1984, Jaitly, 1982, 1985, 1996, 1998, 2000; Singh & Agrawal, 1985; Fürsich, Oschmann, Jaitly & Singh, 1991; Fürsich, Oschmann, Singh & Jaitly, 1992; Kanjilal & Prasad, 1992; Pandey, 1992c; Pandey & Agrawal, 1992; Prasad, 1993; Fürsich & Oschmann, 1993; Fürsich, Pandey, Callomon, Oschmann & Jaitly, 1993; Fürsich, Jaitly, Oschman, Pandey & Callomon 2000; Fürsich, Pandey, Callomon & Jaitly, 2000; Fürsich, Pandey, Callomon, Jaitly & Singh, 2001; Fürsich, Callomon, Pandey & Jaitly, 2003). Various groups of fossils including Foraminifera (Singh, 1977, 1979; Bhalla & Talib 1985; Mandwal & Singh, 1989), Corals (Gregory, 1900; Pandey & Fürsich, 1993; Fürsich, Oschmann, Pandey & Jaitly, 1994), Brachiopoda (Kitchin, 1900, Ghosh, 1968a,b; Mitra & Ghosh 1974, 1979), Ammonoidea (Spath, 1927-33; Kachhara & Kanjilal, 1972; Kanjilal, 1975b, 1978b, c, d, 1980c, 1983a, b; Singh, Agrawal & Kacker, 1979; Kanjilal & Singh, 1980b, 1986; Pandey & Singh, 1982; Singh, Jaitly & Pandey, 1982a; Singh, Pandey & Jaitly, 1983; Jaitly & Singh, 1983a, 1984; Prasad & Kanjilal, 1985; Pandey & Westermann, 1988; Pandey, 1992b; Pandey & Alabushev, 1993; Callomon, 1993; Pandey & Agrawal, 1994a; Dutta *et al.*, 1996), Nautiloidea



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

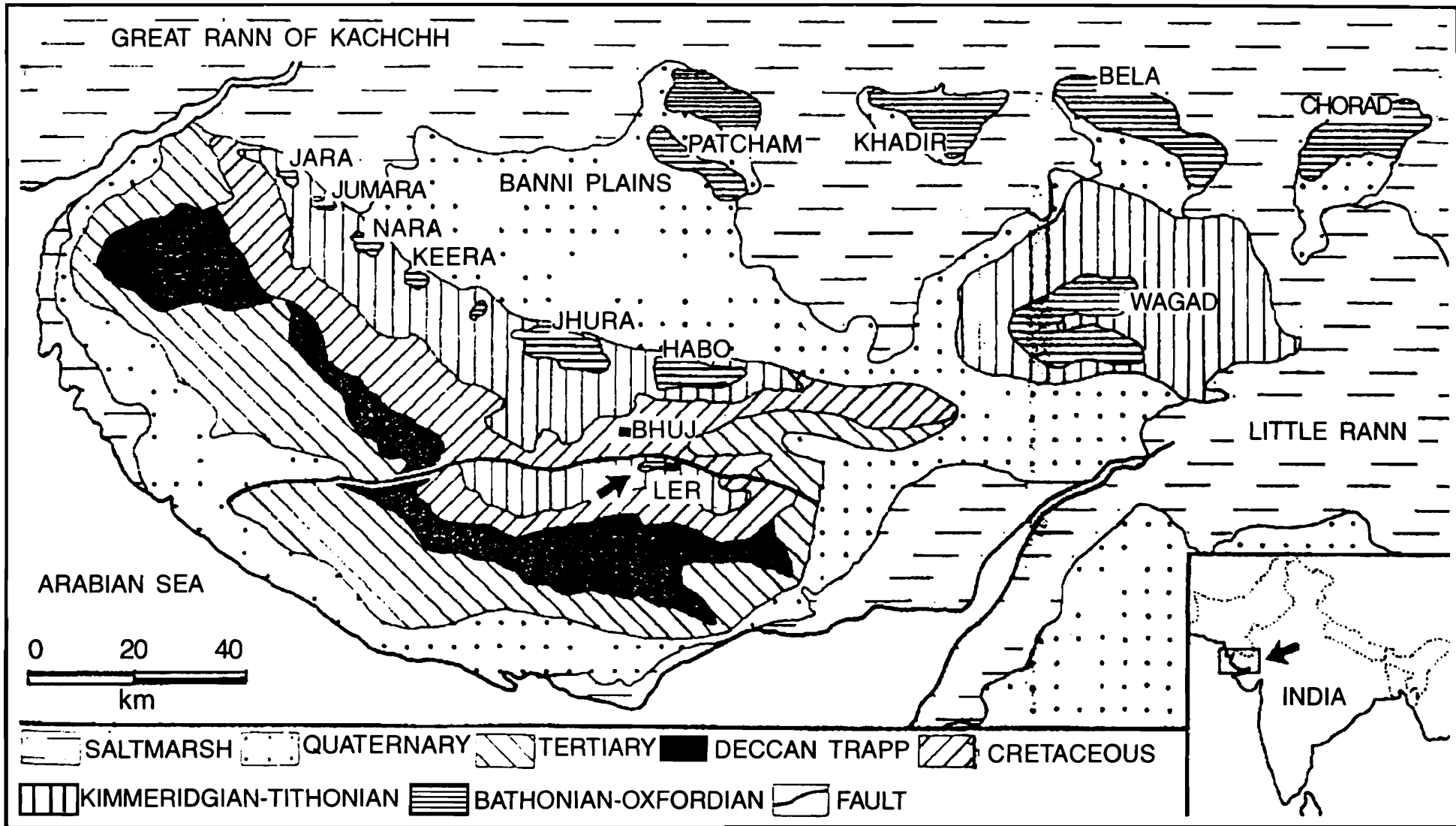
(Kanjilal, 1978e; Bardhan *et al.*, 1994; Halder & Bardhan, 1996a, b; 1997), Gastropoda (Maithani, 1967; Mitra & Ghosh, 1979; Das *et al.*, 1999; Jaitly, Szabo & Fürsich, 2000; Jaitly & Szabo, 2002), Bivalvia (Kitchin, 1903; Cox, 1940, 1952; Kanjilal, 1972, 1975a, 1977, 1979a, b, 1980a, b, 1981, 1990; Kanjilal & Singh, 1973, 1980c; Singh & Kanjilal, 1974, 1977, 1982; Singh & Rai, 1980; Pandey & Singh, 1981; Singh, Jaitly & Pandey, 1982b; Singh & Jaitly, 1983; Jaitly & Singh, 1983c; Jaitly, 1986a, b, c, 1988, 1989a, 1992; Pandey, 1992a; Jaitly, Fürsich & Heinze, 1995; Fürsich, Heinze & Jaitly, 2000), Echinodermata (Gregory, 1893), and Ichnofossils (Badve & Ghare, 1978; Howard & Singh, 1985; Fürsich, 1998; Jaitly, 2000a) have attracted attention of the palaeontologists and stratigraphers.

Although, Grant (1840) and Wynne (1872) published adequate geological account of the Tertiary sediments, however, unlike the Mesozoic sediments, the Tertiary sediments (App. 900 m. thick) failed to draw as much attention from the subsequent workers, especially the megapalaeontologists. Poddar (1959), Tiwari (1956, 1957), Sengupta (1963, 1964) and Biswas (1965), classified the Tertiary sediments of Kachchh in light of the earlier classification proposed by Wynne (1872). Subsequently, these sediments were much explored especially for the microfossils and nannofossils (e.g., Drooger & Raju, 1978; Guha, 1961, 1968, 1974; Khosla & Pant, 1988; Mohan & Soodan, 1970; Mohan & Bhatt, 1968; Raju, 1971, 1974a,b, 1978, 1990; Samanta & Lahiri, 1985; Samanta, 1989; Singh & Singh, 1986; Jafar & Rai, 1984, 1994; Singh, 1978a,b, 1980a,b; Jauhari, 1980, 1981, 1991, 1994; Rai, 1997 etc). Amongst the megainvertebrates, no significant attempt has been made and the echinoids got maximum notice (e.g., Roy & Das Gupta, 1970; Tandon, 1973; Tandon & Srivastava, 1980; Srivastava, 1988; Srivastava, Mishra & Srivastava, 1992; Srivastava & Singh, 1999, 2001 etc.).

In the background of the potentiality of Kachchh basin as a fossil storehouse, it was thought that a lot more interesting forms are still lying unrecovered from the area. Considering the sedimentary sequences in the basin of Kachchh that containing a rich fossil biota, a field work was carried out recently by the ZSI in this area for exploration of the nature of the faunal content, especially the megainvertebrates. The collection made during the field study has been worked out and result of the study is being presented here in the background of depositional history and lithostratigraphy of Kachchh basin.

## STRATIGRAPHY

The Mesozoic rocks count for nearly fifty per cent area of Kachchh, covering the mainland and three 'islands' in Rann. They lie unconformably over the Precambrian basement (see Text-Fig. 2). The Jurassic rocks are best developed in the Central anticline (Wynne, 1872; Rajnath, 1932; Poddar, 1959). A set of zones of culmination is noticed along the anticlines. These zones of culmination crop out as topographical domes at Jhura, Jumara, Keera etc. (see Text-Fig. 3).



Txt-Fig. 3. Geological sketch map of Kachchh area, Western India (after Fürsich *et al.*, 2001).

Lithologically, the Mesozoic rocks of Kachchh have been divided into four subdivisions viz, Patcham, Chari, Katrol and Umia Formations in an ascending order of superposition, ranging in age from Bajocian to Albian (Table 1). Waagen (1873-75) relied upon Stoliczka's unpublished four-fold lithostratigraphic scheme considering it well founded (Krishna, 1987). This scheme of lithic sequence was largely followed by the subsequent workers, occasionally with minor nomenclatural changes of Stoliczka's subdivisions. Rajnath (1932,1942) mapped out NW Kachchh using Stoliczka's scheme. He erected Bhuj Unit as a part of the Umia Formation. Agrawal (1956,1957,1981) proposed modified nomenclatures for the lithostratigraphic units. Biswas (1971) recognised different lithostratigraphic sequences for the 'islands' and the mainland areas of Kachchh-Kathiawar region and indicated certain deficiencies of Stoliczka's scheme. But Krishna (1987) opined for not using new schemes with newer nomenclature for the same stratigraphic units. He (*loc. cit.*) however, suggested right usage of the stratigraphic terminologies and elaborate definition of the type sections for resolving the differences in opinion and objections. Mitra *et al.* (1979) also opined in favour of accepting Stoliczka's scheme. Krishna (1987) made little adjustments in Stoliczka's scheme for eliminating minor objections raised by some earlier workers. Krishna's arrangement found acceptance by the subsequent workers (Mandwal & Singh, 1989; Bardhan *et al.*, 1994 a,b; Halder & Bardhan, 1996 a,b; Naik & Pal, 2004). Fürsich, Pandey, Callomon, Jaitly & Singh (2001) made extensive investigations all along the Jurassics of Kachchh and further modified the earlier classifications of the Jurassic sediments up to Kimmeridgian (Text-Figs. 4, 5). Their classification has been followed in the present study.

The Tertiary sediments are exposed all along the coastal plains of the Kachchh Mainland and along the peripheral plains around the Jurassic sediments both in the Kachchh Mainland and the "Islands" (Text-Fig. 6). The sediments were deposited during different tectonic regime and represent particular geological events related to the evolution of the Kachchh basin. Biswas (1992) reviewed the earlier works and presented a modified lithostratigraphic classification of the Tertiary sediments of Kachchh (Text-Fig. 7). These sequences are considered to be Tertiary stratotype for the shallow marine sediments of India.

## SYSTEMATICS

M. Ghosh and U. Saha (of ZSI, Kolkata) in 2000 collected all the material for the present study as a part of the scheme initiated by the ZSI to investigate both extinct and extant macrofauna of Kachchh basin. The initial identification of the material was done by TKP, SKR and BT and later on reviewed by one of the authors (AKJ).

*Repository* : Palaeozoology Division, ZSI.

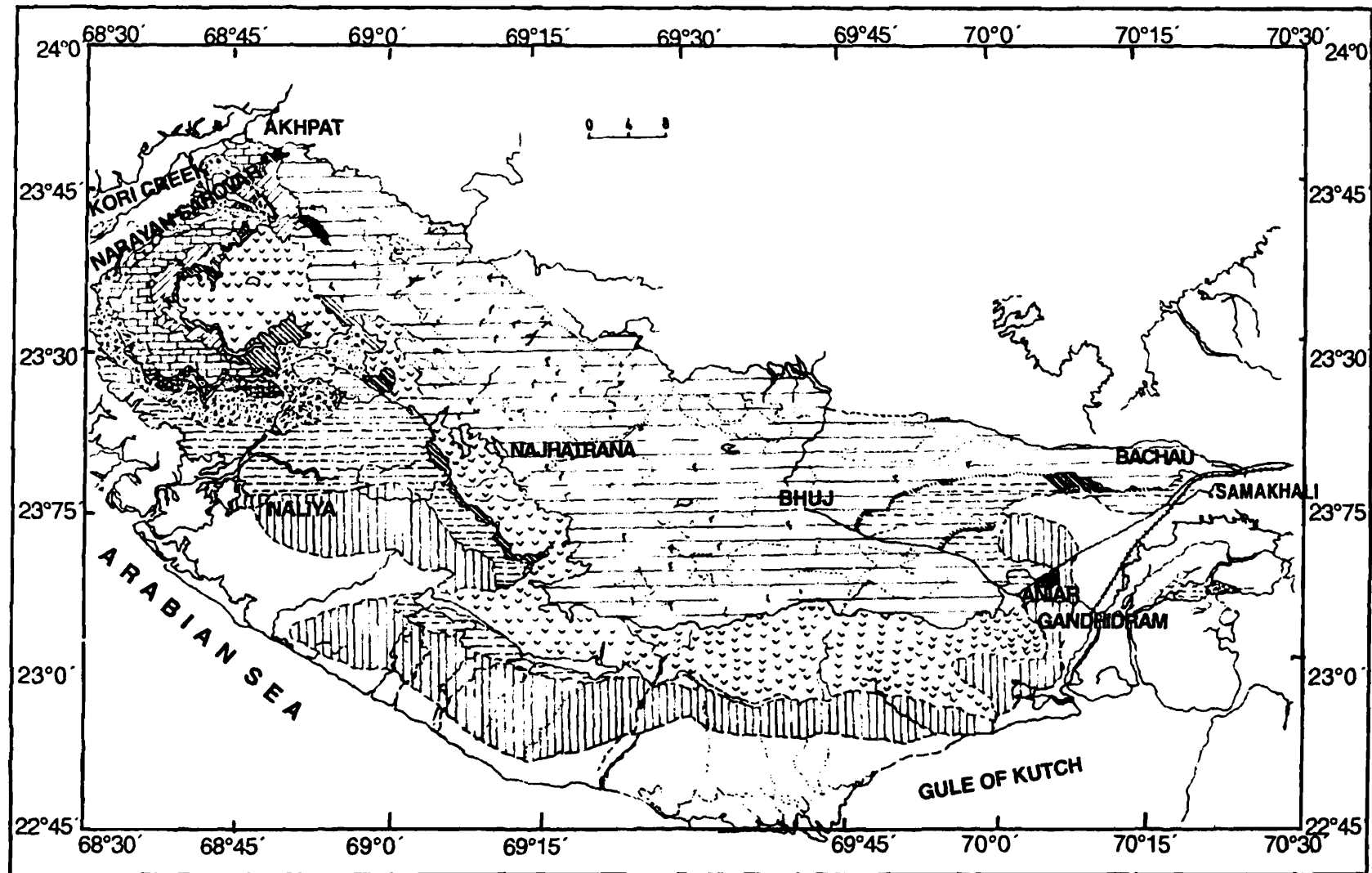
The following abbreviations have been used for the purpose of measurements of the different groups of macrofauna :

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



<b>CRETACEOUS</b>			<b>KACHCHH</b>									
		ALBIAN	UMIA FORMATION					BHUJ MEMBER UKRA MEMBER GHUNERI MEMBER UMIA MEMBER				
		APTIAN										
		NEOCOMIAN										
<b>JURASSIC</b>	<b>UPPER</b>	TITHONIAN	KATROL FORMATION					DHOSA OOLITE MEMBER				
		KIMMERIDGIAN										
		OXFORDIAN	CHARI FORMATION									
	<b>MIDDLE</b>	CALLOVIAN	PATCHAM FORMATION									
		BATHONIAN										
		BAJOCIAN										
		AALENIAN										
	<b>LOWER</b>											

**Text-Fig. 5.** Stratigraphic framework of the Bajocian-Oxfordian rocks of Kachchh basin, Western India (after Fürsich *et al.*, 2001).



**LEGEND**

- |                        |                          |              |
|------------------------|--------------------------|--------------|
| Quaternary             | Ramanian Stage           | Pre Tertiary |
| Kanakwafian Superstage | Babian stage             |              |
| Vinjhan Stage          | Kakadian & Khasian Stage |              |
| Adion Stage            | Madhian Stage            |              |
| Wairian Stage          | Deccan Trap              |              |

**Text-Fig. 6.** Tertiary stages of Kachchh mainland, Western India (after Biswas, 1992).

TIME IN M. Y.	SERIES		STAGES	LITHOSTRATIGRAPHY FORMATIONS	MEMBERS	FORAMINIFERAL ZONES	W.COAST/ KUTCH STAGES
	PLIOCENE	MIOCENE					
10	UPPER	MESSINIAN				To be Zoned	KANKAAWATIAN SUPER STAGE
		TORTONIAN					
	MIDDLE	SERRAVALLIAN	SANDHAN				
		LANGHIAN					
20	LOWER	BUROIGALIAN	CHHASRA	SIL TSTONE CLAYSTONE	<i>A. Papillosus</i> <i>M. (L.) excentrica</i> <i>M. (L.) droogeri</i> <i>M. globulna - thecideaeformis</i>	VINJHANIAN	
		AQUITANIAN	KHARI NADI		<i>M. (M.) tani</i> poorly Fossiliferous	AIDAIAN	
		CHATTIAN		BERMOTI	<i>M. (M.) complomato-formosensis</i> <i>M. (M.) barmudezi</i> <i>P. freudenthali</i>	WAIORIAN	
30	UPPER		MANIYARA FORT	CORAL LIMESTONE	<i>N. fichteli</i>   <i>E. dialata</i>	LR. UPPER RAMANIAN	
	LOWER	RUPELIAN		LUMPY CLAY BASAL MEMBER	<i>N. fichteli</i>		
40	UPPER	PRIABONIAN				NOT NAMED	
		BARTONIAN					
	MIDDLE	LUTETIAN	FULRA LIMESTONE		<i>T. rohri</i> <i>O. beckmanni</i>	BABIAN	
50	LOWER	YPRESIAN	HARUDI		<i>T. topilensis</i> <i>N. obtusus</i>	KAKADIAN	
		THANETIAN	NAREDI	FERR. CLAYSTONE ASSILINA LIMESTONE GYPSEOUS SHALE	Poorly Fossiliferous <i>A. granulosa</i> <i>A. spinosa</i> Ostracod Zone	KHASIAN	
60	UPPER		MATANOMADH			MADHIAN	
	LOWER	DANIAN	DECAN TRAP			DECCAN TRAPS NO-SEDIMENTS	
70	UPPER	MAASTRICHTIAN					

Text-Fig. 7. Stratigraphic classification of the Tertiary sediments of Kachchh, Western India (after Biswas, 1992).



*Gastropods* : H- total height; Hl- height of last whorl; D- diameter of last whorl; Ha- height of aperture; Wa- width of aperture; AA- apical angle.

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

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

*Echinoids* : L- length of test; B- breadth of test; H- height. All the measurements in millimeter.

Phylum MOLLUSCA  
 Class GASTROPODA  
 Order ARCHAEOGASTROPODA  
 Family NERITIDAE

Genus *Nerita* Linnaeus, 1758

Subgenus *Amphinerita* Martens, 1887

*Nerita (Amphinerita)* sp. (Pl. I, Fig. 1)

*Material* : 1 example.

*Diagnosis* : Shell small, globular-turbiniform, anomphalous, spire short regularly conical, ending in a smooth protoconch with flattened nucleus; whorl convex, shortly increasing, narrow, separated by channel sutures, almost smooth with faint axial ornamentation; aperture large, semicircular, situated upon a very oblique in plane, peristome entire, outer lip straight, columellar range diverged from the internal curve.

*Measurements* : H- 34.00, D- 31.02, Ha- 31.50, Wa- 11.05.

*Locality* : Bandiya.

*Geological age*: Cenozoic.

*Remarks* : Shell dorsoventrally flattened owing to earth pressure and apertural dimension indistinct.

Family EULIMIDAE

Genus *Euchrysalis* Laube, 1866

*Euchrysalis* sp. (Pl. I, Figs. 2, 3)

*Material* : 1 example.

*Diagnosis* : Shell ovate-elongate, subcylindrical in the middle, anteriorly somewhat narrower, whorls nine in number (not completely visible in the studied specimen) being slightly convex, aperture ovate, posteriorly very narrow, anteriorly roundish.

*Measurements* : H- 34.05, D- 21.20, Ha- 22.05, Wa- 14.10.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

*Remarks* : Tip of the shell (whorl) broken.

#### Family STROMBIDAE

Genus *Rostellaria* Lamarck, 1799

1799. *Rostellaria* Lamarck, *Soc. Histoire Nat. Paris, Mem.*, 1 : 63-91.

*Rostellaria* sp. (Pl. 1, Figs. 4, 5)

*Material* : 1 example.

*Diagnosis* : Shell spindle shaped, surface of the whorls smooth, fine spiral striation, first whorl consists of about six flat volution with scarcely impressed sutures; aperture elongate-ovate, obliquely placed; posterior canal very distinct and separates both margins.

*Measurements* : not recorded (of a broken specimen).

*Locality* : Bandiya.

*Geological age* : Cenozoic.

*Remarks* : Part of the shell is broken.

#### Family VALUTIDAE

Genus *Lyria* Gray, 1847

1847. *Lyria* Gray, *Zool. Soc. London, Proc.* 15 : 129-219.

*Lyria (Lyria)* sp. A (Pl. 1, Figs. 6, 7)

*Material* : 2 examples.

*Diagnosis* : Shell moderately large, thick; spire short, conical, smooth; globular protoconch with hemispherical cap; four spire whorl depressed, slightly convex, separated by deeply channelled sutures, ornamented with thick oblique widely spread axial ribs prolonged beyond posterior portion, such whorl in the form of a series of nodules crenulations; aperture long, wide in the middle and channelled in the posterior part of the whorl.

*Measurements* : H- 36.00, D- 16.20, Ha- 25.10, Wa- 6.90.

*Locality* : Bandiya.

*Geological age* : Cretaceous-Recent.

*Lyria (Lyria)* sp. B (Pl. I, Figs. 8, 9)

*Material* : 1 example.

*Diagnosis* : Shell large, elongate-oval, spire short, conical, body whorl large, somewhat convex, separated by very oblique channeled suture, ornamented with collabral costae, aperture narrow and elongate, columella feebly excavated.

*Measurements* : H-40.00, D-17.15.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

Family DIASTOMIDAE

Genus *Diastoma* Deshayes, 1850

*Diastoma* sp. (Pl. I, Figs. 10, 11)

*Material* : 1 example.

*Diagnosis* : Shell large, turreted, elongate, sculpture of fine spiral lines with imbricate appearance, crossed by coarse costae and varices; aperture oval, peristome entire, labrum curved over narrow siphonal fasciole, columella posteriorly thickened with rib-like callus.

*Measurements* : H-23.55, D-1.50.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

*Remarks* : Tip of the shell broken; aperture broken.

Family AMPHIPERATIDAE

Genus *Eocypraea* Cossman, 1903

*Eocypraea* sp. A (Pl. I, Figs. 12, 13)

*Material* : 3 examples.

*Diagnosis* : Shell medium sized, inflated-pyriform, very convex in transverse axis, spire short, involute and obtuse, slightly eccentric; aperture curved posteriorly, a little wider anteriorly, carving anteriorly to end in a canal with deep terminal notch, posterior canal faint, fossula eroded; posterior end cut into the curved end of the labrum.

*Measurements* : (n= 3) shell No. 1 : H-36.20, D-30.00, Ha-43.75 and Wa-12.25. Shell No. 2 : H-32.40, D-22.70, Ha-41.40 and Wa-5.85. Shell No. 3 : H-36.25, D-23.90.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

***Eocypraea* sp. B (Pl. I, Figs. 14, 15)**

*Material* : 2 examples from the Cenozoic bed of Bandiya.

*Diagnosis* : Shell large, thick, solid, more or less ovate in shape, ventral aspect more inequilateral; aperture narrower, elongated, curved posteriorly and more expanded anteriorly.

*Measurements* : shell No. 1 : H-35.10, D-26.20, Ha-35.50, Wa-8.90. (shell aperture broken). Shell No. 2 : H-30.70, D-24.15, Ha-28.30, Wa-8.65.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

Family TURRITELLIDAE

Genus *Zaria* Gray, 1847

***Zaria* sp. (Pl. I, Figs. 16, 17)**

*Material* : 1 example from the Cenozoic bed of Bandiya.

*Diagnosis* : Shell moderately large, turreted, anomphalous, whorls eight in number, concave, sculptured with three spiral keel/ridges, intermediate grooves concave and spirally striated; aperture subquadrangular.

*Measurements* : H-24.35, D-9.75.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

*Remarks* : Tip of shell broken, aperture not distinct for measurement.

Family NATICIDAE

Genus *Natica* Scopoli, 1777

Subgenus *Cochlis* Roeding, 1798

***Natica (Cochlis)* sp. (Pl. I, Figs. 18, 19)**

*Material* : 1 example.

*Diagnosis* : Shell subglobose, medium sized, spire fairly low, sculptured with axial growth striae and radial ribs at the suture; aperture oval (?), columellar callus present, reflect over umbilical opening.

*Measurements* : H-13.55, D-12.30.

*Material* : 1 example.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

*Remarks* : Shell partially broken.

Genus *Ampullella* Cox, 1931

*Ampullella* sp. (Pl. I, Figs. 20, 21)

*Material* : 4 examples.

*Diagnosis* : Shell large, elongated, spire elongated, regularly conical in outline; body whorl large, whorls convex, separated by deep sutures (step like) and with weakly developed spiral ornamentation; aperture wide, semilunar, holostomatous, obliquely inclined, posteriorly canaliculated, columella slightly excavated in the middle, columellar edge wide and reflected over the umbilicus.

*Measurements* (n= 1) : H-52.70, D-37.80, Ha-32.80 and Wa-21.10 mm.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

#### Family PYRENIDAE

Genus *Pterygia* Roeding, 1798

*Pterygia* (*s. str.*) sp. (Pl. II, Figs. 22, 23)

*Material* : 6 examples from the Cenozoic bed of Bandiya.

*Diagnosis* : Shell biconical, size moderate, spire short, protoconch small and button shaped; four whorls, body whorl large, outline slightly convex posteriorly, aperture long and narrow, slightly excavated anteriorly into a sharp weak fasciole, labrum slightly oblique, inwardly bulged.

*Measurements* (n = 1) : H-45.35, D-22.80, Ha-34.65, Wa-5.80.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

*Remarks* : Shell partly broken; 5 of 6 shells are not suitable for measurements.

Genus *Genota* Adams & Adams, 1853

1853. *Genota* H. Adams & A. Adams, *The genera of recent Mollusca arranged according to their organization*, vol. 1.

*Genota* sp. (Pl. II, Fig. 24)

*Material* : 5 examples.

*Diagnosis* : Shell large, biconical; fusiform, spire long, seven in number, depressed, imbricate and separated by deep suture, with crenulated angulation anterior to which there are collabral costellae and fine spiral threads; body whorl large, its vertical dimension equal to two-third of the total height, ventricose, slightly excavated at its base; aperture narrow, nearly parallel-sided, anteriorly terminated by a long narrow canal; columella smooth.

*Measurements* (n = 1) : H-44.65, D-23.45.

*Material* : 5 examples.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

*Remarks* : Aperture of the shells faced with earth mass.

## Family AMPALLOSPIRIDAE

Genus *Globularia* Swainson, 1840

1840. *Globularia* Swainson, *The Cabinet Cyclopaedia. Nat Hist.*, 420 p.

*Globularia* sp. (Pl. II, Figs. 25, 26)

*Material* : 1 example.

*Diagnosis* : Shell globular, height slightly exceeding the diameter, spire depressed and obtuse; whorl six in number, convex, separated by deeply channeled suture, last whorl large, its periphery situated slightly below the prolongation of the last suture, profile to base showing an obtuse angulation about half way between periphery and the umbilicus; aperture semicircular.

*Measurements* : H-36.50, D-28.85.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

Family CONIDAE

Genus *Conus* Linnaeus, 1758

*Conus* sp. (Pl. II, Figs. 27, 28)

*Material* : 1 example.

*Diagnosis* : Shell large, conical; spire low, coeloconoid, five spire whorls separated by shallow, finely incised sutures and ornamented with fine spiral threads, somewhat irregularly distributed wavy nodes on the shoulder angles, last whorl smooth, very large forming almost entire shell, aperture high, narrow and margined; columella rectilinear.

*Measurements* : H-63.35, D-30.95.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

*Remarks* : Posterior portion of aperture of the shell broken.

Family OLIVIDAE

Genus *Ancillus* Montfort, 1810

*Ancillus* sp. (Pl. II, Figs. 29, 30)

*Material* : 2 examples.

*Diagnosis* : Shell moderately large, oval-conical, slender, spire short, extraconical, consisting of four flat top whorls whose height is equal to half their diameter and separated by deeply channeled sutures; body whorl large; aperture narrow angular, posteriorly notched, anteriorly terminated by a short and broad notched canal.

*Measurements* (n= 2): Shell No. 1 : H-42.95, D-14.40. Shell No. 2 : H-30.10, D-12.70.

*Locality* : Bandiya.

*Geological age* : Cretaceous-Recent.

*Remarks* : Aperture of both the shells are broken.

Family VASIDAE

Genus *Eovasum* Douville, 1920

*Eovasum* sp. (Pl. II, Figs. 31, 32)

*Material* : 1 example.

*Diagnosis* : Shell moderately large, biconical, spire slightly concave laterally, protoconch mammillated; whorls four in number, slightly concave embracing the shoulder and separated by sutures, last whorl coinciding with the well marked shoulder angle; shell tapers posteriorly, form an obtuse angulation on the half way between shoulder angle and outer extremity; aperture long narrow with subparallel sides.

*Measurements* : H-54.25, D-33.65, Ha-42.20, Wa-8.20.

*Locality* : Bandiya.

*Geological age* : Cretaceous-Recent.

Class BIVALVIA (PELECYPODA)  
Order ARCOIDA  
Family PARALLELODONTIDAE

Genus *Grammatodon* Meek & Hayden, 1861

*Grammatodon* sp. (Pl. II, Fig. 33)

*Material* : 1 example.

*Diagnosis* : Shell taxodonta, equivalve with closed margins, posteriorly truncate, anterior and posterior teeth similar in size and number; cylindrical external ligament posterior to umbones.

*Measurements* : L-24.85, I-31.65.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

*Remarks* : Single valve embedded in earth mass.

Subgenus *Indogrammatodon* Cox, 1937

1937. *Grammatodon* (*Indogrammatodon*) Cox, *Proc. Malac. Soc. London*, **22** : 194-198.

*Grammatodon* (*Indogrammatodon*) sp. (Pl. II, Fig. 34)

*Material* : 2 examples.

*Diagnosis* : Shell trapezoidal, posterior umbonal ridge poorly developed, smooth over middle of shell, valve margin closed, inner margin of hinge plate straight, taxodont dentition, anterior teeth short and not horizontal; radials on both valves, left valve- less and right valve- more, costae narrow, widely spaced and coarser on left valve.

*Measurements* : L- 26.60, I- 38.70.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

Family MYTILIDAE

Genus *Modiolus* Lamarck, 1799

Subgenus *Modiolus* (s. str.)

*Modiolus (Modiolus)* sp. (Pl. III, Fig. 35)

*Material* : 1 example.

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

*Measurements* : L-52.65, I-22.70, H-20.00.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

*Remarks* : Shell partly broken.

Order PTERIOIDA

Family PECTINIDAE

Genus *Chlamys* Roeding

Subgenus *Argopecten* Monterosato, 1899

*Chlamys (Argopecten)* sp. (Pl. III, Fig. 36)

*Material* : 1 example.

*Diagnosis* : Shell orbicular, biconvex, umbo orthogyrous, anterior auricle large, ornamented with transverse riblets, bysal notch large; sculpture of radial ribs with smooth interspaces, the two anterior and two posterior ribs are bifurcating, all crossed by looped lamellae.

*Measurements* : L- 42.65, H- 41.51.

*Locality* : Bandiya.

*Geological age* : Early Miocene.

Subgenus *Lyropecten* Conrad, 1862*Chlamys (Lyropecten)* sp. (Pl. III, Fig. 37)

*Material* : 7 examples.

*Diagnosis* : Shell orbicular, equilateral, umbo central, auricles subequal, surface with undivided subrounded radial ribs separated by narrower interspaces, both radial and interspaces are covered by radial striae, interspaces with transverse threads.

*Measurements* (n= 6) : Shell No. 1 : L-61.60, H-52.60, I-28.15 (complete shell). Shell No. 2 : L-53.60, H-53.40 (single valve). Shell No. 3 : L-45.20, H-40.00 (single valve). Shell No. 4 : L-54.60, H-50.50 (single valve). Shell No. 5 : L-54.70, H-54.00 (umbonal region broken). Shell No. 6 : L-58.60 (broken single valve).

*Locality* : Bandiya.

*Geological age* : Cenozoic.

Subgenus *Vertipecten* Grant & Gale, 1931

1931. *Chlamys (Vertipecten)* Grant & Gale, *San Diego Soc., Nat. Hist. Mem.* 1 : 1036 pp.

*Chlamys (Vertipecten)* sp. A (Pl. III, Fig. 38)

*Material* : 5 examples.

*Diagnosis* : Shell large, biconvex, umbo broad and central; large byssal notch below anterior ear; sculptured, surface with squamose radial ribs separated by wider and smooth interspaces, right valve with paired rounded radials, left valve ribs unpaired and every third one is elevated above others.

*Measurements* (n= 3) : Shell No. 1 : L-53.50, H-48.10, I-23.90. Shell No. 2 : L-49.25, H-42.60 (Single valve). Shell No. 3 : L-45.50, H-41.20 (Single valve).

*Locality* : Bandiya.

*Geological age* : Early Oligocene - Early Miocene.

*Chlamys (Vertipecten)* sp. B (Pl. III, Fig. 39)

*Material* : 1 example.

*Diagnosis* : Shell suborbicular, well inflated, umbo orthogyrous and protruding above the hinge, central in position. Almost similar to *Chlamys (Vertipecten)* sp. A, but for the radials less rounded and separated by more wider interspaces.

*Measurements* : L-54.00, H-49.72 (single valve).

*Locality* : Bandiya.

*Geological age* : Early Oligocene – Early Miocene.

Subgenus *Pecten* Müller, 1776

*Chlamys (Pecten)* sp. (Pl. III, Fig. 40)

*Material* : 1 example.

*Diagnosis* : Shell of moderate size, ovate, umbo pointed, central; surface with rounded radial ribs separated by narrower interspaces; both ribs and interspaces crossed by faint concentric growth lines.

*Measurements* : L-23.30, H-23.40.

*Locality* : Bandiya.

*Geological age* : Early Miocene – Middle Pliocene.

Family SPONDYLIDAE

Genus *Spondylus* Gray, 1826

Subgenus *Corallospondylus* Monterosato, 1917

*Spondylus (Corallospondylus)* sp. (Pl. III, Fig. 41)

*Material* : 7 examples.

*Diagnosis* : Shell prosocline suborbicular, subequilateral accline, with relatively short hinge margin, feebly convex left valve, slightly concave right valve with deep suborbicular notch, cardinal areas divergent upward.

*Measurements* : Not taken for lack of suitable material.

*Locality* : Bandiya.

*Geological age* : Oligocene.

Order OSTREINA

Family OSTREIDAE

Genus *Lopha* Roeding, 1798

1798. *Lopha* Roeding, *Museum Boltenianum sive catalogues cimeliorum e tribus regnis naturae quaeolim collegerat joa.* 119 pp. (Hamburg).

***Lopha* sp. A (Pl. III, Fig. 42)**

*Material* : 5 examples.

*Diagnosis* : Shell irregular in shape, undulated margin, left valve larger 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 regularly plicate valve commissure, single large adductor impression on the centre of the valve.

*Measurements* : Not recorded.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

*Remarks* : Right measurements of the shell was not obtained from the material.

***Lopha* sp. B (Pl. III, Fig. 43)**

*Material* 1 example.

*Diagnosis* : Resembles *Lopha* sp. A; shell medium sized, both valves convex, subequivalve with similar rib patterns, fairly sharp crested plicae which produce a regularly plicate valve commissure, slightly elongated tubercles.

*Size (measurements)* : Not recorded.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

**Family LIMNOCARDIIDAE**

Genus *Pseudocardita* Oppenheim, 1918

***Pseudocardita* sp. A (Pl. III, Fig. 44)**

*Material* : 2 examples.

*Diagnosis* : Shell inequivalve, right valve more convex than left valve, inequilateral, six radial ribs of equal strength flat topped, separated by linear depressions, hinge plate wide with two stout cardinal teeth, ligament nymphs elongated, inner margin denticulated.

*Measurements* (n= 2) : Shell No. 1 : L-50.25, H-40.00. Shell No. 2 : L-34.35, H-33.30.

*Locality* Bandiya.

*Geological age* : Neogene.

*Pseudocardita* sp. B (Pl. III, Fig. 45)

*Material* : 1 example.

*Diagnosis* : Shell oblique, inequilateral, outline oblique, ribs broad and rounded, hinge plate wide, teeth stout, pallial line entire.

*Measurements* : L-63.20, H-34.75.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

Family CULTELLIDAE

Genus *Siliqua* Mühlfeld, 1852

*Siliqua* sp. (Pl. IV, Fig. 46)

*Material* : 4 examples.

*Diagnosis* : Shell large, transversally elongate, quadrangular, compressed, umbo submesial, surface with weak comarginal ribs.

*Measurements* (n= 3) : Shell No. 1 : L-28.25, I-55.56, H-15.50. Shell No. 2 : L-32.85, I-68.70, H-18.00. Shell No. 3 : L-32.50, I-54.60, H-15.60.

*Locality* : Bandiya.

*Geological age* : Eocene.

Family CORBICULIDAE

Genus *Polymesuda* Réfinesque, 1828

Subgenus *Geloina* Gray, 1842

*Polymesuda (Geloina)* sp. (Pl. IV, Fig. 47)

*Material* : 1 example.

*Diagnosis* : Shell small, rounded, surface with comarginal striae, anterior and rounded posterior, umbo submesial, inturned.

*Measurements* : L-22.20, I-22.50, H-12.75.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

## Family VENERIDAE

Genus *Periglypta* Jukes-Browne, 1828*Periglypta* sp. A (Pl. IV, Fig. 48)*Material* : 2 examples.*Diagnosis* : Shell transversally ovate, umbo prosogyrous, lunule and escutcheon well impressed, surface with cancellate ornamentation having concentric ribs.*Measurements* : L-41.26.*Locality* : Bandiya.*Geological age* : Oligocene.*Remarks* : Except length other measurements could not be taken from the available material.*Periglypta* sp. B (Pl. IV, Fig. 49)*Material* : 13 examples.*Diagnosis* : Shell subtrapezoidal, inequilateral, umbo prosogyrous, umbonal carina prominent, cardinal area broad, surface with concentric ribs crossed by fine radials.*Measurements* : L-38.85, H-49.85, I-25.50.*Locality* : Bandiya.*Geological age* : Oligocene.*Remarks* : Of the 13 examples, measurements of one suitable shell is recorded.

Class	CEPHALOPODA
Order	AMMONOIDEA
Suborder	AMMONITINA
Family	PERISPHINCTIDAE

Genus *Hubertoceras* Spath, 19301930. *Hubertoceras* Spath, *Monog. Geol. Dept. Hunterian Mus.*, 4 : 13-70.*Hubertoceras* sp. A (Pl. IV, Fig. 50)*Material* : 1 example.

**Diagnosis** : Shell large, compressed, planulate, strong biplicate ribbing, rather evolute, without lappets.

**Measurements** : D- 27.25.

**Locality** : Jhura Dome.

**Geological age** : Middle Jurassic.

**Remarks** : Part of the shell is recovered.

***Hubertoceras* sp. B (Pl. IV, Fig. 51)**

**Material** : 2 examples.

**Diagnosis** : Shell evolute, depressed, ribbing coarse and closely spaced, passing over obtuse venter, aperture small and rounded.

**Measurements** (n = 1) : D-20.20, Wu-07.20.

**Locality** : Jhura Dome.

**Geological age** : Middle Jurassic.

**Genus *Kinkeleniceras* Buckman, 1921**

***Kinkeleniceras* sp. A (Pl. IV, Fig. 52)**

**Material** : 2 examples.

**Diagnosis** : Shell compressed, planulate, inner whorls finely ribbed, primary ribs long and thick, outer whorls large, ribbing gradually become more distant.

**Measurements** (n = 1) : D-78.75, Wu-32.50.

**Locality** : Jhura Dome.

**Geological age** : Middle Jurassic.

***Kinkeliniceras* sp. B (Pl. IV, Fig. 53)**

**Material** : 2 examples.

**Diagnosis** : Shell compressed, planulate, involute whorls; with coarse, blunt and moderately differentiated ribs, secondaries not interrupted on venter.

**Measurements** (n = 1) : D-45.25.

**Locality** : Jhura Dome.

*Geological age* : Middle Jurassic.

*Remarks* : Part of the shell, embedded in rock, is observed.

Family MACROCEPHALITIDAE

Genus *Macrocephalites* Zittel, 1884

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

*Macrocephalites* (*s. str.*) sp. A (Pl. IV, Fig. 54)

*Material* : 1 example.

*Diagnosis* : Large sized, umbilicus of moderate diameter, compressed, aperture triangular, ribs prosiradiate, numerous, polytome in nature.

*Measurements* : D-67.75, Wu-23.65.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

*Macrocephalites* (*s. str.*) sp. B (Pl. IV, Fig. 55)

*Material* : 1 example.

*Diagnosis* : Shell large, involute, ribs rather sharp, inner whorls moderately compressed and ribbed, outer whorls gradually becoming smooth.

*Measurements* : D-220, Wu-70.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

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

Genus *Subkossmatia* Spath, 1924

*Subkossmatia* sp. (Pl. V, Fig. 56)

*Material* : 1 example.

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

*Measurements* : D-127.70.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

Family POLYMORPHITIDAE

Genus *Kondiloceras* Fucini, 1901

1901. *Kondiloceras* Fucini *Palaeontogr. Italica*, 7 : 89 p.

*Kondiloceras* sp. (Pl. V, Fig. 57)

*Material* : 1 example.

*Diagnosis* : Shell evolute, compressed, enlarged whorls, ribs straight ending in ventro-lateral tubercles known as clavi, median row of clavi on venter simulating a serrated keel.

*Measurements* : Not recorded.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

*Remarks* : A part of the shell is recovered.

Family MAYATIDAE

Genus *Mayaites* Spath, 1924

*Mayaites* sp. (Pl. V, Fig. 58)

*Material* : 1 example.

*Diagnosis* : Inflated, involute, whorls depressed, venter well rounded, ribs coarse, rectiradiate, bifurcating.

*Measurements* : D-29.60, Wu-16.15.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

Family REINECKEIIDAE

Genus *Reineckeia* Bayle, 1878

*Reineckeia* sp. (Pl. V, Fig. 59)

*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* : Not recorded.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

*Remarks* : Only a part of the shell is recovered.

Phylum	BRACHIOPODA
Class	ARTICULATA
Order	RHYNCHONELLIDA
Family	RHYNCHONELLIDAE

Genus *Burmirhynchia* Buckman, 1915

1915. *Burmirhynchia* Buckman, *Rec. Geol. Surv. Ind.*, 45(1) : 76.

*Burmirhynchia* sp. (Pl. V, Figs. 60, 61, 62)

*Material* : 3 examples more or less complete, 15 examples partly broken, 11 examples in cluster embedded in rock.

*Diagnosis* : Shell medium sized, 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 the middle and anteriorly protruding.

*Measurements* (n = 1) : H-21.64, W-30.07, I-21.08.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

*Gen. indet.* (rhynchonellid) (Pl. V, Fig. 66)

*Material* : 1 example.

*Diagnosis* : Shell elongated, costate, beak prominent and a shallow triangular area below it, both valves covered by strong radial costae, ventral valve convex, straight hinge line, radiating costae rounded on their tops and separated from each other by rounded furrows.

*Measurements* : H-27.68, W-28.92, I-16.64.

*Locality* : Jhura Dome.

*Geological age* : Jurassic.

Family WELLERELLIDAE

Genus *Kallirhynchia* Buckman, 1918

1918. *Kallirhynchia* Buckman, *Rec. Geol. Surv. Ind.*, 45(1) : 31.

*Kallirhynchia* sp. (Pl. V, Figs. 63, 64, 65)

*Material* : 2 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* (n = 1) : H-30.59, W-36.61, I-26.64.

*Locality* : Jhura Dome.

*Geological age* : Middle Jurassic.

Phylum	ECHINODERMATA
Clas	ECHINOZOA
Order	CIDAROIDA
Family	CIDARIDAE

Genus *Prinocidaris* Agassiz, 1863

*Prinocidaris* sp. (Pl. VI, Figs. 67, 68)

*Material* : 1 example.

*Diagnosis* : Test more or less flattened, primary tubercles noncrenulated aborally, areoles shallow, pores conjugate, simple ambulacral plates, periproct on midline.

*Measurements* : B-27.73, H-14.95.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

Order	CLYPEASTEROIDA
Family	CLYPEASTERIDAE

Genus *Clypeaster* Lamarck, 1801

1801. *Clypeaster*. Lamarck, *Systeme des animaux sans vertebrae* : 432 p.

***Clypeaster* sp. (Pl. VI, Fig. 69)**

*Material* : 2 examples.

*Diagnosis* : Test flattened, medium-sized, margin rounded, inflated, oral surface closed, periproct inframarginal, developed ambulacra with needle shaped pillars near the edge of the test and between the ambulacra within the test, peristome covered.

*Measurements* : L-68.84, B-62.75, H-11.62.

*Locality* : Nangia.

*Geological age* : Cenozoic.

***Clypeaster* cf. *apertus* Duncan & Sladen, 1883 (Pl. IV, Fig. 70)**

*Material* : 1 example.

*Diagnosis* : Test thin, over-elliptical in marginal outline, flat beneath, depressed, with a rounded off edge which slopes gradually at first from the margin to the apical system, ambulacral subequal, interporiferous zones broad and poriferous are narrow, pores subequal, needle pillars numerous.

*Measurements* : L-71.10, B-64.98, H-1.10.

*Locality* : Nangia.

*Geological age* : Cenozoic.

***Clypeaster* cf. *monticulifera* Duncan & Sladen, 1883 (Pl. VI, Fig. 71)**

*Material* : 2 examples.

*Diagnosis* : Test flattened, medium-sized, elliptical in marginal outline, inflated, periproct inframarginal, developed ambulacra with needle shaped pillars, peristome covered, interporiferous zones broad and poriferous are narrow, pores subequal.

*Measurements* (n=1) : L-46.68, B-43.82, H-8.90.

*Locality* : Bandiya.

*Geological age* : Cenozoic.

Order SPATANGOIDA  
Family SCHIZASTERIDAE

Genus *Schizaster* Sanchez Agassiz, 1949

***Schizaster* cf. *granti* Duncan & Sladen, 1836 (Pl. VI, Figs. 72, 73)**

*Material* 1 example.

**Diagnosis** : Test high, keel of posterior interradium low and slopes backward to the point which overhangs periproct; anterior groove broad and deep abactinally, less shallower and less evident in front of curved fasciole; anterior ambulacral pores separated by a nodule and these are flanks of the groove; apical system with four generative plates and four pores.

**Measurements** : L-28.95, B-28.85, H-14.92.

**Locality** : Bandiya.

**Geological age** : Cenozoic.

## DISCUSSION

Terrestrial rocks of Jurassic age occur in the upper zone of Gondwana Series. On the basis of a study of depositional facies interpretation, an essentially marine origin has been depicted for the Kachchh basin of Upper Gondwana sequence (Krishna, 1982; Krishna, Singh, Howard & Jafer, 1983; Krishna, 1983b). The marine body fossil rich Jurassic sediments of Kachchh was however, considered by many as entirely marine, and the plant fossil bearing but marine body fossil lacking Lower Cretaceous part as non-marine/fluvial/deltaic (Blanford, 1877; Wynne, 1872; Spath, 1933; Rajnath, 1932, 1942; Biswas, 1971, 1977, 1982; Cashyap, 1983). Later, it has been postulated with the support of modern concepts of sedimentation, based on the presence of numerous wave and current built sedimentary structures, that the entire Mesozoic succession of Kachchh evolved out of marine depositional process (Howard & Singh, 1985; Bose *et al.*, 1986).

The basin of Kachchh originated in response to reactivation of ancient fracture zones on western margin of the Indian plate which was a part of the overall rifting episode of the Gondwana superplate. The rifting activity initiated around the start of the Permian and proceeded in a north-south direction (Krishna, 1987). Around the Triassic-Jurassic boundary evolved the E-W trending Kachchh basin. Near-shore shallow water sediments contained a quite rich fauna of ammonoids, bivalves, gastropods, brachiopods, echinoderms, corals, etc. The lowest ammonoid in Kachchh could be date back to Upper Bajocian (Singh, Jaity & Pandey, 1981). Here, the Upper ammonoid could be date back to the top of the Ukra Member (of Umia Formation). This is overlain by Bhuj Member (Krishna, 1987). The sedimentation often shows cyclic shallow marine shelf type, presenting dominance of near-shore shallow water benthonic communities. The fossils are often numerous and well preserved. Of the various fossils, ammonoids have attracted greater attention of the palaeontologists. Many ammonoids are time-diagnostic forms that provide reliable clue to time-zone and throw light in understanding regional biozonations and intercontinental correlation with Europe and other areas. These fauna originated perhaps at the southern margin of the Tethys sea and as presumed, the Ththonian fauna show a strong relationship with the fauna of Spiti shale of Himachal Pradesh. (Berggren *et al.*, 1979). The Tithonian of Madagascar has close faunal

affinity with Kachchh (Berggren *et al.*, 1979). Enay (1973) reviewed the zoogeography of Tithonian ammonoid fauna and indicated the difficulties in taxonomic separation of the Perisphinctaceae (Ammonoidea). A close relationship between the Jurassic cephalopod (Ammonoidea and Nautiloidea) fauna of Kachchh and Europe has been indicated by Halder & Bardhan (1997).

It is apparent from the available works (cited in 'Introduction') that the gastropods and bivalves of Kachchh have been well worked out groups. Recently, Das *et al.* (1999) described some eleven new species of gastropods from the Middle Jurassic sediments of this bed. According to them the gastropod fauna show clearly Tethyan affinity at generic level, especially with Europe (see Knight *et al.*, 1960). Distribution pattern of other Kachchh biota points out to the prevalence of faunal emigrational pathways across the Tethys (Hallam, 1982; Krishna & Cariou, 1990; Kayal & Bardhan, 1998). Though in the supraspecific level the fauna showed affinity with Europe, East Africa, Madagascar and Saudi Arabia they showed separation and regional pattern in the specific level.

The sediments that developed due to marine transgression-regression cycles in the basin emerged from the break-up of Gondwana superplate and was surrounded by East Africa-Madagascar and western India (Fürsich *et al.*, 1991). This newly formed basin served as nursery of evolution of many immigrant fauna that invaded it (Dutta *et al.*, 1996). Rapid diversification of various taxa developed a clear endemism of fauna that constitute Indo-Madagascan or Ethiopian faunal province (Das *et al.*, 1999). Eventually, it is realized that further investigation on the various megainvertebrate groups of Kachchh will be able to bring on record many newer forms and help in characterizing its faunal peculiarities as well, that are different from other parts of the Indo-Madagascan faunal province.

## SUMMARY

The Jurassic sediments of Kachchh have been well known over the years as a classical storehouse of diverse marine fauna and especially the molluscs. The Kachchh basin, along with the Jaisalmer basin of Rajasthan, 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. Lithostratigraphically, the Mesozoic rocks of the area are divided into four subdivisions: Patcham, Chari, Katrol and Umia Formations and their age range from Bajocian to Albian. The fossils are well preserved and a number of studies on different invertebrate groups are in existence. Of these, molluscs (ammonites, nautiloids, bivalves and gastropods) received major attention of the palaeontologists, and that were utilized for time diagnosis and lithostratigraphic interrelations. The megainvertebrate fossils explored recently from the basins are worked out and that comprise 18 species of Gastropoda, 17 species of Bivalvia, 9 species of Cephalopoda, 3 species of Brachiopoda, and 5 species of Echinodermata. The assemblage of fauna shows Tethyan features at supraspecific level but there is a tendency of regional

pattern in the specific level. The present findings stress upon further intensive studies on the spatio-temporal distribution and divergence of various faunal groups in the basins along the coast of Tethys.

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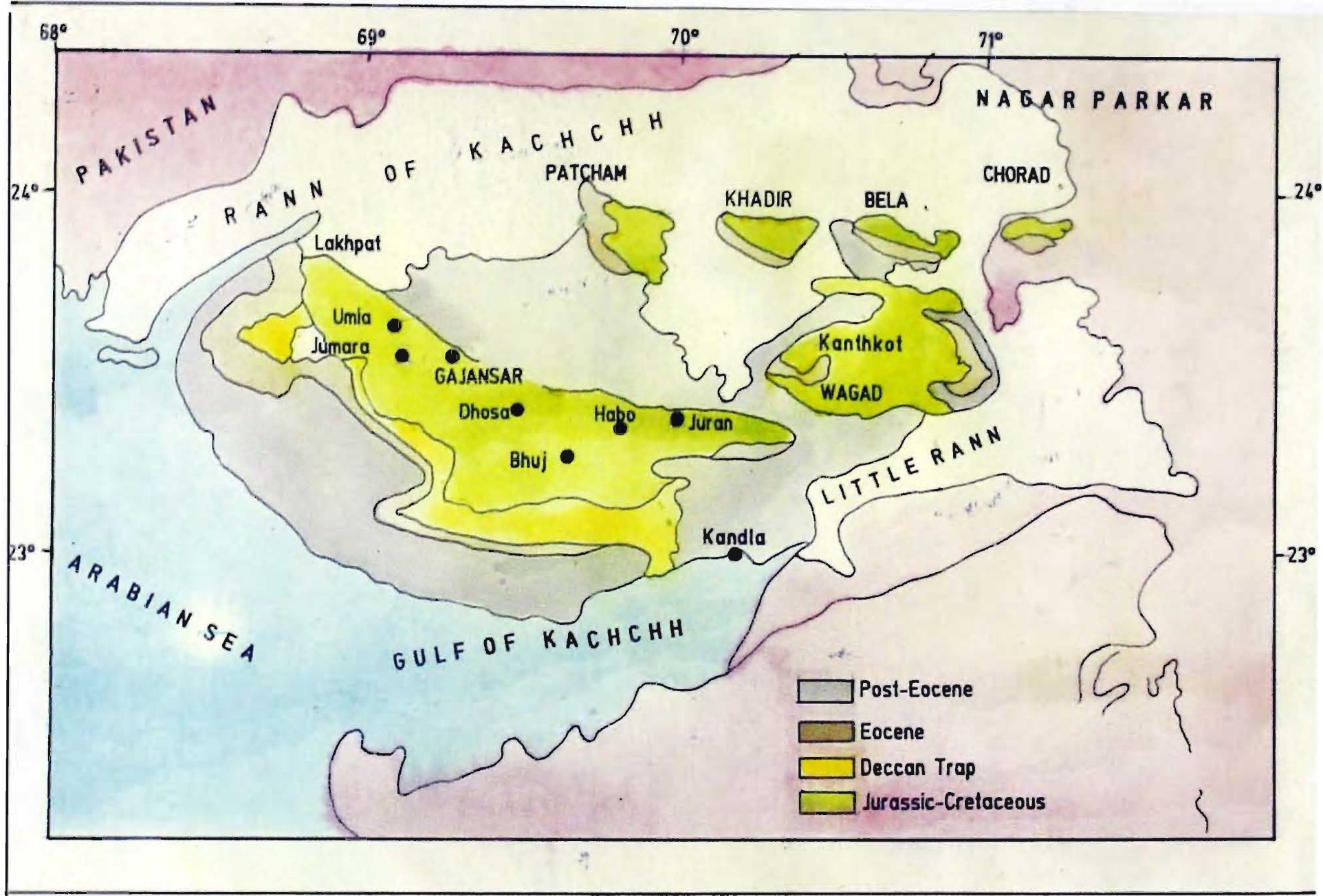
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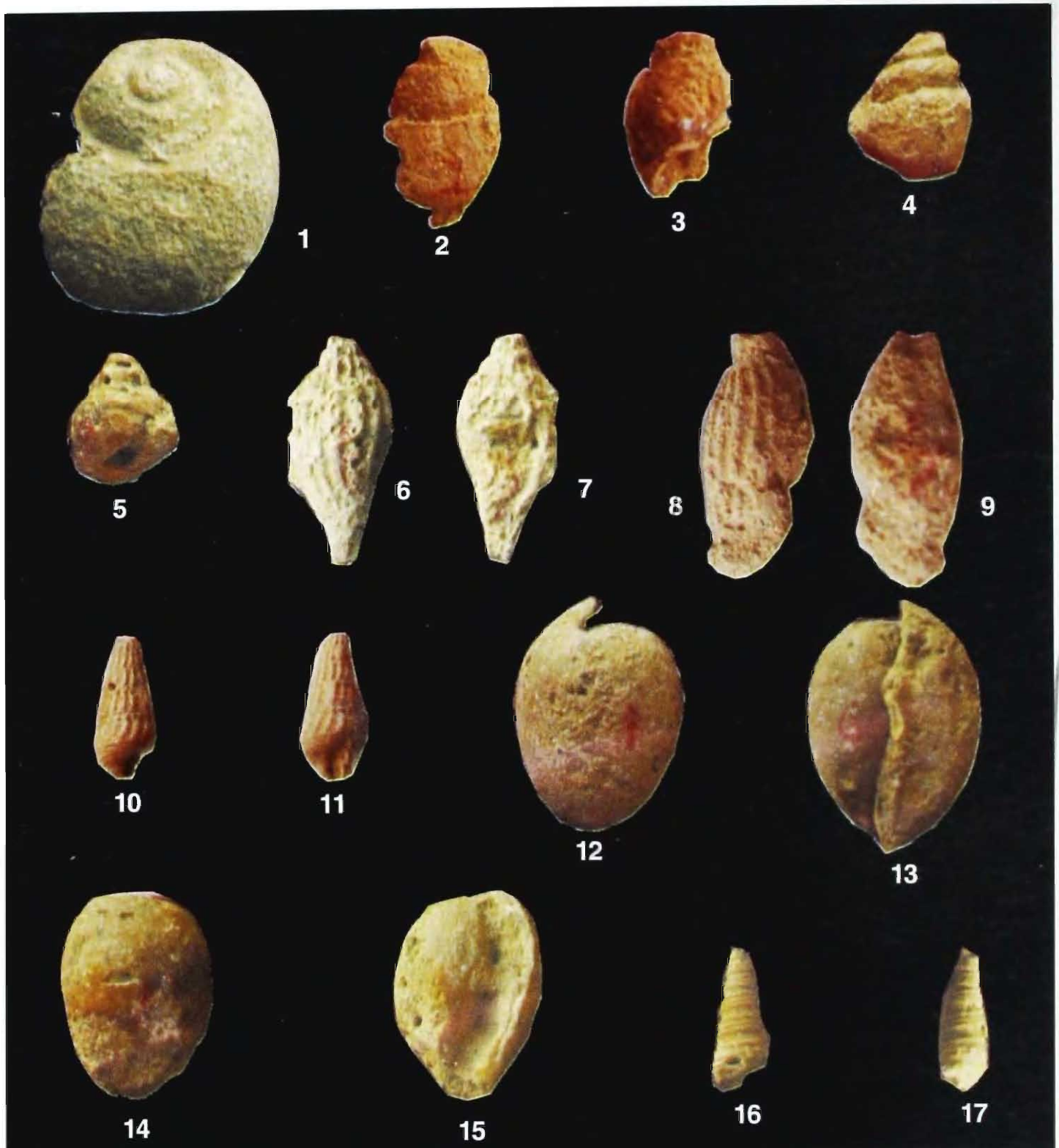
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Text-Fig. 2. Location map and lithological features of Kachchh basin, Western India.



**Plate. I : Figs. 1-17.** 1. *Nerita (Amphinerita)* sp.; Adapertural view (0.94x); Tertiary; IVP 350., 2-3. *Euchrysalis* sp.; Tertiary; IVP 351; 2. Adapertural view(0.61x); 3. Apertural view (0.66x)., 4-5. *Rostellaria* sp.; Tertiary; IVP 352; 4. Adapertural view (0.73x); 5. Apertural view (0.78x)., 6-7. *Lyria (Lyria)* sp. A; Tertiary; IVP 353; 6. Adapertural view (0.81x); 7. Apertural view (0.85x)., 8-9. *Lyria (Lyria)* sp. B; Tertiary; IVP 355; 8. Adapertural view (0.85x); 9. Apertural view (0.81x)., 10-11. *Diastoma* sp.; Tertiary; IVP 356; 10. Adapertural view (0.84x); 11. Apertural view (0.86x)., 12-13. *Eocypraea (Eocypraea)* sp. A; Tertiary; IVP 357; 12. Adapertural view; 0.75x; 13. Apertural view (0.78x)., 14-15. *Eocypraea (Eocypraea)* sp. B; Tertiary; IVP 360; 14. Adapertural view (0.76x); 15. Apertural view (0.77x)., 16-17. *Zaria* sp.; Tertiary; IVP 362; 16. Adapertural view (0.78x); 17. Apertural view (0.76x);

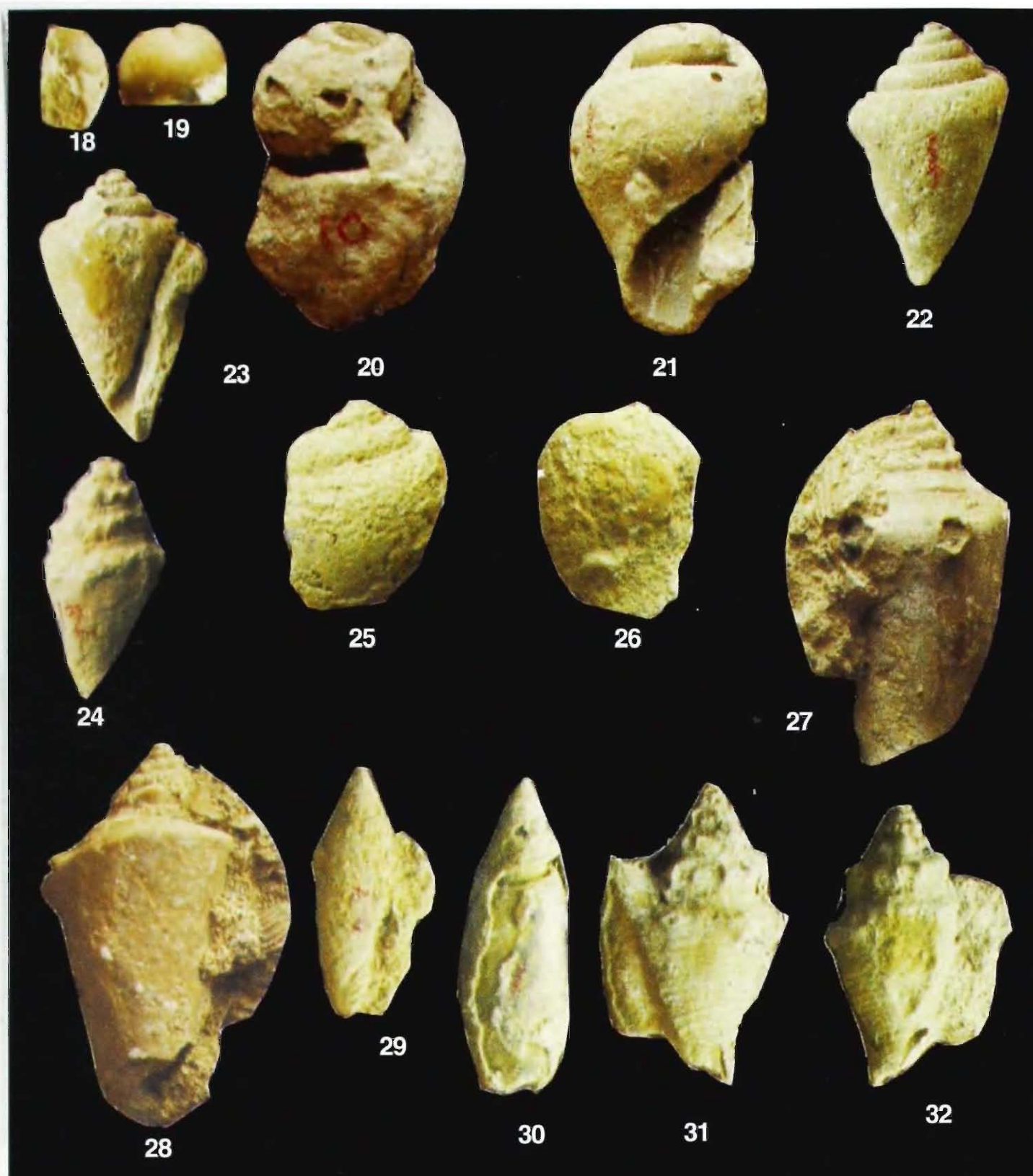
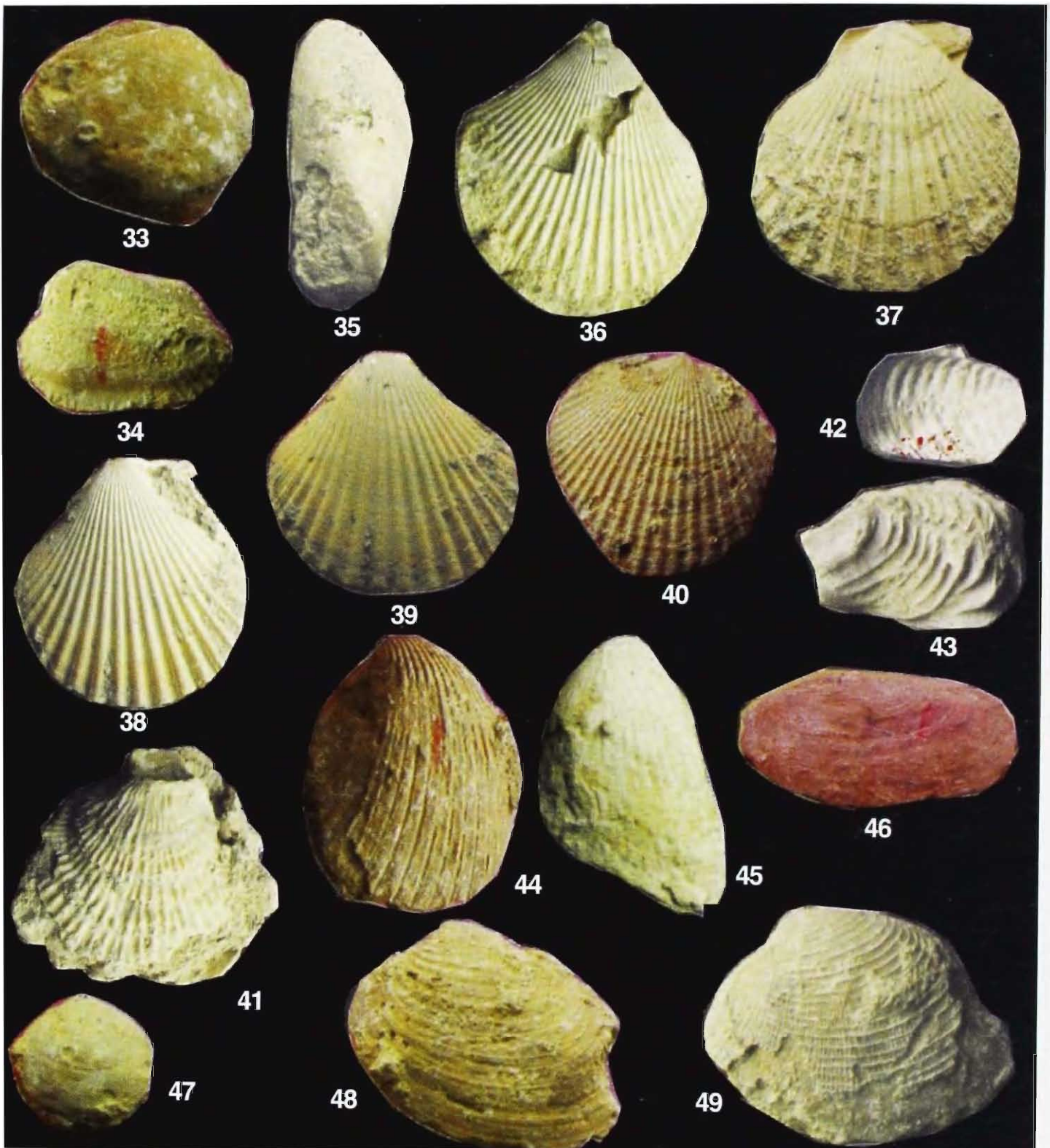
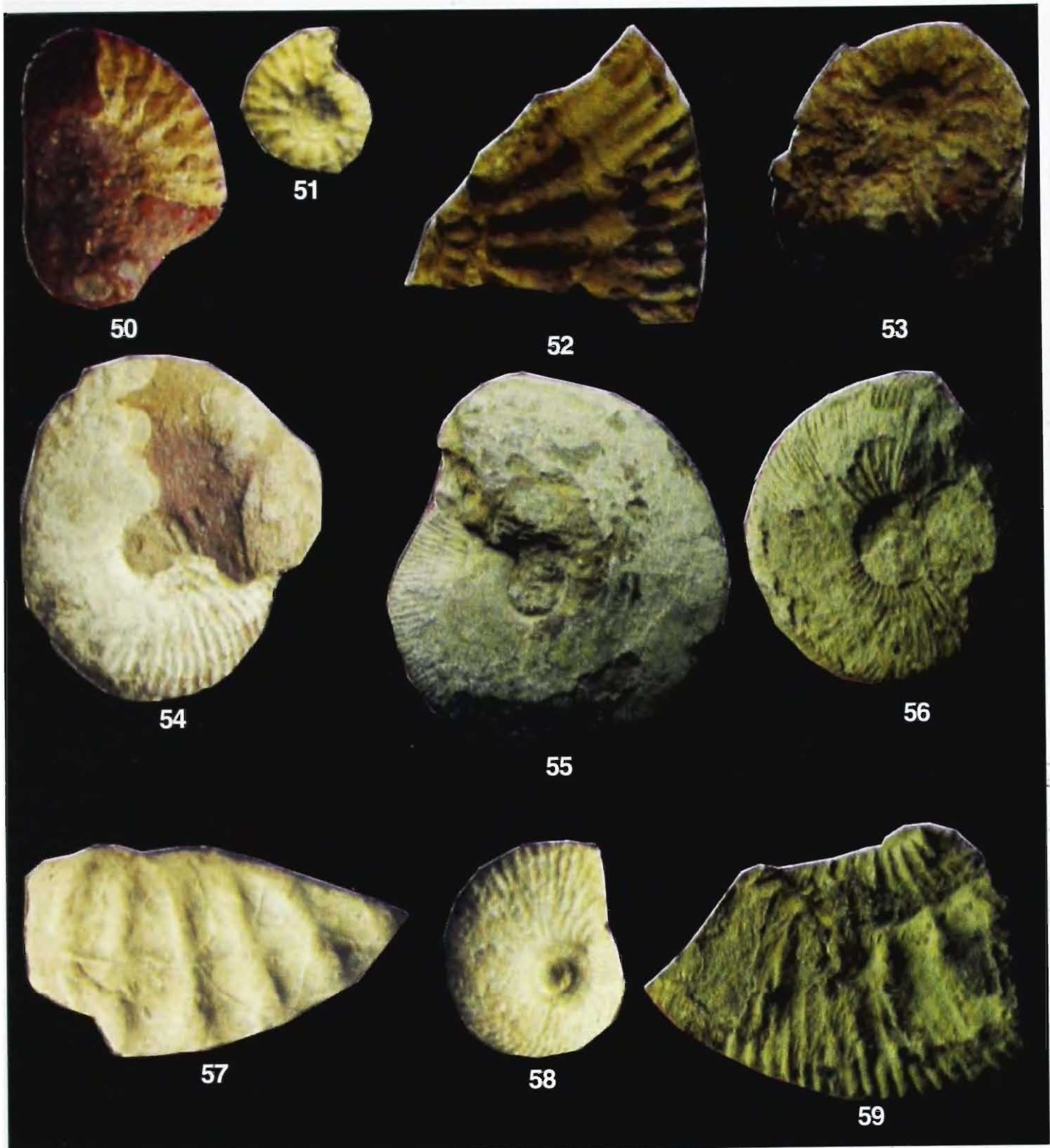


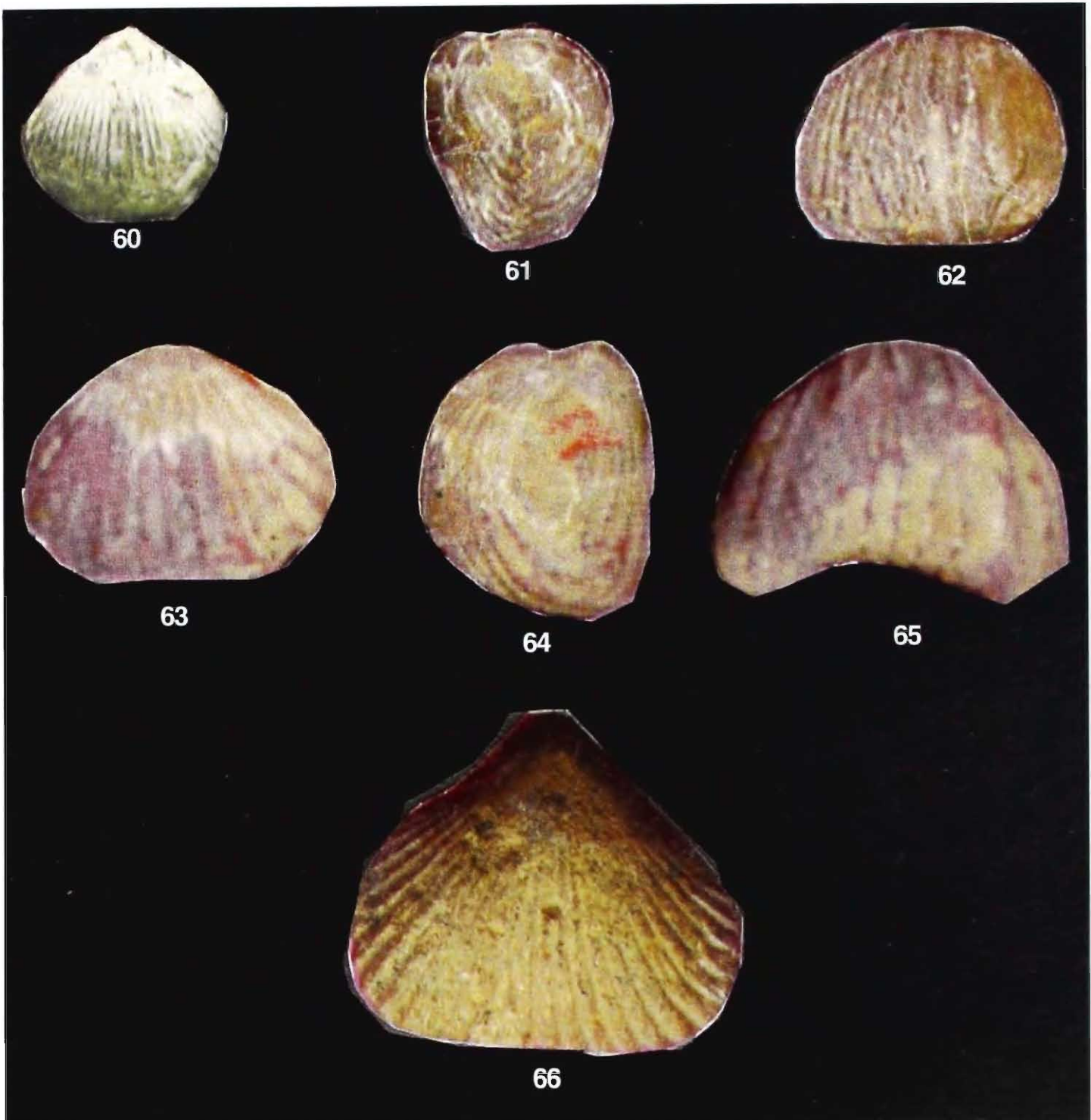
Plate I (Contd.) : Figs. 22-32. 18-19. *Natica (Cochlis)* sp.; Tertiary; IVP 363; 18. Adapertural view (0.55x); 19. Apertural view (0.66x)., 20-21. *Ampullella* sp.; Middle Jurassic; IVP 364; 20. Adapertural view (0.82x); 21. Apertural view (0.79x). Figs. 22-34. 22-23. *Pterigya* sp.; Tertiary; IVP 367; 22. Adapertural view (0.78x); 23. Apertural view (0.80x)., 24. *Genota* sp.; Tertiary; IVP 372; Adapertural view (0.74x)., 25-26. *Globularia* sp.; Tertiary; IVP 373; 25. Adapertural view (0.80x); 26. Apertural view (0.80x)., 27-28. *Conus* sp.; Middle Jurassic; IVP 374; 27. Adapertural view (0.79x); 28. Apertural view (0.81x)., 29. *Ancillus* sp. A; Tertiary; IVP 375; Apertural view (0.79x)., 30. *Ancillus* sp. B; Tertiary; IVP 376; Adapertural view (0.83x)., 31-32. *Eovasum* sp.; Tertiary; IVP 377; 31. Adapertural view (0.82x); 32. Apertural view (0.81x).



**Plate II : Figs. 33-49.** 33. *Grammatodon* sp.; Middle Jurassic; IVP 381; External view of left valve(1x)., 34. *Grammatodon* (*Indogrammatodon*) sp.; Middle Jurassic; IVP 382; External view of left valve (0.80x). **Fig. 35-45.** 35. *Modiolus* (*Modiolus*) sp.; Middle Jurassic; IVP 384; External view of right valve (0.72x)., 36. *Chlamys* (*Argopecten*) sp.; Tertiary; IVP 385; External view of left valve (0.97x)., 37. *Chlamys* (*Lyropecten*) sp.; Tertiary; IVP 386; External view of left valve (0.73x)., 38. *Chlamys* (*Vertipecten*) sp. A; Tertiary; IVP 394; External view of left valve (0.67x)., 39. *Chlamys* (*Vertipecten*) sp. B; Tertiary; IVP 393; External view of left valve (0.70x)., 40. *Chlamys* (*Pecten*) sp.; Tertiary; IVP 399; External view of left valve (0.32x)., 41. *Spondylus* (*Corallospondylus*) sp.; Tertiary; IVP 400; External view of left valve (0.76x)., 42. *Lopha* sp. A; Middle Jurassic; IVP 407; External view of left valve (0.81x)., 43. *Lopha* sp. B; Middle Jurassic; IVP 409; External view of left valve(0.73x)., 44. *Pseudocardita* sp. A; Tertiary; IVP 410; External view of left valve (0.93x)., 45. *Pseudocardita* sp. B; Tertiary; IVP 412; External view of left valve (0.77x); 46. *Siliqua* sp.; Tertiary; IVP 413; External view of left valve (0.83x)., 47. *Polymesuda* (*Gelonia*) sp.; Tertiary; IVP 417; External view of left valve (0.60x)., 48. *Periglypta* sp. A; Tertiary; IVP 418; External view of left valve (1.01x)., 49. *Periglypta* sp. B; Tertiary; IVP 419; External view of left valve (0.78x).



**Plate III : Figs. 50-59.** 50. *Hubertoceras* sp. A; Middle Jurassic; IVP 432; Lateral view (0.91x)., 51. *Hubertoceras* sp. B; Middle Jurassic; IVP 432A; Lateral view (0.89x)., 52. *Kinkeleniceras* sp. A; Middle Jurassic; IVP 433; Lateral view (0.75x)., 53. *Kinkeleniceras* sp. B; Middle Jurassic; IVP 434; Lateral view (0.76x)., 54. *Macrocephalites (Macrocephalites)* sp. A; Middle Jurassic; IVP 437; Lateral view (0.69x)., 55. *Macrocephalites (Macrocephalites)* sp. B; Middle Jurassic; IVP 438; Lateral view (0.28x). 56. *Subkossmatia* sp.; Middle Jurassic; IVP 439; Lateral view (0.52x)., 57. *Kondiloceras* sp.; Middle Jurassic; IVP 440; Lateral view (0.79x)., 58. *Mayaites* sp.; Middle Jurassic; IVP 441; Lateral view (0.96x)., Fig. 59. *Reineckeia* sp.; Middle Jurassic; IVP 442; Lateral (view 0.50x).



**Plate IV : Figs. 60-66.** 60-62. *Burmirhynchia* sp.; Middle Jurassic; IVP 443; 60. Dorsal view (0.75x); 61. Side view (0.75x); 62. Anterior view (0.78x); 63-65. *Kallirhynchia* sp.; Middle Jurassic; IVP 468; 63. Dorsal view (1.16x); 64. Side view (1.18x); 65. Anterior view (1.60x)., 66. Fam. Rhynchonellidae, Gen. indet.; Middle Jurassic; IVP 478; Dorsal view (1.14x).



Plate IV (Contd.) : Figs. 67-73. 67-68. *Prinocidaris* sp.; Tertiary; IVP 473; 67. Lateral view (0.66x); 68. Aboral view (0.90x)., 69. *Clypeaster* sp.; Tertiary; IVP 474; Aboral view (0.97x)., 70. *Clypeaster* cf. *apertus*; Tertiary; IVP 475; Aboral view (0.92x)., 71. *Clypeaster* cf. *monticulifera*; Tertiary; IVP 476; Aboral view (0.93x)., 72-73. *Schizaster* cf. *granti*; Tertiary; IVP 477; 72. Aboral view (1.25x); 73. Aboral view—slightly tilted posteriorly (0.98x).