Iqbal, M.W.A
1969

Invertebrate Palaeontology
Earth Sciences Division
Natural History Museum

MEMOIRS
OF
THE GEOLOGICAL SURVEY OF PAKISTAN

Palaeontologia Pakistanica
Vol. 5

MEGA-FAUNA FROM THE GHAZIJ FORMATION (LOWER EOCENE) QUETTA SHAHRIG AREA, WEST PAKISTAN

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Issued by the Director General, Geological Survey of Pakistan, Quetta.
1969

Repl. 2257

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ABSTRACT

The Ghazij fm. of Early Eocene age is exposed in the eastern part of Quetta, West Pakistan. It consists of 1500 feet of alternating shale, sandstone, limestone and conglomerate. Shale is predominant and at places contains coal beds. The contact relationship between the Ghazij fm. and the underlying Dunghan Limestone (Late Cretaceous-Early Eocene) is variable, locally the contact is unconformable, but in Sanjawi and Siazgai areas the contact is concordant and apparently conformable, while in Brewery there is locally either an angular or disconformable relationship. The contact between the Ghazij fm. and the overlying Kirthar Formation (Middle Eocene-Oligocene) is also variable, locally, *e.g.* in Quetta, it is unconformable, while in the Bolan and Mari Bughti areas the contact is apparently conformable or concordant.

The micro-fauna and the mega-fauna collected from three sections in the Sinjdi and Shahrig localities include seventeen species of Foraminifera, mostly calcareous perforate forms; five coral species, four of which are hermatypic and colonial forms; and twenty-seven molluscan species, of which six pelecypod species and ten gastropod species are new. The fauna includes three local paleontological zones: namely (from top to bottom) the *Cirsotrema jinnahi* Iqbal zone, Coralline zone and *Ostrea* zone.

Foraminifera and gastropoda suggest Early Eocene (Ypresian) age for the Ghazij Fm. The mega-fauna shows an affinity to that in the "Laki" (lower Eocene) and is correlated with the Lakhi Group of Sind, Nammal Formation, Sakesar Limestone and Bhadrar Formation of Salt Range and Trans-Indus Ranges; upper part of Hill Limestone and Chor Gali Formation of the Potwar and Kala Chitta areas in West Pakistan.

A generalised paleoecological interpretation is made. The mega-fauna of the Ghazij fm. is typically marine. In the section "B", the occurrence of four species of hermatypic corals representing colonial forms is reported for the first time which suggests that the fauna was probably laid down on the sublittoral to littoral zone of a warm sea, about 150 to 200 feet deep; the temperature of water would have been between 77 to 86 degrees Fahrenheit and the fauna also indicates clear water condition. The coral species are present only in one section in association of larger foraminifers, and in this particular section the pelecypods and gastropods are entirely absent, whereas in other sections such as "A" and "C", the fauna is composed of pelecypods, gastropods and smaller foraminifers and the corals are absent. This evidence indicates that particularly in this part due to fluctuating wave base, the ecological conditions were not favourable for the growth of hermatypic corals, this rapidly changing ecological condition favoured the pelecypods and gastropods to thrive in the shallower muddy water environment.

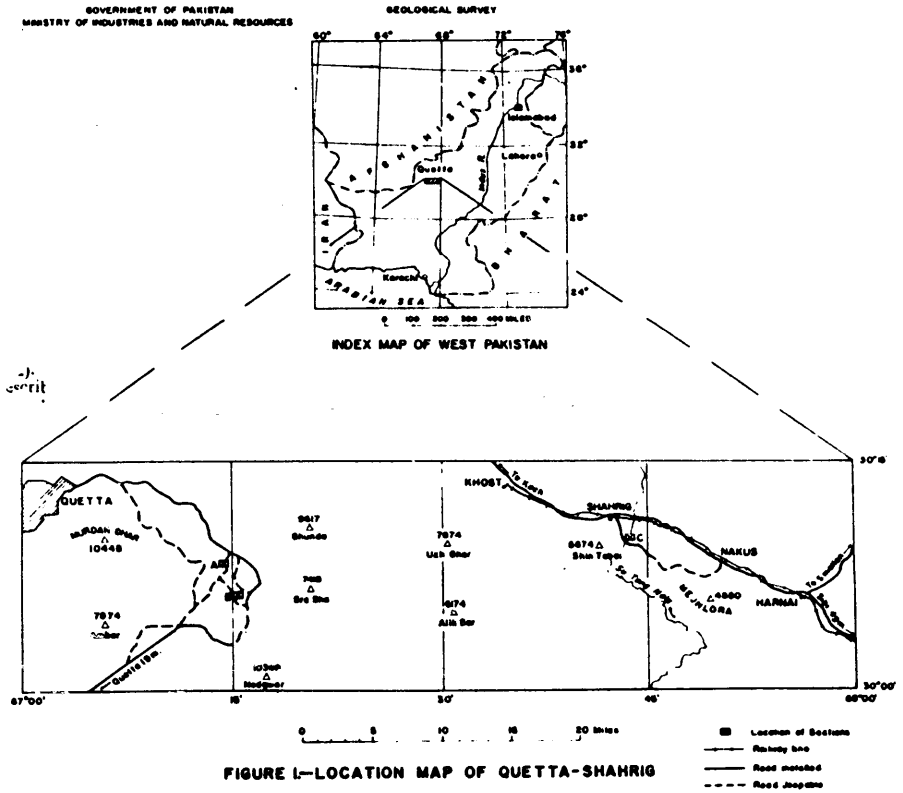

FIGURE 1.—LOCATION MAP OF QUETTA-SHAHRIG

INTRODUCTION

General statement

This report is based on the thesis for Master's degree submitted to the University of California, Los Angles USA, 1963. Only that part which contains discussion and systematic description on the mega-fauna from the Ghazij fm. (Lower Eocene) has been included in this report. The purpose is to describe the invertebrate mega fauna of the Ghazij fm. in order to provide a basis for further studies regarding time-rock equivalencies, successive biotopes, their biological aspects and biofacies within the formation. This work is a revised and up dated 1969 edition of the author's previous report (Iqbal, 1966a).

Field work was carried out during the summer of 1961. Three sections were measured, two in Sinjdi and one in Shahrig and mega-fauna was collected from those sections. Only a few beds yielded mega-fossils.

Location and accessibility

The area investigated is situated in the eastern part of Quetta, West Pakistan. The Sinjdi locality (Lat. 30°7'30"; Long 67° 15': 34 N) in which sections "A" and "B" are lying is about fourteen miles south-east of Quetta and can be reached by two routes: the Sor Range-Deghari Road and the Quetta-Sariab-Deghari Road. The Shahrig locality (Lat. 30°9'30": Long. 67°43'30"; 34 N) in which section "C" is lying, is situated at a distance of about forty-four miles east-south-east of Quetta. It is connected with Quetta by the Sibi-Khost Railroad and is also reached by the Quetta-Kach-Khost jeep trail (Fig.1).

Previous work

The Lower Eocene rocks of parts of Quetta Division, formerly known as Baluchistan, were described and mapped by Griesbach (1881), Blanford (1883), Oldham (1890, 1892) and Pilgrim (1912). D' Archiac and Haime (1853-4) described the fossils from the Upper Cretaceous to the Miocene rocks of the Salt Range, Thal, and Sind areas, but all the horizons were grouped together into the "Nummulitic" by them. Nuttall (1925) described the stratigraphy of the "Laki Series" (Lower Eocene) and examined the larger foraminifers from the Sind and Quetta area. Cox (1931) studied the Lower Eocene molluscan fauna from Sind and Quetta and re-examined the type material described by d' Archiac and Haime (1853-54). The Lower Eocene molluscan fauna from the Rakhi-Gaj and the Zinda Pir areas was described by Eames (1951, 1952). Gill (1953) described the larger foraminifers from the Bhadrar fm. (Lower Eocene). Haque (1956, 1959, 1959b) described the Tertiary Foraminifera from the Nammal Gorge, (Salt Range), Sore Range (Quetta) and Meting (Hyderabad). Kazmi (1962) described the stratigraphy of the Ghazij fm. exposed in Zardalu area towards east of Quetta, West Pakistan. Recently Kazi (1968), Ferahori and Ahmed (1969) have described sedimentology of the Ghazij fm. exposed in northeastern part of Quett Division.

A general geological map, with a scale of one inch to four miles, was prepared by the Photographic Survey Corporation, Canada and Geological Survey of Pakistan in 1953-6, was used in this study.

Acknowledgements

The writer wishes to thank Dr. C.A. Hall, Jr., Dr. W.P. Popenoe, Dr. N.G.Lane, Dr. (Mrs.) H. T. Loeblich of the University of California, Los Angeles (U.S.A.) and Dr. L.R. Cox of the British Museum (Natural History), London, for their inspiration, guidance, helpful discussions and critical review of the manuscript dealing with the systematic palcontology of this report. Gratitude is also expressed to the Director General, Geological Survey of Pakistan, whose keen interest encouraged the writer to present this work.

Depository

The holotypes, paratypes and identified speciemens figured in this report are with the Foreign Tertiary Reference Collection of the University of California, Los Angeles, (U.S.A.). The accessory specimens will be kept in the Tertiary reference Collection of the Geological Survey of Pakistan, Quetta, West Pakistan.

STRATIGRAPHY

General statement

The rocks exposed in the eastern part of Quetta, range in age from Middle Jurassic to Early Pleistocene. The predominant rock-types are shale and sandstone but some conglomerate and limestone are also present. The major mountain ranges in the area are Murdar Ghar, Sor Range, Zarghun, Ghunda, Tor Dabbar, Kamman Ghar and Tangi Sar. These ranges with a north-west to south-east trend, were uplifted along with the remainder of the Himalayan mountains

during Late Mesozoic through the Tertiary (Krishanan, 1960, p. 434, 490). The "calcareous" zone, described by Vredenburg (1909) is present in this region and consists mainly of calcareous and argellaceous deposits and fresh water sediments. The area is highly folded and faulted, with the major trend of these structural features being north-west to south-east. As pointed out by Krishanan (1960, p. 82), the folding and faulting took place during the successive periods of the mountain building of the Himalayas.

Stratigraphic succession

The following is a generalized stratigraphic succession within the Quetta-Shahrig area :

Pleistocene : Pliocene Miocene .. Oligocene	.. ..	Lower Pleistocene Pliocene Upper Miocene Oligocene Middle Eocene	{ Siwalik Group (conglomerate, sandstone and shale.)	17000 ft.
			Kirthar Formation ..	1000 ft.
Eocene ..	..	Lower Eocene	{ Ghazij formation Dunghan Limestone (Up. part)	1500 ft.
Paleocene	.. ..	Paleocene	Dunghan Limestone : *total* (Middle part)	800 ft.
		Upper Cretaceous	Dunghan Limestone (Lr. part)	
Cretaceous	.. ..	Lower Cretaceous	{ Parh Limestone .. Sember Formation ..	1500 ft. 1300 ft.
Jurassic ..	.. ..	Middle Jurassic	Massive, grey limestone beds.	4000 ft.

The Jurassic rocks include a maximum thickness of 4,000 feet of massive gray limestone beds that grade upward into thin-bedded limestone and shale. These beds are unconformably overlain by Sembar Formation, composed of 1300 feet of black splintery shale containing abundant *Belemnites*. These beds were referred to as the "Belemnite Beds" by Oldham (1892, p. 19). Conformably overlying the Sembar Formation is the thin-bedded porcellaneous Parh Limestone, with a maximum thickness of 1500 feet. The Sembar Formation and the Parh Limestone are of Early Cretaceous age.

The Dunghan Limestone of Late Cretaceous to Early Eocene age consists of 500 to 800 feet of compact, thick-bedded, blue, or dark gray limestone, unconformably overlying the Parh Limestone. The ages of the lower, middle, and upper parts of the formation are Late Cretaceous, Paleocene, and Early Eocene respectively. The Dunghan Limestone is overlain by the Lower Eocene Ghazij fm. which is 1500 feet thick. The contact between the Dunghan Limestone and the Ghazij fm. is variable, that is, in Quetta it is unconformable, in Sanjawi and Siazgai the contact is concordant and apparently conformable, while in Brewery there is either an angular or disconformable relationship.

The Kirthar Formation of Middle Eocene to Oligocene age, overlies the Ghazij fm. In the area of this report the contact is unconformable, but in the Bolan and Mari Bughti areas is conformable. The Kirthar Formation contains interbedded thick beds of gypsum and green shale and has a maximum thickness of 1000 ft.

The fresh-water deposits of Upper Miocene to Early Pleistocene age are referred to as the Siwalik Group (Medlicott, 1864, p. 13). This unit consists of conglomerate, sandstone and shale and unconformably overlies the Kirthar Formation. the maximum thickness of the Siwalik Group is 17,000 feet.

GHAZIJ FORMATION

General statement

The Ghazij formation is principally shale with subordinate beds of sandstone, limestone, conglomerate, and locally coal. It lies above the Dunghan Limestone (Upper Cretaceous-Lower Eocene) and below the Middle Eocene to Oligocene Kirthar Formation. Oldham (1890, p. 95) first designated the formation as the "Ghazij Shale" later referred by Khan & Haque (1956, chart opp. p. 7 ; p. 87) as "Ghazij bed" and "Ghazij Shale." Presently the proposed name is Ghazij formation. The type locality is the Ghazij Valley near Dunghan Hill (Lat. 29° 52' : Long. 68° 22').

In the eastern part of Quetta, the exposures of the Ghazij fm. form an arcuate belt between Harnai, Hanna, and Deghari. There are also a few scattered outcrops between Zarghun and Kaman Ghar. The shale weathers easily and holds up low, rounded hills. The thickness is from 1000 to 1500 feet.

Lithology

The Ghazij formation is divided locally into four lithological subdivisions : (1) shale, (2) sandstone, (3) limestone, and (4) conglomerate. These subdivisions have variable thickness (4' to 240'). (1) The shale is predominant, light green, gray or olive green in color, with maroon, purple and yellow colors being subordinate. The shale contains veinlets or thin partings of gypsum. (2) The sandstone is grey or brown, mostly coarse-grained and pebbly. (3) The brown sandy limestone is interbedded with sandstone and shale. (4) The lenses of conglomerate, a minor constituent at most localities, become continuous and attain a thickness of 200 feet in the Sor Range. The clasts are derived from the older strata and are composed of Cretaceous chert and limestone. Thin beds and lenses of coal are also present in the formation. The coal is mostly grayish to brown, or brownish black in color and is slightly fissile. Veinlets of gypsum and partly decomposed woody material are present in the coal.

Description of the sections

Three sections of the Ghazij fm. were measured ; two in Sinjdi and one in Shahrig. The lithological details of each section are given below (Fig. 3).

SECTION "A" (SINJDI) :

(From higher to lower stratigraphic unit)

Bed "L": Thickness 10 feet ... ... *Claystone.*—yellowish brown, silty beds about 1/4th of an inch thick.

Bed "K": Thickness 12 feet ... ... *Sandstone.*—medium-grained, pale yellowish brown, grains mostly subangular, calcareous, irregular, lenticular beds as much as 2 ft. thick.

Bed "J" : Thickness 83 feet ... ... *Conglomerate.*—clasts mostly rounded, composed of limestone/chert, matrix of fine grained sandstone, indistinct bedding, few sandstone lenses.

Bed "I": Thickness 51 feet 6 inches ... *Claystone.*—light olive gray, silty, with scattered carbonaceous material. Contains two coal beds, four inches and one feet nine inches thick, coal is brownish black, shaley, contains gypsum and partly decomposed woody material.

Bed "H" : Thickness 4 feet 1 inch ... ... *Sandstone.*—fine-grained, grayish, yellow, calcareous, grains subangular to angular, beds 1/2 inch to 1-1/2 feet thick.

Bed "G" : Thickness 9 feet ... ... *Claystone.*—pale olive, weathering to dusty yellow, slightly silty.

Bed "F" : Thickness 25 feet ... ... *Sandstone.*- fine-grained, light olive gray, weathering to dull yellow color, calcareous, grains subangular to angular, indistinct bedding.

Bed "E" : Thickness 26 feet ... ... *Claystone.*- olive gray, weathering to pale yellowish brown, silty and with few sandy layers.

Bed "D" : Thickness 13 feet ... ... *Sandstone.*—fine grained, yellowish gray, evenly laminated, with carbonaceous material on laminae, beds from less than one inch to several feet, mostly even, grains angular to subangular, mostly white and gray, calcareous.

Bed "C" : Thickness 2 feet ... ... *Claystone.*—Carbonaceous, mottled gray to grayish black, contains coal bed in the part. Coal bed 1 feet 6 inches thick, color black, contains gypsum.

Bed "B" : Thickness 32 feet ... ... *Claystone.*—light olive gray to brownish gray, slightly silty, contains molluscan fossils.

Bed "A" : Thickness 12 feet ... ... *Sandstone.*—fine-grained, light yellowish gray, cross laminated, in very uneven lenticular beds, interbedded with olive gray, silty claystone.

SECTION " B " (SINJDI) :

(from higher to lower stratigraphic unit)

Bed "N" : Thickness 4 feet .. .. *Sandstone.*—light gray, weathering to yellow gray, medium-grained, cross bedded and cross laminated, grains sub-angular to subrounded.

Bed "M" : Thickness 50 feet ... . *Claystone.*—light olive gray, weathering to brownish color, with scattered carbonaceous material and containing three coal beds : three coal beds : three feet, three feet one inch, and six feet thick. Coal black and shaley.

Bed "L" : Thickness 6 feet ... . *Sandstone.*—fine-grained, brown, weathers to light yellowish brown, beds fairly even, as much as 2 feet thick.

Bed "K" : Thickness 33 feet .. .. .. *Claystone.*—light brownish gray, with gyspsum and scattered carbonaceous material.

Bed "J" : Thickness 20 feet .. .. *Limestone.*—grayish brown weathering to dark brown, containing abundant corals and larger Forminifera.

Bed "I" : Thickness 11 feet 6 inches .. .. *Claystone.*—same as bed "K".

Bed "H" : Thickness 14 feet .. .. .. *Sandstone* : medium-grained, light gray, weathering to yellowish brown, beds lenticular, calcareous.

Bed "G" : Thickness 5 feet .. .. .. *Claystone.*—same as bed "I".

Bed "F" : Thickness 5 feet .. .. .. *Sandstone.*—same as bed "H".

Bed "E" : Thickness 16 feet .. .. .. *Claystone.*—Pale olive, weathering to dull yellow color,—silty.

Bed "D" : Thickness 19 feet 6 inches .. .. *Sandstone.* gray to brownish gray, weathering to yellowish brown uneven beds, calcareous.

Bed "C" : Thickness 20 feet .. .. .. *Claystone.*—light olive gray, weathering to light yellowish brown, slightly silty.

Bed "B" : Thickness 9 feets .. .. .. *Sandstone.*—yellowish brown, weathering to gray : fine-grained, grains angular to subangular.

Bed "A" : Thickness 6 feets .. .. .. *Claystone.*—Olive gray, silty, contains few layers of sandstone.

SECTION " C " (SHAHRIG) :

(from higher to lower stratigraphic unit)

Bed "L" : Thickness 3 feet .. .. .. *Sandstone.*—gray, medium-grained, calcareous, thin to thick bedded.

Bed "K" : Thickness 10 feet 6 inches .. .. *Claystone.*—light olive gray, slightly silty.

Bed "J" : Thickness 18 feet .. .. .. *Limestone.*—light medium gray, medium-grained, thick-bedded, sandy, weathering color light brown to dark yellowish orange, contains abundant molluscan fossils.

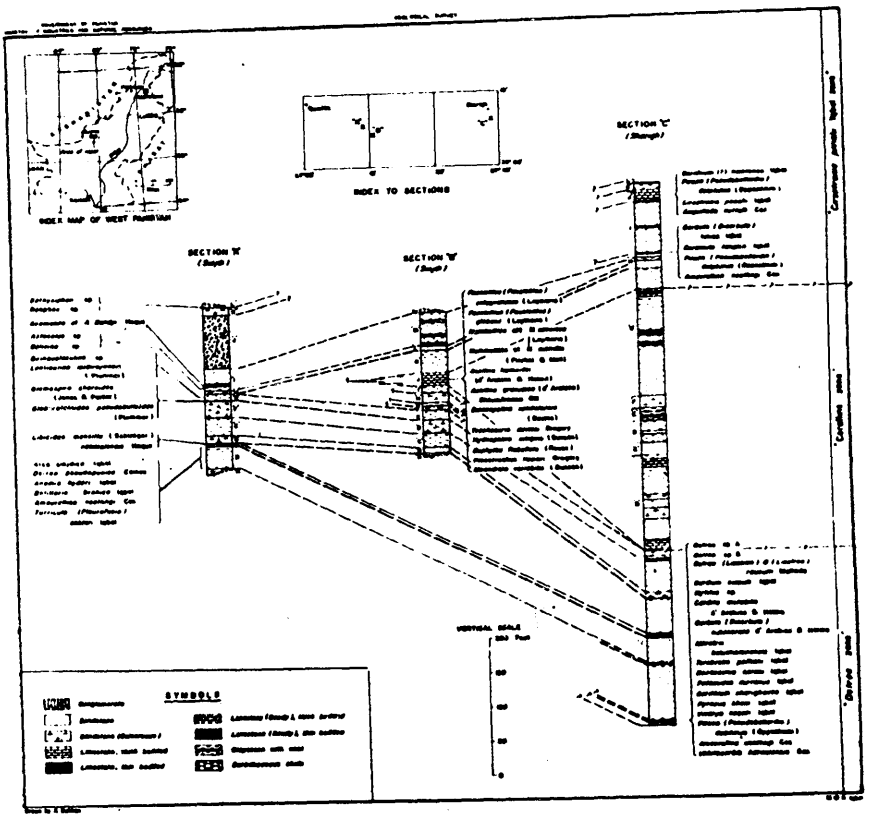

FIGURE 3.- COLUMNAR SECTIONS OF THE GHAZIJ SHALE

Bed "I" : Thickness 83 feet	*Claystone.*—light bluish gray', contains two thin bands of sandy limestone, gray in color and nodular, the last one contains molluscan fossils.
Bed "H" : Thickness 21 feet	*Sandstone.*—gray, medium-grained, thick-bedded, contains 3 feet thick claystone bed, which is silty.
Bed "G" : Thickness 190 feet	*Claystone.*—light blusih gray, weathering color dark gray, mostly covered, interbedded with nodular limestone, coal and carbonaceous shale bands.
Bed "F" : Thickness 16-1/2 feet	*Sandstone*—olive gray, thin to thick-bedded, medium to coarse-grained, with thin carbonaceous shale bands.
Bed "E" : Thickness 18 feet 2 inches	*Claystone.*—carbonaceous, with a thin band of gray, nodular limestone.
Bed "D" : Thickness 31 feet	*Claystone.*—light bluish gray, slightly carbonaceous with gray, medium-grained sandstone band.
Bed "C" : Thickness 18 feet	*Sandstone.*—gray medium-grained, grains angular to subrounded.
Bed "B" : Thickness 75 feet	*Claystone.*—light gray, interbedded with olive gray, medium-grained sandstone which is calcareous ; and sandy limestone.
Bed "A" : Thickness 240 feet	*Claystone.*—light gray to light bluish gray, mottled yellowish and brownish color, partly covered, interbedded with gray, medium-grained sandstone and carbonaceous shale with coal band, also contains a thin band of sandy limestone, gray in color weathering to grayish orange color, with abundant molluscan fossils.

Discussion.—Three local paleontological subdivisions are established which are based on the faunal assemblages and are named (from top to bottom) the (1) *Cirsotrema jinnahi* Iqbal zone, (2), Coralline zone and (3) *Ostrea* zone. The correlation is shown in the table (*See* columnar sections of the Ghazij fm. fig. 3).

AGE & CORRELATION

A classification of the Tertiary rocks of West Pakistan was first proposed by Blanford (1880) ; Noetling (1905) introduced the term "Laki" for the limestone beds of the Laki Range in Sind, containing abundant *Fasciolites* : and Vredenburg (1906, 1909) adopted the term "Laki" and regarded it as Lower Lutetian in age. His correlation was, however, shown to be incorrect by Cox (1931, p. 26,27) who concluded that it was equivalent of the Ypresian.

Nuttal (1925) on the basis of his work in the Sind and Quetta areas, correlated the lower part of the Ghazij fm. with the Laki Limestone of Sind and the Laki Limestone is considered by Davies (1926) to be Ypresian in age.

Haque (Khan and Haque, 1956, table, opp. p. 7) has included the Ghazij fm. in the Lower Eocene Series and correlated the formation with the Laki Group (Laki Limestone) of Sind, the Shekan Limestone of Kohat, the "Shale with Alabaster" of the Rakhi-Gaj, the Bhadrar Formation of the Salt Range and the "Nummulitic" of the Pir Panjal-Hazara.

According to the recent work by Haque (1959a, pp. 11, 13,), on the evidence of the planktonic Forminifera, the upper part of the Ghazij fm. is Middle to Late Eocene in age. As pointed out by Nuttal (1925, p. 420) the upper part of the Ghazij fm. is younger in age than the Laki Group in Sind ; and the uppermost beds of the Ghazij fm. are correlated with the upper part of the Navet Formation (Middle to Late Eocene) in the West Indies, with the Late Eocene of Cuba, and with the Middle Eocene to Late Eocene of Alabama and Texas in the U.S.A.

According to Hunting Survey Corporation (1961, pp. 124, 125, 126) on the basis of micro-fauna, the Ghazij fm. is of Early Eocene age in most cases, and can be correlated with the Laki Group (Lower Eocene) of Sind. In certain localities, the micro-fossil collection from the basal part of the Ghazij fm. indicates Paleocene age or Paleocene affinity.

Regarding the age and correlation of the Ghazij fm. the writer wishes to record the following statement that is based on the synthesis of paleontological, lithological and mapping evidence :—

The Ghazij fm. throughout the area lies above the Dunghan Limestone (Upper Cretaceous-Lower Eocene) and below the Kirthar Formation (Middle Eocene-Oligocene) and in most cases the paleontologial evidence suggests Ypresian age (Early Eocene) (Nuttal, 1925, pp. 429, 430, 431) for the Ghazij fm. The molluscan fauna shows an affinity to that in the "Laki" considered to be lower Eocene by Cox (1931, pp. 27, 33, 34). As pointed out by Nuttal (1925, p. 432), the larger Forminifera are more useful in this respect due to their limited stratigraphic range and wide geographic distribution. The writer also collected and identified some larger Foraminifera from the Ghazij fm. such as *Fasciolites* (*Fasciolites*) *subpyrenaica* (Leymerie), *F.* (*F*). *globosa* (Leymerie), *Nummulites* aff. *N. atacicus* Leymerie, *N.* cf *N. mamilla* (Fitchel & Moll), *Assilina leymerei* (Archiac & Haime), *A. granulosa* (Arch. & Haime) subspecies *chhumbiensis* Gill which are restricted to Lower Eocene throughout West Pakistan and France (Nuttal, 1925, pp. 429, 430).

The writer also found certain species of smaller foraminifera in the Ghazij fm. which indicate older age (Aptian, Albian, and Cenomanian) than the Lower Eocene. It is probable that they are reworked from older strata such as Cretaceius. The worn appearance of the specimens also suggests reworking.

As pointed out by Nuttal (1925, p. 420) and Haque (1959a, p. 11), it is quite possible that the upper most beds in the Ghazij fm. are Middle to Late Eocene provided these beds are included in the Ghazij fm. The lithology of these beds referred as uppermost beds in the Ghazij fm. is typically the same as that of Kirthar Formation. The writer would prefer to regard the so-called uppermost beds in Ghazij formation as the basal part of the Kirthar Formation. All the previous workers on mega-fauna such as Cox (1931) Eames (1951, 1952) and at present, the writer himself could not find a single molluscan species in the Ghazij fm. which could be regarded as an index species for the Middle Eocene.

The Ghazij fm. is regarded by the writer as of Early Eocene age and it is correlated with the Laki Group (Lower Eocene) of Sind, Nammal Formation (Lower Eocene), Sakesar Formation (Lower Eocene) and Bhadrar Formation (Lower Eocene) of Salt Range and Trans Indus Ranges, upper part of 'Hill Limestone' (Lower Eocene) and Chor Gali Formation (Lower Eocene) of the Potwar and Kala Chitta areas in West Pakistan.

Palaeoecology

According to a generalized interpretation made by Haque (1959a, pp. 13, 14)".....the fauna was laid down on the continental shelf of a warm sea less than four hundred fathoms deep. The presence of planktonic elements in the fauna suggests that the basin of deposition was connected with an open ocean. From the fact that 1-third of the population is undescribed, it seems likely that the fauna is provincial".

Hunting Survey Corporation (1961, pp. 44-45 ; 242-426) have discussed in detail on the geological environment and other related aspects of the Ghazij fm. and accordingly the formation is partly marine and partly fluviatile-deltaic. Kezi (1968) also confirms this point of view.

According to Kazmi (1962, pp. 39, 40) the sediments were deposited rather rapidly in a slow-sinking basin while the adjacent land was rapidly being uplifted, and the environment was deltaic.

The palaeoecological interpretation cannot be made accurately as no information is available on the ecology of the living pelecypods and gastropods in the Arabian Sea and Indian Ocean. However, a generalized interpretation is made. The mega-fauna of the Ghazij fm. is typically marine. This is also the first report on the occurrence of corals in the Ghazij fm. In section "B" of the Sinjdi locality, the occurrence of four species of hermatypic corals representing three colonial forms, according to Thornbury (1960, p. 481) suggests that the fauna was probably laid down on the sublittoral to littoral zone of a warm sea, about 150 feet to 200 feet deep, the temperature of water would have been between 77 and 86 degrees Fahrenheit and the coral species also indicate clear water condition. It is interesting to note that the coral species are present only in one section named "B", in association of larger Formanifera and in this particular section, the pelecypods and gastropods are entirely absent. Whereas in other sections such as "A" and "C" the fauna is composed of pelecypods, gastropods and smaller Forminifera and the corals are absent. This evidence indicates that particularly in these parts (representing section "A" and "C"), due to fluctuating wave base, the ecological conditions were not favourable for the growth of hermatypic coral forms and the over-all result of this rapidly changing ecological condition favoured the pelecypods and gastropods to thrive in the shallower muddy water environment (Fig. 3.). Farshori and Ahmed (1969, p.5) suggest that basins were still shallower than 150 feet.

FAUNAL ANALYSIS

Micro-fauna

Foraminifera are sparse and occur only within narrowly restricted horizons. Approximately nineteen families, twenty-eight genera and thirty-two species have been identified. Of these, seventeen species are listed separately and are thought to be reworked because they have a worn appearance. Further discussion of the reworking is included elsewhere in this report.

The larger Foraminifera occur in the coralline limestone bed of section "B". Three families four genera and seven species have been identified.

The systematic treatment of Foraminifera has been excluded from the report. Both arenaceous and calcareous perforate species are present. The foraminifers of the Ghazij fm. are represented by the following:—

Family	Genus	Species
Astrorhizinae	*Bathysiphon*	
Ammodiscidae	*Glomospira*	*Glomospira charoides* (Jones & Parker)
Aschemonellidae	*Reophax*	
Miliolidae	*Quinqueloculina*	
Nodosariidae	Astacolus	
	Lenticulina	*Lenticulina midwayensis* (Plummer)
Bolivinitidae	*Bolivina*	
Globigerinidae	*Globorotaloides*	*Globorotaloides pseudo-bulloides* (Plummer)
Cibicididae	*Cibicides*	*Cibicides mensilla* (Schwager) subspecies *nammalensis* Haque
Anomalinidae	*Anomalina*	*Anomalina* cf. *A. bandyi* Haque
Alveolinidae	*Fasciolites*	*Fasciolites* (*Fasciolites*) *subpyrenaica* (Leymerie) *F.* (*Fasciolites*) *globeosa* (Leymeie)
Nummulitidae	*Nummulites*	*Nummulites* aff. *N. atacicus* Leymerie
		N. cf. *N. mamilla* (Fitchel & Moll)
	Assilina	*Assilina* leymeriei (d'Arch. & Haime)
		A.granulosa (d' Archiac & Haime) subspecies *chhumbiensis Gill*
Discocyclinidae	*Discocyclina*	*Discocyclina ranikotensis* (Davies)

The smaller Foraminifera were recovered mostly from the shale beds of the formation. The larger Foraminifera are abundant in the coralline limestone bed and sparse in the shale beds of section "B". Particularly *Fasciolites* (*Fasciolites subpyrenaica* (Leymerie) is entirely absent in the shale beds.

The species *Lenticulina midwayensis* (Plummer), *Cibicides mensilla* (Schwager) subspecies *nammalensis* Haque, and the genera *Quinqueloculina*, *Astacolus* and *Bolivina* have been recorded by Haque (1956) from the Lower Eocene of the Nammal Gorge (West Pakistan). *Glomospira charoides* (Jones & Parker) has been recorded from the Eocene of Trinidad (West Indies) by Cushman and Renz (1948) and *Globorotaloides pseudobulloides* (Plummer) from the Upper Midway formation (Paleocene) has been recorded by Plummer (1926). *Bathysiphon* sp. and *Reophax* sp. are reported for the first time from the Ghazij fm.

Most of the species listed above are restricted to the Lower Eocene and are also reported from southern France (Nuttal, 1925, p. 417). *Assilina granulosa* (d'Archiac) and *Fasciolites* (*Fasciolites*) *globosa* (Leymerie) are from the Lower Eocene of Sind, West Pakistan. Gill (1953) has described a new subspecies (referred by him as a new variety) *Assilina granulosa* (d' Archiac) *chhumbiensis* Gill, from the Bhadrar Formation (Lower Eocene) of the Salt Range (West Pakistan). *Nummulites atacicus* Leymerie, *Fasciolites* (*Fasciolites*) *subpyrenaica* (Leymerie) and *Assilina leymeriei* (d' Archiac & Haime) are the most common forms in the Lower Eocene of Sind, Quetta (West Pakistan) and France (Nuttal, 1925, P.429, 430).

As mentioned above, there are species present in the Ghazij fm. of an older age than the Lower Eocene. It is probable that they are reworked from older strata such as Cretaceous. The worn appearance of the specimens also suggests reworking.

The following list shows such reworked forms with their respective age:—

Rotalipara greenhornensis (Morrow): Upper Cretaceous.

R. cushmani (Gandolfi): Cretaceous

R. appencies (O. Renz): "

Orbitoides media (d' Archiac): Upper Cretaceous.

Planomalina buxtorfi (Gandolfi): Albian-Cenomanian.

Ticinella multiloculata (Morrow) : Cenomanian.

Globotruncana fornicata (Plummer) : Upper Cretaceous.

Praeglobotruncana stephani (Gandolfi) : Cenomanian.

Heterohelix sp. : Cretaceous.

Globigerinelloides eagleforlensis (Morrow) : Cretaceous.

Anomalinoides sp. : Upper Cretaceous.

Pseudoguembelina sp. : Upper Cretaceous.

Rugoglobigerina sp : Upper Cretaceous.

Hedbergella sp. : Cretaceous.

Mega-fauna

The mega-fauna of the Ghazij fm. consists of five species of corals, thirteen species of pelecypods and fourteen species of gastropods. It includes six new species of pelecypods and ten new species of gastropods. The occurrence of the corals is restricted to the limestone bed of the section " B ". The rocks shown in the section " C " have yielded the majority of well-preserved specimens from the impure limestone bands.

This is the first report of the occurrence of corals in the Ghazij fm. The following species representing the families Agariciidae, Faviidae, Meandrinidae, Caryophylliidae and Flabellidae are present in limestone bed of the section " B ":—

Trochoseris davisi Gregory

Hydnophora insignis (Duncan)

Meandrina variabilis (Duncan)

Euphyllia flabellata (Reuss)

Placotrochus tipperi (Gregory)

Except for *Paracotrochus tipperi* (Gregory,) all of the species are hermatypic and except for *Trochoseris davisi* Gregory, they are all colonial forms.

The pelecypods are represented by nine families :

Arcidae, Ostreidae, Anomiidae, Mytilidae, Carditidae, Corbiculidae, Corbulidae, Veneridae and Cardiidae and include the following taxa :—

Arca sinjdica Iqbal

Ostrea pseudopunica Eames

Ostrea sp. A, Iqbal

Ostrea sp. B, Iqbal

Ostrea (*Liostrea*) cf. *O.* (*Liostrea*) *roualdi* Mallada

Anomia hyderi Iqbal
Mytilus sp. Iqbal
Venericardia mutabilis (Archiac and Haime)
Corbicula tangica Iqbal
Corbula (*Bicorbula*) *subexarata* d 'Archiac and Haime
Corbula (*Bicorbula*) *lunica* Iqbal
Meretrix baluci histanensis Iqbal
Cardium suicum Iqbal

The following seven gastropod families are present : Cerithiidae, Melanopsidae, Naticidae, Ampullospiridae, Epitoniidae, Volutidae and Turridae and include :—

Cerithium (?) *kalatense* Iqbal
Cerithium sharighense Iqbal
Batillaria ? *brohica* Iqbal
Vicarya liaqati Iqbal
Pyrazus khani Iqbal
Potamides durranus Iqbal
Terebralia pathani Iqbal
Bezanconia heroni Iqbal
Pirena (*Pseudobellardia*) *delphinus* (Oppenheim)
Amaurellina noetlingi Cox
Ampullella nuttalli Cox
Cirsotrema Jinnahi Iqbal
Volutocorbis harnaiensis Cox
Turricula (*Pleurofusia*) *akhtari* Iqbal

The molluscan fauna described in this report includes four pelecypod species and four gastropod species which are known to occur in the Lower and Middle Eocene rocks of various parts of West Pakistan, India, Burma, Egypt, Somaliland, France and Spain. The species common in Eocene rocks within and outside Pakistan are listed below :—

Ostrea pseudopunica Eames
Ostrea (*Liostrea*) *cf. O.* (*Liostrea*) *rouaulti* Mallada
Venericardia mutabilis d' Archiac & Haime
Corbula (*Biocorbula*) *subexarata* d ' Archiac & Haime
Pirena (*Pseudobellardia*) *delphinus* (Oppenheim)
Amaurellina noetlingi Cox
Ampullella nuttalli Cox
Volutocorbis harnaiensis Cox

All the four gastropod species *Pirena* (*Pseudobellardia*) *delphinus* (Oppenheim), *Amaurellina noetlingi* Cox, *Ampullella nuttalli* Cox, and *Volutocorbis harnaiensis* Cox, occur only in the Ghazij fm. (Lower Eocene) and may therefore be regarded as index species. On the other hand, the pelecypod species are not restricted to the Ghazij fm. (Lower Eocene). *Venericardia mutabilis* (Archiac & Haime) ranges from Paleocene to Lower Eocene ; *Corbula* (*Bicorbula*) *subexarata* Archiac and Haime, and *Ostrea pseudopunica* Eames, range from Lower Eocene to Middle Eocene. (Fig. 4, showing distribution of the moga-fauna).

According to Cox (1931, pp. 26, 33) the fauna of Ghazij fm. has a well-marked affinity with that of the Somaliland Eocene. Most of the pelecypod species common to West Pakistan and the European area are forms with a long vertical range. In some cases, species recovered from the Ghazij fm. (Lower Eocene) are known in Europe only from the Middle Eocene or even younger rocks. The writer agrees with the opinion expressed by Cox (1930, p. 137 ; 1931, p. 35) that the Lower Eocene is poorly developed in southern Europe. In northern Italy, the molluscan fauna is abundant from the Lutetian onwards, but the rocks of Ypresian age contain few molluscan fossils. There is no evidence that the species common to West Pakistan and Europe arppeared first in this part of Pakistan and migrated towards Europe during Eocene times.

SYSTEMATIC PALEONTOLOGY

Phylum *COELENTERATA*

CLASS ANTHOZOA

Order Soleractinia

Family AGARICIIDAE

Genus :*Trochoseris* M. Edw.—H., 1849.

(Type species : ***Anthopyllum distortum*** Michelin, 1844)

TROCHOSERIS DAVIESI Gregory

(Pl. 8, fig. 4)

= LACMIP 12379.

Trochoseris daviesi Gregory, 1930, pp. 114-5, pl. 14, Figs. 4 - 11.

hypo

Type number : Specimen, UCLA cat. no. 35272.

Locality : Sinjidi, (UCLA Loc. 4610), bed " J ", section " B ".

Remarks : This specimen agrees well with that figured by Gregoy (1930, pp. 114-5, pl. 14, fig. 6) from the Paleocene of Thal, (West Pakistan). This specimen has smaller dimensions and represents the tall form of an elliptical variety.

Family Faviidae

Genus ***Hydnophora*** Fischer, 1807.

(Type species ***Hydnophora demidovii*** (Fischer)

HYDNOPHORA INSIGNIS (Duncan).
(*Pl.* 8, Figs. 9-10)

Monticulastrea insignis Duncan, 1880, pp. 78—8, pl. 26, figs. 1—3.

hypo

Type number : Specimen. UCLA cat. No. 35271. = LACMIP 12380.

Locality :Sinjidi (UCLA loc. 3610) bed "J" section "B"

Remarks : This specimen is similar to that figured by Duncan (1880, pp. 87 -8, pl. 26, figs. 1 —3) from the base of the Miocene of Magar Pir, Sind (West Pakistan). The corallum of this specimen is large, thick, becoming thin at the edges. The colonies are numerous, irregular, conical, and of varying dimensions.

Family Meandriidae

Genus ***Meandrina*** **Lamarck**, 1801

(Type species ***Meandrina pectinata*** (Lamarck)

MEANDRINA VARIABILIS (Duncan)
(*Pl. 8, figs.* 5-6)

Placocyathus variabilis Duncan, 1863, pp. 22— 4, Pl. ii, fig. 1.

hypo

Type number : Specimen, UCLA cat. no. 35269. = LACMIP 12381

Locality : Sinjdi (UCLA loc. 4610) bed " J ", section " B ".

Remarks : This specimen agrees well with that figured by Duncan (1863, pp. 22—4, pl. ii, fig. 1) from the Nivaja Shale (Miocene) of San Domingo, West Indies. This is the first report of this species from West Pakistan. The specimen has larger dimensions.

GOVERNMENT OF PAKISTAN
MINISTRY OF INDUSTRIES AND NATURAL RESOURCES — GEOLOGICAL SURVEY

	PAKISTAN									OUTSIDE PAKISTAN
	QUETTA LOCALITY [illegible]	[illegible]	[illegible]	HARNAI	HINDUBAGH	SIND	SALT RANGE	RAKHI GAJ	KOHAT	
Amaurellina oostingi Cox	×		×	L Eocene						
Ampullella nuttalli Cox			×	L Eocene	L Eocene					
Anomia hyderi Iqbal	×									
Arca sinjdica Iqbal	×									
Batillaria ? brahica Iqbal	×									
Bezanconia herani Iqbal			×							
Cardita mutabilis d'Archiac & Haime			×	L Eocene		Paleocene				Simla (India) L Eocene
Cardium suncum Iqbal			×							
Cerithium ? Kalatense Iqbal			×							
Cerithium sharighense Iqbal			×							
Circotroma jinnahi Iqbal			×							
Corbicula longica Iqbal			×							
Corbula (Bicorbula) lunica Iqbal			×							
Corbula (Bicorbula) subexarata d'Archiac & Haime			×		L Eocene	L Eocene		L Eocene	M Eocene L. Eocene	Burma U Eocene Egypt & Somaliland M Eocene Simla (India) L Eocene
Euphyllia flabellata (Reuss)		×				Paleocene				
Hydnophora insignis (Duncan)		×				Miocene				
Meandrina variabilis (Duncan)		×								West Indies Miocene
Meretrix baluchistanensis Iqbal			×							
Mytilus sp			×							
Ostrea sp "A"			×							
Ostrea sp "B"			×							
Ostrea pseudopunica Eames	×							L Eocene	M Eocene	
Ostrea (Liostrea) cf *O. (Liostrea) roundi* Mallada			×		L Eocene		L Eocene		M Eocene	France M Eocene Spain M Eocene
Pirena (Pseudobellardia) delphinus (Oppenheim)			×	L Eocene						Bosnia U Eocene Kashmir M Eocene
Placotrochus lipperi Gregory		×							Paleocene	
Potamides durrani Iqbal			×							
Pyrazus khani Iqbal			×							
Terebralia pathani Iqbal			×							
Trochoseris daviesi Gregory		×							Paleocene	
Turricula (Pleurofusia) akhtari Iqbal	×									
Vicarya hagei Iqbal			×							
[illegible] harnaiensis Cox			×	L Eocene						

M W A IQBAL

FIGURE 4.—DISTRIBUTION OF MEGA—FAUNA

Family Caryophylliidae

Genus *Euphyllia* Dana, 1846

(Type species *Caryophyllia glabrescens* Chamisso & Eysenhardt, 1821)

EUPHYLLIA FLABELLATA (Reuss)

(Pl. 8, figs. 1—3).

✓ *Plocophyllia flabellata* Reuss, 1868, Pal. Stud. Uber. die altern Tertiarschi chetn der Alpen, iii, Abtheil. p. 30.

Plocophyllia flabellata Reuss, Duncan (1880, p. 39, pl. 16, fig. 5).

hypo *Type Number* : Specimen. UCLA cat. no. 35270. = LACMIP 12382, 12384. / fig 1 / figs 2-3

Locality : Sinjdi (UCLA loc. 4610) bed "J", section "B". (oops! skipped 12383)

Remarks : This specimen strongly resembles to that figured by Duncan (1880, p. 39, pl. 16, fig. 5) from the Paleocene of Lynan (Sind : West Pakistan). These specimens are larger, the calyx in one specimen is much derpressed.

Family Flabellidae

Genus *Placotrochus* M. Edw., H., 1848.

(Type species *Placotrochus laevis* M. Edw.—H)

PLACOTROCHUS TIPPERI Gregory

(Pl. 8, figs. 7-8)

✓ *Placotrochus tipperi* Gregory, 1930, pp. 86-7, pl. xi, fig. 4.

hypo *Type number* : Specimen. UCLA cat. no. 35268. = LACMIP 12386.

Locality : Sinjdi (UCLA loc. 4610), bed "J", section "B".

Remarks : This specimen agrees well with that figured by Gregory (1930, pp. 86-7, pl. xi, fig. 4) from the Paleocene of Thal, West Pakistan. This specimen is slightly larger, has sharply pointed and slightly curved peduncle.

PHYLUM MOLLUSCA

CLASS PELECYPODA

S. Class Protobranchia, Pelseneer

Order Prionodonta, Mac Neil

Family ARCIDAE

Genus *Arca* Linneus, 1758.

(Type species *Arca antiquata* Linneus)

ARCA SINJDICA Iqbal

(Pl. 9, fig. 3.)

Description : Shell small, thick, sub-ovate in outline ; equivalve ; inequilateral ; inflated ; moderately convex ; shell wall thin ; umbonal area short, umbones distant, beaks conspicuous, distinct, opisthogyrate, situated about one-third the length of the shell from the anterior extremity ; hinge line wide, straight ; anterodorsal margin short, convex, anterior margin sharply rounded ; ventral margin long, broadly rounded ; posterior margin sharply angular, truncated, slightly inclined dorsally ; posterodorsal margin slightly concave, inclined posteriorly ; sculpture radial, well-preserved on the surface of the left valve, consists of fine, prominent ribs, thin, finely nodulous in the umbonal area, becoming gradually thicker and convex toward margin, about thirty-two in number, the posterodorsal portion of the valve below the hinge line has comparatively coarse and thick ribs, broadly spaced, about six in number ; the entire margin of the valves is crenulated due to strong radial ornamentation.

Type number : Holotype, UCLA, cat. no. 35260. = LACMIP 12386

Dimensions of type : Holotype, length 15.0 mm., height 11.5 mm., thickness 11.0 mm.

Locality : Sinjdi (UCLA loc. 4609), bed " B ", section " A ". One specimen.

Remarks.- *Area feddeni* Vredenberg (1928, pp. 415-6, pl. 33, fig. 1 -3) from the Miocene of Kach, India, differs in outline, the position of umbones and sculpture ; it is triangular in outline, umbones are not distant, the ribs alternate regularly in thickness and are granulated at their intersection and with distinct numerous concentric ridges ; the entire margin of the valves is indistinctly crenulated.

Order Isodonta Dall

Family Ostreidae

Genus *Ostrea* Linne, 1758.

(Type species : *Ostrea edulis* Linne ; Children, 1823)

OSTREA PSEUDOPUNICA Eames

(Pl. 9, figs. 10-11 ; pl. 10, figs. 13-14 and 17).

Ostrea pseudopunica Eames, 1951, pp. 358-9, pl. 12, figs. 54a-b, 55, 56, 57.

Type number : Specimens, UCLA, cat. no. 35261. = LACMIP 12387-12389

Locality : Sinjdi (UCLA loc. 4609), bed " B ", section " A ".

Remarks : The specimens in general character agree with that figured by Eames (1951, pp. 358-9, pl. 12, figs. 54a-b, p. 56, 57), from the Middle Eocene of Dera Ghazi Khan and the Rakhi Nala, West Pakistan. In one specimen both the left and the right valves are intact, ventroposterior portion slightly broken, strongly opisthogyrate. One specimen regularly oval, the other less regular and elongated. Ornamentation characteristically the same.

Further distribution in West Pakistan : The " Lower Chocolate Clay " (Middle Eocene) of Tobah, Dera Ghazi Khan (type occurrence), the lower Eocene and Middle Eocene of the Rakhi Nala (Eames, 1951, p. 358).

OSTREA sp. A, Iqbal

(Pl. 9, fig. 13)

Description : Shell large, thick suboval to sub-rectangular, subequivalve, inequilateral, shell moderately inflated, left valve larger, more convex than the right one which is somewhat flattened ; margin smooth, regular, anterodorsal margin short, sharply convex; anterior margin long, straight, inclined dorsally ; ventral margin long, gently convex ; posterior margin long, straight, inclined dorsally ; posterodorsal margin short, sharply convex ; ornamentation poorly preserved.

Type number : Specimen, UCLA cat. no. 35280. = LACMIP 12390

Dimensions of type : Length 25.0 mm., thickness 14.5 mm., height 31.9 mm.

Locality : Shahrig (UCLA loc. 4611), bed " A ", section " C ". One specimen.

Remarks : The specimen is worn and nothing can be said about the specific position and identification.

OSTREA sp. B, Iqbal

(P. 9, fig. 15)

Description : Shell large, thick, sub-oval to sub-rectangular, elongate, almost slipper like in general appearance; almost equivalve; inequilateral; left valve convex, inflated; right valve almost flat, slightly inflated in the umbonal area which is feebly convex; margin smooth, regular; anterodorsal margin short, sharply convex; anterior margin long, straight, inclined dorsally; ventral margin long, strongly convex; posteior margin long, broadly concave; posterodorsal margin broken but indicating short, convex outline; ornamention not preserved.

type

Type number : UCLA cat. no. 35281. = LACMIP 12391

Dimensions of type : Length 21.5 mm., height 37.5 mm., thickness 10.5 mm.

Locality : Shahrig (UCLA loc. 4611), bed " A ", section " C ". One specimen.

Remarks : Differs with *Ostrea* sp. A, diagnostic features not preserved, specific identification not possible.

Subgenus *Liostrea* Douville, 1904 (in Morgan)

(Type species ***Ostrea sublamellosa*** Dunker, Basal Liassic; monotypy)

Synonyms. ***Flemingostrea*** Vredenburg, 1916 (p. 196) type species ***Ostrea flemingi*** d'Archiac and Haime, Eocene, by tautonymy.

Sinastrea Yablov, 1936 (C. R. Acad. Sci., URSS, V. 4, p. 18) type species *Ostrea morgani* Vredenburg, Upper Cretaceous; monotypy.

OSTREA (LIOSTREA) cf. O. (L.) ROUAULTI Mallada
(pl. 9, fig. 14)

cf. *Ostrea*, indet., Rouault, 1850, p. 472, pl. 14, fig. 22. ***Ostrea rouaulti*** Mallada, 1878, a, p. 397; 1883, pl. xi. fig. 4.

type

Ostrea (Liostrea) cf. ***O. (Liostrea) rouaulti*** Mallada, Cox, (1931, p. 63, pl. 3, figs. 5- 8).

Ostrea (Liostrea) cf. ***O. (Liostrea) rouaulti*** Mallada, Vokes, 1937, p. 4.

Type number : Specimen. UCLA cat. no. 35273. = LACMIP 12392

Locality : Shahrig (UCLA loc. 4611), bed " A ", section " C ". One specimen.

Remarks : This specimen agrees well with the general characters of ***Ostrea (Liostrea)*** cf. ***O. (Liostrea) rouaulti*** Mallada, figured by Cox (1931, p. 63, pl. 3, fig. 6) from the Ghazij fm. (Lower Eocene) of Hindubagh (Quetta Division, West Pakistan). This specimen has smaller dimensions.

Further distribution in West Pakistan : Middle Eocene of Kohat, Bahadur Khel; Lower Eocene of the Salt Range.

Distribution elsewhere : Middle Eocene of Spain and southern France (Cox, 1931, p. 63).

Family Anomiidae

Genus *Anomia* Linnaues, 1758

(Type species ***Anomia ephippium*** Linnaeus; Schmidt, 1818)

holo para

ANOMIA HYDERI Iqbal

(Pl. 9, figs. 7 & 5).

Description : Shell large, moderately thick, compressed; elongate to broadly oval in outline, broadly rounded in front; shell internally nacreous; the left valve appears to be larger than the right one; only a fragment of the anterior portion of right valve is preserved; inequilateral, with the right valve somewhat flat and the left valve inflated, broadly rounded, incurved; hinge plate bulged downward; beak conspicuous, margin smooth; anterodorsal margin long, straight, inclined anteriorly ; anterior margin narrow, inflated, well-rounded; ventral margin long, gently convex; posterior margin long, inflated, gently rounded, somewhat angular below; posterodorsal margin short, straight, inclined posteriorly; ornamentation consists of distinct, fine, smooth, concentric striae, very numerous and regularly spaced; major part of the interior not exposed. = LACMIP 12393 fig 7

Type number : Holotype, UCLA cat. no. 35262, and paratype, UCLA cat. no. 35263. = LACMIP 12394 fig 5

Dimensions of type : Holotype, left valve, length 28.0 mm., height 18.5 mm., thickness of the shell (including the fragmentary right valve) 9.0 mm., paratype, left valve, length 16.5 mm., height 22.0 mm., thickness cannot be measured.

Locality : Sinjdi (UCLA loc. 4609), bed " B ", section " A ". Two specimens, left valves.

Remarks : *Anomia interrupta* Eames (1951, p. 341, pl. 11, figs. 41a–c), from the " Shales with Alabaster " (Lower Eocene) of Rakhi Nala, Dist. D. G. Khan, West Pakistan, and *Anomia pakistanica* Eames (1951, p. 342, pl. 11, figs. 42a-b), from the " Lower Chocolate Clays " (Middle Eocene) of Zinda Pir, Dist. D. G. Khan, West Pakistan, differ from this species in shape, size and ornamentation; they are suborbicular in outline, smaller in size and the ornamentation is distinctly radial.

This species is distinguished by its typical ornamentation, consisting of fine, smooth, concentric striae. The shape and the size cannot be regarded as diagnostic as the genus *Anomia* is well-known for having many variations in this respect. The only criteria for the specific determination is the type and the pattern of ornamentation. The specimens figured display a variation in shape and size but they have remarkably similar ornamentation.

Order Dysodonta Neumayr.

Family Mytilidae.

Genus *Mytilus* Linne, 1758.

(Type species *Mytilus edulis* Linne).

MYTILUS sp. Iqbal

(Pl. 9, fig. 12)

hype

Description : Shell large, thick, moderately inflated, transversely elongated, slipper-like in general appearance; shell wall thin; umbonal area and the dorsal portion broken; anterior margin, long, broadly convex; ventral margin broadly convex; posterior margin long, straight; ornamented by strong, somewhat granulose radial ribs having wider intervals, anterior and posterior marginal region bears more fine ribs, the ribs along ventral margin bifurcated; interior not exposed.

Type number : Specimen, UCLA cat. no. 35282. = LACMIP 12395

Dimensions of type : Left valve, incomplete length 17.0 mm., height 26.0 mm., thickness cannot be measured.

Locality : Shahrig (UCLA loc 4611), bed " A ", section " C ". One specimen, left valve.

Remarks : Because there is only one specimen that is poorly preserved a new specific name is not assigned. *Mytilus* (*Arcomytilus*) sp. Cox (1931, p. 60, pl. 4, fig. 12) from the Ghazij fm (Lower Eocene) of Harnai (Quetta Division, West Pakistan) resembles this specimen in ornamentation but differs greatly in shape, being narrow anteriorly, compressed and expanded posteriorly.

Order Diogenodonta, Dall

Family Carditidae

Genus *Venericardia* Lamarck, 1801.

(Type species : *Venericardia imbricata* Lamarck, Eocene (— *Venus imbricata* Gmelin; Schmidt, 1818 and Gray 1847). For details *see* Eames (1951, p. 372).

VENERICARDIA MUTABILIS (Archiac and Haime)

(Pl. 9, figs. 4 and 6).

Cardita mutabilis d' Archiac and Haime, 1854, p. 256, pl. 21, figs. 3–6.

Cardita depressa d' Archiac and Haime, 1854, p. 255, pl. 21, figures 1-2.

hype

Venericardia depressa : Vredenburg (in Cossmann and Pissarro, 1927, p. 16, pl. ii, figs. 35-36); non *C. depressa* Lam., 1819; non *C. depressa* Munster, 1839.

Cardita mutabilis d' Archiac and Haime, Cox (1931, pp. 69-70, pl. III, figures 14–16).

Venericardia mutabilis (Archiac and Haime) Eames, (1951, p. 372).

Type number : Specimen, UCLA cat. no. 35274. = LACMIP 12396 - 12397

Locality : Shahrig (UCLA loc. 4611), bed "A", section "C". Two specimens, left valves.

Remarks : These specimens are similar to that figured by Cox (1931, pp. 69-70, pl. III, figs. 14—16) from the Ghazij fm. (Lower Eocene) of Harnai (Quetta Division). The specimens are variable in size; in one specimen the ribs are smooth.

Further distribution in West Pakistan : Ghazij fm. (Lower Eocene) of Harnai (Quetta Division) and the Paleocene of Sind, Lower Eocene of Rakhi Nala, Zinda Pir (District Dera Ghazi Khan) and Kohat (Eames, 1951, p. 373).

Distribution elsewhere : Lower Eocene of Simla, India (Type occurrence). (Note : In the distribution Chart fig. 4, this species is erroneously shown as *Cardita mutabilis* Archiac and Haime).

Family Corbiculidae

Genus *Corbicula* Megerle von Muhlfeld, 1811

Type species *Corbicula fluminalis* Megerle; by subsequent designation, Gray, 1847 (= *Tellina fluminalis* Muller).

CORBICULA TANGICA Iqbal

(Pl. 10, figs. 19-20).

Description : Shell large, thick; inflated; subtrigonal, slightly elongate, somewhat tapering posteriorly, broadly rounded in front, contracted behind, equivalve; inequilateral; close; umbones prominent, very slightly prosogyrate, umbonal ridges distinct but no escutcheon; margin regular, smooth; anterodorsal margin short, straight inclined anteriorly; anterior margin short, gently convex; ventral margin long, broadly rounded; posterior margin long, inclined and convex ventrally, straight dorsally; surface ornamented by concentric growth lines, irregularly spaced; interior not exposed as the valves are intact.

Type number : Holotype. UCLA cat. no. 35277. = LACMIP 12398

Dimensions of type : Holotype, length 29·0 mm., height 23·5 mm., thickness 18·0 mm.

Locality : Shahrig (UCLA loc. 4611), bed "I", section "C". One specimen.

Remarks : *Corbicula pilgrimi* (Cox), (1931, p. 79, pl. 4, figs. 9a-b) from the Lower Eocene of Hindubagh (Quetta Division) has similar ornamentation as in this species, but differs in having a large shell, trigonally ovate in outline and not as inflated : the umbones are situated at about the anterior two-fifths of the shell.

Family Corbulidae

Genus *Corbula* Bruguiere, 1792.

(Type species *Corbula culcata* Lamarck; Recent; Gray, 1847).

Subgenus *Bicorbula* Fischer, 1887.

(Type species *Corbula gallica* Lamarck; Eocene; sole original species)

CORBULA (BICORBULA) SUBEXARATA d' Archiac and Haime.
(Pl. 9, fig. 2)

Corbula subexarata d' Archiac and Haime, 1854, pl. 16, figs. 10, 10a, 11.

Corbula subexarata var. *lituus* Cotter, 1923, pp. 6, pl. i, figs. 2—5.

Thracia costata Bellardi, 1854, p. 17, pl. ii, fig. 6 non *Corbula costata* Brown, 1845, 1849; non *Corbula costata* Sow., 1850.

Corbula harpaeformis Oppenheim, 1906, p. 193, pl. 18, figs. 7—10.

Corbula (Bicorbula) subexarata d' Archiac and Haime, Cox (1931, p. 84, pl. 4, figs. 14a-b); Eames (1951, p. 443).

Type number : Specimen UCLA cat. no. 35275. = LACMIP 12399

Locality : Shahrig (UCLA loc. 4611) bed "A", section "C". One specimen.

Remarks : This is the smallest specimen reported from West Pakistan, length 14.5 mm., height 13.0 mm., thickness 12.0 mm., agrees well with the original description. Cox (1931, pp. 84-5) identified the specimens of Davies' collection from the Lower Eocene of Hindubagh (Quetta Division) as this species, but his figure 14b (p. 92) figured as a left valve, is a right valve.

Further distribution in West Pakistan : The Lower Eocene of Sind (type occurrence). Middle Eocene of Kohat, Bahadur Khel and Dera Ghazi Khan. Eames (1951, p. 444) reports the occurrence of this species from the Lower Eocene of the Rakhi-Gaj, Zinda Pir and Kohat.

Distribution elsewhere : Subathu Group (Lutetian) of Simla : India ; Upper Eocene of Burma; Middle Eocene of Egypt and Somaliland (Cox, 1931, p. 84).

holo ✓

CORBULA (BICORBULA) LUNICA Iqbal

(Pl. 10, fig. 18).

Description : Shell large, thick, inflated; broadly subtrigonal, slightly elongate anteriorly, broadly rounded in front, contracted behind, inequivalve; inequilateral; close, both the valves inflated, convex, right valve slightly larger, more inflated, more convex; umbones prominent, incurved, umbonal area in the right valve larger, more pronounced than the left valve; beaks prominent, incurved, very slightly prosogyrate in the right valve and strongly opisthogyrate in the left valve; margin smooth, regular; anterodorsal margin short, concave (forming lunule); anterior margin straight, subangular ventrally; ventral margin broadly rounded; posterior margin strongly concave, angular ventrally; surface ornamented by concentric folds not so well-defined and with fine, smooth growth lines; both the valves have the same ornamentation; interior not exposed as the valves are intact.

Type number : Holotype. UCLA cat. no. 35276. = LACMIP 12400

Dimensions of type : Holotype, length 24.5 mm., height 20.0 mm., thickness 20.0 mm.

Locality : Shahrig (UCLA loc. 4611), bed " I ", section " C ". One specimen.

Remarks : *Corbula tunicosulcata* Vredenburg (1928, p. 460, pl. 31, figs. 14-15) from the Miocene of Kachh (India), has some superficial resemblance with this species but differs in having very pronounced curvilinear ridge in the posterior portion of the valves; the shell is ornamented with broadly spaced angular costae.

This species has both the valves inflated, convex, and the right one more convex, the beak of the right valve very slightly prosogyrate but the beak of the left valve strongly opisthogyrate; the ornamentation is typical, remarkably similar in both the valves.

Order Teleodonta, Dall

Family Veneridae

Genus *Meretrix* Lamarck, 1799.

(Type species *Venus meretrix* Linnaeus; Recent; sole original species).

holo ✓

MERETRIX BALUCHISTANENSIS Iqbal

(Pl. 9, figs. 8-9).

Description : Shell large, thick; moderately inflated; trigonal, rounded in front, contracted behind; equivalve; equilateral; close, umbones prominent, broad; beaks distinct, close, lunule limited by a linear groove; margin smooth, regular, anterodorsal margin short, narrowly concave (forming lunule) anterior margin straight, inclined and rounded ventrally; ventral margin long, well-rounded; posterior margin straight, inclined and rounded ventrally surface ornamented by smooth concentric folds, not well-defined, and with smooth, fine striae; interior not exposed as the valves are intact.

Type number : Holotype, UCLA cat. no. 35279. =LACMIP 12401.

Dimensions of type : Holotype, length 22.5 mm., height 21.0 mm., thickness 14.5 mm.

Locality : Shahrig (UCLA loc. 4611), bed " A ", section " C ". One specimen.

Remarks : *Meretrix* cf. *villanovae* (Deshayes), Hebert and Renevier, Cox (1931, pp. 80-81, pl. 4, fig. 5) from the Ghazij fm. (Lower Eocene) of Harnai (Quetta Division) has some superficial resemblance with this species but differs in shape and size, being considerably longer than high, lunule is wider and ornamentation is well-pronounced, consisting of concentric ribs, unevenly distributed and with distinct intervening striae.

Order Cyclodonta, Newell

Family Cardiidae

Genus *Cardium* Linnaeus, 1758.

(Type species *Cardium costatum* Linnaeus)

CARDIUM SUICUM Iqbal

(Pl. 9, fig. 1)

Description : Shell small, thick, ovoid, higher than wide, moderately convex; shell wall thin, umbonal ridge short; beaks strongly convex, incurved; slightly prosogyrate; margin regular, gently crenulated; anterodorsal margin short, straight inclined dorsally; anterior margin strongly convex; ventral margin long, broadly convex; posterior margin strongly convex; posterodorsal margin short, straight, inclined dorsally; surface ornamented by smooth, flat-topped, prominent radial ribs, about forty-two in number, much wider than their intervals which are sharp, smooth, regularly spaced depressions; ribs comparatively narrow in the umbonal area, becoming wider towards margins; interior of the valve not exposed.

holo *Type number* : Holotype. UCLA cat. no. 35278. = LACMIP 12402.

Dimensions of type : Holotype, right valve, length 17.0 mm., height 19.5 mm., thickness 9.0 mm.

Locality : Shahrig (UCLA loc. 4611), bed " A ", section " C ". One specimen, rightvalve.

Remarks : *Cardium* (*Discors*) *naricum* Vredenburg, (1928, p. 443. pl. 27, figs. 4-6, 8, 11-13 and 16) from the Oligocene of Sind (West Pakistan) is similar to this species in shape and in the character of the umbo, beak and margin, but differs in size, and is larger. The ornamentation is different, the radial ribs are very numerous, more crowded anteriorly and in the middle region than posteriorly. The radial ribs are traversed anteriorly by broad markings and cross-bars.

This species is distinguished by its smooth, flat-topped radial ribs, with their sharp smooth regularly spaced intervals.

CLASS GASTROPODA

Order Ctenobranchiata, Schweigger.

Family Cerithiidae

Genus *Cerithium* Bruguiere, 1789.

(Type species *Cerithium adansonii* Bruguiere : provisional)

CERITHIUM (?) KALATENSE Iqbal

(Pl. 10, figs. 11-12).

Description : Shell small, turreted, thin, fragile, strongly conical spire high, acute, spiral angle about thirty-five degrees; whorls about six, increasing rapidly in size as added, feebly convex; suture closely appressed, occupies narrow deep depression, and bears a thin, smooth spiral band in the middle part, leaving two deep grooves to the anterior and the posterior suture; periphery of base evenly rounded; sculpture consists of faint traces of axial varices, adjacent to the anterior suture; aperture not known.

holo *Type number* : Holotype. UCLA cat. no. 35283. LACMIP 12403.

Dimensions of type : Holotype, incomplete height 19.0 mm., diameter 10.0 mm.

Locality : Shahrig (UCLA loc. 4611), bed " J ", section " C ". One specimen.

Remarks : *Cerithium* ? *oldhami* Cox (1931, p. 43, pl. 1, fig. 9) from the Ghazij fm. (Lower Eocene) of Harnai (Quetta Division) has a long sutural slope, the suture bears two spiral bands, one adjacent to the posterior suture and the other somewhat weaker just below the first one and separated by a deep groove.

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CERITHIUM SHARIGHENSE Iqbal

(Pl. 10, figs. 7-8).

Description : Shell small, thick, strongly conical; spire high, spiral angle about thirty-five degrees; whorls about five, increasing rapidly in size as added, with slightly convex side; suture closely appressed; base of the last whorl slightly rounded, separated by a short ridge; whorls ornamented by thick and regularly spaced varices, superimposed by very numerous, thin, but distinct spiral lines; aperture very poorly preserved.

Type number : Holotype, UCLA cat. no. 35284. = LACMIP 12404

Dimensions of type : Holotype, incomplete height 25.0 mm., diameter 10.0 mm.

Locality : Shahrig (UCLA loc. 4611), bed " A ", section " C ". One specimen.

Remarks : *Cerithium ? oldhami* Cox (1931, p. 42, pl. 1, fig. 9) from the Ghazij fm. (Lower Eocene) of Harnai (Quetta Division), and *Cerithium ? kalatense* Iqbal, described elsewhere in this paper, have some superficial resemblance to this species but differ in sutural characters. *C. oldhami* Cox bears a narrow, smooth spiral band, adjacent to the posterior suture, separated by a deep groove from the rest of the surface of the whorl; a second band somewhat weaker appears just below the first one. *C. kalatense* Iqbal has an appressed suture occupying a narrow deep depression and bearing a thin, smooth spiral and in the middle part, leaving two deep grooves to the anterior and posterior suture.

Cerithium sharighense Iqbal is characterized by strong varices upon which the spiral lines are superimposed

Genus *Batillaria* Benson, 1842

(Type species *Cerithium zonale* Lamarck)

BATILLARIA ? BROHICA Iqbal

(Pl. 12, fig. 3-4.)

Description : Shell large, thick ; slightly conical ; spire high, acute, spiral angle about eighteen degrees ; whorls about four, increasing in size as added, slightly shouldered, with strong convex sides ; suture channelled ; last whorl moderately inflated ; base short, separated by a distinct ridge ; columellar margin distinct ; spire ornamented by thin varices slightly curved in backward direction, six in number, crossed by a faint spiral line along the posterior margin of the shoulder, somewhat tuberculated at the point of intersection ; the last whorl bears more pronounced spiral lines on abapertural side, about thirteen in number, including four thinner lines alternating in the abapical part ; these spiral lines are crossed by thin but strong, prosocyrt growth lines ; aperture partly preserved, pear shaped, with anterior canal and a lateral notch in the labrum. = LACMIP 12405 = LACMIP 12406.

Type number : Holotype. UCLA cat. no. 35264, and paratype UCLA cat. no. 35265.

Dimensions of type : Holotype, incomplete height 31.0 mm., diameter 22.0 mm.

Locality : Sinjdi, (UCLA loc. 4609), bed " B ", section "A". Two specimens.

Remarks : *Batillaria mekranika* Vredenburg (1928, p. 372, p. 2 b, fig. 4) from the Lower Miocene of Mekran (Quetta Division) has some superficial resemblance to this species, but differs in the whorl profile, sutural characters and ornamentation. The whorls are not shouldered, the suture is closely appressed, the ornamentation consists of about twelve spiral lines, crossed by thin varices, six in number ; the spiral lines disappear in the last whorl.

Genus *Vicarya* d'Archiac & Haime.

(Type species *Vicarya verneuilli* d'Archiac & Haime)

VICARYA LIAQATI Iqbal

(Pl.10, figs. 5-6)

Description : Shell, small, of medium thickness ; turreted ; spire high, spiral angle about twenty-seven degrees ; whorls about six, increasing somewhat rapidly in size as added, with flat sides ; suture linear well-incised ; base short, separated from the side of the last whorl by a distinct ridge ; sculpture consists of a prominent, smooth spiral band occupying the sutural depression entirely, two more fine spiral lines comparatively less prominent but distinct, occupy the middle part of the whorl ; the last whorl bears opisthocyrt growth lines ; aperture partly preserved, more or less oval, with a distinct lateral notch in th labrum and a short inflected anterior canal.

Type number : Holotype. UCLA cat. no. 35289. = LACMIP 12467.

Dimensions of type : Holotype, incomplete height 20.0 mm., diameter 10.0 mm.

Locality : Shahrig, (UCLA loc. 4611), bed "A", section "C". Two specimens.

Remarks : *Vicarya eocenica* Cox (1931, p. 44, pl. 1, figs. 7a, b & 8) from Ghazij fm. (Lower Eocene) of Harnai (Quetta Division) differs in sculpture ; in the later whorls there are three rows of granules, separated by few fine granulated spiral lines ; there is a narrow, smooth spiral band adjacent to the anterior suture. The sutural slope is also less and the dimensions much greater.

As to the affinity of this genus, the writer disagrees with Cox (1931, p. 44) who confirms the view of Dollfus that "*Vicarya* is merely a derivative of the genus *Potamides*". As described above, the aperture of this species is more or less oval with somewhat inflated anterior canal, in case of *Potamides* as considered by Davies (1935, p. 254), the abrupt truncation of the canal and the roundness of aperture are the main distinguished characters. Most likely, *Vicarya* is a derivative of *Melanopsis* or *Cerithium*.

Genus *Pyrazus* Montfort, 1810

(Type species *Pyrazus baudani* Monfort = *ebenius* (Bruguiere)

PYRAZUS KHANI Iqbal

(Pl. 11, figs. 11-12.)

Description : Shell, large, thick ; strongly conical ; spire high, spiral angle about thirty-four degrees ; whorls about four, increasing somewhat rapidly as added, with almost flat sides ; ornamentation consists of oblique varices, regularly spaced, five in number, moderately thick, separated by flat or slightly concave interspaces which are about three times the width of the varices ; the varices are not in alignment from one whorl to the next ; the spiral sculpture consists of coarse spiral lines, about four to six in number, somewhat crenulated at the points where they intersect the varices ; the axial sculpture is comparatively predominant ; on the abapertural side of the last whorl the varices are reduced to tubercles, located adjacent to the anterior suture ; the base is broad, moderately convex, carries five spiral lines ; aperture partly preserved, oval in outline and indicating the development of a posterior notch close to suture.

Type number : Holotype. UCLA cat. no. 35285. = LACMIP 12408

Dimensions of type : Holotype, height incomplete 51.0 mm., diameter 29.0 mm.

Locality : Shahrig, (UCLA loc. 4611) bed "A", section "C". One specimen.

Remarks : *Pyrazus indicus* Cox (1931, p. 45, pl. 1, figs. 12, 15) from the Lower Eocene of Hindugbagh (Quetta Division) resembles this species superficially, but differs in size, whorl profile, spiral angle and pattern of ornamentation. *Pyrazus indicus* Cox has a larger shell, the whorls have well-rounded sides and the spiral angle is about eighteen degrees. The axial ornamentation consists of strongly convex, (curved backward) rounded varices, about seven to nine in number, with flat or slightly concave interspaces, about twice the width of the varices. The spiral sculpture consists of four, rounded cords, with one or more secondary spirals ; on the last whorl the varices are shortened and form prominent rounded tubercles.

This species can be distinguished by its flat sided whorls and typical axial ornamentation consisting of oblique varices, crossed by the coarse spiral lines, crenulated at points of intersection.

Genus *Potamides* Brongniart, 1810

(Type species *Potamides lamarcki* Brongniart)

POTAMIDES DURRANUS Iqbal

(Pl. 10, figs. 9-10).

Description : Shell small, robust ; turreted ; spire high, acute, spiral angle about twenty degrees ; whorls about four increasing regularly in size as added, with strongly convex sides ; suture closely appressed ; sculpture consists of five, strong, thick, somewhat curved varices in each whorl, superimposed on numerous, thin, faintly visible spiral lines ; base short, separated from the side of the last whorl by a distinct, short ridge ; aperture poorly preserved, indicating feeble development of a short anterior canal.

holo ✓

Type number : Holotype, UCLA cat. no. 35288. = LACMIP 12409

Dimensions of type : Holotype, incomplete height 23·0 mm., diameter 12·0 mm.

Locality : Shahrig, (UCLA loc. 4611), bed "A" section "C". One specimen.

Remarks : *Potamides pascoi* Cox (1931, pp. 43-4, pl. 1, fig. 3) from the Lower Eocene of Hindubagh (Quetta Division) differs from this species in size, whorl profile, suture and ornamentation. *Potamides pascoi* Cox, has a larger shell, and linear suture ; and ornamentation consisting of two rows of tubercles, one row adjacent to each suture with the interspace occupied by two, fine beaded threads.

Potamides (*Cerithidea*) *sindiensis* Vredenburg, (1928, p. 371-72, pl. 15, fig. 19) from the Miocene of Sind (West Pakistan) also differs from this species in having much larger shell ; the sculpture is reticulate consists of nine, narrow spiral threads crossed by slightly curved, close-set axial varices.

Genus *Terebralia* Swainson, 1840

(Type species *Terebralia palustris* (Bruguiere)

TEREBRALIA PATHANI Iqbal
(Pl. 12, figs. 11-12)

holo ✓ = LACMIP 12410

Description : Shell large, thick ; turreted ; spire high, acute, spiral angle about thirty-one degrees ; whorls five, increasing regularly in size feebly convex on the sides ; suture closely appressed, occupies a shallow depression ; ornamentation is either weak or lacking in the spire, but the last whorl bears coarse, broad spiral lines about eleven in number and four regularly spaced tubercles adjacent to the anterior suture, sharply pointing towards the spire ; a prominent, thick varix is noticeable on the periphery ; base rounded, bears three spiral bands ; aperture partly preserved, almost oval, indicating a faint angulation posteriorly, outer lip broken, inner lip broadly excavate, partly covered with callus.

Type number : Holotype, UCLA cat. No. 35287.

Dimensions of type : Holotype, incomplete height 54.0 mm, dia. 24.0 mm.

Locality : Shahrig, (UCLA loc. 4611), bed "A", section "C". One specimen.

Remarks : *Terebralia dimorpha* Vredenburg, (1928, p. 368, p. 16, fig. 11) from the Miocene of the Talar Gorge (Quetta Division) resembles this species in the whorl profile, but differs in size and ornamentation. *T. dimorpha* Vredenburg is larger and is sculptured with prominent, thick spiral bands.

This species is distinguished by the coarse and broad spiral bands and prominent tubercles, adjacent to the anterior suture, sharply pointing towards the spire.

Genus *Bezanconia* Bayle, 1884

(Type species *Bezanconia spirata* (Lamarck)

holo ✓

BEZANCONIA HERONI Iqbal
(Pl. 11, figs. 5-6)

Description : Shell large, thick ; turreted ; spire high, spiral angle about thirty-five degrees ; whorls about five increasing regularly in size as added, with flat sides ; suture linear, well-incised, occupies a broad shallow depression; ornamented by very small closely spaced tubercles, adjacent to the anterior suture and arranged in such a manner that the posterior maring of the whorl appears undulated ; the last whorl ornamented with faint spiral lines and a varix on the periphery of the whorl somewhat distinct and oblique; base short, separated from the side of the last whorly by a ridge (partly preserved) ; aperture not preserved.

Type number : Holotype. UCLA cat. no. 35286. = LACMIP 12411

Dimensions of type : Holotype, incomplete height 37. 0, diameter 19.0 mm.

Locality : Shahrig, (UCLA loc. 4611), bed "A", section "C". One specimen.

Remarks : This is the first report of this genus from West Pakistan. The type species of this genus, *Bezanconia spirata* (Lamarck) figured by Wenz (1940, p. 760) from the Middle Eocene (Lutetian) of Parnez, France, is similar in general characters but differs from this species in size, whorl profile, spiral angle and ornamentation. *Bezanconia spirata* (Lamarck) is much larger, the whorls are broadly convex, the spiral angle is about twenty-five degrees, there is no spiral or axial ornamentation except faint growth lines and the whorl surface is more or less smooth.

Family Melanopsidae

Genus *Pirena* Lamarck, 1812

(Type species *Pirena madagascariensis* Lamarck : Recent ; sole original species. Synonym *Melantria* Bowdich, 1822, same type species : generic name and figure).

Subgenus *Pseudobellardia* Cox, 1931

(Type species *Muricites auriculatus* Shlotheim (=*Cerithium combustum* Brongniart), Middle Eocene of northern Italy).

hypo

PIRENA (PSEUDOBELLARDIA) DELPHINUS (Oppenheim)

(Pl. 11, figs. 7-10 ; pl. 12, figs. 1-2).

Cerithium (Bellardia) delphinus Oppenheim, 1901a, p. 269, figs. 13, 13a, & 14.

Melantria delphinus Mancini, 1928, p. 292, pl. 28, fig. 2 ; pl. 31, figs. 20-34.

Pirena (Pseudobellardia) delphinus (Oppenheim) Cox, (1931, p. 47, pl. 1, figs. 2a-b).

Type number : Specimen. UCLA cat. no. 35290. = LACMIP 12412-12419

Locality : Shahrig, (UCLA loc. 4611), bed "A", "I", and "J", section "C". Six/four specimens.

Remarks : These specimens are similar to that figured by Cox (1931, p. 47, pl. 1, figs. 2a-b) from the Ghazij fm. of Harnai (Quetta Division), but lack the spiral lines. The aperture is well preserved in one specimen and agrees well with the living form representing the genus *Pirena*. The adult ornamentation is very well preserved in two specimens. The writer agrees with Cox (1931, p. 46) that the superficial resemblance, to *Bellatara* is probably due to convergence. The aperture, however, is quite different and characteristic of the genus *Pirena*.

Further distribution in West Pakistan : Ghazij fm. (Lower Eocene) of Harnai (Quetta Division) Middle ? Eocene of Juruste (Kashmir). (Cox, 1931).

Distribution elsewhere : U. Eocene of Bosnia (type occurrence).

Family Naticidae

Genus *Amaurellina* Bayle in Chelot, 1885

(Type species *natica spirata* Lamarck)

hypos

AMAURELLINA NOETLINGI Cox

(Pl. 11, figs. 1-4)

Amaurellina noetlingi Cox, 1931, p. 41, pl. 1, figs. 10a-b. = LACMIP 12415-12417

Type number : Specimen. UCLA cat. no. 35266, and 35292.

Locality : Sinjdi (UCLA loc. 4609), bed "B", section "A" and Shahrig (UCLA loc. 4611), bed "A", section "C" Three specimens.

Remarks : These specimens are similar to those described by Cox (1931, p. 41, pl. 1, figs. 10a-b) from the Ghazij fm. (Lower Eocene) of Harnai (Quetta Division). They vary in dimensions and have lost much of their surface ornamentation. Aperture is well-preserved in one specimen.

Further distribution in West Pakistan : Ghazij fm. of Harnai : Quetta Division (type occurrence) (Cox 1931, p. 41).

Family Ampullospiridae

Genus *Ampullella* Cox, 1931

(**Type species** *Ampularia depressa* Lamarck ; Middle Eocene ; original designation. Synonym. *Ampullina auct* non Bowdich, 1822)

AMPULLELLA NUTTALLI Cox

(Pl. 12, figs. 5-10)

Ampullella nuttalli Cox, 1931, p. 41, pl. 1, figs. 14a-b.

LACMIP 12418 - 12421

Type number : Specimen. UCLA cat. no. 35293

Locality : Shahrig (UCLA loc. 4611), bed "J", section "C". Six specimens.

Remarks : These specimens are similar to those figured by Cox (1931, p. 41, pl. 1, figs. 14a-b) from the Lower Eocene of Hindubagh (Quetta Division). They are, however, of smaller dimensions. Aperture is partly preserved in some specimens.

Further distribution in West Pakistan : Lower Eocene of Hindubagh, Quetta Division (type occurrence) (Cox, 1931, p. 41).

Family Epitoniidae

Genus *Cirsotrema* Moerch, 1852

(**Type species** *Scalaria varicosa* Lamarck ; Recent : monotypy)

CIRSOTREMA JINNAHI Iqbal

(Pl. 10, figs. 15-16)

Description : Shell large, of medium thickness ; turriculate, conical, spire high, acute, spiral angle about twenty-one degrees ; whorls about seven, increasing rapidly in size as added with convex sides, suture linear, well-incised, occupies a narrow, deep depression bearing a thick, smooth band covering the entire sutural area ; sculpture consists of about six strong bulging varices regularly spaced, dividing the whorl surface into six equal divisions, crossed over by comparatively thin, less prominent spiral lines, about five in number which develop small crenulations at the point of intersection ; base somewhat flat, bears about three ribs, the first one adjacent to the posterior margin of the last whorl is comparatively thicker and the third one is thinner than the second one ; aperture not preserved.

Type number : Holotype. UCLA cat. no. 35291. = LACMIP 12422

Dimensions of type : Holytype, height incomplete 30.0 mm., diameter 13 0 mm.

Locality : Shahrig (UCLA loc. 4611), bed "J" section "C". One specimen.

Remarks : *Cirsotrema diversiformis* Eames, (1952, pp. 51-2, pl. 1, figs. 29a-b ; pl. 2, fig 6f) from Middle Eocene of Zinda Pir (West Pakistan), differs from this species in whorl profile, sutural characters and sculpture. The early whorls of *Cirsotrema diversiformis* Eames, are bicarinate, with two strong spiral lines, one close to the anterior suture and other to the posterior suture. An intercalary thread is added between he posterior primary line and the posterior suture on the fourth whorl and on the next whorl one more intercalary thread develops between the two primary lines. The spiral threads cross the axial riblets, developing crenulatings on the points of intersection. The suture of the same species is not covered by any spiral band ; varices develop irregularly from the sixth whorl ; the latter whorls are convex, the last whorl bears two varices and twelve spiral lines.

C. jinnahi Iqbal has a uniform whorl profile, each whorl having convex sides ; the suture occupies a smooth, prominent band ; the sutural slope is steeper ; the pattern of sculpture is uniform throughout and there is no such order of appearance of the spiral lines. These characteristics of the shell are of diagnostic value.

Family Volutidae

Genus *Volutocorbis* Dall, 1890

(Type species *Volutilithes* (*Volutocorbis*) *limopsis* Conrad : Eocene ; original designation) Synonym. *Volutilithopsis* (Petho, 1896) (M. Ker. Földtani Intezet, Expt. Millen. Hung. Inst., Geol. p. 32) *teste* Petho, 1906, (Paleontographica, v. 52, p. 117).

VOLUTOCORBIS HARNAIENSIS Cox

(Pl. 10 figs. 3-4)

Volutocorbis harnaiensis Cox, 1931, p. 56, pl. 2, fig. 5.

Type number : Specimen. UCLA cat. no. 35294. = LACMIP 12423

Locality : Shahrig (UCLA loc. 4611), bed "A", section "C". Two specimens.

Remarks : These specimens are similar to those figured by Cox (1931, p. 56, pl. 2, fig. 5) from the Ghazlj fm. (Lower Eocene) of Harnai (Quetta Division) except that they are smaller.

Further distribution in West Pakistan : Ghazij fm. (Lower Eocene) of Harnai ; Quetta division (type occurrence) (Cox 1931, p. 56).

Family Turridae

Genus *Turricula* Schumacher, 1817

(Type species *Turricula flammea* Schumacher ; Recent)

Subgenus *Pleurofusia* de Gregorio, 1890

(Type species *Pleurotroma longirostropsis* de Gregorio ; Eocene)

TURRICULA (PLEUROFUSIA) AKHTARI Iqbal

(Pl. 10, figs. 1-2)

Description : Shell very small, thin ; slender, fusiform ; spire high, spiral angle about seventeen degrees ; whorls about three, increasing regularly in size as added, with convex sides ; suture impressed, well-incised, occupies deep, narrow depression, and bears a smooth, narrow band covering the entire sutural area ; sculpture consists of about five smooth, axial threads with sharp pointed ends, broad in the middle part, slightly retrocurrent, with equal ratio of width as their intervals in each whorl, on the last whorl the axial threads cover the base as far as the end of the canal ; no spiral ornamentation ; no growth lines ; last whorl with the exception of the posterior portion, gently convex, receding anteriorly, becoming pointed towards base so as to appear somewhat spindle shaped in outline ; base short ; neck slightly curved, very short aperture, spindle shaped, with slightly oblique canal, lips very poorly preserved, the abapertural part is marked horizontally by very sort but distinct ridges, about four in number.

Type number : Holotype. UCLA cat. no. 35267. = LACMIP 12424

Dimensions of type : Holotype, height incomplete 9·0 mm., diameter 5·0 mm.

Locality : Sinjidi (UCLA loc. 4609), bed "B", section "A". One specimen.

Remarks : *Turricula* (*Pleurofusia*) *pseudoscala* Eames, (1952, pp. 132-3, pl. 6, figs. 139a-b) from the Middle Eocence of the Rakhi Nala (West Pakistan), superficially resembles this species but differs in certain characters which are mentioned below :—

The last whorl is oval-conic, well-shouldered posteriorly ; aperture is narrowly oval ; base is well-excavated and has moderate length ; the length of the canal is equal to the height of the aperture ; the suture is not covered by any spiral band ; ornamentation is strong, consists of spiral threads, axial ribs and the growth lines ; the whorls have concave (towards apex) bands posteriorly, occupying quarter of the whorl height, there are four spiral threads to the anterior of the concave, band, the body whorl bears about seventeen more threads anteriorly ; there are strong axial ribs which are nodular and straight, the interspace of the axial ribs becomes wider on the last whorl.

This species is characterized by not having any spiral ornamentation. Other forms such as *Turricula* (*Pleurofusia*) *kcala* (Vredenburg) from the Middle Eocene of Burma, and *Turricula* (*Pleurofusia*) *polycesta* (Bayen), from the Paleocene of Jherruck (Sind : West Pakistan) and from the Eocene of Paris, according to Eames (1952, p. 133), have axial and spiral ornamentation.

ALPHABETICAL INDEX TO THE SPECIES FIGURED ON PLATES 8—12

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PLATE 8

All figures are natural size except as otherwise stated.

FIGURE

1, 2, 3. *Euphyllia flabellata* (*Reuss*), figure 1, the corallum, side view, figure 2, the calyx, figure 3, the corallum, side view, section ' B ', Sinjdi.

4. *Trochoseris daviesi* (Gregory) the corallum, side view, section ' B ', Sinjdi.

5-6. *Meandrina variabilis* (Duncan), figure 5, the corallum, side view, figure 6, the calyx, section ' B ', Sinjdi.

7-8. *Placotrochus tipperi* (Gregory), figure 7, the calyx, figure 8, the corallum, side view, section ' B ', Sinjdi.

9-10. *Hydnophora insignis* (Duncan), figure 9, the corallum, side view, figure 10, some colonies magnified (X3), section ' B ', Sinjdi.

PLATE 8

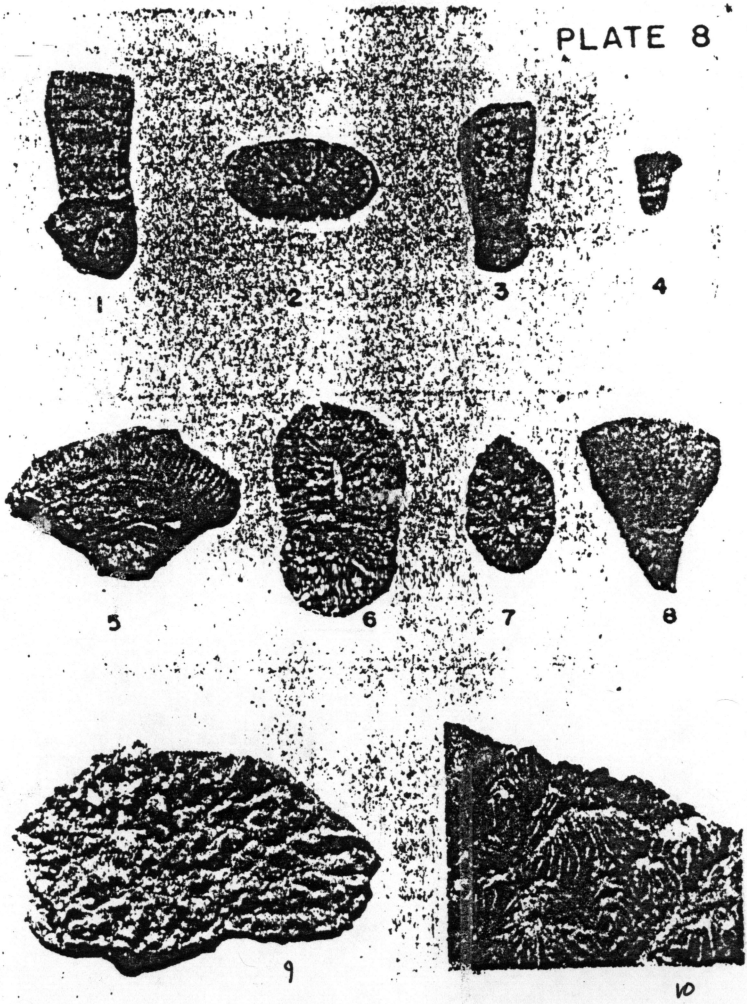


PLATE 9

All figures are natural size except as otherwise stated.

FIGURE

1. *Cardium suicum* Iqbal, exterior right valve, section 'C', Shahrig, holotype.
2. *Corbula* (*Bicorbula*) *subexarata* Archiac & Haime, exterior right valve, section 'C', Shahrig, specimen.
3. *Arca sinjdica* Iqbal, exterior left valve, section 'B', Sinjdi, holotype.
4-6. *Venericardia mutabilis* (Arch. & Haime), figure 4, exterior left valve, fig. 6, exterior left valve of another specimen, section 'C', Shahrig, specimen.
5-7. *Anomia hyderi* Iqbal, figure 5, paratype, figure 7, holotype, exterior left valves, section ' A ', Sinjdi.
8-9. *Meretrix baluchistanensis* Iqbal, figure 8, exterior left valve, figure 9, dorsal view, L/R valves, section ' C ', Shahrig, holotype.
10-11. *Ostrea Pseudopunica* Eames, figure 10, exterior left valve, figure 11, interior left valve of the same, specimen, section ' A ', Sinjdi, Specimen.
12. *Mytilus* sp. Iqbal, exterior left valve, section ' C ', Shahrig, holotype.
13. *Ostrea* sp. A, Iqbal, exteror left valve, section ' C ', Shahrig, specimen.
14. *Ostrea* (*Liostrea*) cf. *O.* (*Liostrea*) *rouaulti* Mallada, exterior left valve, section ' C 'Shahrig, specimen.
15. *Ostrea* sp. B, Iqbal, exterior left valve, section ' C ', Shahrig, specimen.

PLATE 9

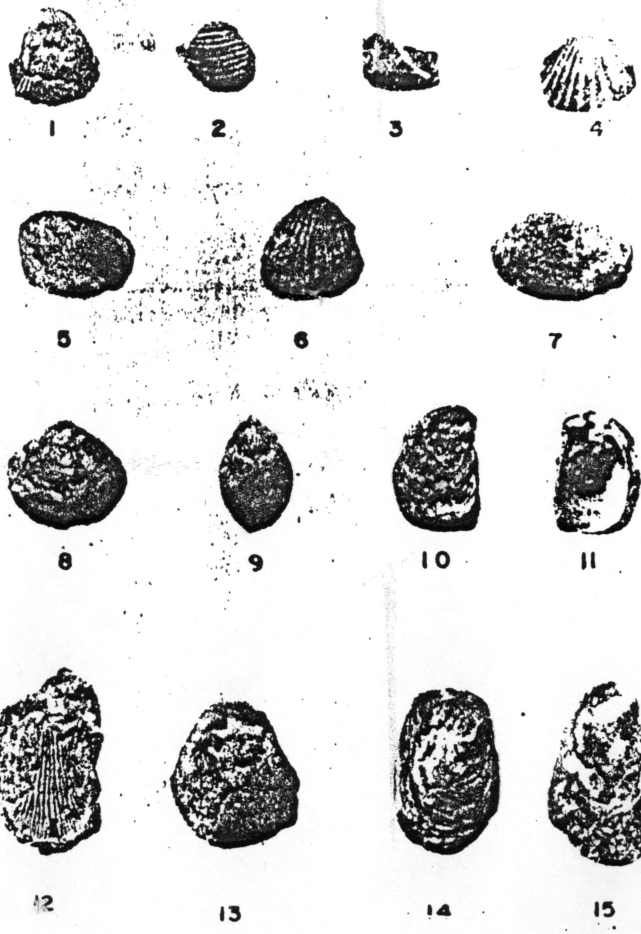


PLATE 10

All figures are natural size except as otherwise stated.

FIGURE

1-2. *Turricula* (*Pleurofusia*) *akhtari* Iqbal, X2, figure 1, apertural view, figure 2, abapertural view of the same specimen, section ' A ', Sinjdi, holotype.

3-4. *Volutocorbis harnaiensis* Cox, figure 3, apertural view, fig. 4, abapertural view of the same specimen, section ' C ', Shahrig, specimen.

5-6. *Vicarya liaqati* Iqbal, figure 5, apertural view, figure 6, abapertural view of the same, section ' C ', Shahrig, holotype.

7-8. *Cerithium sharighense* Iqbal, fig. 7, apertural view, fig 8, abapertural view of the same, section ' C ', Shahrig, holotype.

9-10. *Potamides durranus* Iqbal, figure 9, apertural view, fig. 10, abapertural view of the same specimen, section ' C ', Shahrig, holotype.

11-12. *Cerithium kalatense* Iqbal, figure 11, apertural view, fig. 12, abapertural view of the same, section ' C ', Shahrig, holotype.

13-14 & 17. *Ostrea pseudopunica* Eames, figure 13, exterior left valve, fig. 14, exterior right valve of the same specimen, fig. 17, exterior left valve of another specimen, section ' A ', Sinjdi.

15-16. *Cirsotrema jinnahi* Iqbal, fig. 15, apertural view, fig. 16, abapertural view of the same, section ' C ', Shahrig, holotype.

18. *Corbula* (*Bicorbula*) *lunica* Iqbal, exterior left valve, section ' C ', Shahrig, holotype.

19-20. *Corbicula tangica* Iqbal, fig. 19, exterior left valve, fig. 20, dorsal view L/R valves, section ' C ', Shahrig, holotype.

PLATE 10

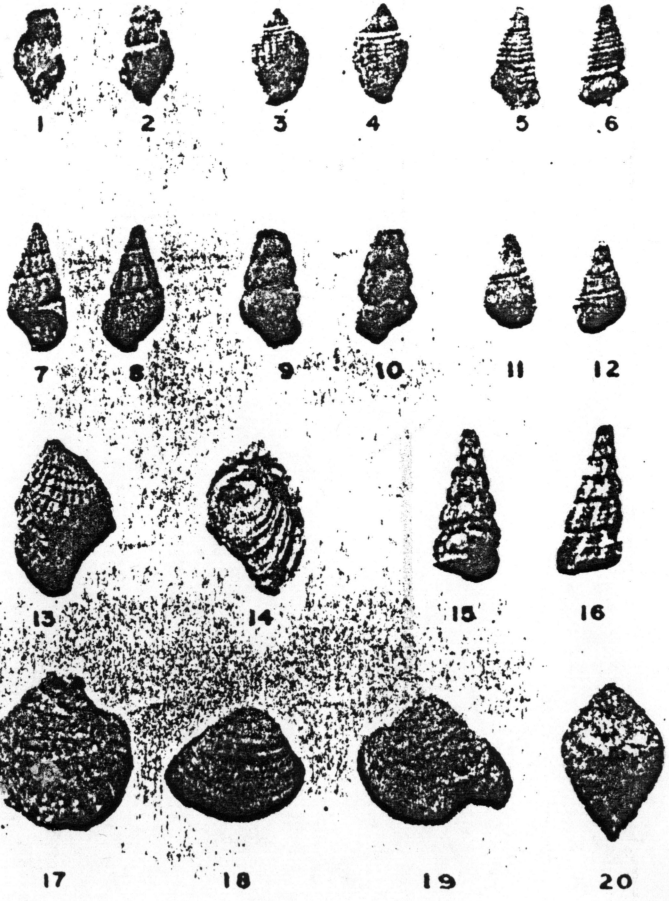


PLATE 11

All figures are natural size except as otherwise stated.

FIGURE

1-4. *Amaurellina noetlingi* Cox, fig. 1, abapertural view, section 'A'; Sinjdi, figs. 2 & 4, abapertural views of two different specimens, fig. 3, apertural view of another specimen, section 'C', Shahrig, specimens.

5-6. *Bezanconia heroni* Iqbal, fig. 5, apertural view, fig. 6, abapertural view of the same, section 'C', Shahrig, holotype.

7-10. *Pirena* (*Pseudobellardia*) *delphinus* (Oppenheim), fig. 7, apertural view, fig. 8, abapertural view of the same specimen, fig. 9, apertural view, fig. 10, abapertural view of another specimen, section 'C', Shahrig, specimens.

11-12. *Pyrazus khani* Iqbal, fig. 11, apertural view, fig. 12, abapertural view of the same, section 'C', Shahrig, holotype.

PLATE . II

PLATE 12

All figures are natural size except as otherwise stated.

FIGURE

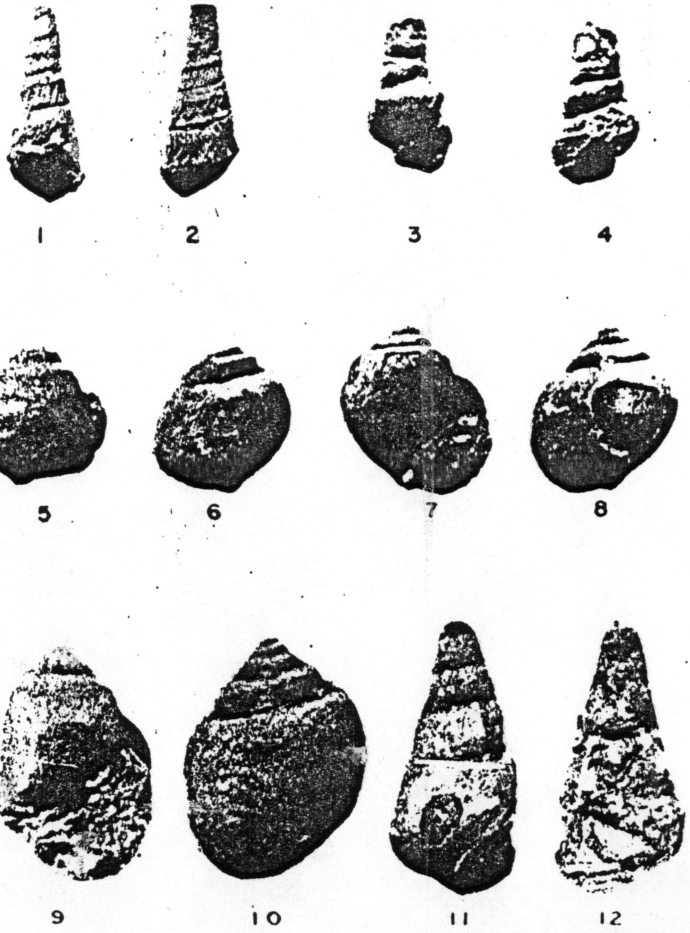
1-2. *Pirena* (*Pseudobellardia*) *delphinus* (Openheim), fig. 1, apertural view, fig. 2, abapertural view of the same specimen, section ' C ', Shahrig, specimens.

3-4. *Batillaria ? brohica* Iqbal, fig. 3, apertural view, fig. 4, abapertural view of the same specimen, section ' A ', Sinjdi, holotype.

5-10. *Ampullella nuttalli* Cox, fig. 5, apertural view, fig. 6, abapertural view of the same specimen; fig. 7, apertural view, fig. 8, abapertural view of another specimen; fig. 9, apertural view, fig. 10, abapertural view of another specimen; section ' C ', Shahrig, specimens.

11-12. *Terebralia pathani* Iqbal, fig. 11, apertural view, fig. 12, abapertural view of the same, section ' C ', Shahrig, holotype.

PLATE 12



4606 S3-62 SANTA BARBARA CO., CALIF. PLIOCENE
Same general locality as 4605 (S2062), but stratigraphically 10' higher in the section.

March 4, 1962 Susuki Family: Collectors

4607 S4-62 SANTA BARBARA CO., CALIF. PLIOCENE
Same general locality as 4605 (S2-62), highest bed exposed in the section.

March 4, 1962 Susuki Family: Collectors

4608 S5-62 SANTA BARBARA CO., CALIF. PLIOCENE
Fossiliferous beds with abundant Pectens exposed on a hill due north of locality 4605 (S2-62), 1600' S 43° W from intersection of San Marcos Pass Rd. and Cathedral Oaks-Foothill Blvd., Goleta quad. (USGS, 1950 ed.), Santa Barbara County, California.

March 4, 1962 Susuki Family: Collectors

4609 QUETTA, WEST PAKISTAN LOWER EOCENE
Greenish shale containing Lower Eocene molluscs collected from Sinjdi No. 1, 17 miles SE of Quetta, West Pakistan. Ypresian Ghazij shale

June-July 1961 Iqbal Mir Ahmed: Collector

4610 QUETTA. WEST PAKISTAN LOWER EOCENE
Greenish shale containing Lower Eocene molluscs collected from Sinjdi No. 2, 15 miles SE of Quetta, West Pakistan. Ypresian Ghazij shale

June-July 1961 Iqbal Mir Ahmed: Collector

4611 QUETTA, WEST PAKISTAN LOWER EOCENE
Lower Eocene molluscs collected from grayish siltstone and bluish marl beds, from Sui Tangi Sharigh, 42 miles ESE of Quetta, West Pakistan. Ypresian Ghazij shale

June-July 1961 Iqbal Mir Ahmed: Collector

4612 LOS ANGELES CO., CALIF. PLEISTOCENE
From fossiliferous sand in bluff opposite the "Sun Lumber Company" on Wilmington and San Pedro road, San Pedro, Calif.

Sep. 22, 1963 Paleo. 110 Class: Collectors

4613 SONORA, MEXICO RECENT
Sandy beach exposed at the high tide mark, north and east of Puerto Penasco; at bottom of bluff, below Playa Hermosa Motel and for several hundred yards north from there. Shells picked up on beach.

March 23, 1963 Paleo. 137 Class: Coll.

4614 L19-63 SONORA, MEXICO RECENT
Tidepools and rocks exposed at low tide north