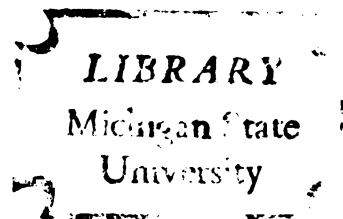


UPPER CRETACEOUS AND TERTIARY  
OSTRACOD FAUNAS FROM KOHAT  
DISTRICT OF WEST PAKISTAN

Thesis for the Degree of Ph. D.  
MICHIGAN STATE UNIVERSITY  
GHOLAM SORRWAR  
1970



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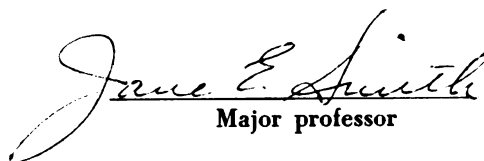
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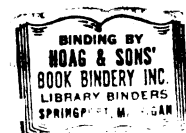
Gholam Sorrwar

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## ABSTRACT

### UPPER CRETACEOUS AND TERTIARY OSTRACOD FAUNAS FROM KOHAT DISTRICT OF WEST PAKISTAN

By

Gholam Sorrwar

The Upper Cretaceous and Tertiary Ostracod faunas from Kohat District of West Pakistan were studied. In this work 106 species and subspecies have been identified, discussed, and illustrated. Among them nine species and subspecies are new. Of the 106 species and subspecies 73 are Upper Cretaceous and 33 are Tertiary in age. The Upper Cretaceous species have been found to range from Cenomanian to Maestrichtian and the Tertiary forms range from Paleocene to Miocene in age. The vertical range of some Upper Cretaceous species has been extended. The Tertiary beds of the area previously thought to be only Paleocene are shown to be Paleocene to Miocene.





UPPER CRETACEOUS AND TERTIARY OSTRACOD  
FAUNAS FROM KOHAT DISTRICT OF WEST PAKISTAN

By

Gholam Sorrwar

A THESIS

Submitted to  
Michigan State University  
in partial fulfillment of the requirements  
for the degree of

DOCTOR OF PHILOSOPHY

Department of Geology

1970



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#### ACKNOWLEDGEMENTS

I am deeply indebted to my guidance committee member Dr. Robert Ehrlich of the Geology Department for his patient guidance, valuable suggestions, unfailing understanding, and for his constructive criticisms and advice in the writing of this thesis. I am especially grateful to Dr. Chilton E. Prouty for his wise and patient counsel throughout all phases of the study. His ever present guidance and support have been a constant inspiration throughout my graduate program in Geology. I wish to express my most grateful appreciation to Dr. Aureal T. Cross for suggesting the present project, for acquiring the materials from Pakistan, and for his invaluable suggestions in preparing this thesis. I owe my greatest debt to Dr. Jane E. Smith who has been instrumental in guiding the present study from its beginning to the end. I wish to acknowledge the intellectual stimulation and professional guidance that Dr. Smith has offered with great warmth throughout the period of my

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studies in the Department of Geology, Michigan State University. It is impossible for me to express my gratitude sufficiently to Dr. Frederick M. Swain of the University of Minnesota who most kindly checked all the specimens of this work, gave me invaluable suggestions concerning the identification of genera and species, and loaned me his own reference collections and type specimens and those of several other workers for comparison with my specimens. Dr. Swain most graciously loaned me the rare literature of his personal library and gave me suggestions regarding the technique of writing this thesis. Special thanks are hereby acknowledged to the Pakistan Geological Survey and to Mr. Ali Nasar Fatmi of the Geological Survey of Pakistan for donating the materials and for supplying the necessary available maps and information. Finally, I wish to thank my wife Jane and two children Adina and Naomi for the sacrifice they made in order to pursue this research and I wish to thank my parents-in-law Mr. and Mrs. John G. Fitch for their constant encouragement and help in numerous ways and for taking care of my family whenever I neglected them in the course of this study.

ACKNOWLEDGEMENTS

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### Table

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## INTRODUCTION

The present work, to study the Upper Cretaceous and Tertiary Ostracod faunas from Kohat District of West Pakistan, was suggested by Dr. Aureal T. Cross of Michigan State University. No previous studies have been made of ostracod faunas of any age of this area.

The samples donated by the Geological Survey of Pakistan for the present study were collected from outcrops and represent rocks belonging to Upper Jurassic, Lower and Upper Cretaceous and Tertiary ages. Many of the samples did not reveal any microfossils and some contained extensively weathered and distorted or broken specimens. As a result, the study was directed principally to the taxonomic classification of the ostracod faunas and to the determination of ages of the rocks from which they were collected. No attempt was made to establish the boundaries between the strata of different ages.

The majority of the specimens studied are Upper Cretaceous in age. The Tertiary forms are well-represented

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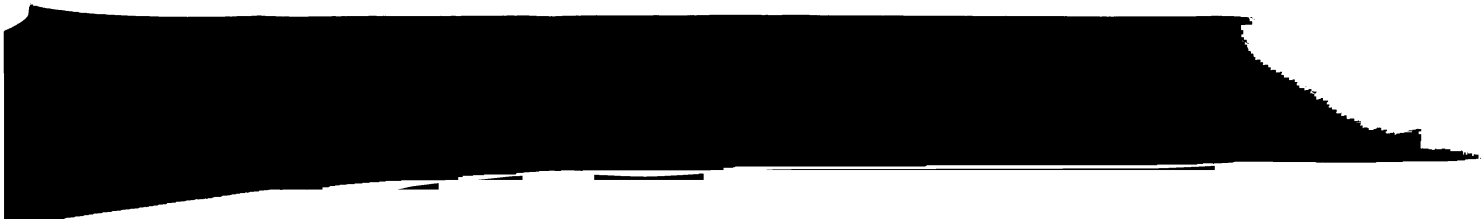
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but less so than the Upper Cretaceous ones. No ostracods were found in the samples from rocks considered by some to be of possible Lower Cretaceous and Jurassic ages.

It was not possible for the writer to visit the area of collection, and therefore, he had to get information and data by correspondence, which took considerable time. Because limited field work in the area has been completed the information in many cases was insufficient and doubtful.

Among the many difficulties faced by the writer in writing this dissertation one was the lack of literature on the area. Personal communications were helpful, but not adequate. The only published literature on the geology of the eastern half of the study area (the Samana Range) is by L. M. Davis (1930). There is no literature on the geological studies of the western half of the area. Therefore, the descriptions of the geologic formations of the western half are presented here from personal communications and by studying the samples.

Another difficulty encountered was that the writer came across some mislabeled and wrongly numbered samples. The numbering system was very inconsistent and



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unsystematic. Therefore, duplication of the same number on samples collected from different levels and different localities was the common error. Some of these errors connected with the samples that did not reveal any ostracod fossils did not affect the present work. But the cases where the samples contained good specimens did affect the work because those samples could not be used.

Other errors encountered were that the numbers on slides and/or samples were not recorded on the map. Or the lithology of the samples did not agree with that of the rock formation from which the samples were supposedly collected.

In this work 106 ostracod species and subspecies have been identified. Nine of them are new. The already known ones are discussed, the new ones are described, and all are illustrated. Two species among these 106 have a doubtful stratigraphic position at one locality; but the other specimens of these two species from different localities have unquestioned stratigraphic position. It is indicated with an asterisk in the table and discussed in the "Remarks" of the descriptions of these two species.



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The samples for the present work were collected, numbered, and labeled by the personnel of Pakistan Geological Survey under the guidance of a geologist. The first shipment of the samples received by the writer were all slides. The samples were washed, specimens were picked, and the slides were prepared by the same persons. The later shipments were all unpicked samples in small containers. The writer studied and recorded the lithologies of these samples before washing them. More specimens were picked and new slides were prepared with these specimens. Because of the presence of mislabeled and wrongly numbered samples and slides the writer carefully avoided using any doubtful sample or specimens and used as many specimens as possible from his own preparation which ultimately amounted to 55 species and subspecies (a little over 50 per cent) of the total 106.



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GEOGRAPHIC LOCATION OF THE COLLECTION AREA  
AND THE SPECIMEN LOCALITIES

The collection area of the present study is located in the district of Kohat, Northwest Frontier Province, West Pakistan. It extends from Thal on the west to the Samana Range on the east, which is about halfway between Kohat and Thal cities and is bounded by longitudes  $70^{\circ}30'$  E. and  $71^{\circ}0'$  E., and the latitudes  $33^{\circ}20'$  N. and  $33^{\circ}35'$  N. and covers an area of about 150 square miles. It is a patch 30 miles long and 5 miles wide (Fig. 1).

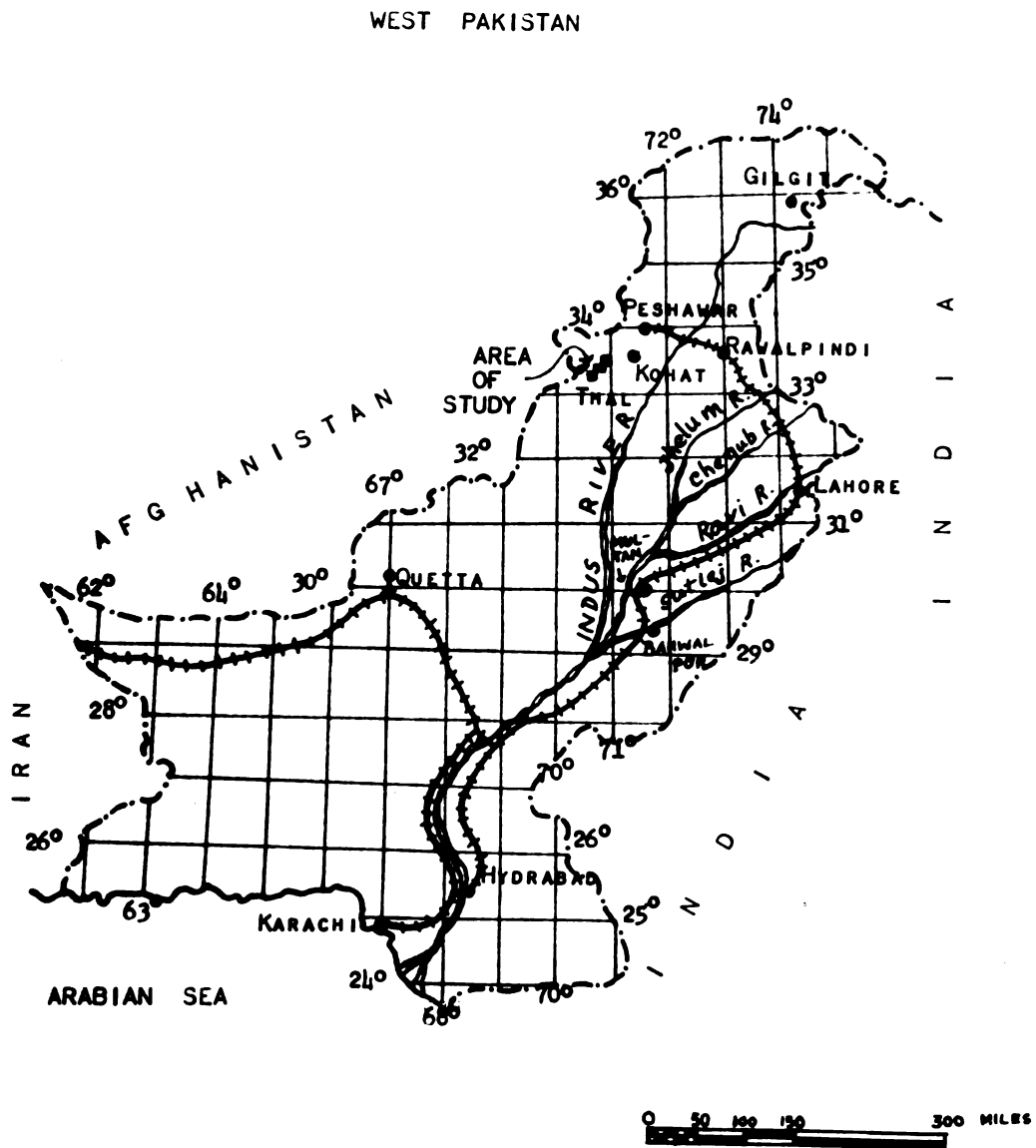
The whole area can be divided into four isolated outcrop areas from which the materials of the present study were collected.

(1) Samana Range outcrop area--The Samana Range lies halfway between Thal and Kohat. It is situated a few miles to the north of the central portion of the Kohat-Thal road and its axis runs roughly parallel to that road. It extends from longitude  $70^{\circ}48'$  E. to  $71^{\circ}0'$  E., and latitude  $33^{\circ}30'$  N. to  $33^{\circ}37'$  N. The actual collection

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Figure 1



Map of West Pakistan showing the location  
of the study area.

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area of the present study lies between longitudes  $70^{\circ}53'$  E. and  $70^{\circ}57'30''$  E., and latitudes  $33^{\circ}31'30''$  N. and  $33^{\circ}33'30''$  N. Localities  $A_1$ ,  $A_2$ ,  $A_3$ ,  $A_4$ , and  $B_1$ ,  $B_2$ ,  $B_3$ ,  $B_4$  are located in this outcrop area (Fig. 2).

(2) Shinawari outcrop area--This area lies about one and a half mile northeast of Shinawari and about one mile southwest of Bandachi on the Shinawari road at the longitude  $70^{\circ}49'$  E. and latitude  $33^{\circ}32'$  N. Locality C is located in this outcrop area (Fig. 3).

(3) Darsamand outcrop area--This area is located about one mile west and northwest of Darsamand between the longitudes  $70^{\circ}37'30''$  E. and  $70^{\circ}39'$  E., and the latitudes  $33^{\circ}26'30''$  N and  $33^{\circ}27'30''$  N. Localities  $D_1$ ,  $D_2$ ,  $D_3$ ,  $D_4$ , and L are located in this area (Fig. 4).

(4) Thal-Khadimakh outcrop area--This area is located to the north, northwest, northeast, and east of Thal and on the west, south, and east flanks of the Khadimakh hills, between the longitudes  $70^{\circ}30'$  E. and  $70^{\circ}35'$  E., and the latitudes  $33^{\circ}21'30''$  N. and  $33^{\circ}24'30''$  N. Localities E, F,  $G_1$ ,  $G_2$ ,  $G_3$ ,  $H_1$ ,  $H_2$ , I, J,  $K_1$ ,  $K_2$ , M, N, O, P, and Q are located in this outcrop area (Fig. 4).







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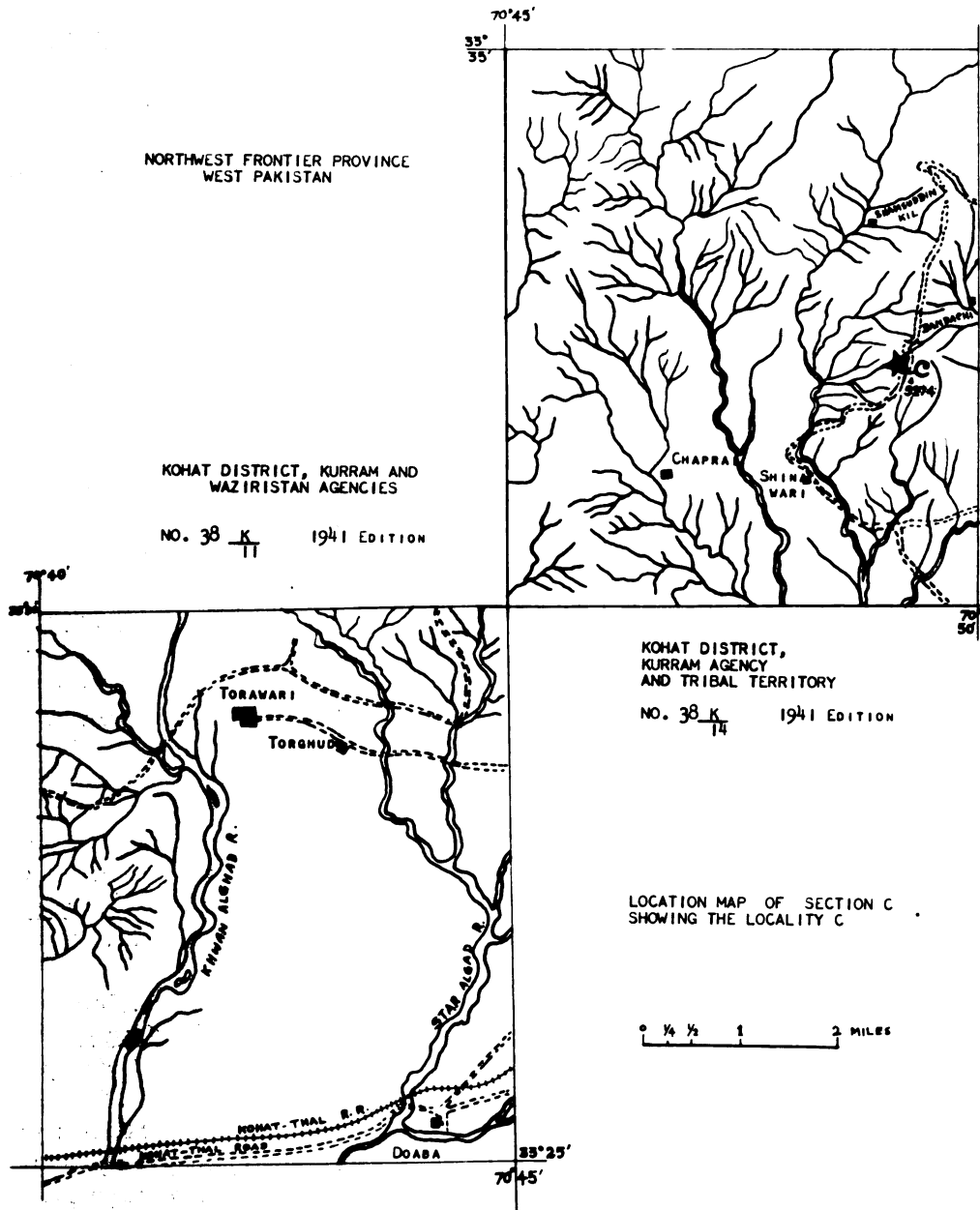
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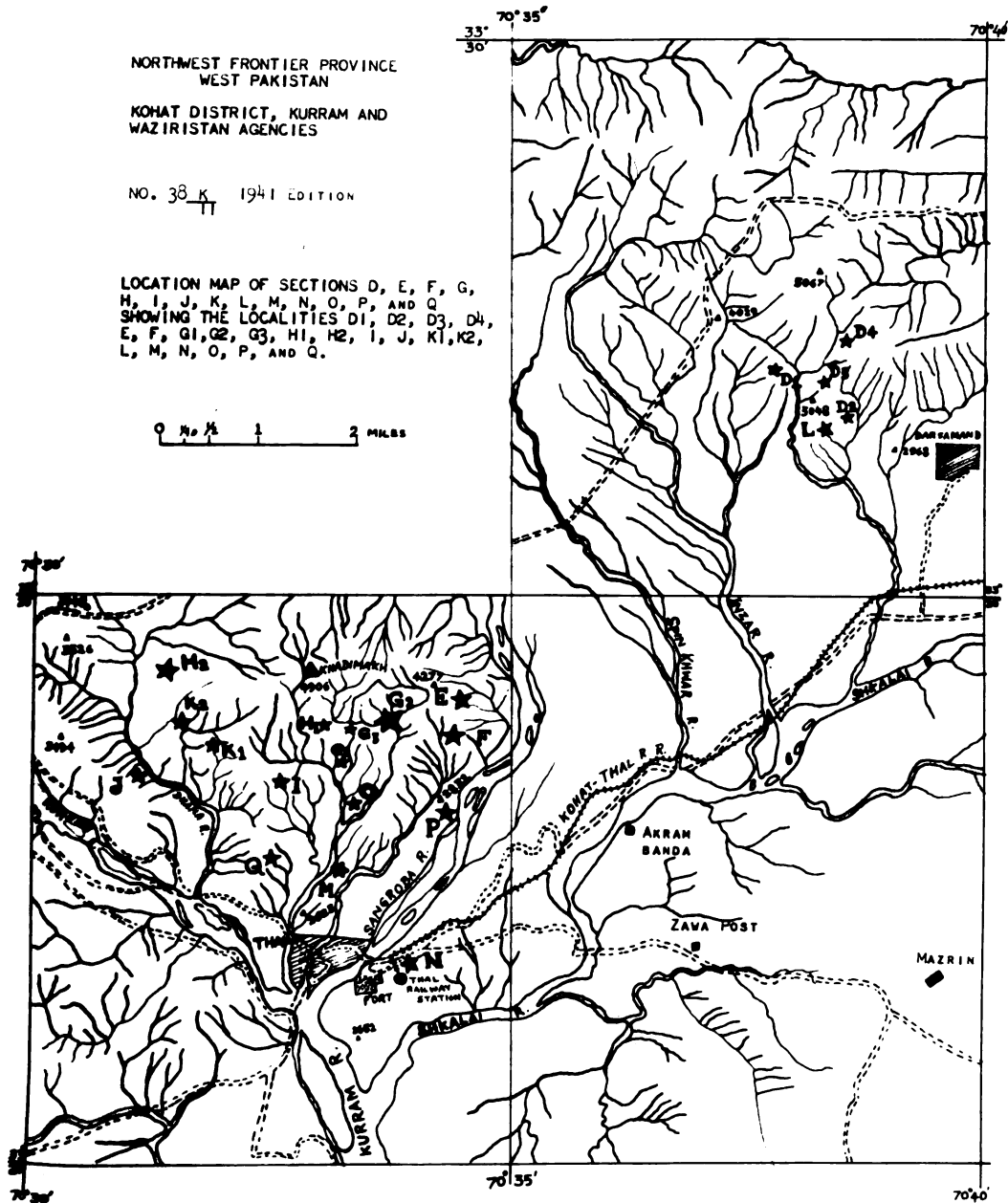
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Figure 3



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Figure 4



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Descriptions of Localities

Locality A<sub>1</sub>--(Samana Range outcrop area, Lat. 33°33'20" N., Long. 70°55' E.) It is situated about 175 yards northwest of Fort Lockhart (Fig. 2). At this locality the Tertiary beds of Tarkhobi shale, Lockhart limestone, and Hangu sandstone are exposed. The exposure is well over half a mile long, extending northeast-southwest.

Locality A<sub>2</sub>--(Samana Range outcrop area, Lat. 33°33' N., Long. 70°53'48" E.) This locality is situated about 1.3 miles west-southwest of Fort Lockhart (Fig. 2). The Tsukail-Tsuk limestone, upper member of the Upper Cretaceous Darsamand limestone is exposed here. The outcrop is more than 250 yards long.

Locality A<sub>3</sub>--(Samana Range outcrop area, Lat. 33°32'50" N., Long. 70°53'45" E.) This locality is 0.25 miles southwest of the locality A<sub>2</sub> and 0.5 miles northeast of Chalor Silli (Fig. 2) and has the outcrop of Chalor Silli limestone, the lower member of the Upper Cretaceous Darsamand limestone. The outcrop is about 180 yards long.

Locality A<sub>4</sub>--(Samana Range outcrop area, Lat. 33°33' N., Long. 70°53' E.) It is exactly 0.5 miles east



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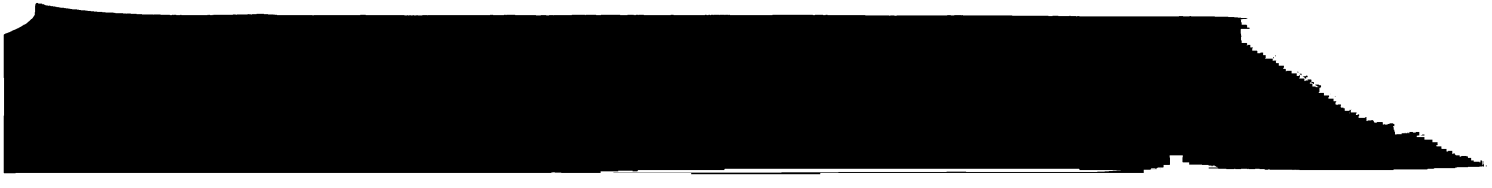
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of Ayazkhel and 0.2 miles northeast of Khoano Tabbi (Fig. 2). The Lower Cretaceous Khadimakh formation and Nawakilli sandstone and the Upper Jurassic Samana Suk limestone are exposed at this locality. The exposure is about 0.25 miles long.

Locality B<sub>1</sub>--(Samana Range outcrop area, Lat. 33°31'30" N., Long. 70°56' E.) It lies within 0.1 to 0.2 miles west of the road to Fort Lockhart and 0.8 miles northwest of Banda Patdarband (Fig. 2). The same three Tertiary formations exposed at locality A<sub>1</sub> are also exposed here. The outcrop extends for about 350 yards.

Locality B<sub>2</sub>--(Samana Range outcrop area, Lat. 33°31'35" N., Long. 70°56'20" E.) This locality is on the east side of the road to Fort Lockhart, across from Locality B<sub>1</sub> and is within a few yards of the road (Fig. 2). Both the upper and lower members of the Upper Cretaceous Darsamand limestone are exposed at this locality. The exposure is more than 175 yards long.

Locality B<sub>3</sub>--(Samana Range outcrop area, Lat. 33°32' N., Long. 70°56'35" E.) It is 0.6 miles north of the locality B<sub>2</sub>, on the road side and 0.4 miles south of Dhar (Fig. 2). The Lower Cretaceous Khadimakh formation





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is well-exposed at this locality. The outcrop is about 350 yards long.

Locality B<sub>4</sub>--(Samana Range outcrop area, Lat. 33°32' N., Long. 70°56' E.) This locality is exactly 0.5 miles west of the locality B<sub>3</sub> and 0.5 miles south of Nawakilli. From Dhar, this locality is less than a mile to the southwest (Fig. 2). The Upper Jurassic Samana Suk limestone crops out at this locality along a small river for about half a mile.

Locality C--(Shinawari outcrop area, Lat. 33°32' N. Long. 70°48'48" E. to 70°49'36" E.) It is located 1.5 miles northeast of Shinawari on the main road side (Fig. 3). The outcrop is about a mile long, extending almost east-west across the road and several small streams cut across the exposure. Samana Suk limestone of Jurassic age is exposed here. The younger rocks are missing from this locality.

Locality D<sub>1</sub>--(Darsamand outcrop area, Lat. 33°26'50" N., Long. 70°37'40" E.) This locality is situated two miles northwest of Darsamand at the source of a tributary of the Inzar River (Fig. 4). The Tertiary formations of Tarkhobi shale, Lockhart limestone and



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Hangu sandstone are exposed at this locality. The exposure extends for about 260 yards.

Locality  $D_2$ --(Darsamand outcrop area, Lat.  $33^{\circ}26'30''$  N., Long.  $70^{\circ}38'30''$  E.) It is 1.2 miles northwest of Darsamand on a narrow road side (Fig. 4). Both the members of the Upper Cretaceous Darsamand limestone are exposed here and the outcrop is over 300 yards long.

Locality  $D_3$ --(Darsamand outcrop area, Lat.  $33^{\circ}26'55''$  N., Long.  $70^{\circ}38'30''$  E.) This locality is 0.4 miles north of the locality  $D_2$  and 0.6 miles east of the locality  $D_1$ . From Darsamand, this locality is 1.5 miles to the northwest (Fig. 4). The Lower Cretaceous Khadimakh formation and Nawakilli sandstone are exposed here and the outcrop extends for about 300 yards.

Locality  $D_4$ --(Darsamand outcrop area, Lat.  $33^{\circ}27'$  N., Long.  $70^{\circ}38'25''$  E.) This is situated about 200 yards north of the locality  $D_3$  and 1.7 miles northwest of Darsamand (Fig. 4). The Jurassic rocks of Samana Suk limestone and Shinawari limestone crop out at this locality along a small river. Samples were collected along a NNE-SSW line about 500 yards long.

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Locality E--(Thal-Khadimakh outcrop area, Lat. 33°24' N., Long. 70°34'35" E.). It is located about 3 miles north-northeast of Thal and about a quarter mile west of the Sangroba River (Fig. 4). The outcrop that extends east-west for more than half a mile includes the Tertiary Lockhart limestone and Hangu sandstone, the Upper Cretaceous Darsamand limestone and the top of the Lower Cretaceous Khadimakh formation.

Locality F--(Thal-Khadimakh outcrop area, Lat. 33°23'48" N., Long. 70°34'35" E.). This locality lies 0.3 miles south of locality E and about half a mile west of the Sangroba River (Fig. 4). At this locality only the Tertiary rocks are exposed. A limestone cap is present above the Tarkhobi shale at this locality. The Lockhart limestone and the top of Hangu sandstone are also exposed here. Samples were collected along a north-south line about 350 yards long on this exposure.

Locality G<sub>1</sub>--(Thal-Khadimakh outcrop area, Lat. 33°23'25" N., Long. 70°33'10" E.). It is located two miles north of Thal (Fig. 4). The Tertiary Hangu sandstone and the Upper Cretaceous Darsamand limestone are exposed at this locality. Samples were collected from this locality on a north-south line about 300 yards long.

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Locality  $G_2$ --(Thal-Khadimakh outcrop area, Lat.  $33^{\circ}24'$  N., Long.  $70^{\circ}33'42''$  E.). This locality is situated half a mile northeast of the locality  $G_1$  (Fig. 4) and it has the outcrops of the Lower Cretaceous Khadimakh formation and Nawakilli sandstone. Samples were collected on a 0.3 mile-long NW-SE line.

Locality  $G_3$ --(Thal-Khadimakh outcrop area, Lat.  $33^{\circ}23'30''$  N., Long.  $70^{\circ}33'42''$  E.). This is located just 0.25 miles directly north of the locality  $G_1$  (Fig. 4). Only the top of the Jurassic Samana Suk limestone is exposed here.

Locality  $H_1$ --(Thal-Khadimakh outcrop area, Lat.  $33^{\circ}23'45''$  N., Long.  $70^{\circ}33'$  E.). It lies about 175 yards west of the locality  $G_3$  and about 0.4 miles to the northwest of the locality  $G_1$  (Fig. 4). The Cretaceous formations of Darsamand limestone and Khadimakh formation are exposed at this locality.

Locality  $H_2$ --(Thal-Khadimakh outcrop area, Lat.  $33^{\circ}24'20''$  N., Long.  $70^{\circ}31'24''$  E.). This locality is situated 0.3 miles to the east of the Dhana River (Fig. 4). Here the Tertiary formations of Lockhart limestone and Hangu sandstone are well-exposed.



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Locality I--(Thal-Khadimakh outcrop area, Lat. 33°23'15" N., Long. 70°32'36" E.). It is located 1.8 miles north-northwest of Thal (Fig. 4). The Upper Cretaceous Chuido sandstone and Kurram formation and the Lower Cretaceous Dhana shale are exposed here.

Locality J--(Thal-Khadimakh outcrop area, Lat. 33°23'20" N., Long. 70°31' E.). This locality is just west of the Dhana River (Fig. 4) and displays the outcrops of the same rock formations as the locality I.

Locality K<sub>1</sub>--(Thal-Khadimakh outcrop area, Lat. 33°23'35" N., Long. 70°31'48" E.). The locality lies halfway between, and little north of, the localities I and J, and 0.8 miles from each locality (Fig. 4). It has the outcrops of the Upper Cretaceous Chuido sandstone and Kurram formation.

Locality K<sub>2</sub>--(Thal-Khadimakh outcrop area, Lat. 33°23'55" N., Long. 70°31'30" E.). This locality is situated 0.3 miles northwest of the locality K<sub>1</sub> and 0.5 miles east of the Dhana River (Fig. 4). The Lower Cretaceous Dhana shale is exposed at this locality.

Locality L--(Darsamand outcrop area, Lat. 33°26'30" N., Long. 70°38'15" E.). It is one of the



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Darsamand outcrop area localities and lies 1.3 miles west of Darsamand. The locality is only 175 yards west of the locality  $D_2$  and 0.5 miles south of the locality  $D_3$  (Fig. 4). Upper Cretaceous rocks (unnamed) and the Tertiary Mulla Bata limestone are exposed here.

Locality M--(Thal-Khadimakh outcrop area, Lat.  $33^{\circ}22'30''$  N., Long.  $70^{\circ}33'$  E.). The locality is situated about 0.7 miles north of Thal and also 0.7 miles east of the locality Q (Fig. 4). Only the Tertiary Mulla Bata limestone crops out here.

Locality N--(Thal-Khadimakh outcrop area, Lat.  $33^{\circ}21'43''$  N., Long.  $70^{\circ}34'$  E.). It is located on Thal roadside on the east side of the Sangroba River and about 150 yards east of Thal railway station (Fig. 4). The Tertiary Shakalai shale is exposed at this locality.

Locality O--(Thal-Khadimakh outcrop area, Lat.  $33^{\circ}23'$  N., Long.  $70^{\circ}33'15''$  E.). The locality lies about 1.5 miles north-northeast of Thal and halfway between the localities I and P (Fig. 4). The Sangroba sandstone of Tertiary age is the only rock formation exposed here.

Locality P--(Thal-Khadimakh outcrop area, Lat.  $33^{\circ}23'$  N., Long.  $70^{\circ}34'25''$  E.). This locality is situated

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two miles northeast of Thal on the west bank of the Sangroba River (Fig. 4). The Upper Cretaceous Tandora formation is exposed at this locality.

Locality Q--(Thal-Khadimahk outcrop area, Lat.  $33^{\circ}22'42''$  N., Long.  $70^{\circ}32'20''$  E.). It is located one mile north-northwest of Thal and 0.7 miles west of the locality M (Fig. 4). Outcrops of the Upper Cretaceous Tandora formation and a possible Danian bed are present at this locality.

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## STRATIGRAPHY OF THE STUDY AREA

The stratigraphy of the area consists of great alternating masses of sandstones, limestones, and shales. Fossils, however (as is usually the case with the Mesozoic rocks of these regions), are relatively scarce, and often too indefinite to be specifically, or even generically, identifiable where they do exist. Lithologically, also, the successive masses of limestone or sandstone are apt to be surprisingly alike, even when very different in age so that a degree of caution is necessary in correlating similar rock masses which are not directly connected with each other laterally. Certain features do exist, however, which afford very reliable "datum lines" for the geological mapping of the area and some of these features can be distinguished at considerable distances.

### The Geological Sequence

Samana Suk limestone (Jurassic)--The oldest strata from which the samples were collected for the present



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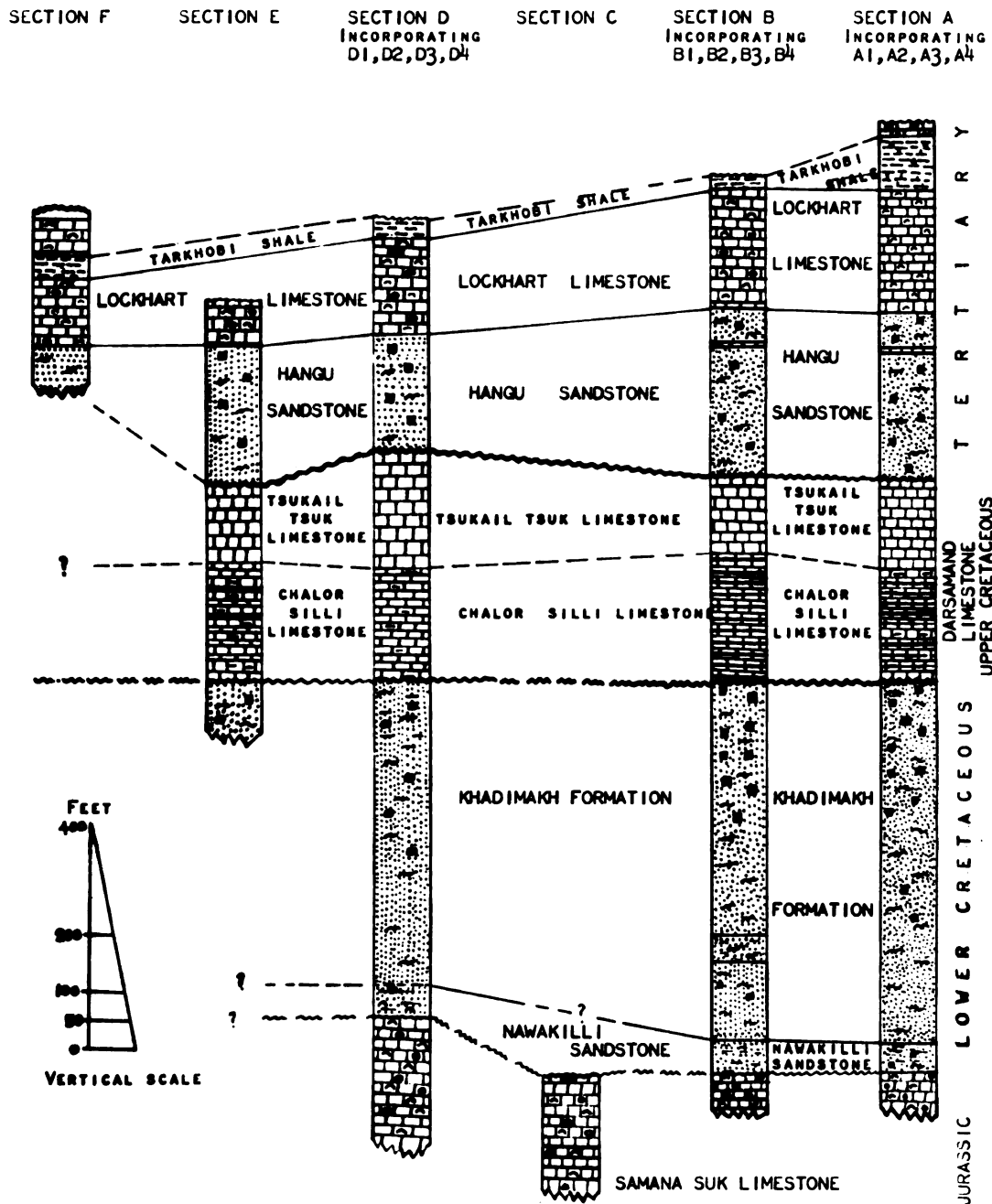
study are those of the Upper Jurassic Samana Suk limestone (Fig. 5). Samana Suk limestone is a great mass of dark gray (almost black) limestone, from 500 to 600 feet thick. This limestone can nearly always be distinguished from those of higher levels both by its darker color and by its generally coarse, almost granular, texture. In the central parts of the Samana Range this limestone is generally seen forming escarpments in the lower parts of the valleys cut by denudation into the southern flanks of the range.

Nawakilli sandstone (Lower Cretaceous)--Above the Samana Suk limestone is the Nawakilli sandstone, the lowest member of the Lower Cretaceous rocks. Nawakilli is a glauconitic sandstone and up to 50 feet thick (Fig. 5). It often weathers to a browner tint than the underlying Samana Suk limestone.

Khadimakh formation (Lower Cretaceous)--This formation overlying Nawakilli sandstone is a white quartzitic sandstone ranging up to more than 700 feet in thickness (Fig. 5). These sandstones are coarse-grained and become marked, when weathered, with hematite and limonite bands. Fragments, when broken off the parent rock, show numerous

Figure 5

COLUMNAR SECTIONS A, B, C, D, E, AND F



(Modified from Geological Survey of Pakistan)

Figure 5

COLUMNAR SECTIONS A, B, C, D, E, AND F

## SECTION F

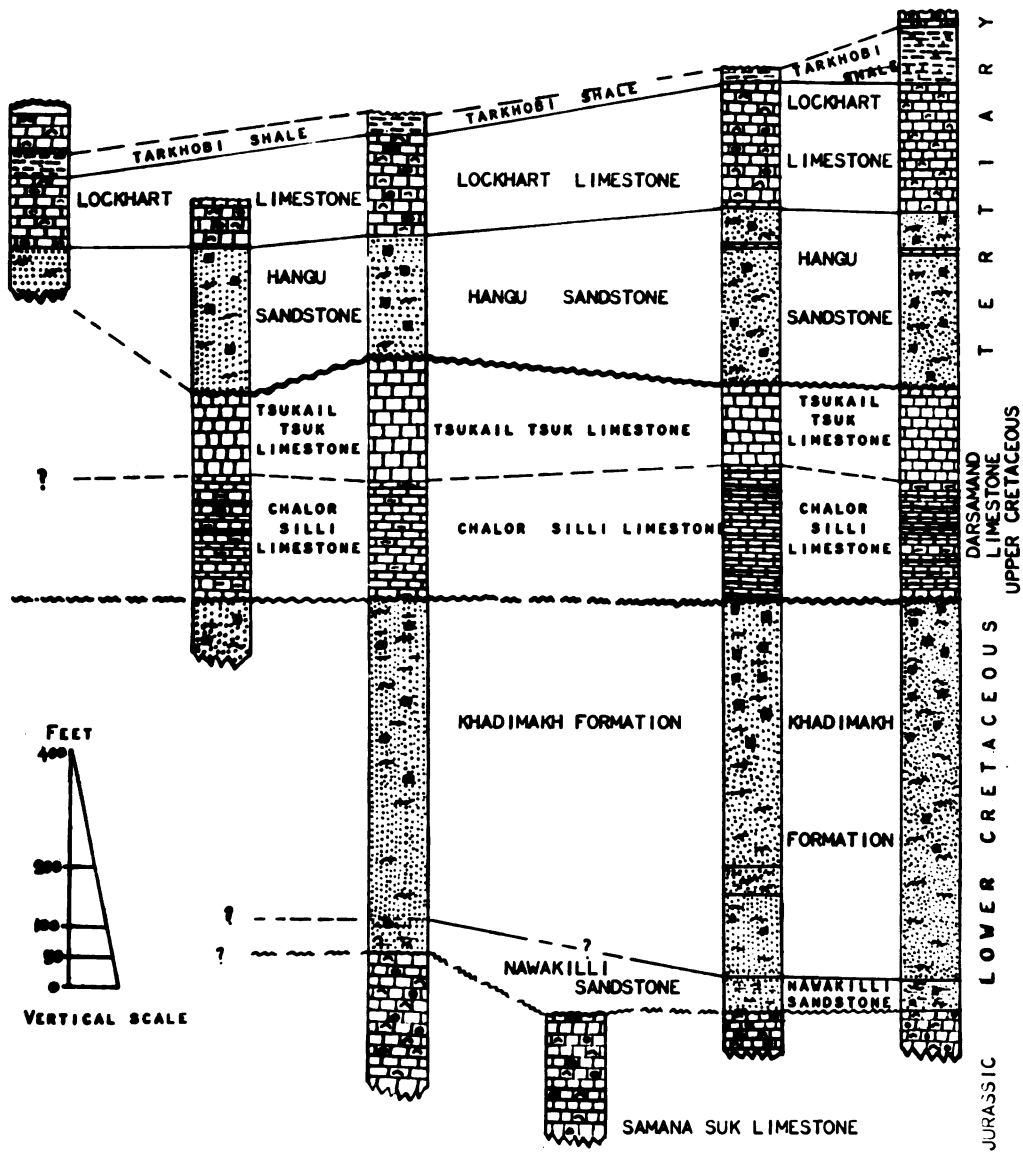
## SECTION E

SECTION D  
INCORPORATING  
D1,D2,D3,D4

## SECTION C

SECTION B  
INCORPORATING  
B1, B2, B3, B4


SECTION A  
INCORPORATING  
A1,A2,A3,A4



(Modified from Geological Survey of Pakistan)

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red, yellow, or purple bands, parallel to the joint faces or surface cracks of the boulders. Blocks of this stone are thus often very ornamental and many vividly banded specimens are to be seen along the bridle path from Paddarband to Fort Lockhart, since this path is, for half its total length, cut out of the sandstone layers of this great series, up the strike of which it winds. About the center, or a little above the center, of the series, the sandstones for about 200 feet lie in massive flags with thin clay partings. These flags are apt to break off in rectangular masses after the manner of limestones, so that a continuous scarp is formed which, from a distance, closely resembles the limestone scarps above and below it. It is, however, part of the sandstone mass. Near the top of the Khadimakh formation a change becomes apparent and the white sandstones merge upwards into about 30 feet of greenish sandstone. Finally the latter in turn becomes very gritty, the uppermost 5 or 6 feet of it being full of large rounded grains of quartz, sometimes interspersed with thin yellow calcareous bands and often crowded with fossil casts of all sorts which are phosphatic and of a very dark color. Glauconite is also found here. These



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topmost and fossiliferous grits by the dark colors which they display serve to afford another of the general "datum lines" so useful in mapping this area. For, thin as the fossiliferous layer actually is, the detritus from it, discharged over the light colored sandstones below, forms characteristic sooty smears which are distinguishable at great distances, and indicate the continuations of this series among the associated strata on distant slopes.

Darsamand limestone (Upper Cretaceous)--The next unit in the ascending series consists of about 200 feet of light colored flaggy limestones, called Chalor Silli limestone (Fig. 5). These are very fine-grained and homogeneous, often lithographic, in texture, and vary in tint from pale gray to faintly yellow, greenish or almost white aspect. Abrupt as the change is, from the grits just below to this fine-grained limestone, there appears to be no structural unconformity between the two. There is no apparent change, that is, in the dip of the beds. At the same time, the existence of a considerable disconformity in age seems to be possible (L. M. Davies, 1930, p. 8).



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Above the Chalor Silli limestone lies another 200 feet of compact or homogeneous, almost lithographic limestone and the two limestones together form the Darsamand limestone (Fig. 5) which represents the Upper Cretaceous rocks. The younger of the two, called Tsukail-Tsuk limestone (Fig. 5), has a texture very similar to that of the Chalor Silli limestone and therefore hand specimens of the two often appear to be identical. The color, however, is generally darker and the whole formation is massive, rather than flaggy, forming much more abrupt scarps on the hillsides.

Hangu sandstone (Tertiary)--The next higher bed consists of 150 to 300 feet of white quartzitic sandstone, indistinguishable from that of the Khadimakh formation. It is known as Hangu sandstone (Fig. 5). Its texture is the same, it weathers in the same way, as the Khadimakh and it is sometimes covered with large rust-colored spots. Whatever the conditions may have been which produced this type of sandstones, they appear to have been recurrent in this region throughout the Cretaceous and into the basal Tertiary. In its uppermost layers this bed shows

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marked signs of merging conformably into the one above it. It becomes strongly calcareous toward the top.

Lockhart limestone (Tertiary)--The next younger bed is the Lockhart limestone which, in the Fort Lockhart region, consists of 200 feet of massive gray limestone (Fig. 5). In some places the lower 20 or 30 feet of this bed is less massive than the rest, being of a blue-black, shaly type, readily splitting along laminae when struck, and ocherous on weathered surfaces. Elsewhere, however, and also above these softer lower portions, the bed is much more compact, and lighter gray in color. The upper portions of this bed in places resemble Tsukail-Tsuk limestone, but can be distinguished from the latter by their slightly coarser texture. Denudation has almost everywhere removed the uppermost layers of this limestone, which are now only to be seen behind Fort Lockhart. These uppermost layers there consists of dark gray crystalline limestone interspersed with bands and lentils of black impure chert.

Tarkhobi shale (Tertiary)--The youngest rock exposed in the area is the Tarkhobi shale (Fig. 5), which is on the crest of the Samana Range, close behind Fort

Lockhart, where a small outlier exists of still younger beds. Everywhere else, denudation seems to have removed the latter. These beds consist of about 150 feet of clays, shales, and impure limestone bands.

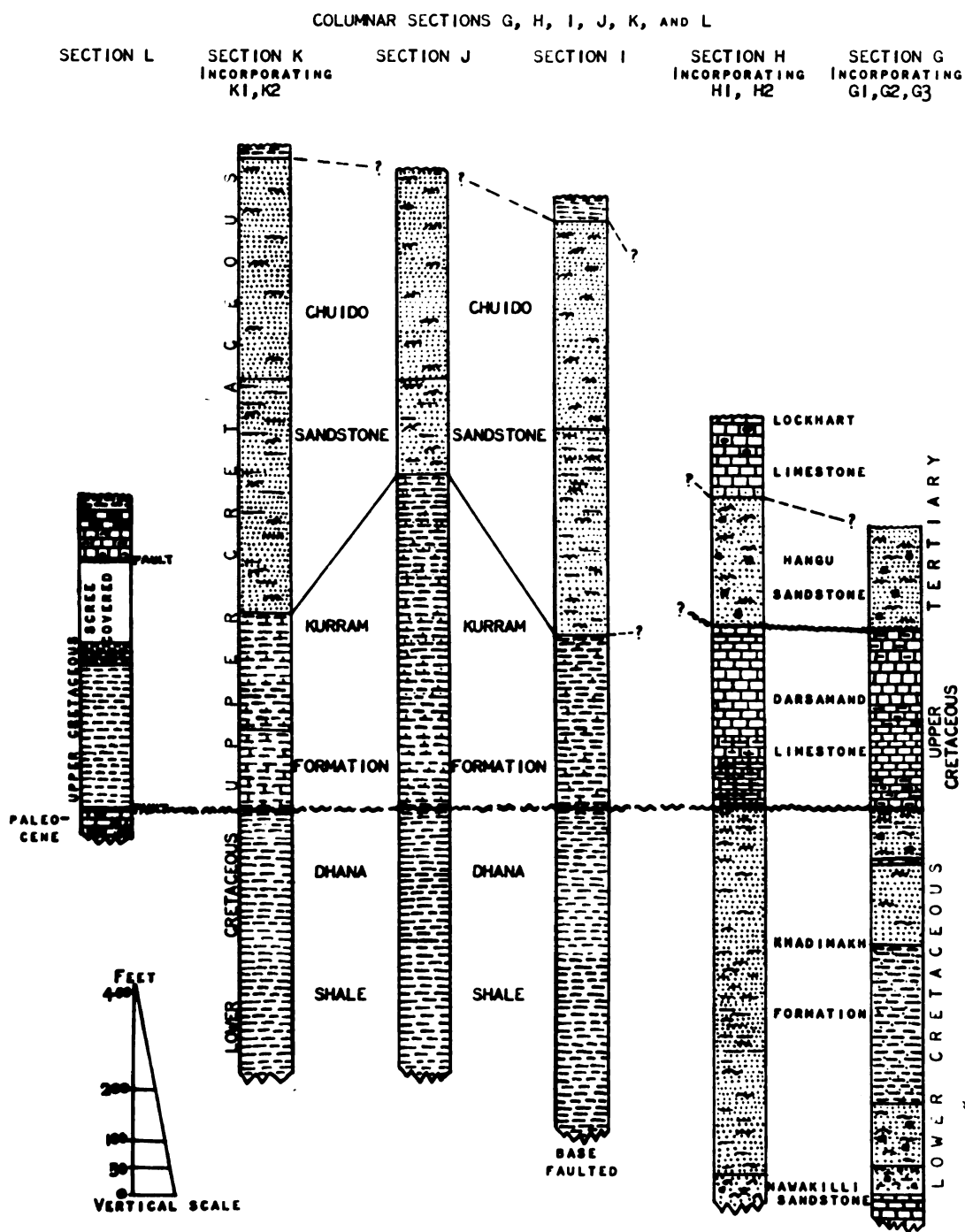
Dhana shale (Lower Cretaceous)--In the Thal-Khadimakh area at localities I, J,  $K_1$ , and  $K_2$ , the oldest strata present is the Lower Cretaceous Dhana shale (Fig. 6). Dhana shale is from 500 to 600 feet thick and gray in color. At a few places in the formation thin lighter gray colored clay lenses are present. Toward the top Dhana shale gets calcareous and brownish.

Kurram formation (Upper Cretaceous)--Above the Dhana shale in the Thal-Khadimakh area at the same localities is the Upper Cretaceous Kurram formation which is between 300 and 650 feet thick (Fig. 6). The lower part is greenish brown and highly calcareous shale. Upwards the shale becomes less and less calcareous and the color is lighter.

Chuido sandstone (Upper Cretaceous)--Kurram formation is overlain by the Chuido sandstone in this area (Fig. 6). The lower part of this sandstone is up to 500 feet thick, yellowish-white in color, fine-grained and

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Figure 6



(Modified from Geological Survey of Pakistan)

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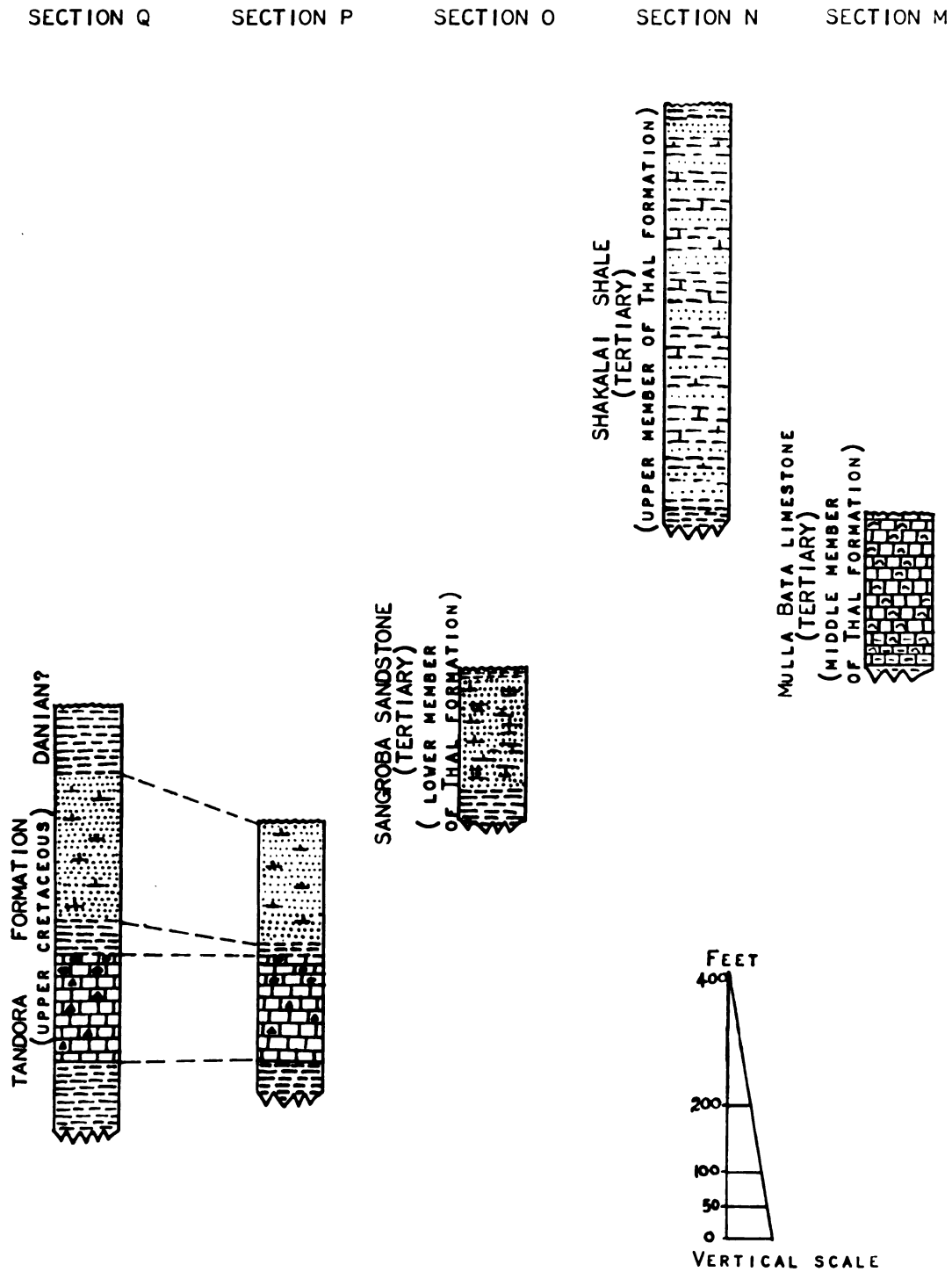
calcareous; whereas the upper part is almost white, quartzitic and coarse-grained sandstone.

Tandora formation (Upper Cretaceous)--This formation is present at localities P and Q in the Thal-Khadimakh area and has at the base a fairly dark brown shale about 100 feet thick (Fig. 7). Above this shale member is a 250-foot-thick bed of calcareous sandstone. This sandstone is almost white and contains brown-colored shale lenses. The sandstone is succeeded by a layer of soft, very light gray shale. This shale is exposed only at locality Q.

Thal formation (Tertiary)--Thal formation consisting of three members is about 1,000 feet thick (Fig. 7). The lower member, Sangroba sandstone, is 200 feet thick, is predominantly calcareous sandstone with shale at the base and is exposed only at locality O (Fig. 7). The middle member, Mulla Bata limestone, is a dark gray limestone, about 250 feet thick and is exposed only at locality M (Fig. 7). The upper member, Shakalai shale, is 600 feet thick, most part is calcareous and is exposed at locality N only. All three members of the Thal formation have not been reported from any single locality.

Figure 7

COLUMNAR SECTIONS M, N, O, P, AND Q



(Modified from Geological Survey of Pakistan)

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The above descriptions of the geological formations of the study area were partly based on L. M. Davies (1930) and partly on personal communications and sample study. The formations described after L. M. Davies (1930) are--Samana Suk limestone (Jurassic), Nawakilli sandstone (Lower Cretaceous), Khadimakh formation (Lower Cretaceous), Upper Cretaceous Darsamand limestone (Chalor Silli limestone and Tsukail-Tsuk limestone), Hangu sandstone (Tertiary), Lockhart limestone (Tertiary), and Tarkhobi shale (Tertiary). The formations, descriptions of which were based on personal communications and sample study are--Dhana shale (Lower Cretaceous), Kurram formation (Upper Cretaceous), Chuido sandstone (Upper Cretaceous), Tandora formation (Upper Cretaceous), and Tertiary Thal formation (Sangroba sandstone, Mulla Bata limestone and Shakalai shale).

SYSTEMATIC DESCRIPTIONS

Phylum ARTHROPODA

Subphylum MANDIBULATA

Class CRUSTACEA

Subclass OSTRACODA Latreille, 1806

Order PODOCOPIDA Müller, 1894

Suborder PODOCOPINA Sars, 1866

Superfamily CYTHERACEA Baird, 1850

Family BRACHYCYTHERIDAE Puri, 1954

Subfamily BRACHYCYTHERINAE Puri, 1954

Genus Brachycythere Alexander, 1933

Type species: Cythere sphenoides Reuss, 1854, K. Akad.  
Wiss. Wein. Math.-Naturw. Kl., Denkschr. p. 141, pl. 27,  
fig. 2a-c.

Range: Cretaceous to Recent

Brachycythere ovata (Berry)

Plate 1, fig. 1a-b

Cythereis ovatus Berry, 1925, Amer. Jour. Sci., ser. 5,  
vol. 9, pp. 484-485, text-fig. 15.

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Cytheropton sp. A, Israelsky, 1929, Arkansas Geol.

Surv., Bull. no. 2, pp. 7-8, pl. IA, fig. 1a-c.

Cythere ovata (Berry)--Alexander, 1929, Univ. Texas

Bull. no. 2907, p. 87, pl. 7, figs. 10, 13.

Brachycythere ovata (Berry)--Jennings, 1936, Bull.

Amer. Paleo., vol. 23, no. 18, p. 50, pl. 6, fig.

16a-b.--van den Bold, 1946, Univ. Utrecht Thesis, p.

108, pl. 13, fig. 9a-d.--Skinner, 1956, Gull Coast

Assoc. Geol. Soc. Trans., vol. 6, p. 190, pl. 2, fig.

3a-c.--Howe and Laurencich, 1958, Introduction to the

Study of Cretaceous Ostracoda, p. 89, text-fig. p. 89--

Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 210,

pl. 4, fig. 1a-b.

Dimensions of figured specimen: Adult--length 1.15 mm.,  
height 0.70mm.; instar--length 0.57 mm., height 0.35  
mm.

Occurrence in material studied: Chalor Silli lime-  
stone--abundant at locality A<sub>3</sub>, common at locality D<sub>2</sub>,  
rare at localities B<sub>2</sub>, E, and H<sub>1</sub>; Tsukail-Tsuk lime-  
stone--rare at locality G<sub>1</sub>.





Types: Homoeotype, one adult complete carapace, No. A3-1, and one complete instar, No. A3-2, from locality A<sub>3</sub>; one adult carapace, No. B2-1, and one instar, No. B2-2, from locality B<sub>2</sub>; one adult carapace, No. D2-1, and one instar, No. D2-2, from locality D<sub>2</sub>; one adult carapace, No. E-1, and one instar, No. E-2, from locality E; one adult carapace, No. G1-1, from locality G<sub>1</sub>; one instar, No. G1-2, also from locality G<sub>1</sub>; one adult carapace, No. H1-1, and one instar, No. H1-2, from locality H<sub>1</sub>.

Remarks: Compared to the specimens of Dr. Swain's reference collections these specimens are less punctate, the surface is almost smooth, the keel on ventral swelling of the right valve is more distinct, and the ventral surface is faintly striated.

In the present collection the instars are more numerous than the adults. The species is restricted to Upper Cretaceous and the American specimens are reported mostly from Taylorian and Navarroan stages whereas most of the Pakistani specimens come from the lower member of the Upper Cretaceous Darsamand limestone.

Brachycythere ovata vecarina Crane

Plate 7, figure 1

Brachycythere ovata vecarina Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 210, pl. 4, fig. 3a-b.

Dimensions of figured specimen: Length 0.80 mm., height 0.55 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality A<sub>3</sub>, rare at localities B<sub>2</sub> and D<sub>2</sub>.

Types: Hypotypes, one complete carapace, No. A3-3, from locality A<sub>3</sub>; one carapace, No. B2-3, from locality B<sub>3</sub>; one carapace, No. D2-3, from locality D<sub>2</sub>.

Remarks: Some of the present specimens are weathered but some are well-preserved and show the characteristics of the subspecies. These have a total absence of any keel development on either valve and thus differ from Brachy-  
cythere ovata (Berry). These are smaller specimens in size than the holotype of the subspecies.

Crane's specimens come from the Taylorian and Navarroan rocks and the present specimens are all from Chalor Silli limestone.

Brachycythere ledaforma (Israelsky)

Plate 1, figure 2a-b

Cytheropteron ledaforma Israelsky, 1929, Arkansas Geol.

Survey, Bull. no. 2, p. 8, pl. IA, figs. 5-7.

Cythere acutocaudata Alexander, 1929, Univ. of Texas,

Bull. no. 2907, p. 87, pl. 7, figs. 5-6.

Brachycythere ledaforma (Israelsky)--Alexander, 1933,

Jour. Paleontol., vol. 7, p. 206, pl. 25, fig. 9; pl. 27,

fig. 20.--Jennings, 1936, Bull. Amer. Paleo., vol. 23,

no. 18, p. 49, pl. 6, fig. 15.--Calahan, 1939, Shreveport

Geol. Soc., Guide-book, 14th Ann. Field Trip, p. 41, pl. 3,

fig. 2.--Skinner, 1956, Gulf Coast Assoc. Geol. Soc.,

Trans., vol. 6, pp. 187-190, pl. 2, fig. 2a-d.--Butler

and Jones, 1957, Louisiana Geol. Survey, Bull. no. 32,

pp. 26-27, pl. 3, fig. 3.--Brown, 1957, North Carolina

Dept. of Cons. and Devel., Bull. no. 70, p. 12, pl. 4,

fig. 6.--Howe and Laurencich, 1958, Introduction to the

Study of Cretaceous Ostracoda, pp. 87-88, text-figs. p. 88.

--Crane, 1965, Micropaleontology, vol. 11, no. 2, pp. 208-

209, pl. 3, fig. 9a-b.

Dimensions of figured specimen: length 0.67 mm., height 0.27 mm.

Occurrence in material studied: Chalor Silli limestone--rare at localities A<sub>3</sub> and D<sub>2</sub>.

Types: Homoeotypes, one complete carapace, No. A3-4, from locality A<sub>3</sub>; one carapace, No. D2-4, from locality D<sub>2</sub>.

Remarks: The posterior end of these specimens is less pointed than the specimens of Dr. Swain's reference collections; also these are slightly smaller in size than all the reported specimens.

The species is restricted to Upper Cretaceous and has been reported so far from the Taylorian and Navarroan stages in America. The Pakistani specimens were collected from Chalor Silli limestone.

Brachycythere ledaforma erugata Crane

Plate 7, figure 2

Brachycythere ledaforma erugata Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 209, pl. 3, fig. 11a-b.

Dimensions of figured specimen: length 0.86 mm., height 0.50 mm.

Occurrence in material studied: Chalor Silli limestone--common at localities A<sub>3</sub> and E; Tsukail-Tsuk limestone--rare at locality G<sub>1</sub>.

Types: Hypotypes, one carapace, No. A3-5, from locality A<sub>3</sub>, one carapace, No. E-3, from locality E, one carapace, No. G1-3, from locality G<sub>1</sub>.

Remarks: The present specimens closely resemble the subspecies in external features. In size these are somewhat larger than the holotype.

Crane's specimens come from Austin and Taylor groups; the Pakistani specimens come from both the upper and lower members of the Upper Cretaceous Darsamand limestone.

Brachyocythere ledaforma porosa Crane

Plate 7, figure 3a-b

Brachyocythere ledaforma porosa Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 209, pl. 3, fig. 12a-b.

Dimensions of figured specimen: Length 0.72 mm., height 0.44 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality A<sub>3</sub>.

Types: Hypotype, one complete carapace, No. A3-6, from locality A<sub>3</sub>.

Remarks: The present specimens resemble the holotype in having pitted and sculptured lateral surface and striated ventral surface.

Crane's specimens come from all the three groups of the Upper Cretaceous rocks in the Gulf Coast area; the present specimens come only from Chalor Silli limestone and have been collected only from locality A<sub>3</sub>.

Brachycythere ledaforma leioventra n. subsp.

Plate 7, figure 4a-c

Etymology: leioventra (L), smooth venter, referring to the smooth ventral surface, lacking any striations.

Distinguishing characteristics: This subspecies is characterized by having punctate lateral surface, smooth ventral surface and sharp, ventrally pointed posterior.

Description: Carapace medium size, subtriangular, venter strongly swollen; anterior margin rounded, denticulate; dorsal margin straight on right valve, slightly arched; ventral margin more or less straight, posterior sharply angulated at junction with ventral margin; left valve larger, with greatest overlap ventrally and dorsally; hingement of right valve with anterior tooth, socket, groove, and posterior crenulate; hingement of left valve

complements that of right valve, and possesses a prominent accommodation groove above the hinge elements. Lateral surface of the valves distinctly punctate and ventral surface smooth without any striations. The males are elongated and narrower posteriorly.

Comparison: The subspecies Brachycythere ledaforma leioventra differs from Brachycythere ledaforma Israelsky in having the distinctly punctate and somewhat sculptured lateral surface and smooth ventral surface; from the subspecies Brachycythere ledaforma erugata Crane it differs in having a punctate lateral surface and by lacking the striations on ventral surface; from Brachycythere ledaforma porosa Crane it differs by having the unstriated, smooth ventral surface.

Dimensions of holotype: Length 0.85 mm., height 0.62 mm., width 0.49 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality A<sub>3</sub>; Tsukail-Tsuk limestone--rare at locality G<sub>1</sub>.

Type locality: Locality A<sub>3</sub>, Samana Range, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Upper Cretaceous.

Types: Holotype, a complete male carapace, No. A3-9, from locality A<sub>3</sub>; allotype, a complete female carapace, No. A3-8; paratypes, a complete female carapace, No. A3-7, from locality A<sub>3</sub>, a female carapace, No. G1-4, a male carapace, No. G1-5, from locality G<sub>1</sub>.

Remarks: Some of the specimens of the subspecies Brachycythere ledaforma leioventra are weathered to some extent but most of them are well-preserved. Dimorphism in the genus Brachycythere is not pronounced in most species; but in this subspecies the dimorphism is clearly seen. The females are thicker, higher, and have less sharp posterior end whereas the males are elongated, narrower, and have sharply pointed posterior end.

Brachycythere brevivalvula n. sp.

Plate 7, figure 5a-c

Etymology: brevivalvula (L), 'short valve, referring to the short length of the valves.

Distinguishing characteristics: Brachycythere brevivalvula is characterized by its small size, smooth lateral surface and striated ventral surface.

Description: Carapace small to medium, ovate in lateral view and subtriangular in cross section; greatest height



anterior to middle; dorsal margin arched and slightly angulated at the greatest height; anterior margin broadly rounded; ventral margin gently convex; posterior margin narrowly rounded and oblique through the dorsal half; anterior and posterior ends compressed, anterior end more compressed than posterior end; valves convex and convexity of valves increases from ends toward center; ventral swelling of valves projects below the contact of valves on ventral margin. Left valve larger than right valve and overlaps the latter on all sides except ventral margin; maximum overlap on the dorsal margin. Lateral surface smooth, without punctae; ventral surface striated with two to three striae on each valve; no denticulation on the anterior or posterior end. Hingement typical of the genus.

Comparison: Brachycythere brevivalvula differs from Brachycythere ovata (Berry) in being much smaller in size, in lacking the keel on ventral swelling, in having striae on ventral surfaces of the valves. Brachycythere brevivalvula differs from the Miocene species Brachycythere physigastera van den Bold in general shape and in having the lateral surface impunctate and in having the ventral surface striated.

Dimensions of holotype: Length 0.63 mm., height 0.38 mm., width 0.38 mm.

Occurrence in material studied: Chalor Silli limestone--common at localities A<sub>3</sub> and D<sub>2</sub>; Tandora formation--rare at locality Q.

Type locality: Locality A<sub>3</sub>, Samana Range, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Upper Cretaceous.

Types: Holotype, a complete carapace, No. A3-10, from locality A<sub>3</sub>; paratypes--a carapace, No. A3-11, from locality A<sub>3</sub>, a carapace, No. D2-5, from locality D<sub>2</sub>, a carapace No. Q-1, from locality Q.

Brachycythere elongata n. sp.

Plate 7, figure 6a-b

Etymology: elongata (L), elongated, referring to the elongate shape of the carapace.

Distinguishing characteristics: Brachycythere elongata is characterized by its elongate carapace, smooth and shiny lateral and ventral surfaces and by having the denticulate anterior and posterior ends.

Description: Shell rather large and thick-walled; elongate-subovate in lateral view; greatest height about

two-fifths from anterior end along the eye spot. Dorsal margin gently arched, obscurely angled at each end of straight hinge line, ventral margin almost straight, anterior margin broadly rounded and denticulated with five denticles; posterior margin narrowly rounded bearing three denticles and extended ventrally; left valve larger and overlaps the right valve on all sides, greatest overlapping on dorsal and ventral borders; valves strongly convex; greatest thickness in ventral one quarter in the posterior half of carapace. Ventral swelling of the valves posterior to middle; faint keel on ventral swellings slightly overhang ventral border. Both ends compressed, anterior being more compressed than posterior. Lateral and ventral surfaces smooth and shiny. Hingement typical of the genus. Internal features not observed.

Comparison: Brachycythere elongata resembles Brachycythere infundibuliformis. Van Veen, 1935, in general shape but differs from it by being shorter and by having the height and width same dimension. Also, Brachycythere infundibuliformis has the greatest overlap on the ventral margin whereas Brachycythere elongata shows similarly prominent overlap on both dorsal and ventral margins. Brachycythere infundibuliformis does not have any

denticulation on the anterior and posterior ends, but Brachycythere elongata has 5 denticles on the anterior end and 3 on the posterior end.

Brachycythere elongata resembles Brachycythere darensis Swain, 1952, to some extent in shape, but Brachycythere elongata is more pointed posteriorly. Also, Brachycythere darensis does not have the angulation on dorsal margin as Brachycythere elongata does.

Dimensions of holotype: Length 0.88 mm., height 0.60 mm., width 0.60 mm., L:H ratio 1.33.

Occurrence in material studied: Chalor Silli limestone-- abundant at locality A<sub>3</sub>, common at localities E and G<sub>1</sub>.

Type locality: locality A<sub>3</sub>, Samana range, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Upper Cretaceous.

Types: Holotype, one complete carapace, No. A3-12, from locality A<sub>3</sub>; paratypes, one carapace, No. A3-13, from locality A<sub>3</sub>, one carapace, No. E-4, from locality E, one carapace, No. G1-6, from locality G<sub>1</sub>.

Remarks: According to Howe and Laurencich (1958) Brachycythere darensis Swain, 1952 and Brachycythere infundibuliformis Van Veen, 1935 are synonymous. Brachycythere elongata differs from both of these species.

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Brachycythere pakistanensis n. sp.

Plate 7, figure 7a-b

Etymology: named after the country of Pakistan where the species was found.

Distinguishing characteristics: Brachycythere pakistansensis is characterized by having a reticulated lateral surface, striated ventral surface, a blunt posteriorly and outwardly projected spine on the ala of each valve, and a faint sulcus at the middle point on each valve.

Description: In side view the carapace elongate-ovate, highest at the middle, dorsal margin arched, straight along the hinge line, cardinal angles evident, ventral margin slightly sinuate. Anterior end broadly rounded and compressed, slightly produced ventrally, dorsal half oblique, finely denticulate with five or six denticles; posterior end compressed like anterior end, narrowly rounded but not pointed; posterior end of some specimens denticulate with three teeth. Lateral surface finely reticulate; reticulation seems to be concentric. A crescent-shaped sulcus (or depression) present at the middle of each valve, depression convex anteriorly. Ventral swelling of each valve bears a blunt, short spine

projecting outward and slightly posteriorly. Ventral surface of the valves flat and striated. Eye tubercles prominent on both valves. Left valve larger and insignificantly overlaps the right valve on dorsal border. Greatest thickness ventrad along the spines. Hingement typical of the genus. Dimorphism not observed.

Comparison: The general shape of Brachycythere pakistanensis somewhat resembles the Tertiary species Brachycythere plena Alexander, 1934 and Brachycythere nanafaliana Howe and Pyeatt (MS thesis) in Howe and Garrett, 1934, but Brachycythere pakistanensis differs from both by having the medial sulcus, spine on ventral swelling and in the type of overlap.

Dimensions of holotype: Length 0.63 mm., height 0.38 mm., width 0.39 mm. (including spines).

Occurrence in material studied: Cholor Silli limestone--common at locality A<sub>3</sub>, rare at locality D<sub>2</sub>.

Type locality: Locality A<sub>3</sub>, Samana range, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Upper Cretaceous.

Types: Holotype, one complete carapace, No. A3-14, from locality A<sub>3</sub>; paratypes, one complete carapace, No. A3-15, from locality A<sub>3</sub>, one carapace, No. D2-6, from locality D<sub>2</sub>.

Brachycythere sp. aff. B. pseudovata Jennings

Plate 1, figure 3a-b

Brachycythere pseudovata Jennings., 1936, Bull. Amer. Paleo., vol. 23, no. 78, p. 50, pl. 6, fig. 7a-b.--Howe and Laurencich, 1958, Introduction to the study of Cretaceous Ostracoda, p. 90, text-fig., p. 90.

Dimensions of figured specimen: Length 0.63 mm., height 0.38 mm.

Occurrence in material studied: Chalor Silli limestone--Common at locality A<sub>3</sub>, rare at locality D<sub>2</sub>.

Types: Hypotypes, one complete carapace, No. A3-16, from locality A<sub>3</sub>, one carapace, No. D2-7, from locality D<sub>2</sub>.

Remarks: The present specimens are somewhat weathered, but most of them show the external features that are characteristics of Brachycythere pseudovata Jennings 1936. These specimens are smaller than the holotype. Howe and Laurencich (1958) remarked about Jennings' species that, "length uncertain, in text = 1.10 mm., recalculated from plate = 0.88 mm." The length of the present specimens varies from 0.60 mm. to 0.75 mm.



Brachycythere driveri angulata n. subsp.

Plate 7, figure 8a-b

Etymology: angulata (L.), angled, referring to angulated dorsal margin.

Distinguishing characteristics: The subspecies Brachycythere driveri angulata is characterized by possessing an angulated dorsal margin sharply pointed and straight posterior end, and by lacking denticles on anterior and posterior ends.

Description: Carapace heavy, thick-walled widest near middle just below median line, parabolic in side view, triangular in end view with flat base and moderately convex sides; dorsal margin strongly arched with angulations on both ends of the straight hinge line; left valve larger; ventral surface broad, ventrolateral ridges well-developed; anterior end obliquely rounded; posterior end projecting, sharply angulate; surface ornamented with deep pseudo-hexagonal pits of various sizes, arranged in horizontal lines; low cardinal tubercle present below dorsal edge.

Comparison: Brachycythere driveri angulata differs from Brachycythere driveri LeRoy, 1943, in having angulations on the dorsal margin on both ends of the straight hinge line; by having the projecting sharply pointed posterior end and in lacking any dentation on anterior and posterior ends.

Dimensions of holotype: Length 0.81 mm.. height 0.52 mm., width 0.49 mm.

Occurrence in material studied: Limestone lens of the upper part of Hangu sandstone--rare at localities B<sub>1</sub> and F; Mulla Bata limestone--rare at localities L and M; Shakalai shale--rare at locality N.

Type locality: Locality B<sub>1</sub>, Samana range, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Tertiary (Hangu sandstone).

Types: Holotype, a complete carapace, No. B1-1, from locality B<sub>1</sub>; paratypes, one carapace, No. B1-2, from locality B<sub>1</sub>, one carapace, No. F-1, from locality F, one carapace, No. L-1, from locality L, one carapace, No. M-1, from locality M, one carapace, No. N-1, from locality N.

Brachycythere sp.

Plate 7, figure 9a-b

Description: Shell rather large; in lateral view carapace subtriangular to subovate-acuminate; greatest height anterior to middle; dorsal margin strongly arched, posterior slope long and truncated; ventral margin almost straight; anterior margin broadly rounded, lower half denticulate, posterior end somewhat acuminate and extended medially. Left valve larger than and strongly overlapping right whole length of hinge line, less strongly along ventral margin; median surface of valves strongly convex, right valve bears three longitudinal ridges, ventral ridge longest running parallel to ventral margin in middle three-fourths of valve, dorsal ridge shorter than ventral one and stops before eye tubercle, median ridge shortest; ridges separated by shallow sulci. Left valve smooth. Thickest posterior to middle. Internal features not observed.

Dimensions of figured specimen: Length 1.00 mm., height 0.63 mm., width 0.56 mm.

Occurrence in material studied: Base of Chalor Silli limestone--rare at locality A<sub>3</sub>.

Specimens: Two carapaces, Nos. A3-17 and A3-18 from locality A<sub>3</sub>.

Remarks: Only two well-preserved specimens were available for study. External features of these specimens are same as those of a Brachycythere. Therefore, the specimens are classified as such.

Genus Alatacythere Murray and Hussey, 1942

Type species: Cythereis (Pterigocythereis?) alexanderi Howe and Law, 1936, Louisiana Geol. Surv., Bull. no. 7, p. 42, pl. 4, fig. 23; pl. 5, fig. 5 (not Morrow, 1934), Alatacythere ivani Howe, 1951, p. 538, nom. nov.

Range: Cretaceous to Oligocene.

Alatacythere sp.

Plate 8, figure 1a-b

Description: Shell large; more or less elongate-ovate in side view; dorsal margin almost straight, ventral margin gently convex downward; anterior end broadly and evenly rounded, posterior end narrowly rounded. A sharp and marginal rim runs along the anterior margin from antero-ventral corner upward and extends beyond the

anterior end of dorsal margin forming an ear; a prominent outwardly and posteriorly projecting wing-like process present on each valve at the ventral border in posterior one-third; a ridge extends parallel to ventral margin anteriorly from the base of the wings to the anterior rim; anterior end denticulate with five to ten denticles. Surface smooth.

Dimensions of figured specimen: Length 1.00 mm., height 0.63 mm.

Occurrence in material studied: Kurram formation--rare at locality J.

Specimen: One complete carapace, No. J-1, from locality J.

Remarks: Only one specimen was available for investigation. The specimen is more closely identical to Alatacythere allinensis Grekoff and Deroo, 1956 than any other species of the genus. It differs from Alatacythere allinensis in having the denticulation on the anterior end.

Alatacythere allinensis is reported from Middle Cretaceous (Cenomanian-Turonian) rocks of Spain. The Pakistani specimens came from the Upper Cretaceous Kurram formation.

## Family CYTHERIDEIDAE Sars, 1925

## Subfamily CUNEOCYTHERINAE Mandelstam, 1960

Genus Cuneocythere Lienenklaus, 1894

Type species: Cuneocythere truncata Lienenklaus, 1894,

Z. Deut. Geol. Ges., vol. 46, no. 1, p. 260, pl. 18,

fig. 6a-e (= Bairdia marginata Bosquet, 1852, Mém. Cour.

Mém. Sav. Entrang., vol. 24, p. 28, pl. 1, fig. 12.

Range: Eocene to Miocene.

Subgenus Monsmirabilia Apostolescu, 1955

Type species: Monsmirabilia subovata Apostolescu, 1955b,

Cahier Géol. vol. 33, p. 327 (nom. nov. for Bairdia per-

forata Bosquet, 1850, non Cytherina perforata Roemer,

1838).

Range: Eocene.

Cuneocythere (Monsmirabilia) subovata Apostolescu

Plate 1, figure 4a-c

Bairdia perforata Bosquet (pars) (non Roemer), 1852, Mém.

Cour. Mém. Sav. Engrang., vol. 24, p. 24, pl. 1, fig. 8.

Monsmirabilia perforata (Bosquet)--Apostolescu, 1955a,

Cahiers Geol., nos. 28-29, p. 256, pl. 1, fig. 8.

Monsmirabilia subovata Apostolescu nom. nov., 1955b,

Cahiers Geol. vol. 33, p. 327.

Dimensions of figured specimen: Length 0.60 mm., height 0.35 mm.

Occurrence in material studied: Tarkhobi shale--rare at locality A<sub>1</sub>; limestone lens of Hangu sandstone--common at locality B<sub>1</sub>.

Types: Hypotypes, one complete female carapace, No. A1-1, from locality A<sub>1</sub>, one male carapace, No. B1-3, from locality B<sub>1</sub>.

Remarks: The present specimens are smaller in size than the holotype. The species has so far been reported from European Eocene. The Pakistani specimens come from Hangu sandstone.

Cuneocythere (Monsmirabilia) triebeli Keij

Plate 1, figure 5a-b

Cuneocythere (Monsmirabilia) triebeli Keij, 1957, Ins.

Roy. Soc. Nat. Belgique, Mém. no. 136, p. 79, pl. IX, figs. 1-4.

Dimensions of figured specimen: Length 0.55 mm., height 0.36 mm., width 0.25 mm.

Occurrence in material studied: Tarkhobi shale--rare at locality A<sub>1</sub>.

Types: Hypotype, one complete female carapace, No. A1-2a and one male shell, No. A1-2b, from locality A<sub>1</sub>.

Remarks: Only two well-preserved specimens were available for study. The external characteristics prescribed for the species by Keij, 1957, are clearly observed in these specimens. The holotype is reported from Eocene beds of Europe (Belgium and Great Britain). The present specimens were collected from Tarkhobi shale.

Subfamily KRITHINAE Mandelstam in Bubikan, 1958

Genus Krithe Brady, Crosskey, and Robertson, 1874

Type species: Cythere (Cytherideis) bartonensis Jones, 1857, Palaentogr. Soc. London, Monogr., vol. 9 (1856), p. 50, pl. 5, figs. 2-3.

Range: Upper Cretaceous to Recent.

Krithe sp. aff. K. cushmani Alexander

Plate 1, figure 6a-b

Krithe cushmani Alexander, 1929, Univ. of Texas Bull. no. 2907, p. 67, pl. IV, figs. 9, 11.--Alexander, 1939,



Shreveport Geol. Soc. Guidebook, 14th Ann. Field Trip, p. 66.--Bonnema, 1940, Natuurhist. Maandblad, vol. 27, p. 118, pl. 2, figs. 48-54.--Albritton and others, 1941, Field and Lab., Dallas, vol. 10, no. 1, pp. 40, 59.--van den Bold, 1946, Univ. Utrecht Thesis, p. 77, pl. IV, fig. 18.--Butler and Jones, 1957, Louisiana Geol. Survey, Bull. no. 32, p. 17, pl. 1, fig. 2.

Dimensions of figured specimen: Length 0.81 mm., height 0.44 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality A<sub>3</sub>, rare at locality D<sub>2</sub>, rare at locality E.

Types: Homoeotypes, one complete carapace, No. A3-19, from locality A<sub>3</sub>, one carapace, No. D2-8, from locality D<sub>2</sub>, one carapace, No. E-5, from locality E.

Remarks: The general shape and surface features of the present specimens resemble Krithe cushmani Alexander, 1929 more than any other species of the genus. The posterior incision of these specimens is not very distinct and the posterior end is thinner than the holotype. That is why the classification is tentative. The specimens were compared with Dr. Swain's reference collections.

Subfamily SCHULERIDEINAE Kollmann, 1960

Genus Schuleridea Swartz and Swain, 1946

Type species: Schuleridea acuminata Swartz and Swain, 1946, Jour. Paleontol., vol. 20, no. 4, p. 366, pl. 52, figs. 1-10, text-fig. 1a-c.

Range: Middle Jurassic to Miocene.

Remarks: Most European species now included in the genus were formerly considered to belong to Haplocytheridea; in 1954 Triebel referred some of his Mesozoic forms to Schuleridea and Oertli in 1956 for the first time assigned some Tertiary species to this genus. One of those, Cytherina perforata Roemer, 1838, was chosen previously as the type species of his new genus Aequacytheridea by Mandelstam (1947). Recent authors, like Maltz (1958) and Kollmann (1960), consider Aequacytheridea as a subgenus of Schuleridea, to include the tertiary species which differ from the Mesozoic Schuleridea representatives by having considerably more marginal pore canals.

Schuleridea (Aequacytheridea) perforata (Roemer)

Plate 1, figure 7

Cytherina perforata Roemer, 1838, Neues Jahrb. f. Min., etc., p. 516, pl. 6, fig. 11. Cythere hilseana Jones,

1849, Monogr. Entom. Creta. Eng., Palaentogr. Soc. London,  
p. 10, pl. 1, fig. 1a-g.

Bairdia perforata Bosquet, 1852, Mém. Cour. Acad. Roy.

Sci. Belg., vol. 24, p. 24, pl. 1, fig. 8a-d.

Cytheridea incrassata Bosquet, 1852, Mém. Cour. Acad. Roy.

Sci. Belg., vol. 24, p. 44, pl. 3, fig. 11.

Cytheridea ionesiana Bosquet, 1854, Mém. Comm. carte.

Geol. Neerland., vol. 2, p. 64, pl. 8, fig. 5a-d.

Cytheridea perforata Jones, 1857, Monogr. Tert. Entom.

Eng., Palaentogr. Soc. London, p. 44, pl. 4, fig. 14a-e.--

Jones and Hinde, 1889, Suppl. Monogr. Creta. Entom. Eng.

Irel., Palaentogr. Soc. London, p. 29, pl. 1, figs. 1-4.--

Lienenklaus, 1894, Zeitschr. Deut. Geol. Ges., vol. 46,

p. 255, pl. 15, fig. 5.--Kuiper, 1918, Univ. Groningen

Dissert., p. 33, pl. 1, fig. 11.--Alexander, 1929, Univ.

of Texas Bull. no. 2907, pp. 72-73, pl. V, figs. 1-2.

Haplocytheridea perforata Apostolescu, 1955, Cahiers Geol.

A. Chavan, no. 28, p. 248, pl. 2, figs. 21-24.--Keij,

1957, Inst. Roy. Sci. Nat. Belgique, Mém., no. 136, p. 63,

pl. IV. fig. 20.

Schuleridea (Aequacytheridea) perforata (Roemer)--van

Morkhoven, 1963, Post Paleozoic Ostracoda, vol. II, p.

310, fig. 489.

Dimensions of figured specimen: Length 1.25 mm., height 0.88 mm.

Occurrence in material studied: Tarkhobi shale--rare at locality A<sub>1</sub>; limestone lens in Hangu sandstone--rare at locality B<sub>1</sub>.

Types: Hypotypes, one complete carapace, No. A1-2, from locality A<sub>1</sub>; one carapace, No. B1-4, from locality B<sub>1</sub>.

Remarks: The specimens available were not very well-preserved; only three specimens were good enough to work on. All the identifiable characteristic features of the shells most closely resemble those of Schuleridea perforata (Roemer), 1838.

Subfamily CYTHERIDEINAE Sars, 1925

Genus Cytheridea Bosquet, 1852

Type species: Cythere mülleri Münste, 1830, Jahrb. Min. Geogn., Geol. Petref-Kunde, vol. 1, part 1, p. 62 (Designated by Brady and Norman, 1889). Neotype chosen by Goerlich (1952).

Range: Eocene to Recent

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Cytheridea falcoburgensis van Veen

Plate 1, figure 8

Cytheridea falcoburgensis van Veen, 1936, Natuurhist.

Maandbl., vol. 25, p. 43, pl. 9, figs. 47-51.--van Veen, 1938, Natuurhist. Maandbl., vol. 27, no. 1, p. 11.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 276-277, text-fig. p. 277.

Dimensions of figured specimen: Length 0.50 mm., height 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, one complete carapace, No. A3-20, from locality A<sub>3</sub>.

Genus Ovocytheridea Grekoff, 1951

Type species: Ovocytheridea nuda Grekoff, 1951, Inst.

Francais du Pétrol, Rev., vol. 6, p. 56, pl. 1, figs. 1-7.

Range: Upper Cretaceous.

Ovocytheridea nuda Grekoff

Plate 1, figure 9a-b; Plate 2, figure 1a-b

Ovocytheridea nuda Grekoff, 1951, Inst. Francais du Pétrol Revue, vol. 6, pp. 53-59, pl. 1, figs. 1-7.

Dimensions of figured specimen: Male--length 0.88 mm., height 0.47 mm., width 0.43 mm.; Female--length 0.70 mm., height 0.46 mm., width 0.36 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality A<sub>3</sub>, common at localities D<sub>2</sub> and E.

Types: Hypotypes, one complete male carapace, No. A3-21, and one female carapace, No. A3-22, from locality A<sub>3</sub>; one male carapace, No. D2-9, and one female carapace, No. D2-10, from locality D<sub>2</sub>; one male carapace, No. E-6, and one female carapace, No. E-7, from locality E.

Remarks: The specific features of the present specimens conform with those of the holotype except for the anterior end which in these specimens is thinner.

Holotype and some of the paratypes come from the Upper Cretaceous, Senonian, Campanian, and Santonian rocks. The Pakistani specimens were collected from the lower member of the Upper Cretaceous Darsamand limestone.

Family CYTERETTIDAE Triebel, 1952

Subfamily CYTHERETTINAE Triebel, 1952

Genus Cytheretta Müller, 1894

Cytheretta Müller, 1894, p. 382.

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Cytheretta Müller, 1912, p. 366.

Cytheretta Müller--Edwards, 1944, p. 524.

Cytheretta Müller--van den Bold, 1946, p. 27.

Cytheretta Müller--Puri, 1952a, p. 202.

Cytheretta Müller--Triebel, 1952, pp. 16-18.

Pseudocytheretta Cushman, 1906, p. 382.

Cylindrus Neviani, 1928, pp. 106-107.

Prionocytheretta Méhes, 1941, p. 60.

Type species: Cytheretta rubra Müller, 1894, Zool. Station Naple, Mon. 21, p. 382, pl. 8, figs. 9, 10, 13, 16; pl. 39, figs. 8-22, 24.

Range: Eocene to Recent.

Cytheretta sp. aff. C. sahnii Puri

Plate 8, figure 3

Cytheretta sahnii Puri, 1952, Jour. Paleontol., vol. 26, pp. 206-207, pl. 39, figs. 7-8, text-figs. 1-2.--Puri, 1953, Florida Geol. Surv., Bull. no. 36, pp. 284-285, pl. 8, figs. 7-8.

Dimensions of figured specimen: Length 0.63 mm., height 0.28 mm.

Occurrence in material studied: Tarkhobi shale--rare at locality A<sub>1</sub>.

Types: Hypotype, one complete carapace, No. A1-3, from locality A<sub>1</sub>.

Remarks: Only one good specimen was available to study. This specimen exhibits some of the characteristic features that are prescribed for Cytheretta sahnii Puri. Since only one specimen was available and it does not possess all the required features of Cytheretta sahnii Puri, the classification is tentative.

Family SCHIZOCYTHERIDAE Howe, 1961

Genus Schizocythere Triebel, 1950

Type species: Schizocythere hollandica Triebel, 1950, Senckenbergiana, vol. 31, p. 322, pl. 2, figs. 12-17; pl. 3, figs. 18-19.

Range: Eocene to Pliocene.

Schizocythere hollandica Triebel

Plate 8, figure 4

Cythere acuticosta Eggar--Brady, 1879, Zool. Soc. London, Trans., vol. 10, pt. 9, p. 391, pl. 66, fig. 5a-d.

Not--Cythere acuticosta Eggar, 1858.

Cythereis truncata (Reuss)--Kuiper, 1918, Groningen, Netherlands, Hottsema Bros., p. 72, pl. 3, fig. 31a-b.

Not--Cypridina truncata Reuss, 1849.

Schizocythere hollandica Triebel, 1950, Senckenbergiana, Frankfurt on Main, vol. 31, no. 5/6, p. 322, pl. 2, figs. 12-17; pl. 3, figs. 18-19.

Dimensions of figured specimen: Length 0.50 mm., height 0.37 mm.

Occurrence in material studied: Base of Tarkhobi shale--rare at localities A<sub>1</sub> and D<sub>1</sub>; limestone lens in Hangu sandstone--rare at locality B<sub>1</sub>; Shakalai shale--rare at locality N.

Types: Homoeotypes, one complete carapace No. A1-4, from locality A<sub>1</sub>, one complete carapace, No. B1-5, from locality B<sub>1</sub>; a left valve, No. D1-1, from locality D<sub>1</sub>, one complete carapace, No. N1-2, from locality N.

Remarks: The present specimens were compared with Dr. Swain's reference collections and it was found that these specimens are smaller in size. The species has so far been reported from Eocene and Miocene beds.

Schizocythere appendiculata Triebel

Plate 8, figure 5

Cythere tessellata Bosquet (Pars), 1852, Acad. Roy. Sci.

Belg., Mém. Sav., vol. 24, p. 84, pl. 4, fig. 6.

Schizocythere appendiculata Triebel, 1950, Senckenbergiana, Frankfurt on Main, vol. 31, p. 324, pl. 3, figs.

23-27.--Apostolescu, 1955a, Cahiers Géol. A. Chavan Nos.

28-29, p. 257, pl. 4, figs. 58-59.--Keij, 1957, Inst.

Roy. Sci. Nat. Belg. Mém. no. 136, p. 154, pl. XX, fig.

19.

Dimensions of figured specimen: Length 0.50 mm., height 0.25 mm.

Occurrence in material studied: Base of Tarkhobi shale--rare at localities A<sub>1</sub> and D<sub>1</sub>; Base of Lockhart limestone--rare at locality A<sub>1</sub>; Limestone lens in Hangu sandstone--rare at locality B<sub>1</sub>; Lower part of Shakalai shale--rare at locality N. Few weathered specimens were collected from the outcrop of Lower Cretaceous Dhana shale at locality I. These must be some of the washed-away specimens.

Types: Hypotypes, one complete carapace, No. A1-5, from Tarkhobi shale at Locality A<sub>1</sub>, one carapace, No. A1-6,

from Lockhart limestone at locality A<sub>1</sub>; one carapace, No. B1-6, from locality B<sub>1</sub>; one carapace, No. D1-2, from locality D<sub>1</sub>; one carapace, No. N-3, from locality N.

Remarks: The holotype was described from Eocene rocks of France. Other specimens of the species are reported from Miocene and Eocene beds.

Family LEGUMINOCYTHEREIDIDAE Howe, 1936

Genus Triqinglymus Blake, 1950

Type species: Triqinglymus hyperochus Blake, 1950, Jour. Paleontol., vol. 24, pp. 174-184, pls. 29-30.

Range: Paleocene-Eocene.

Triqinglymus cribratus Apostolescu

Plate 8, figure 2

Triqinglymus cribratus Apostolescu, 1950, Inst. Franc. Petrole, Rev., Paris, vol. 11, no. 11, p. 1343, pl. 3, figs. 47-48.

Dimensions of figured specimen: Length 0.94 mm., height 0.56 mm.

Occurrence in material studied: Lower part of Tarkhobi shale--rare at locality A<sub>1</sub>; Limestone lens in Hangu

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sandstone--rare at locality B<sub>1</sub>; Upper part of Shakalai shale--rare at locality N.

Types: Hypotypes, a complete carapace, No. A1-7, from locality A<sub>1</sub>; an adult carapace, No. B1-7, from locality B<sub>1</sub>, an instar, No. N-4, from locality N.

Remarks: There were only three good specimens available for study. The specific characteristics of Triginglymus cribratus are present on these specimens and thus they are undoubtedly conspecific.

#### Family TRACHYLEBERIDIDAE Sylvaster-Bradley, 1948

##### Subfamily TRACHYLEBERIDINAE Sylvaster-Bradley and Harding, 1954

##### Genus Cythereis Jones, 1849

Type Species: Cytherina cilliata Reuss, 1846, Schweizerbart, pt. 2, p. 104, pl. 24, fig. 17.--Cytherina ornatis-sima Reuss, 1846, Schweizerbart, pt. 2, p. 104, pl. 24, figs. 12-13. (Designated by Sutton and Williams, 1939, Jour. Paleontol., vol. 13, no. 6, p. 562; and by Triebel, 1940, Senckenbergiana, vol. 31, pp. 174-180.)

Range: Cretaceous to Recent.

Cythereis verricula Butler and Jones

Plate 8, figure 6

Cythereis verricula Butler and Jones, 1957, Louisiana Geol. Survey, Bull. no. 32, pp. 40-41, pl. 5, fig. 6a-c.  
 --Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 242, text-fig. p. 242.--  
 Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 220, pl. 7, fig. 1.

Dimensions of figured specimen: Length 0.76 mm., height 0.43 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality A<sub>3</sub>, rare at locality D<sub>2</sub>.

Types: Hypotypes, a complete adult carapace, No. A3-22, from locality A<sub>3</sub>, one carapace, No. D2-11, from locality D<sub>2</sub>.

Remarks: The specimens studied are not very well-preserved, but good enough to identify correctly. These specimens do not have the anterior and posterior denticles, but they show evidence that the denticles are broken due to weathering. The present specimens are larger than the holotype.



Cythereis subgracilis Morrow

Plate 8, figure 7

Cythereis subgracilis Morrow, 1934, Jour. Paleontol.,  
vol. 8, no. 2, p. 204, pl. 31, fig. 9.

? Cythereis cf. subgracilis van den Bold, 1946, Univ.  
Utrecht Thesis, p. 99, pl. 10, fig. 20a-b.

Cythereis subgracilis Howe and Laurencich, 1958, Intro-  
duction to the study of Cretaceous Ostracoda, p. 237,  
text-fig. p. 237.

Dimensions of figured specimen: Length 0.82 mm., height  
0.40 mm.

Occurrence in material studied: Chalor Silli limestone--  
abundant at locality A<sub>3</sub>.

Types: Homoeotype, one complete carapace, No. A3-23,  
from locality A<sub>3</sub>.

Remarks: The specimens available for study are poorly  
preserved; but the following specific characteristics of  
Cythereis subgracilis Morrow were observed in them by  
comparing with Dr. Swain's reference collections--elongate  
subovate shape, ventral margin straight, dorsal margin  
almost straight and curving upward in front, ventral, and  
dorsal margins converging slightly behind, anterior margin

evenly curved, making a subangular junction with the dorsal margin, posterior end abruptly and strongly compressed; median horizontal ridge indistinct; a broad rounded knob is present anterior to the center; anterior end thickened into a faint, broad rim; posterior margin thickened, but denticulation missing; greatest thickness is about midway between the posterior end and the middle; in edge view, ventral edge is very broad, almost flat, joining the lateral sides rather abruptly; surface reticulation is either covered with matrix or weathered away.

The present specimens are larger than holotype and other reported specimens.

Cythereis lixula Crane

Plate 8, figure 8

Cythereis ivii Israelsky--Skinner, 1956, Gulf Coast Assoc. Geol. Soc., Trans., vol. 6, pp. 195-196, pl. 3, fig. 6a-f.

Cythereis lixula Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 223, pl. 7, fig. 3a-b.

Dimensions of figured specimen: Length 0.69 mm., height 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality A<sub>3</sub>; a few washed-away and weathered specimens were collected from the outcrop of Lower Cretaceous Dhana shale at locality I.

Types: Hypotypes, one female carapace, No. A3-24, and one male carapace, No. A3-25, from locality A<sub>3</sub>; one female weathered (washed-away) carapace, No. I-2, from locality I.

Remarks: Crane's specimens came from the Upper Cretaceous Navarro group of Gulf coast region. Most of the Pakistani specimens were collected from the Upper Cretaceous Chalor Silli limestone, but a few weathered specimens were found in the Lower Cretaceous Dhana shale at locality I. It is possible that these weathered specimens were carried away from some other place and rock formation by streams and deposited on the outcrop of Dhana shale at locality I like the Tertiary Schizocythere appendiculata Triebel (p. 66) collected from the same locality and the same bed.

Cythereis dallasensis Alexander

Plate 8, figure 9

Cythereis dallasensis Alexander, 1929, Univ. of Texas

Bull. no. 2907, pp. 99-100, pl. 8, figs. 8-9.--Howe and

Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 192-193, text-fig. p. 193.--Crane, 1965, Micropaleontology, vol. 11, no. 2, pp. 219-220, pl. 6, fig. 5.

Cythereis ornatissima (Reuss)--Alexander, 1933, Jour. Paleontol., vol. 7, pp. 210-211, pl. 25, fig. 18; pl. 26, fig. 11a-b; pl. 27, fig. 16a-b.--Calahan, 1939, Shreveport Geol. Soc., Guidebook, 14th Ann. Field Trip, p. 41, pl. 3, figs. 9-10.

Dimensions of figured specimen: Length 0.69 mm., height 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality  $A_3$ , common at locality  $B_2$ , rare at locality  $D_2$ ; Tsukail-Tsuk limestone--common at locality  $G_1$ .

Types: Homoeotypes, one complete carapace, No. A3-26, from locality  $A_3$ , one carapace, No. B2-4, from locality  $B_2$ , one carapace, No. D2-12, from locality  $D_2$ ; a carapace, No. G1-7, from locality  $G_1$ .

Remarks: The present specimens are not very well-preserved, but comparing with the specimens of Dr. Swain's reference collections the following characteristic features were observed in the present specimens--

reticulate surface ornamentation, a prominent median node, rows of nodes or spines in place of the ventral and dorsal longitudinal ridges, tuberculate elevations marking the posterior terminations of the ventral and dorsal nodose lineations.

Cythereis bicornis Israelsky

Plate 8, figure 10

Cythereis bicornis Israelsky, 1929, Arkansas Geol. Survey, Bull. no. 2, pp. 10-20, pl. IVA, fig. 10a-c.--Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 100, pl. 8, figs. 4-5.--Swain, 1948, U.S. Geol. Survey, Prof. Paper no. 234-B, p. 83, pl. 9, fig. 31.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 183-184, text-fig. p. 184.--Crane, 1965, Micropaleontology, Vol. 11, no. 2, p. 218, pl. 6, fig. 1a-b.

? Cythereis niobrarensis Morrow, 1934, Jour. Paleontol., Vol. 8, pp. 203-204, pl. 31, figs. 6, 10a-c.--Loetterle, 1937, Nebraska Geol. Survey, Bull. no. 12, ser. 2, p. 54, Pl. 8, fig. 2a-b.

Cythereis sp. cf. C. bicornis (Israelsky)--Swain, 1948, Maryland Dept. Geol., Mines, and Water Resources, Bull. no. 2, pp. 200-201, pl. 13, figs. 15-16.

Dimensions of figured specimen: Length 0.56 mm., height 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality A<sub>3</sub>, common at locality B<sub>2</sub>, rare at localities D<sub>2</sub>, E, and H<sub>1</sub>; Tsukail-Tsuk limestone--common at locality G<sub>1</sub>.

Types: Hypotypes, one complete carapace, No. A3-27, from locality A<sub>3</sub>, one carapace, No. B2-5, from locality B<sub>2</sub>, one carapace No. D2-13, from locality D<sub>2</sub>, one carapace, No. E-8, from locality E, one carapace, No. G1-8, from locality G<sub>1</sub>, one carapace, No. H1-3, from locality H<sub>1</sub>.

Remarks: Compared to holotype and other specimens reported so far, the present specimens are smaller in size, but they possess all the specific characteristics.

Cythereis costatana Israelsky

Plate 8, figure 11

Cythereis costatana Israelsky, 1929, Arkansas Geol Survey, Bull. no. 2, p. 16, pl. IIIA, fig. 16a-c.--Butler and Jones, 1957, Louisiana Geol. Survey Bull., no. 32, pp. 36-37, pl. 3, fig. 5.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 191,

text-fig. p. 191.--Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 220, pl. 7, fig. 1.

Cythereis costatana angula Schmidt, 1948, Jour. Paleontol. vol. 22, pp. 420-421, pl. 61, figs. 17-18.--Howe and Laurencich, 1958, Introduction to the study of Cretaceous Ostracoda, pp. 191-192, text-fig. p. 192.

Platycythereis costatana angulata (Schmidt)--Brown, 1957, North Carolina, Div. Mineral Res., Bull., no. 70, pp. 15-16, pl. 6, figs. 22-25.--Brown, 1958, North Carolina, Div. Mineral Res., Bull. no. 72, p. 64, pl. 4, fig. 9.

Dimensions of figured specimen: Length 0.75 mm., height 0.44 mm.

Occurrence in material studied: Chalor Silli limestone--rare at localities  $A_3$ ,  $D_2$ , and  $H_1$ .

Types: Homoeotypes, one carapace, No. A3-28, from locality  $A_3$ ; one carapace, No. D2-14, from locality  $D_2$ ; one carapace, No. H1-4, from locality  $H_1$ .

Remarks: The topotype of the species in Dr. Swain's reference collections has slightly more height than the present specimens; also these specimens have pitted surface and the topotype has punctate surface. The other features are the same in both types.

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Cythereis wintoni Alexander

Plate 8, figure 12

Cythereis wintoni Alexander, 1929, Univ. of Texas Bull. no. 2907, p. 93, pl. 8, figs. 3, 7.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 242-243, text-figs. p. 243.

Dimensions of figured specimen: Length 0.50 mm., height 0.28 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, one complete carapace, No. A3-29, from locality A<sub>3</sub>.

Remarks: The present specimens are much smaller in size. The species has been reported so far only from the Lower Cretaceous Fort Worth formation of Texas. The present specimens were collected from the lower member of the Upper Cretaceous Darsamand limestone. It is suggested that the species did continue into Upper Cretaceous in that part of the world, but for some reason, they were dwarfed. Though the number of specimens is few and their size is much smaller, they all are mature and well-preserved.

Cythereis hawleyi Alexander

Plate 8, figure 13

Cythereis hawleyi Alexander, 1929, Univ. of Texas, Bull. no. 2907, pp. 95-96, pl. 9, figs. 3-4.--Howe and Lauren-  
cich, 1958, Introduction to the Study of Cretaceous Os-  
tracoda, p. 201, text-fig. p. 201.

Dimensions of figured specimen: Length 0.57 mm., height 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--  
common at locality A<sub>3</sub>, rare at locality E; Tsukail-Tsuk  
limestone--rare at locality G<sub>1</sub>.

Types: Homoeotypes, one complete carapace, No. A3-30,  
from locality A<sub>3</sub>, one carapace, No. E-9, from locality E,  
one carapace, No. G1-9, from locality G<sub>1</sub>.

Remarks: The specimens studied are not very well-  
preserved, but the following features which are charac-  
teristics of the species Cythereis hawleyi Alexander were  
observed in most of the present specimens--shape oblong,  
highest in front, ventral outline straight, dorsal irreg-  
ularly bumpy; anterior rounded, rimmed, denticulate; pos-  
terior compressed, angled at middle, denticulate below.  
Muscle swelling has a smooth ovate swelling behind it

rather than a ridge as noticed in Dr. Swain's reference collections. Surface finely pitted.

Cythereis eaglefordensis Alexander

Plate 8, figure 14

Cythereis eaglefordensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 98, pl. 9, figs. 9, 12.--Howe and Laurencich, 1958, Introduction to the study of Cretaceous Ostracoda, p. 194, text-fig. p. 194.--Swain and Brown, 1964, North Carolina, Dept. Cons. Devel., Div. Mineral Res., Bull. no. 78, pl. 31, fig. 6a-b, text-fig. 9a-b.

Dimensions of figured specimen: Length 0.75 mm., height 0.44 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality B<sub>2</sub>; Tsukail-Tsuk limestone--common at locality G<sub>1</sub>.

Types: Homoeotypes, one carapace, No. B2-6, from locality B<sub>2</sub>, one carapace, No. G1-10, from locality G<sub>1</sub>.

Remarks: The present specimens were compared with the types of Swain and Brown (1964) and found to be conspecific.

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The reticulation on the lateral surface of the present specimens is not as distinct as on those of Swain and Brown (1964).

Cythereis sp. aff. C. fessa Lübmova

Plate 8, figure 15

Cythereis fessa Lübmova, 1965, Trans. Inst. All-Union Petrol. Res., Geol. Explor., Issue No. 244, pp. 73-74, pl. VIII, figs. 10a-b, 11a-b, 12a-b.

Dimensions of figured specimen: Length 0.75 mm., height 0.41 mm.

Occurrence in material studied: Kurram formation--rare at locality J.

Types: Hypotype, one complete carapace, No. J-2, from locality J.

Remarks: There were only two good specimens available for study. The present specimens differ from the holotype in being a little bigger and in having the ridges less prominent. The ridges and nodes of the Pakistani specimens are not reticulated like the Russian specimens, probably due to weathering.

The holotype is described from the Cenomanian beds of the Caspian Basin. The present specimens were collected from the lower part of the Upper Cretaceous Kurram formation.

Cythereis sp. aff. C. divisa Damotte

Plate 8, figure 15

Cythereis divisa Damotte, 1962, Rev. Micropal., Paris, vol. 5, no. 3, p. 194, pl. 2, fig. 2a-e; pl. 3, fig. 4a-c.

Dimensions of figured specimen: Length 0.74 mm., height 0.38 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, one carapace, No. A3-31, from locality A<sub>3</sub>.

Remarks: The present specimens are not very well-preserved to recognize all the external characteristic features, but the recognizable features conform most closely to Cythereis divisa Damotte, reported from Turonian of France.

Cythereis dentonensis Alexander

Plate 8, figure 17

Cythereis dentonensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 94, pl. 8, figs. 10-11.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 194, text-fig. p. 194.

Dimensions of figured specimen: Length 0.63 mm., height 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality E.

Types: Homoeotype, one complete carapace, No. E-10, from locality E.

Remarks: Only two good specimens were available in the material studied. These were compared with Dr. Swain's type in his reference collections and found to be conspecific. The present specimens are a little elongated and narrower than the figured holotype.

Cythereis sp. aff. C. fredericksburgensis Alexander

Plate 8, figure 18

Cythereis fredericksburgensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 89, pl. 8, figs. 12-13.--

Calahan, 1939, Shreveport Geol. Soc., Guidebook, 14th Ann. Field Trip, p. 49, pl. 7, figs. 5-6.--Lozo, 1944, Amer. Midland Nat., vol. 31, no. 3, p. 530, map of location.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 198-199, text-figs. p. 199.

? Cythereis sp. aff. C. fredericksburgensis Swain, 1952, U.S. Geol. Survey, Prof. Paper 234-B, p. 82, pl. 9, fig. 6.

Dimensions of figured specimen: Length 0.63 mm., height 0.30 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality E.

Types: Homoeotype, one complete carapace, No. E-11, from locality E.

Remarks: Out of three available specimens, only one is good enough to work on. General shape, external features and ornamentation of the specimen conform fairly close to Cythereis fredericksburgensis Alexander. Comparing with Dr. Swain's type (1952), it was found that the present specimen is much closer to the holotype than Swain's specimen.



Cythereis sp. aff. C. hannai Israelsky

Plate 9, figure 1

Cythereis hannai Israelsky, 1929, Arkansas Geol. Survey, Bull. no. 2, pp. 16-17, pl. IV A, fig. 1a-c.--Alexander, 1939, Shreveport Geol. Soc. Guidebook, 14th Ann. Field Trip, p. 66.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 200, text-fig. p. 200.--Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 221, pl. 6, fig. 8a-b.

Dimensions of figured specimen: Length 0.94 mm., height 0.50 mm.

Occurrence in material studied: Chalor Silli limestone--rare at localities E and H<sub>1</sub>; Tsukail-Tsuk limestone--rare at locality G<sub>1</sub>.

Types: Hypotypes, one carapace, No. E-12, from locality E, one carapace, No. H1-5, from locality H<sub>1</sub>, one carapace, No. G1-11, from locality G<sub>1</sub>.

Remarks: The present specimens are somewhat weathered, but exhibit more characteristic features of Cythereis hannai Israelsky than any other species of the genus. These specimens are much larger than any specimens so far reported. Therefore, the classification is tentative.

Cythereis alexanderi abbreviata Morrow

Plate 9, figure 2

Cythereis alexanderi abbreviata Morrow, 1934, Jour. Paleontol., vol. 8, no. 2, p. 203, pl. 31, fig. 8a-c.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 180, text-fig. p. 180.

Dimensions of figured specimen: Length 0.72 mm., height 0.35 mm.

Occurrence in material studied: Challor Silli limestone--rare at localities  $A_3$ ,  $D_2$ ,  $H_1$ .

Types: Hypotypes, one carapace, No. A3-32, from locality  $A_3$ , a carapace, No. D2-15, from locality  $D_2$ , a carapace, No. H1-6, from locality  $H_1$ .

Remarks: The present specimens are larger in size than the holotype. Except for the size, all the characteristic features of the subspecies are possessed by these specimens. Some of the features, like spines, are not as sharp as in holotype.

Cythereis sp. A.

Plate 9, figure 4a-b

Description: Carapace medium size; anterior and posterior ends compressed; eye tubercle prominent, highest anteriorly, anterior margin obliquely rounded, posterior margin narrowly rounded or slightly angulated in some specimens with concave dorsum. Dorsal and ventral margins almost straight and converging posteriorly. Surface coarsely pitted, median node high and round. Three pairs of spines on the posterior half of dorsal border, middle pair being the longest; posterior end denticulate with three to four denticles on each valve, no denticles on anterior end. A long, sharp postero-ventral spine on each valve projecting out and slightly posteriorly located at the posterior end of pitted ventral ridge; ventral ridge dies out anteriorly. Dorsal edge narrow, ventral edge broad and flat.

Dimensions of figured specimen: Length 0.88 mm., height 0.44 mm.

Occurrence in material studied: Uppermost shale member of the Upper Cretaceous Tandora formation--rare at locality Q.

Specimen: One beautifully preserved complete carapace, No. Q-2, from locality Q.

Remarks: The external features of the only specimen conform to those of the genus Cythereis, but no described species of the genus was found to possess all the distinct features that this specimen has.

Cythereis sp. B.

Plate 9, figure 5a-b

Description: Shell rather small. Dorsal margin very slightly concave upward, ventral margin straight; anterior broadly rounded, posterior narrowly rounded; posterior end denticulate; central muscle spot round and smooth, eye tubercle distinct. A postero-ventral ala on each valve forms a spine projecting out and posteriorly; except the coarsely reticulated anterior and posterior ends of the surface the lateral surface coarsely pitted. In edge view, shell triangular; ventral surface flat and pitted.

Dimensions of figured specimen: length 0.69 mm., height 0.41 mm.

Occurrence in material studied: Lowermost Lockhart limestone--rare at locality F.

Specimen: One complete carapace, No. F-2, from locality F.

Remarks: Cythereis sp. B. is similar to Cythereis sp. A., but it differs from the latter in being much smaller in size, in lacking the postero-dorsal spines and ventral ridge, and in having the triangular shape in edge view.

Genus Hermanites Puri, 1955

Synonyms: Hermania Puri, 1954 (preoccupied by Hermania Monterosato 1844--Mollusca); ? Paracythereis Jennings, 1936 (preoccupied by Paracythereis Delachaux, 1928; probably young molts of a Hermanites sp.).

Type species: Hermania reticulata Puri, 1954, Florida Geol. Survey, Bull. no. 36, p. 267, pl. 11, figs. 8-9; text-figs. g-h.

Range: Paleocene to Recent.

Hermanites tschoppi (van den Bold)

Plate 9, figure 3

Cythereis tschoppi van den Bold, 1946, Univ. of Utrecht thesis, p. 93, pl. 10, fig. 14a-b.--van den Bold, 1950, Jour. Paleontol., vol. 24, no. 1, p. 83.

Hermania reticulata Puri, 1954, Florida Geol. Survey,  
Bull. no. 36, p. 267, pl. 11, figs. 8-9; text-figs. g-h.  
Hermanites haidingeri (Reuss).--van den Bold, 1957, Micro-  
paleontology, vol. 3, no. 3, p. 239, pl. 2, fig. 1a-b.  
(not Cypridina haidingeri, Reuss, 1850).

? Hermanites fungosa Butler, 1963, Louisiana Geol. Survey,  
Bull. no. 39, p. 63, pl. 4, figs. 4-6.

Hermanites Tschoppi (van den Bold).--van den Bold, 1960,  
Micropaleontology, vol. 6, no. 2, p. 170.--van den Bold,  
1965, Micropaleontology, vol. 11, no. 4, p. 398, pl. 6,  
fig. 2a-b.

Dimensions of figured specimen: Length 0.69 mm., height  
0.38 mm.

Occurrence in material studied: Limestone lens in Hangu  
sandstone common at locality B<sub>1</sub>; Mulla Bata limestone--  
common at locality L.

Types: Hypotypes, a well-preserved complete carapace,  
No. B1-8, from locality B<sub>1</sub>, a somewhat weathered carapace,  
No. L-2, from locality L.

Remarks: The present specimens slightly differ from the  
holotype in having the median ridge less prominent and  
in having fewer spines on the surface. The species has  
so far been reported from Eocene and Miocene beds.

Hermanites alata n. sp.

Plate 9, figure 6a-b

Etymology: alata (L) winged, referring to the prominent ventral ala.

Distinguishing characteristics: Hermanites alata is characterized by having a strong ventral ala on each valve, reticulated surface, and a ventral ridge.

Description: Carapace comparatively small, elongate, subquadrate; highest at the anterior cardinal angle. Anterior end broadly rounded, rimmed middle part. Posterior end angular below middle, concave dorsally, convex ventrally, slightly compressed. Dorsal margin straight up to the cardinal angle where ear sticks out. Ventral margin straight, partly obscured by ventral ala. Ventral surface flat and triangular due to the outward projecting ala. Valves nearly equal with the slightly larger left valve overlapping the right insignificantly at the anterior cardinal angle and forms the ear. The ventral ridge slopes sharply up from the antero-ventral region and ends in a sharp projection at the beginning of the posterior slope, forming a prominent ala. Shell thickest at the point of alar projection. Surface

ornamented by a network of large reticulations giving a spongy appearance to the carapace. A smooth, large muscle spot located subcentrally.

Internally valves moderately deep, marginal areas relatively narrow, line of concrescence coincides with inner margin; radial pore canals numerous, long, straight to slightly sinuous; muscle scar pattern consists of an inclined row of four scars, the bottom two being elongate, two ovate, slightly elongate scars in front, all scars lie within the muscle pit. Hingement holamphidont; right valve bears high, smooth pyramidal anterior tooth, a large, deep postjacent socket, a finely crenulate median groove and a smooth ovate posterior tooth; the left valve bears the complements.

Comparison: Hermanites alata n. sp. strongly resembles Hermanites tschoppi van den Bold, 1946, but differs in being shorter, yet higher, in having no spines on the posterior end. It differs from Hermanites fungosa Butler, 1963, by lacking the median ridge. From all the described species, the new species differs in possessing the prominent, outwardly, and posterly projecting sharply pointed ventral ala.



Dimensions of holotype: Length 0.69 mm., height 0.38 mm., width 0.38 mm.

Occurrence in material studied: Limestone lens in Hangu sandstone--common at locality B<sub>1</sub>.

Type locality: Locality B<sub>1</sub>, limestone lens in Hangu sandstone, Samana range, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Tertiary.

Types: Holotype, one complete carapace, No. B1-9, from locality B<sub>1</sub>; paratype, one complete carapace, No. B1-10, from locality B<sub>1</sub>.

Genus Isocythereis Triebel, 1940

Type species: Isocythereis fissicostis Triebel, 1940, Senckenbergiana Lethaea, vol. 22, nos. 1-6, p. 209, pl. 7, figs. 71-74; pl. 10, fig. 108.

Range: Albian (Lower Cretaceous).

Isocythereis sp. aff. I. sp. Swain and Brown (unpublished)  
Plate 9, figure 7

Description: Carapace wedge-shaped in profile; dorsal margin straight in left valve and slightly convex in right

valve, ventral margin concave. Surface ornamented with a longitudinal ridge, diagonally located. Anterior margin heavily rimmed, and finely denticulate. Several posteriorly projecting spines present on posterior end. Highest in the anterior third, thickest in the middle. Anterior end broadly rounded, posterior end narrow and angulated.

Dimensions of figured specimen: Length 0.48 mm., height 0.25 mm., width 0.16 mm.

Occurrence in material studied: Base of Cholor Silli limestone--rare at locality A<sub>3</sub>.

Specimens: One complete carapace, No. A3-33, from locality A<sub>3</sub>.

Remarks: The present specimens were found to be exactly the same as Swain and Brown's unpublished collections. There were only two good specimens available for study in the present collection.

#### Family XESTOLEBERIDIDAE Sars, 1928

#### Subfamily XESTOLEBERIDINAE Mertens, 1958

#### Genus Xestoleberis Sars, 1866

Type species: Cythere aurantia Baird, 1838, Mag. Zool. Bot., vol. 2, pp. 16, 132-144, 400-412.

Range: Cretaceous to Recent.

Xestoleberis seminulata Crane

Plate 9, figure 8

Xestoleberis seminulata Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 234, pl. 9, fig. 5.

Dimensions of figured specimen: Length 0.56 mm., height 0.31 mm., width 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality A<sub>3</sub>, rare at localities B<sub>2</sub> and G<sub>1</sub>.

Types: Hypotypes, one carapace, No. A3-34, from locality A<sub>3</sub>, a carapace, No. B2-7, from locality B<sub>2</sub>, a carapace, No. G1-12, from locality G<sub>1</sub>.

Remarks: The present specimens are somewhat weathered, they are not exactly like the holotype, but the main specific characteristic features, prescribed to Xestoleberis seminulata, were recognized in different specimens.

Xestoleberis ovata Bonnema

Plate 2, figure 2a-b

Xestoleberis ovata Bonnema, 1941, Natuurhist. Maanblad, vol. 28, p. 43, pl. 7, figs. 39-45.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda,

p. 517, text-fig. p. 517.--Crane, 1965, Micropaleontology, vol. 11, no. 2, pp. 233-234, pl. 9, fig. 2a-b.

Dimensions of figured specimen: Length 0.50 mm., height 0.32 mm., width 0.32 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality A<sub>3</sub>, common at locality B<sub>2</sub>.

Types: Hypotypes, one carapace, No. A3-35, from locality A<sub>3</sub>, one carapace, No. B2-8, from locality B<sub>2</sub>.

Remarks: The present specimens are in general, slightly smaller than the holotype. The ventral margin of these specimens is less convex than most of the reported specimens. Dimorphism was not observed.

Xestoleberis pergensi Veen

Plate 2, figure 3a-b

Bairdia subglobosa Bosquet, 1854b (not Bosquet, 1852), Commission pour la desc. et la carte géol. de la Neerlande, Mém., vol. 2, p. 55(65), pl. 8, fig. 3a-d.

Xestoleberis pergensi Veen, 1936, Natuurhist. Maandblad, vol. 25, nos. 2-9, p. 17 (69, 70), pl. 3, figs. 12-29.--Veen, 1938, Natuurhist. Maandblad, vol. 27, nos. 1-2, p. 4 (15, 16).--Howe and Laurencich, 1958, Introduction

to the Study of Cretaceous Ostracoda, pp. 517-518, text-fig. p. 518.

Dimensions of figured specimen: Length 0.38 mm., height 0.25 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality A<sub>3</sub>, common at locality B<sub>2</sub>.

Types: Hypotypes, one carapace, No. A3-36, from locality A<sub>3</sub>, a carapace, No. B2-9, from locality B<sub>2</sub>.

Remarks: The present specimens are much smaller than the holotype, but they do show the characteristic external features of the species. These shells are less plump than Veen's specimen.

Xestoleberis opina Schmidt

Plate 2, figure 4a-b

Xestoleberis opina Schmidt, 1948, Jour. Paleontol., vol. 22, no. 4, p. 410, pl. 61, figs. 15-16, text-fig. 26.--  
Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 51, text-figs. p. 51.

Xestoleberis cf. X. opina Butler and Jones, 1957, Louisiana, Geol. Survey, Bull. no. 32, p. 47, pl. 6, fig. 3a-b.

Dimensions of figured specimen: Length 0.34 mm., height 0.21 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at localities A<sub>3</sub> and B<sub>2</sub>.

Types: Hypotypes, one complete carapace, No. A3-37, from locality A<sub>3</sub>, one carapace, No. B2-10, from locality B<sub>2</sub>.

Remarks: In general, the size of the present specimens is smaller than the holotype, but the specific characteristics prescribed for the species are clearly recognizable in most of the specimens.

Xestoleberis sp. aff. X. gunteri Howe

Plate 2, figure 5a-c

Xestoleberis gunteri Howe, 1951b, Florida, Geol. Survey, Bull. no. 34, pp. 30-31, pl. 2, figs. 17-19.--Puri, 1957, Florida, Geol. Survey, Bull. no. 38, p. 195.

Dimensions of figured specimens: Length 0.57 mm., height 0.40 mm.

Occurrence in material studied: Base of Lockhart limestone--rare at locality A<sub>1</sub>; Mulla Bata limestone--rare at locality L.

Types: Hypotypes, one carapace, No. A1-8, from locality A<sub>1</sub>, a carapace, No. L-3, from locality L.

Remarks: There were only two good specimens available for study. The shells are rather small, about half the size of the holotype, but exhibit characteristics of Xestoleberis gunteri Howe. They may very well be instars of the species.

Xestoleberis zuberensis Puri

Plate 2, figure 6a-d

Xestoleberis zuberensis Puri, 1957, Florida, Geol. Survey, Bull. no. 38, p. 194, pl. 6, figs. 13-16.

Dimensions of figured specimen: Length 0.56 mm., height 0.38 mm.

Occurrence in material studied: Lockhart limestone--rare at localities A<sub>1</sub> and H<sub>2</sub>; Mulla Bata limestone--rare at locality L.

Types: Hypotypes, one carapace, No. A1-9, from locality A<sub>1</sub>, one carapace, No. H2-1, from locality H<sub>2</sub>, one carapace, No. L-4, from locality L.

Remarks: The present specimens have a little more height and are thicker than the holotype. Length-height ratio

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of the holotype is 1.56, whereas that of these specimens is 1.52.

Xestoleberis marssoni Bonnema

Plate 2, figure 7a-c

Xestoleberis marssoni Bonnema, 1941, Natuurhist. Maandblad, Maastricht, vol. 30, no. 4, p. 43, pl. 7, figs. 46-50.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 516-517, text-figs. p. 517.

Dimensions of figured specimen: Length 0.52 mm., height 0.36 mm.

Occurrence in material studied: Upper part of Cholor Silli limestone--rare at locality B<sub>2</sub>; Lower part of Dhana shale--rare at locality I.

Types: Hypotypes, one complete carapace, No. B2-11, from locality B<sub>2</sub>, one weathered, washed-away carapace, No. I-3, from locality I.

Remarks: Only two good specimens from locality B<sub>2</sub> and one weathered carapace from locality I were available for study. The holotype, described by Bonnema (1941), comes from Upper Cretaceous of Holland.

Xestoleberis minuta Holden

Plate 2, figure 8a-b

Xestoleberis minuta Holden, 1964, Paleontology, vol. 7, pt. 3, pp. 425-426, text-fig. 27a-e.

Dimensions of figured specimen: Length 0.37 mm., height 0.25 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>; Tsukail-Tsuk limestone--rare at locality G<sub>1</sub>.

Types: Hypotypes, one complete carapace, No. A3-38, from locality A<sub>3</sub>, one carapace, No. G1-13, from locality G<sub>1</sub>.

Remarks: Though the present specimens are small, they are very well-preserved. High magnification revealed the following characteristics of the species described by Holden (1964)--anterior margin sharply pointed and projected a little ventrally; antero-dorsal margin long and oblique, ventral margin long and straight; surface smooth. Holotype was reported from Upper Cretaceous of California.

Xestoleberis sp.

Plate 9, figure 9a-b

Description: Shell subovoid or broadly ovate and plump in side view; greatest height about median; greatest thickness median and a little ventrad; dorsal margin broadly convex and uniformly rounded; hinge line about half of shell length and very slightly convex with broadly obtuse cardinal angles; ventral margin gently convex and partially hidden by the ventral swelling of the valves; anterior margin broadly and uniformly rounded; posterior end somewhat narrowly rounded; anterior end projected out a little; surface smooth.

Dimensions of figured specimen: Length 0.50 mm., height 0.44 mm., width 0.50 mm.

Occurrence in material studied: Shale cap (Shakalai shale?) of Mulla Bata limestone--rare at locality L; Base of Shakalai shale--rare at locality N.

Specimens: One carapace, No. L-5, from locality L, one carapace, No. N-5, from locality N.

Remarks: The present specimens to some extent resemble the Cretaceous Xestoleberis pergensi Veen, 1936, in shape, but differ from it in having more broadly rounded

posterior end and in having a little projection of the anterior end. Also, these specimens measure length and width the same, and the height is about  $7/8$  of the length. There were only two good specimens available for study.

Xestoleberis supplanta Veen

Plate 3, figure 1a-d

Xestoleberis supplanta Veen, 1936, Natuurhist. Maandblad, vol. 25, nos. 2-9, p. 17 (69-70), pl. 3, figs. 30-43.-- Veen, 1938, Natuurhist. Maandblad, vol. 27, nos. 1-2, p. 4 (15, 16).--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 518, text-figs. p. 518.

Dimensions of figured specimen: Length 0.50 mm., height 0.31 mm.

Occurrence in material studied: Limestone member of Tandora formation--rare at locality Q.

Types: Hypotype, one carapace, No. Q-3, from locality Q.

Remarks: The present specimens differ somewhat from the holotype in having a faint incision on the ventral contact of the valves and the striations on the ventral surface

are not very distinct; the anterior end is a little more rounded than the holotype.

Superfamily BAIRDIACEA Sars, 1888

Family BAIRDIIDAE Sars, 1888

Genus Bairdoppilata Coryell, Sample and Jennings, 1935

Type Species: Bairdoppilata martyni Coryell, Sample and Jennings, 1935, Amer. Mus. Nat. Hist. Novitates, no. 777, pp. 1-5, 4 text-figs.

Range: Cretaceous to Recent.

Bairdoppilata pseudoseptentrionalis Mertens

Plate 3, figure 2a-b

Bairdoppilata pseudoseptentrionalis Mertens, 1956, Geol. Jahrb., Hanover, Germany, vol. 72, p. 182, pl. 8, figs. 7-10; pl. 13, figs. 89-90.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 82, text-figs. p. 82.

Dimensions of figured specimen: Length 1.00 mm., height 0.63 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, one carapace, No. A3-39, from locality A<sub>3</sub>.

Remarks: Two beautifully preserved specimens were available for study. Compared to holotype these specimens are slightly shorter, yet have a greater height.

Bairdoppilata? magna Alexander

Plate 3, figure 3

Bairdia magna Alexander, 1927, Jour. Paleontol., vol. 1, p. 32, pl. 6, figs. 7-8.--Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 63, pl. 3, fig. 8.--Alexander, 1934**b**, Jour. Paleontol., vol. 8, no. 2, p. 215.--Kline, 1943, Miss. Geol. Survey, Bull. no. 53, p. 65, pl. 8, fig. 4.

Bairdoppilata viticula Coryell, Sample and Jennings, 1935, Amer. Mus. Nat. Hist. Novitates, no. 777, p. 4, figs. 3-4.--Jennings, 1936, Bull. Amer. Paleontol., vol. 23, no. 78, p. 44.

Bairdoppilata magna Skinner, 1956, Meeting of Gulf Coast Assoc., Geol. Soc., p. 183, pl. 1, fig. 3a-b.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 80-81, text-figs. p. 81.

Dimensions of figured specimen: Length 0.75 mm., height 0.50 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, one carapace, No. A3-40, from locality A<sub>3</sub>.

Remarks: Only two well-preserved, complete carapaces and no single valves were available for study. In general shape, overlap, dorsal and ventral margins, anterior and posterior ends, these two specimens conform to the genus Bairdoppilata, but lack of knowledge as to their internal characteristics, especially the denticulation on the dorsal slopes, prevents the definite classification.

#### Subfamily BAIRDIINAE Sars, 1923

##### Genus Bairdia McCoy, 1844

Genolectotype: Bairdia curtus McCoy, 1844, Synopsis of the Characters of the Carboniferous Fossils of Ireland (Crustacea), Dublin Univ. Press, p. 164, pl. 23, fig. 6.

Bairdia Jones and Kirkby, 1879 (cleaned and refigured type specimen), Quart. Jour., Geol. Soc. London, vol. 35, p. 567, pl. 28, fig. 1.

Range: Ordovician to Recent.

Bairdia harrisiana Jones

Plate 3, figure 4a-b

Bairdia harrisiana Jones, 1849, Palaentogr. Soc. London, p. 25, pl. 6, fig. 17a-f.--Alexander, 1929, Univ. of Texas, Bull. no. 2907, pp. 60-61, pl. 2, figs. 18-19.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 70, text-fig. p. 70.

Dimensions of figured specimen: Length 0.62 mm., height 0.25 mm., width 0.19 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality H<sub>1</sub>.

Types: Hypotype, one carapace, No. H1-7, from locality H<sub>1</sub>.

Remarks: Of three available specimens, only one was well-preserved. External features of the specimen resemble those of the figured and described specimen of Alexander (1929). The ventral margin of the present specimen is less sinuate than Alexander's specimen.

Bairdia sp. aff. B. alexandrina Blake

Plate 3, figure 5

? Bairdia subdeltoidea Alexander (not Münster), 1927, Jour. Paleontol., vol. 1, p. 31, pl. 6, figs. 2, 4.



Bairdia subdeltoidea Alexander, 1929, Univ. of Texas,  
Bull. no. 2907, p. 61, pl. 3, fig. 5.

Bairdia alexandrina Blake (new name), 1931, Jour. Paleonol.  
vol. 5, p. 163.--Moreman, 1942, Jour. Paleontol., vol. 16,  
p. 195.

Bairdia cf. B. alexandrina Swain, 1952, U.S. Geol. Survey,  
Prof. Paper 234-B, p. 71, pl. 8, fig. 13.

Dimensions of figured specimen: Length 0.63 mm., height  
0.37 mm.

Occurrence in material studied: Chalor Silli limestone--  
rare at locality A<sub>3</sub>; Tsukail-Tsuk limestone--rare at lo-  
cality G<sub>1</sub>.

Types: Hypotypes, one carapace, No. A3-41, from locality  
A<sub>3</sub>; one carapace, No. G1-14, from locality G<sub>1</sub>.

Remarks: The assignment of the present forms to Bairdia  
alexandrina is tentative because of the smaller size.

Moreover, the weathered conditions of the specimens pre-  
vents from recognizing specific features.

Bairdia sp. aff. B. gracilis Alexander

Plate 3, figure 6a-b

Bairdia gracilis Alexander, 1929, Univ. of Texas, Bull.  
no. 2907, p. 60, pl. 2, figs. 16-17.--Howe and Laurencich,

1958, Introduction to the Study of Cretaceous Ostracoda, p. 70, text-fig. p. 70.

Dimensions of figured specimen: Length 0.69 mm., height 0.38 mm.

Occurrence in material studied: Tsukail-Tsuk limestone--rare at locality G<sub>1</sub>; Chalor Silli limestone--rare at locality H<sub>1</sub>.

Types: Hypotypes, one complete shell No. G1-15, from locality G<sub>1</sub>; one complete carapace, No. H1-8, from locality H<sub>1</sub>.

Remarks: The present specimens are a little thicker and the posterior end is less pointed than the holotype. The specimen No. G1-15 has doubtful stratigraphic position. The samples containing the specimens had the number that belongs to the Lower Cretaceous Khadimakh formation (sandstone) but the lithology of the samples is limestone similar to Tsukail-Tsuk limestone. Other specimens of the species came from the outcrops of Chalor Silli limestone at locality H<sub>1</sub>. The species has so far been reported from upper Kiamichi, lower Duck Creek, Washita, and Fredericksburg formations of the United States. If it can be established, without doubt, that the specimen G1-15 and its

duplicates were collected from some limestone lenses of the Lower Cretaceous Khadimakh formation then the species will show its continued existence from the Lower Cretaceous to Upper Cretaceous time since the species was found also in Chalor Silli limestone, the lower member of the Upper Cretaceous Darsamand limestone. The same ill-fate was shared by Paracypris acuta (Cornuel), discussed later, which was found in the same samples.

Bairdia gracilis truncata n. subsp.

Etymology: Truncata (L), truncated, referring to the truncated anterior end.

Distinguishing characteristics: This new subspecies is characterized by having the ventral two-thirds of the anterior end obliquely truncated posteriorly, and by having a broadly convexed dorsal margin and almost straight ventral margin.

Description: Shell rather small, oblong-subquadrate in lateral view. Dorsal margin broadly arched, gently sloping to anterior and sharply sloping to the posterior from the middle point. Ventral margin almost straight with slight tendency to concavity at the middle. The dorsal

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one-third of the anterior end narrowly rounded, the lower two-thirds obliquely truncated posteroventrally. Posterior end nearly pointed due to sharp convergence of dorsal margin to ventral edge. Left valve larger and it overlaps the right valve the greatest overlap being on the ventral margin. In dorsal view, carapace lanceolate, widest just behind the middle, highest medially. Anterior end thinner than posterior end in edge view.

Comparison: This new subspecies closely resembles the species Bairdia gracilis Alexander, 1929, but differs from it in general shape and in having the anterior end obliquely truncated, in having the widest point just behind the middle.

Dimensions of holotype: Length 0.68 mm., height 0.37 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality A<sub>3</sub>, rare at locality H<sub>1</sub>.

Types: Holotype, a complete carapace, No. A3-42, from locality A<sub>3</sub>; paratypes, one complete carapace, No. A3-43, from locality A<sub>3</sub>, and one carapace, No. H1-9, from locality H<sub>1</sub>.

Type locality: Lower member of Darsamand limestone, locality A<sub>3</sub>, Samana Range, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Upper Cretaceous.

Bairdia sp. aff. B. exoura van den Bold

Plate 3, figure 7

Bairdia exoura van den Bold, 1957a, Micropaleontology, vol. 3, no. 1, p. 6, pl. 2, fig. 6.--van den Bold, 1957b, Micropaleontology, vol. 3, no. 3, p. 236.

Dimensions of figured specimen: Length 0.82 mm., height 0.50 mm.

Occurrence in material studied: Upper Shakalai shale--rare at locality N.

Types: Hypotype, one carapace, No. N-6, from locality N.

Remarks: Only two good specimens were available for study. The present forms are somewhat smaller than the holotype, and the posterior is less produced.

Bairdia sp. aff. B. jonesi van den Bold

Plate 3, figure 8a-b

Bairdia subdeltoides Jones and Sherborn, 1887, Geol. Mag. New series, Decade III, vol. 4, p. 387.--Jones and Sherborn,

1889, Palaentogr. Soc. London, Monogr., vol. 42, p. 16, pl. I, fig. 5.--Latham, 1938, Proc. Roy. Soc. Edinburgh, vol. 59, p. 39, pl. 1, fig. 1.

Bairdia jonesi van den Bold, 1946, Univ. of Utrecht Thesis, p. 72, pl. 4, fig. 7.

Dimensions of figured specimen: Length 0.91 mm., height 0.52 mm., width 0.49 mm.

Occurrence in material studied: Upper Shakalai shale--rare at locality N.

Types: Hypotype, one carapace, No. N-7, from locality N.

Remarks: Only one good complete specimen was available for study. It exhibits most of the specific features of Bairdia jonesi van den Bold, 1946.

Bairdia machaquillaensis van den Bold

Plate 3, figure 9

Bairdia machaquillaensis van den Bold, 1946, Univ. of Utrecht Thesis, p. 72, pl. 4, fig. 3a-b.--van den Bold, 1960, Micropaleontology, vol. 6, no. 2, p. 153, pl. 2, fig. 8.

Dimensions of figured specimen: Length 0.63 mm., height 0.43 mm., width 0.34 mm.

Occurrence in material studied: Lower part of Lockhart limestone--common at locality A<sub>1</sub>.

Types: Hypotype, one complete carapace, No. A1-10, from locality A<sub>1</sub>.

Remarks: In general, the present specimens are slightly smaller than the holotype.

Bairdia hiwanneensis Howe and Lea

Plate 3, figure 10a-b

Bairdia hiwanneensis Howe and Lea, 1936, in Howe and Law, 1936, Louisiana Dept. Cons., Geol. Bull. no. 7, p. 27, pl. II, fig. 9.--van den Bold, 1957b, Micropaleontology, vol. 3, no. 3, p. 236.

Dimensions of figured specimen: Length 1.0 mm., height 0.63 mm., width 0.53 mm.

Occurrence in material studied: Limestone lens in Hangu sandstone--rare at locality B<sub>1</sub>; Mulla Bata limestone--rare at locality L.

Types: Hypotypes, one carapace, No. B1-11, from locality B<sub>1</sub>, one complete shell, No. L-6, from locality L.

Remarks: The present specimens are bigger than the holotype, and the posterior end is narrower.



Bairdia oviformis Speyer

Plate 3, figure 11

Bairdia oviformis Speyer, 1863, Ver. Naturk. Cassel. Ber.,  
Cassel, Germany, no. 13, p. 44, pl. 1, fig. 6a-c.

Dimensions of figured specimen: Length 0.63 mm., height  
0.38 mm.

Occurrence in material studied: Mulla Bata limestone--  
common at locality L.

Types: Hypotype, one carapace, No. L-8, from locality L.

Remarks: The present forms are in general smaller in size  
than the holotype, and their anterior and posterior ends  
are more sharply pointed; overlap in these shells is less  
clear than the holotype.

Bairdia amygdaloides Brady var. oblongata van den Bold

Plate 4, figure 1a-b

Bairdia amygdaloides oblongata van den Bold, 1946, Univ.  
of Utrecht Thesis, p. 70, pl. 1, fig. 5a-b.

Dimensions of figured specimen: Length 0.63 mm., height  
0.38 mm.

Occurrence in material studied: Mulla Bata limestone--  
common at locality L.

Types: Hypotype, one carapace, No. L-7, from locality L.

Remarks: A few of the present specimens are somewhat weathered; the well-preserved ones possess the shape, overlap, angulation on dorsal margin and the sharply angulated posterior end which are the diagnostic features prescribed by van den Bold (1946) for the subspecies.

Bairdia dimorpha van den Bold

Plate 4, figure 2a-b

Bairdia dimorpha van den Bold, 1963, Micropaleontology, vol. 9, no. 4, pp. 373-374, pl. 1, fig. 6a-d.

Dimensions of figured specimens: Female--length 1.02 mm., height 0.69 mm. Male--length 1.08 mm., height 0.68 mm.

Occurrence in material studied: Mulla Bata limestone--rare at locality L.

Types: Hypotype, one female carapace, No. L-9a, and one male carapace, No. L-9b, from locality L.

Remarks: The present specimens are about 1/3 times bigger than the holotype.

Bairdia comanchensis Alexander

Plate 4, figure 3

Bairdia comanchensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 63, pl. 2, fig. 15; pl. 3, fig. 4--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 66, text-fig. p. 66.--Swain and Brown, 1964, North Carolina Dept. Cons. and Dev. Miner. Res., Bull. no. 78, pp. 12-13, pl. 1, fig. 5a-c.

Dimensions of figured specimen: Length 0.82 mm., height 0.50 mm., width 0.45 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Homoeotype, one complete carapace, No. A3-43, from locality A<sub>3</sub>.

Remarks: The present forms are somewhat weathered. By comparing with the types of Swain and Brown (1964), it was observed that the present forms possess the distinctive specific characteristics listed by Alexander (1929) for the species Bairdia comanchensis Alexander.

Bairdia megista n. sp.

Plate 10, figure 1

Etymology: megista (L), very large, referring to the unusually large size of the carapace.

Distinguishing characteristics: This new species is characterized by having the highest point behind the middle, the height a little more than the shell length, compressed anterior end, the anterior end projected out ventro-medially, and by having an unusually large size.

Description: Carapace triangular-ovate; greatest height just behind the middle; height a little more than half the shell length. Dorsal margin evenly arched with fairly strong convexity. Ventral margin straight in the middle half, curved upward at the anterior and posterior quarters. Anterior end narrowly rounded, compressed, and extended medially, curved ventrally, truncated dorsally. Posterior end more narrowly rounded than the anterior end and projected out ventro-medially to a blunt point, ventral portion of the posterior end being curved up and dorsal portion curved down. Left valve larger than the right, overlapping the latter on all sides with strongest overlap on dorsal margin, less so on ventral margin and the least on the anterior and posterior ends. Lateral surface smooth.

Hingement consists of groove in hinge face of the left valve into which fits edge of right valve. Along dorsal slopes, crenulations that are the characteristics of Bairdoppilata Coryell, Sample and Jennings (1935) are lacking.

Comparison: The new species Bairdia megista to some extent resembles Bairdia comanchensis Alexander, 1929, but differs from it in being much larger, more than twice in size, in having the highest point posterior to middle, height more than half the shell length, ventral margin straight in the middle half, anterior end compressed, posterior end bluntly pointed, the strongest overlap on dorsal margin rather than ventral margin.

Dimensions of holotype: Left valve--length 1.69 mm., height 1.06 mm.; Right valve--length 1.62 mm., height 0.98 mm.; width of the carapace 0.75 mm.

Occurrence in material studied: Lower part of Lockhart limestone--abundant at locality A<sub>1</sub>; Mulla Bata limestone--common at locality L.

Types: Holotype, a complete carapace, No. A1-11, from locality A<sub>1</sub>; Paratypes, one complete carapace, No. A1-12, from locality A<sub>1</sub>; one complete carapace, No. L-10, from locality L.

Type locality: Lockhart limestone, locality A<sub>1</sub>, Samana Range, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Tertiary

Bairdia wauchulensis Swain

Plate 4, figure 4

Bairdia wauchulensis Swain, 1946, Jour. Paleontol., vol. 20, pp. 375-376, pl. 54, fig. 1a-d.

Dimensions of figured specimen: Length 1.25 mm., height 0.81 mm.

Occurrence in material studied: Base of Lockhart limestone--common at locality A<sub>1</sub>.

Types: Homoeotype, one complete carapace, No. A1-13, from locality A<sub>1</sub>.

Remarks: Compared to paratypes in Dr. Swain's reference collections, the present forms exhibit more distinct overlaps and less pointed posterior end.

Genus Bythocypris Brady, 1880

Type species: Bairdia bosquetiana Brady, 1866, Trans., Zool. Soc. London, vol. 5, p. 364, pl. 57,--the young of

Bythocypris reniformis Brady, 1880, Zoology, vol. 1, p. 46, pl. 5, fig. 1a-1.

Range: ? Lower Ordovician to Recent.

Bythocypris goodlandensis Alexander

Plate 4, figure 5a-b

Bythocypris goodlandensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 64, pl. 3, figs. 11, 13.--Lozo, 1944, Amer. Midland Nat., vol. 31, no. 3, p. 530, map of locality.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 97, text-figs. p. 97.

Dimensions of figured specimen: Length 0.63 mm., height 0.25 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, one complete shell, No. A3-44, from locality A<sub>3</sub>.

Remarks: The greatest height of the present specimens is a little posterior to the middle, rather than at the middle, as in holotype.

Family MACROCYPRIDIDAE Müller, 1912

Subfamily MACROCYPRINAE Müller, 1912

Genus MACROCYPRIS Brady, 1868

Type species: Cythere minuta Baird, 1850, Roy. Soc.

London, vol. 1, p. 171, pl. 20, fig. 4a-d.

Range: ? Ordovician--? Miocene; Pliocene to Recent.

Macrocypris simplex Chapman

Plate 4, figure 6a-b

Macrocypris simplex Chapman, 1898, Ann. Mag. Nat. Hist.

ser. 7, vol. 2, p. 333, fig. 1a-c.--Chapman, 1904, South

African Mus., Ann. ser. 4, vol. 5, p. 233, pl. 29, figs.

22, 22a-b.--Howe and Laurencich, 1958, Introduction to the

Study of Cretaceous Ostracoda, p. 394, text-figs. p. 394.

Dimensions of figured specimen: Length 0.98 mm., height 0.38 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, one complete shell, No. A3-45, from locality A<sub>3</sub>.

Remarks: The present specimens are shorter and lower than the holotype.



Macrocypris sp. aff. M. limburgensis Veen

Plate 4, figure 7a-b

Macrocypris siliqua Veen, 1934, Natuurhist. Maandblad, vol. 23, nos. 7-10, p. 39 (89), pl. 1, figs. 1-9.

Dimensions of figured specimen: Length 0.75 mm., height 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality E.

Types: Hypotype, an instar, No. E-13, from locality E.

Remarks: Only three good specimens were available for study and all three of them are instars. Classification is indefinite because no adult carapaces were encountered.

Macrocypris dubia Bonnema

Plate 4, figure 8a-b

Macrocypris dubia Bonnema, 1940-1941, Naturrhist. Maandblad, vol. 27, p. 107, pl. 2, figs. 28-30.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 391, text-figs. p. 391.

Dimensions of figured specimen: Length 0.55 mm., height 0.25 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, a complete carapace, No. A3-46, from locality A<sub>3</sub>.

Remarks: One of the characteristic features of Macrocypris dubia Bonnema, a notch on the dorsal margin near the anterior end, is not quite distinct in the present specimens.

Macrocypris graysonensis Alexander

Plate 4, figure 9a-b

Macrocypris graysonensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 59, pl. 2, figs. 13-14.--Bonnema, 1940, Natuurhist. Maandblad, vol. 27, p. 107, pl. 2, fig. 27.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 391-392, text-fig. p. 392.

Dimensions of figured specimens: Length 0.83 mm., height 0.39 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Homoeotype, one complete carapace, No. A3-47, from locality A<sub>3</sub>.

Remarks: The present specimens were compared with some topotypes in Dr. Swain's reference collections. It was found that the present forms show marked overlap on the

ventral margin which neither the illustrations nor the topotypes exhibit clearly.

Macrocypris modesta (Reuss)

Plate 4, figure 10

Cytherina modesta Reuss, 1851, Naturwiss. Abh. (Haidinger's), Vienna, vol. 4, pt. 1, p. 49, pl. 6, fig. 9a-c.

Not--Bairdia modesta Reuss, 1874, Palaentographica, vol. 20, pt. 2, p. 142, pl. 26, figs. 10-11.

Not--Bairdia modesta Fritsch and Kafka, 1887, p. 13, fig. 21.

Not--Bairdia modesta Schacko, 1889, Deutsch. Geol. Gesell, Zeitschr., vol. 41, p. 617.

Not--Bairdia modesta Egger, 1900, Bayerischen Akad., Wis., Abh. math-phys. Classe, vol. 21, p. 179, pl. 27, figs. 4-6.

Not--Bairdia modesta Egger, 1908, Naturwiss. Verein zu Passau (e.V.) Bericht, vol. 20, p. 57, pl. 10, figs. 1-2.

? Bairdia modesta Marsson, 1880, Naturwiss. verein von Neu. Rugen, Greifswald. Mitteilungen, 1880, p. 37.

Macrocypris ? modesta Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 392-393, text-figs. p. 393.

Dimensions of figured specimen: Length 0.58 mm., height 0.30 mm.

Occurrence in material studied: Cholor Silli limestone--rare at localities D<sub>2</sub> and E.

Types: Hypotypes, one carapace, No. D2-16, from locality D<sub>2</sub>, one shell, No. E-14, from locality E.

Remarks: The present forms are smaller in size than the specimen illustrated by Howe and Laurencich (1958) after Reuss (1874). It seems that in 1874 Reuss decided to include all elongated Cretaceous forms with the shape of either Macrocypris or Paracypris under the name "Bairdia modesta." Later workers, mentioned above, followed him with additional forms. According to Howe and Laurencich (1958) in actuality the original figures and description by Reuss show a very sharp-pointed posterior which is quite unlike all the later figures. Reuss figured the right valve the larger and that is why Howe and Laurencich (1958) tentatively placed the species in Macrocypris rather than Paracypris with a suggestion that "it needs restudy of the original material."

The specimens from Pakistan are definitely Macrocypris because their right valves are larger. Following the

description and illustrations of Reuss (1874), and Howe and Laurencich (1958) coupled with Dr. Swain's suggestions the Pakistani specimens are assigned to Macrocypris modesta.

Macrocypris concinna Jones and Hinde

Plate 4, figure 11

Macrocypris concinna Jones and Hinde, 1890, Palaentogr. Soc., London, vol. 43, p. 11, pl. 2, figs. 66-67.

Macrocypris ? concinna Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 391, text-fig. p. 391.

Dimensions of figured specimen: Length 0.51 mm., height 0.19 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality E.

Types: Hypotype, one complete carapace, No. E-15, from locality E.

Remarks: Jones and Hinde (1890) described and illustrated a single left valve without any internal details to indicate which valve was larger in their specimen and that is why Howe and Laurencich (1958) questioned the generic assignment. The present specimens have the right valves

larger than the left and therefore they are assigned to Macrocypris. Regarding the specific assignment these forms possess the characteristic features that conform to those prescribed to Macrocypris concinna by Jones and Hinde (1890) except that these are smaller in size.

Superfamily CYPRIDACEA Baird, 1845

Family PARACYPRIDIDAE Sars, 1923

Subfamily PONTOCYPRIDINAE Müller, 1894

Genus Pontocyprella Mandelstam, 1955 in Lüvimova

Type species: Bairdia harrisiana Jones, 1849, Paleonto. Soc. London, pp. 25-26, pl. 16, fig. 17a-f.

Remarks: This genus has been variously attributed to Lüvimova, 1955 (Malz, 1959), to Mandelstam, 1955 (Oertli, 1959), to Mandelstam, 1956 (Howe and Laurencich, 1958); Mandelstam and Schneider in Chernysheva, 1960, and to Mandelstam, 1955, in Lyubimova (Neale, 1962). Malz (1959) discussed the situation and noted that the question hinges on the responsibility for publication. This genus has been placed in either the Pontocypridinae (Lüvimova, 1955; Mandelstam and Schneider in Chernysheva, 1960) or the Bairdiinae (Oertli, 1959). The left valve of Jones' material, according to Neale (1962), p. 432, pl. 6, fig. 13a,

reveals that the musclescar pattern consists principally of three horizontally elongate scars, each of which shows subdivisions. This suggests that they belong more with the Cyprididae than with the Bairdiidae, and although their assignment to the Pontocypridinae is debatable, they are retained in this subfamily, following Neale (1962).

Range: Jurassic to Paleocene.

Pontocyprrella rara Kaye

Plate 4, figure 12a-c

Pontocyprrella rara Kaye, 1965a in Kaye, P. and Barker, D., 1965, Palaeontology, vol. 8, pt. 3, pp. 376-377, pl. 49, figs. 6-12.

Dimensions of figured specimens: Female--length 0.83 mm., height 0.44 mm.; Male--length 0.82 mm., height 0.40 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality A<sub>3</sub>; common at localities B<sub>2</sub>, D<sub>2</sub>, E; rare at locality H<sub>1</sub>; Tsukail-Tsuk limestone--rare at locality G<sub>1</sub>.

Types: Hypotypes, one female carapace, No. A3-48, from locality A<sub>3</sub>, one male carapace, No. B2-12, from locality B<sub>2</sub>, a female carapace, No. D2-17, from locality D<sub>2</sub>, one male shell, No. E-16, from locality E, one female carapace,

No. G1-16, from locality G<sub>1</sub>, one male carapace, No. H1-10, from locality H<sub>1</sub>.

Remarks: The males appear to be narrower than the females and the instars have more strongly convexed dorsal margin and are proportionately higher.

Pontocyprrella harrisiana (Jones)

Plate 5, figure 1a-b

Cythere (Bairdia) harrisiana Jones, 1849, Paleontogr. Soc. London, p. 25, pl. 6, fig. 17a-f.

Not--Cytheridea harrisiana Bosquet, 1854, Comm. Pour la desc. et la carte géol. de la Neerlande, Mém., vol. 2, p. 63 (73), pl. 5, fig. 5a-d.

Bairdia harrisiana Jones, 1870, Geol. Mag., vol. 7, pp. 75, 77, pl. 2, figs. 52-55.

Not--Bairdia harrisiana Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 60, pl. 2, figs. 18-19.

Not--Bythocypris harrisiana Veen, 1934, Natuurhist. Maandblad, vol. 23, nos. 7-10, p. 26 (128), pl. 8, figs. 30-38.

Pontocyprrella harrisiana (Jones)--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 462-463, text-fig. p. 463.



Dimensions of figured specimen: Length 0.75 mm., height 0.31 mm.

Occurrence in material studied: Lowermost member of Chalor Silli limestone--rare at locality A<sub>3</sub>.

Types: Hypotype, one carapace, No. A3-49, from locality A<sub>3</sub>.

Remarks: The holotype, which is also the type species of the genus (Bairdia harrisiana Jones, 1849) was described from Aptian beds of Lower Cretaceous. The Pakistani specimens were collected from a bed which seems to be Cenomanian in age.

#### Subfamily PARACYPRIDINAE Sars, 1923

##### Genus Paracypris Sars, 1866

Type species: Paracypris polita Sars, 1866, Forhandl.

Vidensk. Seleskab Christiana, vol. 7, p. 12.

Range: Jurassic to Recent.

##### Paracypris dentonensis Alexander

Plate 5, figure 2a-b

Paracypris dentonensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 65, pl. 4, figs. 1, 4.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 447, text-fig. p. 447.

Dimensions of figured specimen: Length 0.90 mm., height 0.43 mm., width 0.28 mm.

Occurrence in material studied: Chalor Silli limestone--abundant at locality A<sub>3</sub>, rare at locality B<sub>2</sub>; Tsukail-Tsuk limestone--rare at locality G<sub>1</sub>.

Types: Hypotypes, one carapace, No. A3-50, from locality A<sub>3</sub>, one carapace, No. B2-13, from locality B<sub>2</sub>, one complete shell, No. G1-17, from locality G<sub>1</sub>.

Remarks: The present specimens are a little higher than the holotype and thus the height of these forms is about half the shell length.

Paracypris tenuicula Alexander

Plate 5, figure 3a-b

Paracypris pulchella Alexander, 1929, Univ. of Texas, Bull. no. 2907, pp. 66-67, pl. 4, fig. 2, 8.--Albritton, 1941, Field and Lab., Dallas, vol. 10, no. 1, p. 49.

Paracypris tenuicula Alexander, new name in Loetterle, 1937, p. 52, pl. 8, fig. 7a-b.

Dimensions of figured specimen: Length 0.94 mm., height 0.39 mm., width 0.25 mm.

Occurrence in material studied: Chalor Silli limestone--rare at localities A<sub>3</sub> and E.

Types: Hypotypes, one carapace, No. A3-51, from locality A<sub>3</sub>, one carapace, No. E-17, from locality E.

Remarks: The present forms are thinner or more compressed than the holotype.

Paracypris goodlandensis Howe and Laurencich

Plate 5, figure 4a-b

Paracypris siliqua Jones and Hinde.--Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 64, pl. 3, figs. 11, 13.

Paracypris goodlandensis Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 448, text-fig. p. 448.--Swain and Brown, 1964, North Carolina Dept. Cons. Dev., Div. Mineral Res., Bull. no. 78, pp. 13-14, pl. 1, fig. 7a-c.

Dimensions of figured specimen: Length 1.10 mm., height 0.37 mm., width 0.18 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality A<sub>3</sub>, rare at localities B<sub>2</sub> and E.

Types: Homoetypes, one complete carapace, No. A3-52, from locality A<sub>3</sub>, one carapace, No. B2-14, from locality B<sub>2</sub>, one shell, No. E-18, from locality E.

Remarks: The present specimens were compared with the types of Swain and Brown, 1964, and it was found that

these forms are somewhat larger than those and the holotype of Howe and Laurencich (1958); also these specimens have the anterior end slightly narrowly rounded.

Paracypris sp. aff. P. angusta Alexander

Plate 5, figure 5a-b

Paracypris angusta Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 67, pl. 4, figs. 3, 7.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 446, text-fig. p. 446.

? Paracypris aff. P. angusta Alexander.--Swain, 1948, Maryland Dept. Geol., Mines and Water Res., Bull. no. 2, p. 192, pl. 12, fig. 6.

Paracypris cf. P. angusta Alexander.--Swain and Brown, 1964, North Carolina Dept. Cons., Dev. Div. Min. Res., Bull. no. 78, p. 15, pl. 4, fig. 2a-b.

Dimensions of figured specimen: Length 0.87 mm., height 0.38 mm., width 0.21 mm.

Occurrence in material studied: Chalor Silli limestone--rare at localities A<sub>3</sub> and B<sub>2</sub>.

Types: Homoeotypes, one carapace, No. A3-53, from locality A<sub>3</sub>, one carapace, No. B2-15, from locality B<sub>2</sub>.

Remarks: The present forms are a little larger than the holotype. These are also somewhat weathered and distorted. Moreover, there were only three specimens available for study. Therefore the classification is tentative.

Paracypris weatherfordensis Vanderpool

Plate 5, figure 6

Paracypris weatherfordensis Vanderpool, Jour. Paleontol., vol. 2, p. 104, pl. 14, figs. 11-12.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 451, text-fig. p. 451.--Swain and Brown, 1964, North Carolina Dept. Cons. Dev., Div. Min. Res., Bull. no. 78, pp. 14-15, pl. 4, fig. 1a-b.

Dimensions of figured specimen: Length 0.83 mm., height 0.36 mm., width 0.26 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality A<sub>3</sub>, rare at locality B<sub>2</sub>.

Types: Homoeotypes, one complete carapace, No. A3-54, from locality A<sub>3</sub>; one carapace, No. B2-16, from locality B<sub>2</sub>.

Remarks: The ventral margin of the present specimens is slightly more concave than the type of Swain and Brown, 1964, with which these forms were compared.

Paracypris acuta (Cornuel)

Plate 5, figure 7a-b

Cythere acuta Cornuel, 1848, Soc. Géol. de France, Mém., ser. 2, vol. 1, p. 242, pl. 1, figs. 7-8.

Not--Cythere acuta Baird, 1850, Roy. Soc. London, p. 173, pl. 21, fig. 5.

Not--Cythere (Bairdia?) acuta Jones, 1850, Ann. Mag., Nat. Hist., ser. 2, vol. 6, p. 63, pl. 18, fig. 10 (Permian).

Not--Paracypris acuta Sharapova, 1939, Leningrad: Vses. neft. nauch. geologo. inst., Trudy, ser. A, Fascicle 126, p. 10, pl. 1, fig. 1.

Paracypris acuta Stchepinsky, 1954, Bull. Soc. Geol. France, ser. 6, vol. 4, p. 488, pl. 22, fig. 7, text-pl. 1, fig. 7.--Deroo, 1956, Revue d. l'Inst. Français du Petr. et Ann. d. Combust. Liquides, vol. 11, no. 12, p. 1509, pl. 4, figs. 49-50.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 445-446, text-figs. p. 446.

Dimensions of figured specimen: Length 0.67 mm., height 0.23 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality E, Tsukail-Tsuk limestone--rare at locality G<sub>1</sub>.



Types: Hypotypes, one carapace, No. E-19, from locality E; one carapace, No. G1-18, from locality G<sub>1</sub>.

Remarks: The posterior end of the present specimens is narrower and more pointed than the holotype, and the ventral margin is slightly more concave. The specimen No. G1-18 has doubtful stratigraphic position like Bairdia sp. aff. B. gracilis Alexander (p. 107). The samples containing these specimens had a number that belongs to the Lower Cretaceous Khadimakh formation (sandstone) but the lithology of the samples is limestone, similar to the Tsukail-Tsuk limestone, the upper member of the Upper Cretaceous Darsamand limestone. Other specimens were collected at locality E from the outcrops of the Chalor Silli limestone, the lower member of the Upper Cretaceous Darsamand limestone. This species has so far been reported from the Lower Cretaceous (Hauterivian-Aptian) rocks of France. The comments made for Bairdia sp. aff. B. gracilis Alexander (p.107) is applicable to this species also since both the species were found in the same samples that were wrongly numbered and also in rightly numbered samples collected from the Upper Cretaceous rocks exposed at another locality (locality E).





Paracypris depressa Bonnema

Plate 5, figure 8

Paracypris depressa Bonnema, 1940-1941, Natuurhist.

Maandblad, vol. 27, p. 115, pl. 3, figs. 30-31.--Howe  
and Laurencich, 1958, Introduction to the Study of Cre-  
taceous Ostracoda, pp. 447-448, text-fig. p. 448.

Dimensions of figured specimen: Length 0.92 mm., height  
0.36 mm.

Occurrence in material studied: Chalor Silli limestone--  
rare at locality A<sub>3</sub>.

Types: Hypotype, one carapace, No. A3-55, from locality A<sub>3</sub>.

Remarks: The present forms are slightly smaller than the  
holotype, and the posterior end is somewhat more pointed  
and the anterior end is a little higher than the holotype.

Paracypris siliqua Jones and Hinde

Plate 5, figure 9

Paracypris siliqua Jones and Hinde, 1890, Palaentogr. Soc.  
London, vol. 43, p. 2, pl. 2, figs. 48-49, 51; pl. 3,  
figs. 33-34.

? Paracypris siliqua Chapman and Sherborn, 1893, Geol.  
Mag., Decade III, vol. X, p. 346.



? Paracypris siliqua Chapman, 1898, Ann. Mag., Nat. Hist., ser. 7, vol. 2, p. 332.

Not--Paracypris siliqua Egger, 1900, Bayerischen Akad., Wiss., Abh. math-phys. Classe, vol. 21, p. 179, pl. 27, figs. 16-17.--Chapman, 1917, Western Australia Geol. Survey, Bull. no. 72, p. 52, pl. 13, fig. 1.--Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 65, pl. 3, figs. 7, 10; pl. 4, fig. 5.--Weber, 1935, Nieder. Geol. Verein, Hanover, 26, Jahr. 1934/1935, p. 140, pl. 8, fig. 6.

Paracypris siliqua Dupper, 1952, Palaont. Zeitschr., Stuttgart, vol. 26, p. 106, pl. 4, fig. 27.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 450, text-fig. p. 450.

Dimensions of figured specimen: Length 0.93 mm., height 0.35 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality E.

Types: Hypotype, one complete carapace, No. E-20, from locality E.

Remarks: Angulations on both the ends of the straight hinge line of the present forms are much more distinct than the holotype and the posterior end is slightly thicker.

Paracypris sp. aff. P. limburgensis Veen

Plate 5, figure 10

Bairdia arcuata Bosquet, 1854a, Comm. pour la desc. et la carte géol. de la Neerlande, Mém. vol. 2, p. 59 (69), pl. 5, fig. 3a-d.--Bosquet in Staring, 1860, De Bodem Van Nederland, p. 364.--Bosquet in Ubaghs, 1879, Description Géologique et Paleontologique du sol du Lindbourg, p. 200.

Paracypris limburgensis Veen, 1934, Natuurhist. Maandblad, vol. 23, p. 89, pl. 1, figs. 8-10.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 449, text-fig. p. 449.

Paracypris aff. limburgensis Veen.--van den Bold, 1946, Univ. of Utrecht, Thesis, p. 65, pl. 4, fig. 1.--van den Bold, 1957a, Micropaleontology, vol. 3, no. 1, p. 5, pl. 2, fig. 11.

Dimensions of figured specimen: Length 1.00 mm., height 0.37 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality E; Tsukail-Tsuk limestone--common at locality G<sub>1</sub>.

Types: Hypotypes, one complete carapace, No. E-21, from locality E; one carapace, No. G1-19, from locality G<sub>1</sub>.

Remarks: The present specimens, though possess the specific characteristics prescribed by Veen (1934) for Paracypris limburgensis, are too narrow. The length-height ratio of the holotype is 2.27 whereas that of the present forms is 2.70. Therefore the classification of these forms is tentative.

Paracypris franquesi Howe and Chambers

Plate 5, figure 11a-b

Paracypris franquesi Howe and Chambers, 1935, Dept. Cons., Louisiana Geol. Survey, Bull. no. 5, pp. 10-11, pl. III, fig. 13; pl. IV, figs. 15-19.--Garrett, 1936, Jour. Paleontol., vol. 10, no. 8, p. 786.--Monsour, 1937, Amer. Assoc. Petrol. Geol., Bull. no. 21, no. 1, p. 89.--van den Bold, 1946, Univ. of Utrecht, Thesis, p. 66, pl. 1, fig. 16.--Stephenson, 1946, Jour. Paleontol., vol. 13, no. 6, p. 309, pl. 42, fig. 4; pl. 44, fig. 11.--van den Bold, 1950, Jour. Paleontol., vol. 24, no. 1, p. 108.--Krutak, 1961, Jour. Paleontol., vol. 35, no. 4, p. 774, pl. 92, fig. 1.

Paracypris strecca Schmidt, 1948, Jour. Paleontol., vol. 22, no. 4, p. 408, pl. 63, figs. 21-22.



Paracypris cf. P. franquesi Swain, 1951, U.S. Geol. Survey, Prof. Paper 234-A, p. 16, pl. 1, fig. 6.

Dimensions of figured specimen: Length 0.82 mm., height 0.34 mm.

Occurrence in material studied: Mulla Bata limestone--rare at locality L.

Types: Hypotype, one carapace, No. L-11, from locality L.

Remarks: All the characteristic features assigned to the species Paracypris franquesi Howe and Chambers were observed in the present forms except the ventral margin which in these specimens is slightly more curved.

Paracypris communis van den Bold

Plate 5, figure 12a-b

Paracypris communis van den Bold, 1946, Univ. of Utrecht, Thesis, p. 66, pl. 2, fig. 11.--van den Bold, 1957a, Micropaleontology, vol. 3, no. 1, p. 5, pl. 2, fig. 12a-b.

Dimensions of figured specimen: Length 0.76 mm., height 0.37 mm., width 0.31 mm.

Occurrence in material studied: Mulla Bata limestone--rare at locality L.

Type: Hypotype, one carapace, No. L-12, from locality L.



Remarks: The present forms are slightly different from the holotype in being a bit larger and thicker. The holotype is much more compressed compared to the present specimens. Other specific characteristic features conform with those of Paracypris communis van den Bold, 1946.

Paracypris stolki van den Bold

Plate 5, figure 13a-b

Paracypris stolki van den Bold, 1958, Micropaleontology, vol. 4, no. 4, p. 397, pl. 2, fig. 1a-b.

Dimensions of figured specimen: Length 0.75 mm., height 0.41 mm., width 0.26 mm.

Occurrence in material studied: Base of Lockhart limestone--common at locality A<sub>1</sub>; Mulla Bata limestone--common at locality L.

Types: Hypotypes, one complete carapace, No. A1-14, from locality A<sub>1</sub>, one carapace, No. L-13, from locality L.

Remarks: The present forms are slightly larger and higher than the holotype but have the same width; other diagnostic characteristics are identical.

Family PONTOCYPRIDIDAE Müller, 1894

Genus Propontocypris Sylvaster-Bradley, 1947

Type species: Pontocypris trigonella Sars, 1866, Forhandl. Vidensk. Selskab Christiania, vol. 7, p. 16.

Range: Miocene to Recent.

Propontocypris sp. aff. P. solida Ruggieri

Plate 5, figure 14a-c

Propontocypris solida Ruggieri, 1952, Giron Geol., Bologna, ser. 2, vol. 22 (1950), p. 91, pl. 8, figs. 1-5.

Dimensions of figured specimen: Length 0.72 mm., height 0.38 mm., width 0.34 mm.

Occurrence in material studied: Limestone cap of Tarkhobi shale--rare at locality A<sub>1</sub>; Lockhart limestone--rare at localities A<sub>1</sub>, D<sub>1</sub>, F, H<sub>2</sub>; Shakalai shale--rare at locality N.

Types: Hypotypes, one weathered carapace, No. A1-15, from the Tarkhobi shale at locality A<sub>1</sub>; a good carapace, No. A1-16, from the Lockhart limestone at locality A<sub>1</sub>; one complete shell, No. D1-3, from locality D<sub>1</sub>; a carapace, No. F-3, from locality F; one complete shell, No. H2-2, from locality H<sub>2</sub>; one carapace, No. N-8, from locality N.

Remarks: The external diagnostic features of Propontocypris solida Ruggieri are clearly observed in most of the present specimens. But since there was no single valve available to examine the internal features these forms are tentatively assigned to Propontocypris solida Ruggieri, 1952.

Suborder PLATYCOPINA Sars, 1866

Family CYTHERELLIDAE Sars, 1866

Genus Cytherella Jones, 1849

Type species: Cytherina ovata Roemer, 1840, Die Verst. des nord deutsch. Kreide, Hanover, Germany, p. 104, pl. 16, fig. 21; designated by Ulrich, 1894, Minnesota Geol. Nat. Hist. Surv. Rept., vol. 3, no. 2, p. 684.

Range: Jurassic to Recent.

Cytherella beyrichi (Reuss)

Plate 6, figure 1a-b

Cytherina beyrichi Reuss, 1851, Zeitsch. deut. geol. Ges., vol. 3, p. 89, pl. 7, fig. 65.

Cytherella beyrichi (Reuss)--Bornemann, 1855, Zeitschr. deut. geol. Ges., vol. 7, p. 354, pl. 20, fig. 1.--Kuiper,

1918, Thesis, Univ. of Groningen, p. 81, pl. 3, fig. 34.--

Keij, 1957, Inst. Roy. des Sci. Nat. de Belg., Mem. no.

136, p. 45, pl. 1, figs. 8-9.

Not--Cytherella beyrichi (Reuss)--Schmidt, 1948, Jour.

Paleontol., vol. 22, p. 406, pl. 61, fig. 2.

Dimensions of figured specimens: Female--length 0.75 mm., height 0.41 mm., Male--length 0.75 mm., height 0.39 mm.

Occurrence in material studied: Upper part of Shakalai shale--rare at locality N.

Types: Hypotypes, one complete carapace of a male, No. N-9, from locality N; one single right valve of a female, No. N-10, from locality N.

Remarks: The present forms of this species are somewhat variable in outline and punctation. The males are lower and more elongated than the females. The dorsal margin of the males often slopes gradually toward the posterior end which is less broadly rounded in the female.

Cytherella beyrichoides Swain and Brown

Plate 6, figure 2

Cytherella beyrichi (Reuss).--Schmidt, 1948, Jour. Paleontol., vol. 22, p. 406, pl. 61, fig. 2.

Cytherella beyrichoides Swain and Brown, 1964, North Carolina Dept. Cons. Dev. Div., Miner. Res., Bull. no. 78, pp. 8-9, pl. 1, fig. 1, text-fig. 3a.

Dimensions of figured specimen: Length 0.63 mm., height 0.38 mm., width 0.23 mm.

Occurrence in material studied: Chalor Silli limestone--rare at localities  $A_3$ ,  $D_2$ , E,  $H_1$ .

Types: Homoeotypes, one carapace, No. A3-56, from locality  $A_3$ , one carapace, No. D2-18, from locality  $D_2$ , one complete shell, No. E-22, from locality E, one shell, No. H1-11, from locality  $H_1$ .

Remarks: Compared to the paratypes of Swain and Brown (1964) the present forms are slightly smaller.

Cytherella sp. aff. C. polita Brady

Plate 6, figure 3a-b

Cytherella polita Brady, 1869, Les fonds de la mer, vol. 1, p. 161, pl. 19, figs. 5-7.--Müller, 1912, Das Tierreich, p. 396.--van den Bold, 1957b, Micropaleontology, vol. 3, no. 3, p. 235, pl. 1, fig. 2a-b.

? Cytherella polita Brady.--Guppy, 1893, Trinidad Field Nat. Club, Jour., vol. 1, p. 28.--Guppy, 1903, Victoria

Inst. Trinidad, Proc., vol. 2, p. 2.--Chapman, 1926, New Zealand, Geol. Survey, Pal. Bull. no. 11, p. 105, pl. 22, fig. 12.

Not--Cytherella polita Brady.--Brady, 1880, Rept. Voy. Challenger, Zool., vol. 1, pt. 3, p. 172, pl. 43, fig. 5a-c; pl. 44, fig. 1a-g.--Chapman, 1916, Victoria, Geol. Survey, Rec., vol. 3, p. 379, pl. 75, fig. 45.--van den Bold, 1946, Univ. of Utrecht, Thesis, p. 60, pl. 3, fig. 2a-e.

Cytherella sp. van den Bold, 1950, Jour. Paleontol., vol. 24, p. 80, pl. 18, fig. 1a-e.

? Cytherella lata Brady.--Keij, 1954, K. Nederl. Akad. Wetensch., Afd. Natuurk., Verh., ser. 1, vol. 20, p. 218, pl. 3, fig. 6a-b.

Cytherella polita Brady, var.--van den Bold, 1966, Micro-paleontology, vol. 12, no. 3, p. 361, pl. 1, fig. 5.

Dimensions of figured specimen: Length 0.53 mm., height 0.35 mm., with 0.24 mm.

Occurrence in material studied: Shakalai shale--rare at locality N.

Types: Hypotype, one complete carapace, No. N-11, from locality N.

Remarks: Only four specimens were available for study and they are partially weathered. The observed external features are suggestive of Cytherella polita Brady.

Cytherella symmetrica Alexander

Plate 6, figure 4a-b

Cytherella symmetrica Alexander, 1934b, Jour. Paleontol., vol. 8, no. 2, p. 212, pl. 32, figs. 9, 13.

Dimensions of figured specimen: Length 0.80 mm., height 0.47 mm., width 0.37 mm.

Occurrence in material studied: Base of Lockhart limestone--rare at locality F.

Types: Hypotype, one carapace, No. F-4, from locality F.

Remarks: The flange on the anterior border of the left valve of the present forms is more or less like a blunt spine rather than a rim, probably due to weathering.

Cytherella pustulosa Keij

Plate 6, figure 5a-c

Cytherella pustulosa Keij, 1957, Inst. Roy. des Sci. Nat. de Belg., Mém. no. 136, p. 46, pl. 1, figs. 5-6.

Dimensions of figured specimens: Female--length 0.86 mm., height 0.43 mm., width 0.21 mm.; Male--length 0.81 mm., height 0.41 mm., width 0.20 mm.

Occurrence in material studied: Shakalai shale--rare at locality N.

Types: Hypotypes, one female carapace, No. N-12a, and one male carapace, No. N-12b, from locality N.

Remarks: The following diagnostic features were observed in the present specimens--elongate shape of the carapace, subtruncate posterior, marked muscle-scar pit, faintly reticulated surface.

Cytherella austinensis Alexander

Plate 6, figure 6a-b

Cytherella obesa Alexander (not--Jones and Kirkby, 1884), 1929, Univ. of Texas, Bull. no. 2907, p. 51, pl. 1, figs. 3, 6 (female, fide Howe and Laurencich, 1958, p. 244).

Cytherella austinensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 51, pl. 2, figs. 4, 6 (male, fide Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, p. 244, text-fig. p. 244).--Swain and Brown, 1964, North Carolina Dept. Cons. Dev., Div.



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Miner. Res., Bull. no. 78, p. 9, pl. 1, fig. 2a-d.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 244-245, text-figs. p. 245.

Cytherella bullata Alexander, 1932, Amer. Midland Nat., vol. 13, p. 305, pl. 28, figs. 3, 4 (new name for C. obesa Alexander, not Jones and Hinde).--Loetterle, 1937, Nebr. Geol. Surv., 2nd. Sec., Bull. no. 12, p. 50, pl. 8, fig. 4a-b.--Shaver, 1953, Jour. Paleontol., vol. 27, pp. 471-480, 3 figs.--Albritton, 1941, Field and Lab., Dallas, vol. 10, no. 1, p. 49.

? Cytherella sp. Schmidt, 1948, Jour. Paleontol. vol. 22, p. 406, pl. 61, figs. 4-6.

Cytherella cf. C. obesa Alexander, --Swain, 1952, U.S. Geol. Survey Prof. Paper, 234-B, p. 68, pl. 8, fig. 2.

Dimensions of figured specimen: Length 0.94 mm., height 0.50 mm., width 0.38 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality E.

Types: Homoeotype, one complete carapace, No. E-23, from locality E.

Remarks: The present forms were compared with the types of Swain and Brown (1964). The Pakistani specimens are larger in size than all the specimens reported so far.

Cytherella sylverinica Howe and Law

Plate 6, figure 7a-b

Cytherella sylverinica Howe and Law, 1936, Louisiana Dept. Cons., Geol. Bull. no. 7, p. 18, pl. 1, figs. 12-13.--van den Bold, 1958, Micropaleontology, vol. 4, no. 4, p. 394, pl. 1, fig. 1a-b.

Dimensions of figured specimen: Length 1.0 mm., height 0.53 mm., width 0.40 mm.

Occurrence in material studied: Lowermost Lockhart limestone--rare at localities A<sub>1</sub>, F, H<sub>2</sub>.

Types: Hypotypes, one complete carapace, No. A1-17, from locality A<sub>1</sub>; one shell, No. F-5, from locality F; one carapace, No. H2-3, from locality H<sub>2</sub>.

Remarks: In edge view the anterior of the present forms is more compressed than the holotype and the specimens described and figured by van den Bold (1958, p. 394, pl. 1, fig. 1b).

Cytherella ovata n. sp.

Plate 10, figure 2a-b

Etymology: ovata (L) egg-shaped, referring to the general shape of the carapace.

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Distinguishing characteristics: Cytherella ovata n. sp. is characterized by having the compressed anterior half of the carapace; by possessing an ala-type ridge on the posteroventral one-third of each valve; and by having the height and thickness of the carapace same, each being exactly half of the shell length.

Description: In side view the carapace almost perfect oval; highest in middle; dorsal margin moderately and evenly convex downward; both anterior and posterior ends broadly rounded, posterior end being slightly narrow. Right valve larger than the left valve and overlaps the left on all sides with the greatest overlap along dorsal margin, less so along the ventral margin and the least overlaps on the anterior and posterior ends. In dorsal view the carapace oblong-ovate, widest in the posteroventral one-third; anterior end fairly compressed, posterior end inflated. Surface smooth. Hingement typical of the genus. Sexual dimorphism not apparent.

Comparison: Cytherella ovata n. sp. resembles Cytherella ovoidea Alexander, 1929, in general shape and size but differs from it in having a low ridge or ala on the swelling of each valve in the posteroventral one-third due to

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which the posterior one-third of the ventral surface of the carapace is wide and flat. A faint depression is present just over the low ridge. Cytherella ovata differs from all other species of the genus in having the height and width exactly same each being half the shell length. This measurement is consistent in all the 23 well-preserved specimens studied in the present collection.

Dimensions of holotype: Length 0.76 mm., height 0.38 mm., width 0.38 mm.

Occurrence in material studied: Chalor Silli limestone--common at locality H<sub>1</sub>, rare at locality E.

Type locality: Chalor Silli limestone, Locality H<sub>1</sub>, Thal-Khadimakh outcrop area, Kohat District, Northwest Frontier Province, West Pakistan.

Type level: Upper Cretaceous.

Types: Holotype, one complete carapace, No. H1-12, from locality H<sub>1</sub>; paratypes, one carapace, No. H1-13, from locality H<sub>1</sub>, a complete carapace, No. E-24, from locality E.

Cytherella comanchensis Alexander

Plate 6, figure 8a-b

Cytherella comanchensis Alexander, 1929, Univ. of Texas, Bull. no. 2907, p. 49, pl. 1, figs. 7-8 (female).

Cytherella obovata Alexander (not--Jones and Hinde), 1929, Univ. of Texas, Bull. no. 2907, p. 49, pl. 2, figs. 5, 9 (male).

Cytherella comanchensis Alexander, 1932, Amer. Midland Nat., vol. 13, no. 5, p. 307, pl. 28, figs. 5-6.--Lozo, 1951, Fonder Sci. ser. no. 4, p. 81.--Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, pp. 245-246, text-figs. p. 246.

Dimensions of figured specimen: Length 0.75 mm., height 0.44 mm., width 0.32 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality G<sub>1</sub>.

Types: Hypotype, one complete carapace, No. G1-20, from locality G<sub>1</sub>.

Remarks: The present specimens are somewhat larger than the reported specimens. Other characteristics are same as described by Alexander (1929) and Howe and Laurencich (1958).



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Genus Cytherelloidea Alexander

Type species: Cythere (Cytherella) williamsoniana Jones, 1849, Palaentogr. Soc. London, p. 31, pl. 7, fig. 26a-i.

Range: Lower Jurassic to Recent.

Cytherelloides ozanana Sexton

Plate 10, figure 3

Cytherelloides ozanana Sexton, 1951, Jour. Paleontol., vol. 25, p. 812, pl. 117, figs. 3, 6.--Howe and Lauren-cich, 1958, Introduction to the Study of Cretaceous Os-tracoda, pp. 267-268, text-fig. p. 268.--Crane, 1965, Micropaleontology, vol. 11, no. 2, p. 240, pl. 9, fig. 8a-c.

Dimensions of figured specimen: Length 0.59 mm., height 0.34 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality E.

Types: Hypotype, one complete female carapace, No. E-25, from locality E.

Remarks: There was one beautifully preserved female carapace and one single valve available for study. The specimens displayed the diagnostic characteristics of the species without doubt.

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Cytherelloidea sp. aff. C. triebeli Munsey

Plate 10, figure 4

Cytherelloidea triebeli Munsey, 1953, Jour. Paleontol.,  
vol. 27, no. 1, p. 3, pl. 1, fig. 6.

Dimensions of figured specimen: Length 0.41 mm., height  
0.26 mm.

Occurrence in material studied: Tarkhobi shale--rare at  
locality A<sub>1</sub>.

Types: Hypotype, one complete carapace, No. A1-18, from  
locality A<sub>1</sub>.

Remarks: Only two good specimens were available for  
study. The classification is tentative because the size  
of these specimens is quite small.

Cytherelloidea crafti Sexton

Plate 10, figure 5

Cytherelloidea crafti Sexton, 1951, Jour. Paleontol.,  
vol. 25, no. 6, p. 813, pl. 117, figs. 7-10.--Howe and  
Laurencich, 1958, Introduction to the Study of Cretaceous  
Ostracoda, pp. 262-263, text-fig. p. 263.--Crane, 1965,  
Micropaleontology, vol. 11, no. 2, pp. 242-244, pl. 9,  
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Cytherelloidea greenensis Brown, 1957, North Carolina,  
Div. Miner. Res., Bull. no. 70, p. 9, pl. 1, figs. 22-23.

Dimensions of figured specimen: Length 0.68 mm., height  
0.43 mm.

Occurrence in material studied: Chalor Silli limestone--  
rare at localities E and H<sub>1</sub>.

Types: Homoeotypes, one complete carapace, No. E-26,  
from locality E; one carapace, No. H1-20, from locality H<sub>1</sub>.

Remarks: Although there were only two good specimens  
available for study, by comparing with the types of Brown  
(1957) in the reference collections of Dr. Swain it was  
found that these specimens are conspecific. Brown, of  
course, called his specimens Cytherelloidea greenensis  
which Crane (1965) thought to be identical to C. crafti  
and the present writer agrees with Crane.

Cytherelloidea sp. aff. C. umbonata Edwards

Plate 10, figure 6

Cytherelloidea umbonata Edwards, 1944, Jour. Paleontol.,  
vol. 18, no. 6, p. 506, pl. 85, figs. 1-2.--van den Bold,  
1946, Univ. of Utrecht, Thesis, p. 61, pl. 5, fig. 2a-b.--  
Puri, 1953, Florida Geol. Survey Bull. no. 36, p. 303,  
pl. 17, fig. 7.

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Cytherelloidea anderseni Sexton, 1951, Jour. Paleontol., vol. 25, no. 6, p. 815, pl. 117, fig. 17.

Types: Hypotype, one complete carapace, No. A1-19, from locality A<sub>1</sub>.

Remarks: The surface reticulations of the present specimens are faint probably because of weathering. There were only two specimens available for investigation and the recognizable features are those that are prescribed for Cytherelloidea umbonata Edwards, 1944.

Cytherelloidea sp. A

Plate 10, figure 7

Description: Shell elongate-ovate, medium size; marginal rim sharp, most prominent on anterior and posterior margins; on dorsal and ventral borders the rim fades but does not disappear; dorsal margin straight, ventral margin slightly concave behind middle; both anterior and posterior ends broadly rounded, posterior end being slightly narrower than anterior. A crescent-shaped ridge present at the middle half of each valve. The ridge concave upward; a shallow depression just above the ridge in the concavity.



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Dimensions of figured specimen: Length 0.63 mm., height 0.25 mm.

Occurrence in material studied: Chalor Silli limestone--rare at locality A<sub>3</sub>.

Specimens: One complete carapace, No. A3-57, from locality A<sub>3</sub>.

Remarks: Only one well-preserved complete carapace was obtained from the present collections. No described species of the genus seem to have the shape and ornamentation of the present form.

Cytherelloidea sp. B

Plate 10, figure 8

Description: Carapace subquadrate to ovate; anterior end broadly rounded with a very slight truncation; posterior end obliquely truncated and narrowly rounded. Marginal rim with sharp crest extends all around the valves. A crescent-shaped ridge on each valve, concave upward, in the middle half of the valves. A subcentral shallow depression above the ridge. Anterodorsal and postero-ventral corners little projected out. Surface smooth.

Dimensions of figured specimen: Length 0.50 mm., height 0.31 mm.

Occurrence in material studied: Chalor Silli limestone--rare at localities A<sub>3</sub> and E.

Specimens: One complete carapace, No. A3-58, from locality A<sub>3</sub>; one carapace, No. E-27, from locality E.

Remarks: Only two well-preserved carapaces were available for study. External features are identical to those of the genus Cytherelloidea but the specific characteristics of the present specimens do not match with any described species.

The difference between Cytherelloidea sp. A and Cytherelloidea sp. B is that the former is elongated and narrow whereas the latter is short and high, and is more quadrate than ovate.

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## SUMMARY AND CONCLUSIONS

The samples of the present study were collected from 30 outcrop localities where rocks of Jurassic, Cretaceous and Tertiary ages are exposed. Samples from several localities did not reveal any microfossils whatsoever. Some samples contained badly weathered and distorted ostracods which could not be identified even as to genus. On the other hand, samples from other localities revealed well-preserved ostracods in good numbers.

Samples that contained ostracods were collected from localities A<sub>1</sub>, A<sub>3</sub>, B<sub>1</sub>, B<sub>2</sub>, D<sub>1</sub>, D<sub>2</sub>, E, F, G<sub>1</sub>, H<sub>1</sub>, H<sub>2</sub>, J, L, M, N, and Q. Locality A<sub>1</sub>, where the Tertiary formations of Hangu sandstone, Lockhart limestone, and Tarkhobi shale are exposed, revealed Tertiary ostracods from Lockhart limestone and Tarkhobi shale. The lower member of the Upper Cretaceous Darsamand limestone, Chalor Silli limestone, at locality A<sub>3</sub>, is by far the best locality for Upper Cretaceous ostracod faunas

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studied. The major part of the Upper Cretaceous ostracod fossils of the present study came from locality  $A_3$ . Locality  $B_1$  has the exposures of all the three Tertiary beds mentioned above but samples were collected only from the limestone lens of Hangu sandstone and Lockhart limestone, and no sample was collected from the topmost bed. Then only the samples from Hangu sandstone contained some ostracods. At locality  $B_2$  both the members of the Upper Cretaceous Darsamand limestone are exposed but samples from the lower member (Chalor Silli limestone) only contained ostracods. Locality  $D_1$ , with exposures of the same Tertiary formations as the localities  $A_1$  and  $B_1$  revealed a few ostracods from Lockhart limestone and Tarkhobi shale but none from Hangu sandstone. Samples collected from locality  $D_2$  represent both the members of the Upper Cretaceous Darsamand limestone but only the samples from Chalor Silli limestone revealed ostracods. Locality E is another good place for Upper Cretaceous ostracods. Though samples were collected from both the upper and lower members of Darsamand limestone samples from the lower member only contained ostracods. Samples from locality F, where all the above-mentioned Tertiary

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beds are exposed, revealed very few specimens from Hangu sandstone and Lockhart limestone. At locality G<sub>1</sub> both the members of Darsamand limestone and the Tertiary Hangu sandstone are well-exposed. Samples from both the Upper Cretaceous members contained well-preserved ostracod fossils. Samples from Hangu sandstone collected at this locality contained very badly weathered specimens of ostracods which are not identifiable. Locality H<sub>1</sub> has outcrops of both Lower and Upper Cretaceous rocks. The samples from the Lower Cretaceous rocks contained very few badly distorted and broken ostracod shells. A few ostracods were found in the samples collected from the lower member of Darsamand limestone, but no specimens were obtained from the upper member. At locality H<sub>2</sub>, the Tertiary Hangu sandstone and Lockhart limestone are exposed, and the samples from Lockhart limestone only contained a few ostracods. At locality J, though both Lower and Upper Cretaceous rocks are exposed, the samples from Kurram formation only revealed some ostracods. Locality L has the outcrops of the Upper Cretaceous and Tertiary rocks, but samples from the Tertiary beds only contained ostracod fossils. Localities M and N have

outcrops of the Tertiary Mulla Bata limestone and Shakalai shale, respectively, and samples from both the formations revealed well-preserved ostracods. Locality Q has the Upper Cretaceous Tandora formation exposed. Quite a few well-preserved ostracod carapaces were obtained from samples collected from here. Some of the ostracod carapaces found in the samples collected at locality I are badly weathered and they all are reworked specimens. Samples collected from other localities did not reveal any ostracods.

The richest ostracod faunas of all the formations are in the Chalor Silli limestone, the lower member of the Upper Cretaceous Darsamand limestone, exposed at localities  $A_3$ ,  $B_2$ ,  $D_2$ , E,  $G_1$ , and  $H_1$ . Tsukail-Tsuk limestone, the upper member of Darsamand limestone, contains well-preserved Upper Cretaceous ostracod faunas in good numbers, but though it is exposed at localities  $A_2$ ,  $B_2$ ,  $D_2$ , E,  $G_1$ , and  $H_1$  and samples were collected from each of these localities, samples from locality  $G_1$  only revealed the fossils. The Upper Cretaceous Kurram formation exposed at localities I, J,  $K_1$ , and  $K_2$  revealed a few Upper Cretaceous ostracods only in the samples



collected at locality J. Samples of the formation from other localities did not have any fossil content. The Upper Cretaceous Tandora formation, exposed at localities P and Q, revealed beautifully preserved ostracods, though few in number, in the samples collected at locality Q only.

Most of the Tertiary beds of the present study area revealed good numbers of well-preserved ostracod faunas. A few beds, of course, have a poor content of ostracods. The only Tertiary bed that did not reveal any ostracod is the Sangroba sandstone exposed at locality O. Hangu sandstone, exposed at localities A<sub>1</sub>, B<sub>1</sub>, D<sub>1</sub>, E, F, G<sub>1</sub>, and H<sub>2</sub> revealed well-preserved ostracod fossils in good numbers only from the limestone lens of the formation exposed at locality B<sub>1</sub> and the shale lens exposed at locality F. Lockhart limestone, another Tertiary formation, overlying Hangu sandstone crops out at localities A<sub>1</sub>, B<sub>1</sub>, D<sub>1</sub>, E, F, and H<sub>2</sub>. It revealed well-preserved ostracod faunas, not in great numbers, from all localities except B<sub>1</sub> and E. Tarkhobi shale, overlying Lockhart limestone, is exposed at localities A<sub>1</sub>, B<sub>1</sub>, D<sub>1</sub>, and F. It yielded most of its ostracods in the

samples collected at locality A<sub>1</sub>, very few from locality D<sub>1</sub>, and none from the other two localities. The Tertiary Mulla Bata limestone, exposed at localities L and M, contained a fair number of well-preserved Tertiary ostracods. Another Tertiary bed that revealed good numbers of well-preserved ostracods is Shakalai shale, exposed at locality N only.

The formations from which samples were collected, which either did not contain any ostracod faunas or revealed badly weathered, broken, or distorted unidentifiable shells, are those of the Jurassic and the Lower Cretaceous age.

In the present study 106 ostracod species and subspecies have been identified, described, and illustrated. They all belong to the Order Podocopida and two Suborders Podocopina and Platycopina. They are distributed among three superfamilies and 12 families representing 23 genera. Two-thirds of the species are Upper Cretaceous and one-third are Tertiary in age. Out of 106 species and subspecies nine are new; of which six are Upper Cretaceous and three are Tertiary.

The study of the ostracod faunas from Kohat District of West Paksitan revealed that the Upper Cretaceous forms range from the lowermost Eaglefordian (Cenomanian) to the uppermost Navarroan (Maestrichtian stage). Many species were found to have a longer vertical range than was known before. Few species that so far have been reported elsewhere only from the upper stages of Lower Cretaceous (Aptian-Albian) rocks have been found in the lower part of the Chakor Silli limestone together with Upper Cretaceous species.

Darsamand limestone is unquestionably Upper Cretaceous in age. But it could not be subdivided into stages because there is not any sharp faunal break within the formation. Lithologically the formation is divided into Chakor Silli limestone and Tsukail-Tsuk limestone, but paleontologically both belong to the same age since both contain the same ostracod species.

There are six Tertiary formations exposed in the study area. According to the Geological Survey of Pakistan all six formations belong to the Paleocene epoch. But in the present study the ostracod faunas collected from these formations were found to range from Paleocene

to Miocene. Actually, there were fewer Paleocene species found in these formations than the Eocene, Oligocene, or Miocene species.

Each formation of the Tertiary rocks in this area revealed an entirely different group of ostracod species. In other words, Hangu sandstone contains a group of ostracod species which is different from the group found in the overlying Lockhart limestone. Similarly, the group in Tarkhobi shale is made up of species which were not found either in Hangu sandstone or Lockhart limestone. But each formation has at least one species which represents each of the four Tertiary epochs mentioned above.

From this observation, it appears that as the lithology changed due to the change of depositional environment, a new group of ostracod species replaced the former group and the second group in its turn was replaced by the third group as the environment changed further. The time factor does not seem to be important in this case because the new species belong to the same age as the former group.

Many species of Shakalai shale are common to Tarkhobi shale which may indicate that these two

formations were deposited under similar environmental conditions and probably are correlatable. Similarly, several species of ostracods are common to the Lockhart and Mulla Bata limestones. So these two formations may be correlatable.

Based on the vertical ranges of the Tertiary ostracods described in this paper the Hangu sandstone may be assigned to approximate lower Paleogene, Lockhart limestone to upper Paleogene and Tarkhobi shale to lower Neogene.

CHART OF CORRELATION OF THE PAKISTANI  
OSTRACOD SPECIES WITH THE SPECIES REPORTED  
FROM OTHER PARTS OF THE WORLD

In the present study there have been found 90 species and subspecies out of 106 already described from different parts of the world. These 90 species and subspecies have been correlated as follows:

U.S.A.--41 (Upper Cretaceous 35, Tertiary 6)  
Germany--7 (Upper Cretaceous 6, Tertiary 1)  
Caribbean--6 (all Tertiary)  
France--4 (Upper Cretaceous 3, Tertiary 1)  
England--3 (all Upper Cretaceous)  
Netherland--3 (all Upper Cretaceous)  
Belgium--2 (both Tertiary)  
Italy--1 (Tertiary)  
South Africa--1 (Upper Cretaceous)  
Caspian Basin--1 (Upper Cretaceous)

U.S.A. and Caribbean--5 (Upper Cretaceous 2, Tertiary 3)  
U.S.A. and England--2 (both Upper Cretaceous)  
U.S.A. and Netherland--2 (both Upper Cretaceous)  
U.S.A., Caribbean, and Venezuela--2 (both Tertiary)  
U.S.A. and Germany--1 (Upper Cretaceous)  
U.S.A., England, Germany, France, Netherland, and Belgium  
--1 (Tertiary)  
U.S.A., England, Germany, The Alps, and West Africa--1  
(Upper Cretaceous)

France and Belgium--1 (Tertiary)  
 Netherland, Germany, and The Alps--1 (Tertiary)  
 France, Germany, and Belgium--1 (Tertiary)  
 France, Germany, and Caribbean--1 (Upper Cretaceous)  
 Germany, Netherland, and Belgium--1 (Tertiary)  
 England, Caribbean, and India--1 (Tertiary)  
 Caribbean, Venezuela, Columbia, Netherland, New Zealand,  
 and South Africa--1 (Upper Cretaceous)

The above chart shows that except for a very few species all the Pakistani ostracod faunas are correlated with American and European species. Forty-one of the Pakistani species are correlated with the species reported from the United States only; 24 species were reported from the Tethys Sea provinces of southern and southwestern Europe; 7 species have been reported commonly from the United States and Europe, 6 species from the Caribbean alone, 7 others from the United States and Caribbean region, only one from South Africa, and one from the Caspian Basin. One of the remaining four species has been reported from the United States, Europe, and West Africa; the second one from the Caribbean and Europe; the third one from the Caribbean, England, and South India; and the fourth one from the Caribbean, northern South America, the Netherlands, New Zealand, and South Africa.

Considering the paleogeography of the present study area and its geographic position during the Upper Cretaceous and Tertiary times, most ostracod species from West Pakistan should correlate with those that would come from the land masses which emerged from the Tethyan Geosyncline, especially the areas adjacent to the present study area (Baluchistan, Afghanistan, Iran, and the Caspian Basin to the west and north, and Tibet and the Himalayan region to the east). The number of correlatable species should decrease both east- and westward as we move away from West Pakistan. To the east, the land masses emerged from the Tethys Sea are Assam, Burma, Thailand, Malaysia Indonesia, to Australia; to the west the land masses are Iraq, Turkey, and all the present-day Mediterranean countries to the British Isles. An arm of the Tethys Sea stretched southward to connect it with the Indian Ocean through the Arabian Sea. This arm must have been an ideal means of distribution of the Tethyan faunas of that time along the west coast of India, the east coast of Africa--and particularly in Madagascar--to South Africa. The least correlation of the Pakistani ostracod faunas of the Upper Cretaceous and Tertiary ages



should be expected with the new world species. But the reverse has been found true in the present work. Among the areas that should be expected to reveal the most similar ostracod faunas to the study area, the Caspian Basin and South India revealed one species each and South Africa revealed two.

So, from the above discussion it can be stated that the correlations of the ostracod faunas of the present work is probably more literary than actual. Because more studies have been done of ostracod faunas in America and Europe and therefore, more literature is available there. In most of the other areas no studies have been made. From those few countries where studies have been made, like USSR, South Africa and recently Madagascar, adequate helpful literature is not available.

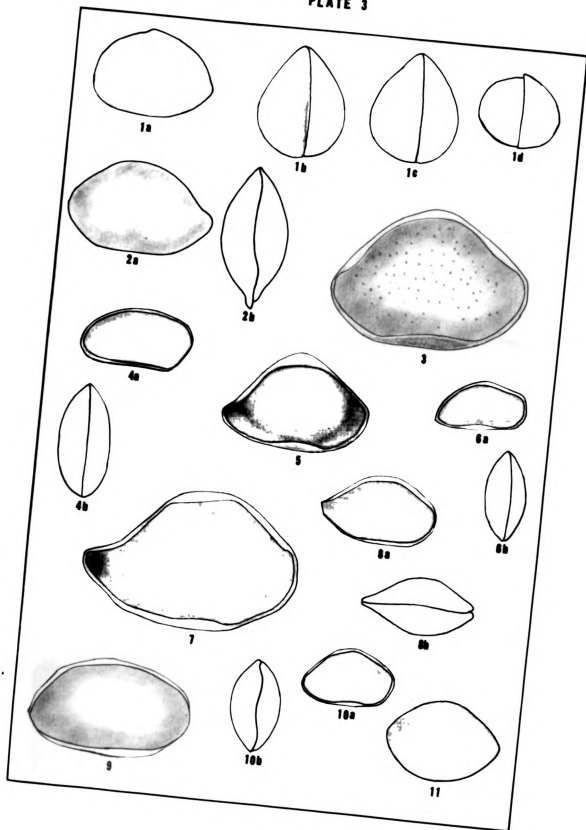
It will be a valuable study for future workers of the present study area or of the neighboring areas to try to find out the extent to which the Upper Cretaceous and Tertiary ostracod faunas of West Pakistan can actually be correlated with those of East Africa in general and Madagascar in particular.

It may be suggested for future workers of the area that samples be collected from each lithologic unit at regular intervals and special attention be paid in collection when lithologic change is observed. Special and extra collections should be made from the top and the bottom of a bed.

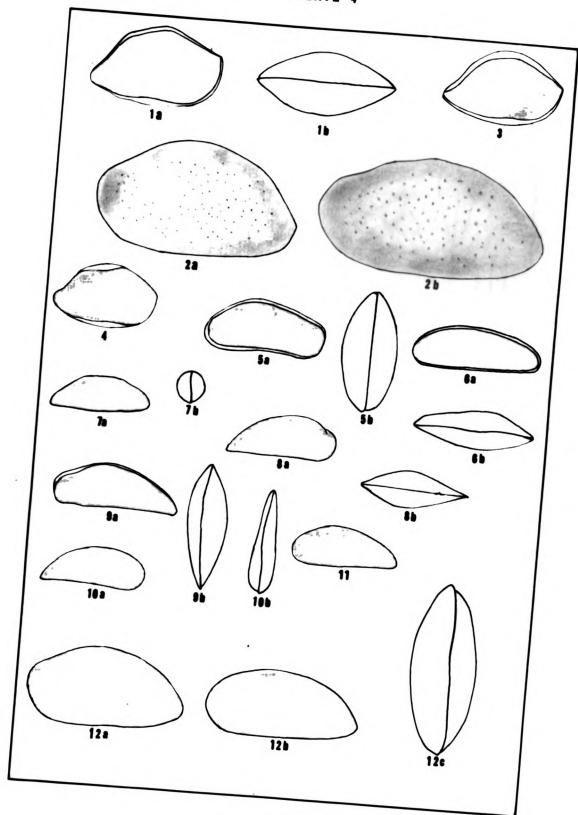
#### Depository

All the specimens of the present work are deposited in the Paleontological Museum of the Geological Survey of Pakistan, Quetta, West Pakistan.

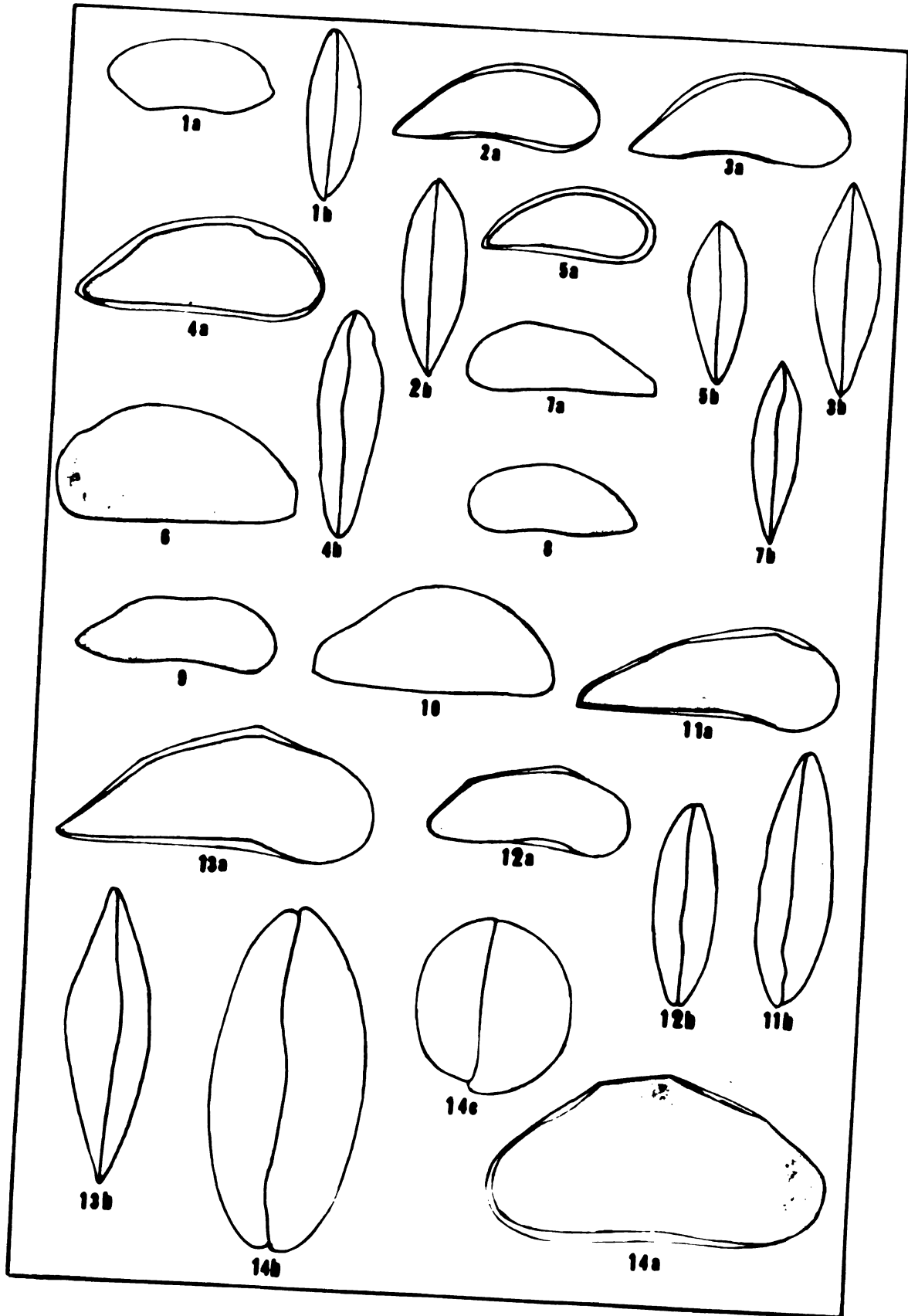
## **PLATES**



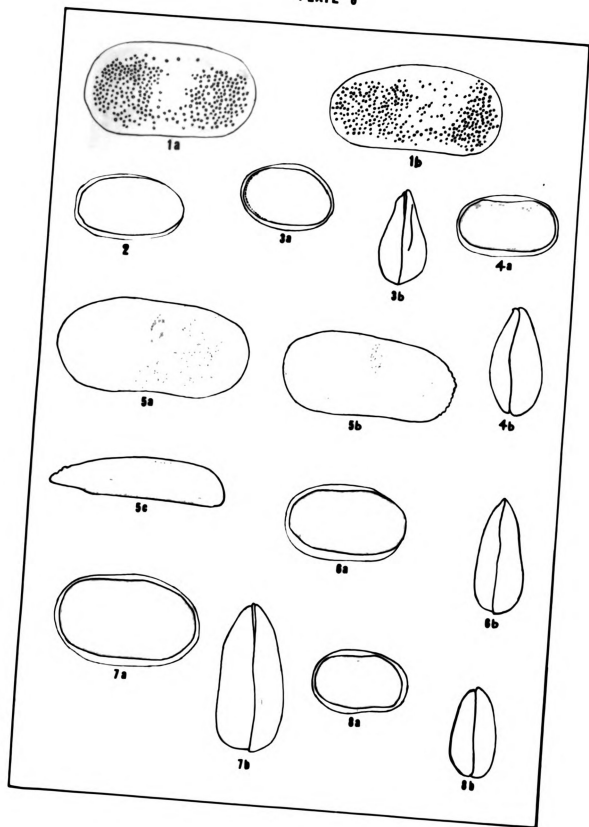
## PLATE 4

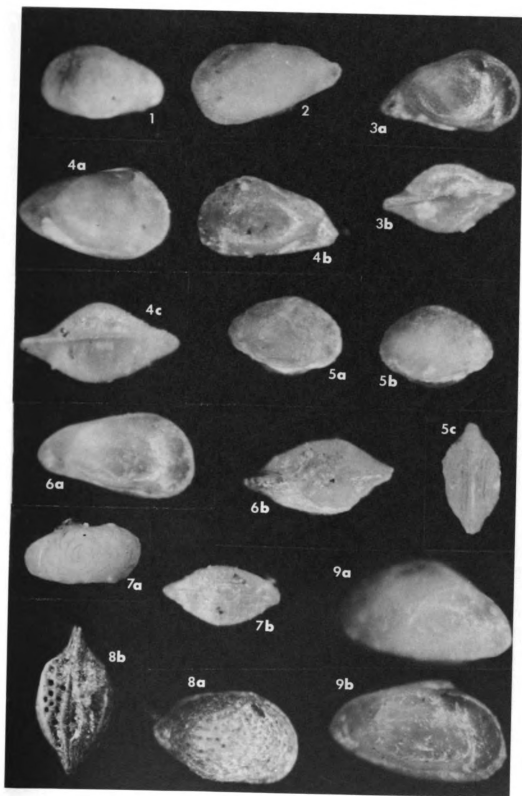


## PLATE 5



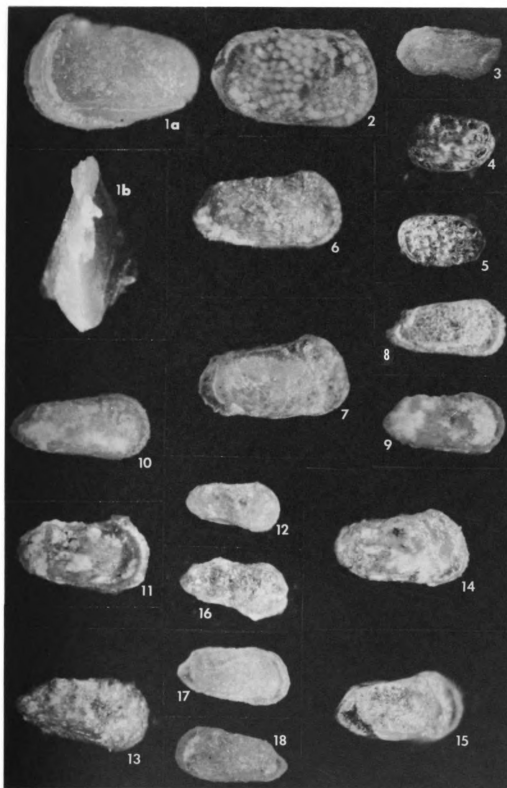
## PLATE 6



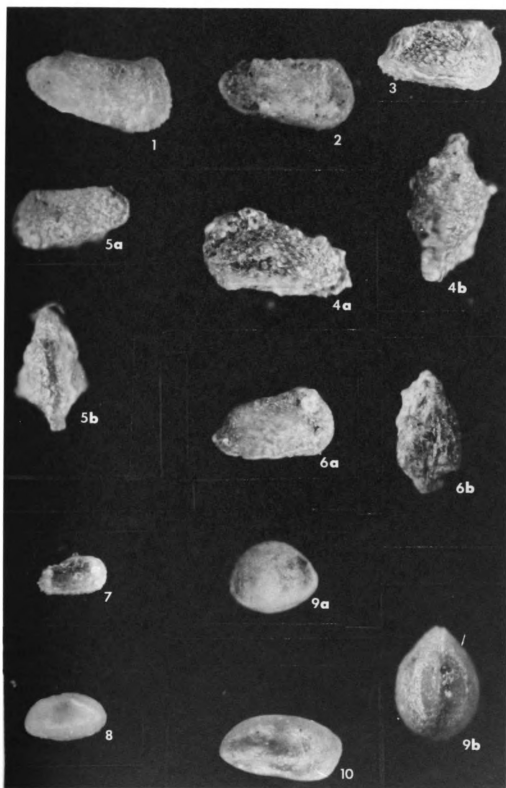




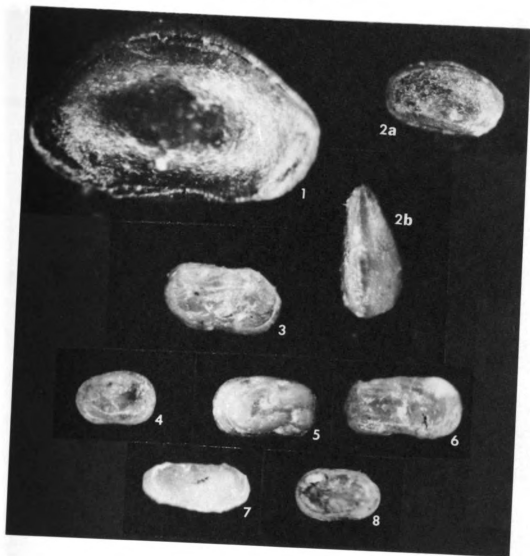
## PLATE 8



## PLATE 9



## PLATE 10



## **EXPLANATIONS OF PLATES**

PLATE 1

Figure

1. Brachycythere ovata (Berry), Chalor Silli limestone, locality A<sub>3</sub>, No. A3-1, X45.
  - a. Right valve view of the shell
  - b. Dorsal view of the shell
2. Brachycythere ledaforma (Israelsky), Chalor Silli limestone, locality A<sub>3</sub>, No. A3-4, X55.
  - a. Right valve view of the shell
  - b. Dorsal view of the shell
3. Brachycythere sp. aff. B. pseudovata Jennings, Chalor Silli limestone, locality A<sub>3</sub>, No. A3-16, X57.
  - a. Right valve view of the shell
  - b. Dorsal view of the shell
4. Cuneocythere (Monsmirabilia) subovata Apostolescu
  - a. Right valve view of female carapace, Tark-hobi shale, locality A<sub>1</sub>, No. A1-1, X73
  - b. Dorsal view of the female carapace

## Plate 1 (Cont.)

## Figure

- c. Right valve view of male carapace, limestone lens of Hangu sandstone, locality B<sub>1</sub>, No. B1-3, X73.
- 5. Cuneocythere (Monsmirabilia) triebeli Keij, Tarkhobi shale, locality A<sub>1</sub>, X75.
  - a. Left valve view of female carapace, No. A1-2a.
  - b. Right valve view of male carapace, No. A1-2b.
- 6. Krithe sp. aff. K. cushmani Alexander, Chalor Silli limestone, locality A<sub>3</sub>, No. A3-19, X37.
  - a. Right valve view of shell
  - b. Dorsal view of shell
- 7. Schuleridea (Aequacytheridea) perforata (Roemer). Tarkhobi shale, locality B<sub>1</sub>, No. B1-2, X37.
  - Left valve view of shell.
- 8. Cytheridea falcoburgensis Veen, Chalor Silli limestone, locality A<sub>3</sub>, No. A3-20, X46.
  - Left valve view of shell

## Plate 1 (Cont.)

## Figure

9. Ovocysteridea nuda Grekoff, Chalor Silli limestone,  
locality A<sub>3</sub>, X79.
- a. Right valve view of female carapace, No.  
A3-22.
  - b. Dorsal view of the female carapace.

## PLATE 2

1. Ovocysteridea nuda Grekoff, Chalor Silli limestone,  
locality E, X70.
- a. Right valve view of male carapace, No. E-6.
  - b. Dorsal view of the male carapace.
2. Xestoleberis ovata Bonnema, Chalor Silli limestone,
- a. Right valve view of shell No. A3-35, lo-  
cality A<sub>3</sub>, X48.
  - b. Left valve view of shell No. B2-8, local-  
ity B<sub>2</sub>, X48.
3. Xestoleberis pergensi Veen, Chalor Silli limestone,  
locality A<sub>3</sub>, X84.

## Plate 2 (Cont.)

## Figure

- a. Left valve view of shell, No. A3-36.
  - b. Dorsal view of the shell
4. Xestoleberis opina Schmidt, Chalor Silli limestone, locality B<sub>2</sub>, X91.
- a. Right valve view of shell, No. B2-10.
  - b. Dorsal view of the shell
5. Xestoleberis sp. aff. X. gunteri Howe
- a. Right valve view of shell, No. A1-8, base of Lockhart limestone, locality A<sub>1</sub>, X61.
  - b. Left valve view of shell, No. L-3, Mulla Bata limestone, locality L, X61.
  - c. Dorsal view of the shell.
6. Xestolebris zuberensis Puri
- a. Right valve view of shell, No. A1-9, Lockhart limestone, locality A<sub>1</sub>, X48.
  - b. Ventral view of the shell.
  - c. Left valve view of shell, No. L-4, Mulla Bata limestone, locality L, X48.
  - d. Dorsal view of the shell.



## Plate 2 (Cont.)

## Figure

7. Xestoleberis marssoni Bonnema, Chalor Silli limestone, locality B<sub>2</sub>, X52.
  - a. Right valve view of shell, No. B2-11.
  - b. Dorsal view of the shell.
  - c. Posterior view of the shell.
8. Xestoleberis minuta Holden, Chalor Silli limestone, locality G<sub>1</sub>, X92.
  - a. Left valve view of shell, No. G1-13.
  - b. Dorsal view of the shell.

## PLATE 3

1. Xestoleberis supplanta Veen, limestone member of Tandora formation, locality Q, X70.
  - a. Right valve view of shell, No. Q-3.
  - b. Ventral view of the shell.
  - c. Dorsal view of the shell.
  - d. Posterior view of the shell.

## Plate 3 (Cont.)

## Figure

2. Bairdoppilata pseudoseptentrionalis Mertens,  
Chalor Silli limestone, locality A<sub>3</sub>, X42.
  - a. Left valve view of shell, No. A3-39.
  - b. Dorsal view of the shell.
3. Bairdoppilata ? magna Alexander, Chalor Silli  
limestone, locality A<sub>3</sub>, X77.
 

Right valve view of shell, No. A3-40.
4. Bairdia harrisiana Jones, Chalor Silli limestone,  
locality H<sub>1</sub>, X53.
  - a. Right valve view of shell, No. H1-7.
  - b. Dorsal view of the shell.
5. Bairdia sp. aff. B. alexandrina Blake, Tsukail-  
Tsuk limestone, locality G<sub>1</sub>, X68.
 

Right valve view of shell, No. G1-14.
6. Bairdia sp. aff. B. gracilis Alexander, Tsukail-  
Tsuk limestone, locality G<sub>1</sub>, X40.
  - a. Right valve view of shell, No. G1-15
  - b. Dorsal view of shell, No. H1-8.
7. Bairdia sp. aff. B. exoura van den Bold, Upper  
Shakalai shale, locality N, X77.
 

Right valve view of shell, No. N-6.

8. Bairdia sp. aff. B. jonesi van den Bold, Upper Shakalai shale, locality N, X36.
- a. Right valve view of shell, No. N-7.
  - b. Dorsal view of the shell.
9. Bairdia machaquillaensis van den Bold, Lower Lockhart limestone, locality A<sub>1</sub>, X74.
- Right valve view of shell, No. A1-10.
10. Bairdia hiwanneensis Howe and Lea, Limestone lens of Hangu sandstone, locality B<sub>1</sub>, X28.
- a. Right valve view of shell, No. B1-11.
  - b. Dorsal view of the shell.
11. Bairdia oviformis Speyer, Mulla Bata limestone, locality L, X52.
- Left valve view of shell, No. L-8.

## PLATE 4

1. Bairdia amygdaloides Brady var. oblongata van den Bold, Mulla Bata limestone, locality L, X63.
- a. Right valve view of shell, No. L-7.
  - b. Dorsal view of the shell.

## Plate 4 (Cont.)

## Figure

2. Bairdia dimorpha van den Bold, Mulla Bata limestone, locality L.
  - a. Left valve view of female carapace, No. L-9a, X60.
  - b. Left valve view of male carapace, No. L-9b, X60.
3. Bairdia comanchensis Alexander, Cholor Silli limestone, locality A<sub>3</sub>, X43.
  - Right valve view of shell, No. A3-43.
4. Bairdia wauchulensis Swain, Base of Lockhart limestone, locality A<sub>1</sub>, X24.
  - Right valve view of shell, No. A1-13.
5. Bythocypris goodlandensis Alexander, Cholor Silli limestone, locality A<sub>3</sub>, X55.
  - a. Right valve view of shell, No. A3-44.
  - b. Dorsal view of the shell.
6. Macrocypris simplex Chapman, Cholor Silli limestone, locality A<sub>3</sub>, X38.
  - a. Left valve view of shell, No. A3-45.
  - b. Dorsal view of the shell.

## Plate 4 (Cont.)

## Figure

7. Macrocypris sp. aff. M. limburgensis Veen, Chalor Silli limestone, locality E, X37.
  - a. Right valve view of shell, No. E-13.
  - b. End view of the shell.
8. Macrocypris dubia Bonnema, Chalor Silli limestone, locality A<sub>3</sub>, X58.
  - a. Right valve view of shell, No. A3-46.
  - b. Dorsal view of the shell.
9. Macrocypris graysonensis Alexander, Chalor Silli limestone, locality A<sub>3</sub>, X42.
  - a. Left valve view of shell, A3-47.
  - b. Dorsal view of the shell.
10. Macrocypris modesta (Reuss), Chalor Silli limestone, locality D<sub>2</sub>, X52.

Right valve view of shell, No. D2-16
11. Macrocypris concinna Jones and Hinde, Chalor Silli limestone, locality E, X60.

Right valve view of shell, No. E-15.

## Plate 4 (Cont.)

## Figure

12. Pontocyprrella rara Kaye, Chalor Silli limestone.
- a. Left valve view of female carapace, No. A3-48, locality A<sub>3</sub>, X56.
  - b. Left valve view of male carapace, No. B2-12, locality B<sub>2</sub>, X56.
  - c. Dorsal view of the female carapace, X57.

## PLATE 5

- 1. Pontocyprrella harrisiana (Jones), lower part of Chalor Silli limestone, locality A<sub>3</sub>, X40.
  - a. Left valve view of shell, No. A3-49.
  - b. Dorsal view of the shell.
- 2. Paracypris dentonensis Alexander, Tsukail-Tsuk limestone, locality G<sub>1</sub>, X41.
  - a. Right valve view of shell, No. G1-17.
  - b. Dorsal view of the shell.
- 3. Paracypris tenuicula Alexander, Chalor Silli limestone, locality E, X43.

## Plate 5 (Cont.)

## Figure

- a. Right valve view of shell, No. E-17.
  - b. Dorsal view of the shell.
4. Paracypris goodlandensis Howe and Laurencich,  
Chalor Silli limestone, locality B<sub>2</sub>, X40.
- a. Right valve view of shell, No. B2-14.
  - b. Ventral view of the shell.
5. Paracypris sp. aff. P. angusta Alexander, Chalor  
Silli limestone, locality B<sub>2</sub>, X36.
- a. Right valve view of shell, No. B2-15
  - b. Dorsal view of the shell.
6. Paracypris weatherfordensis Vanderpool, Chalor  
Silli limestone, locality A<sub>3</sub>, X52.
- Left valve view of shell, No. A3-54.
7. Paracypris acuta (Cornuel), Tsukail-Tsuk limestone,  
locality G<sub>1</sub>, X50.
- a. Left valve view of shell, No. G1-18.
  - b. Dorsal view of shell, No. E-19.
8. Paracypris depressa Bonnema, Chalor Silli lime-  
stone, locality A<sub>3</sub>, X33.
- Left valve view of shell, No. A3-55.

## Plate 5 (Cont.)

## Figure

9. Paracypris siliqua Jones and Hinde, Chalor Silli limestone, locality E, X39.

Left valve view of shell, No. E-20.

10. Paracypris sp. aff. P. limburgensis Veen, Tsukail-Tsuk limestone, locality G<sub>1</sub>, X43.

Left valve view of shell, No. G1-19.

11. Paracypris franquesi Howe and Chambers, Mulla Bata limestone, locality L, X56.

a. Right valve view of shell, No. L-11

b. Dorsal view of the shell.

12. Paracypris communis van den Bold, Mulla Bata limestone, locality L, X47.

a. Right valve view of shell, No. L-12.

b. Dorsal view of the shell.

13. Paracypris stolki van den Bold, Base of Lockhart limestone, locality A<sub>1</sub>.

a. Right valve view of shell, No. A1-14, X86.

b. Dorsal view of the shell, X85.



## Plate 5 (Cont.)

## Figure

14. Propontocypris sp. aff. P. solida Ruggieri, Tark-hobi shale, locality A<sub>1</sub>, X83.
- a. Left valve view of shell, No. A1-15.
  - b. Dorsal view of the shell.
  - c. Posterior view of the shell.

## PLATE 6

1. Cytherella beyrichi (Reuss), upper part of Shakalai shale, locality N.
- a. Exterior of a female valve, No. N-10, X67.
  - b. Right valve view of male carapace, No. N-9, X67.
2. Cytherella beyrichoides Swain and Brown, Chalor Silli limestone, locality A<sub>3</sub>, X49.
- Left valve view of shell, No. A3-56.
3. Cytherella sp. aff. C. polita Brady, Shakalai shale, locality N, X53.
- a. Left valve view of shell, No. N-11.
  - b. Dorsal view of the shell.

## Plate 6 (Cont.)

## Figure

4. Cytherella symmetrica Alexander, base of Lockhart limestone, locality F, X38.
  - a. Left valve view of shell, No. F-4.
  - b. Dorsal view of the shell.
5. Cytherella pustulosa Keij, Shakalai shale, locality N, X65.
  - a. Right valve view of female carapace, No. N-12a.
  - b. Right valve view of male carapace, No. N-12b.
  - c. Dorsal view of male right valve.
6. Cytherella austinensis Alexander, Chalor Silli limestone, locality E, X38.
  - a. Left valve view of shell, No. E-23.
  - b. Ventral view of the shell.
7. Cytherella sylverinica Howe and Law, lowermost Lockhart limestone, locality A<sub>1</sub>, X43.
  - a. Left valve view of shell, No. A1-17.
  - b. Dorsal view of the shell.

## Plate 6 (Cont.)

## Figure

8. Cytherella comanchensis Alexander, Chalor Silli  
limestone, locality G<sub>1</sub>, X37.

- a. Left valve view of shell, No. G1-20.
- b. Dorsal view of the shell.

## PLATE 7

All figures X50

1. Brachycythere ovata vecarina Crane; Chalor Silli  
limestone, locality A<sub>3</sub>, No. A3-3.  
Left valve view of shell.
2. Brachycythere ledaforma erugata Crane; Chalor Silli  
limestone, locality A<sub>3</sub>, No. A3-5.  
Left valve view of shell.
3. Brachycythere ledaforma porosa Crane; Charlor Silli  
limestone, locality A<sub>3</sub>, No. A3-6.  
a. Right valve view of shell.  
b. Ventral view of the shell.

## Plate 7 (Cont.)

## Figure

4. Brachycythere ledaforma leioventra n. subsp.;  
Chalor Silli limestone, locality A<sub>3</sub>.
  - a. Right valve view of the holotype, female carapace, No. A3-7.
  - b. Left valve view of a paratype, male carapace, No. A3-9.
  - c. Ventral view of the holotype.
5. Brachycythere brevivalvula n. sp.; Chalor Silli limestone, locality A<sub>3</sub>, holotype, No. A3-10.
  - a. Right valve view of holotype.
  - b. Left valve view of holotype.
  - c. Ventral view of holotype.
6. Brachycythere elongata n. sp.; Chalor Silli limestone, locality A<sub>3</sub>, holotype, No. A3-12.
  - a. Right valve view of holotype.
  - b. Ventral view of holotype.
7. Brachycythere pakistanensis n. sp.; Chalor Silli limestone, locality A<sub>3</sub>, holotype, No. A3-14.
  - a. Left valve view of holotype.
  - b. Ventral view of holotype.

## Plate 7 (Cont.)

## Figure

8. Brachycythere driveri angulata n. subsp.; limestone lens of Hangu sandstone, locality B<sub>1</sub>, holotype, No. B1-1.
  - a. Right valve view of holotype.
  - b. Ventral view of holotype.
9. Brachycythere sp., Chalor Silli limestone, locality A<sub>3</sub>, No. A3-17.
  - a. Right valve view of shell.
  - b. Left valve view of the shell.

## PLATE 8

All figures X50

1. Alatacythere sp.; Kurram formation, locality J, No. J-1.
  - a. Left valve view of shell.
  - b. Dorsal view of the shell.
2. Triginglymus cribratus Apostolescu; Tarkhobi shale, locality A<sub>1</sub>, No. A1-7.
  - a. Right valve view of shell.

## Plate 8 (Cont.)

## Figure

3. Cytheretta sp. aff. C. sahnii Puri; Tarkhobi shale,  
locality A<sub>1</sub>, No. A1-3  
Left valve view of shell.
4. Schizocythere hollandica Triebel; Tarkhobi shale,  
locality A<sub>1</sub>, No. A1-4.  
Left valve view of shell.
5. Schizocythere appendiculata Triebel; Tarkhobi shale,  
locality A<sub>1</sub>, No. A1-5.  
Left valve view of shell.
6. Cythereis verricula Butler and Jones; Chalor Silli  
limestone, locality A<sub>3</sub>, No. A3-22.  
Right valve view of shell.
7. Cythereis subgracilis Morrow; Chalor Silli lime-  
stone, locality A<sub>3</sub>, No. A3-23.  
Right valve view of shell.
8. Cythereis lixula Crane; Chalor Silli limestone,  
locality A<sub>3</sub>, No. A3-24.  
Right valve view of shell.

## Plate 8 (Cont.)

## Figure

9. Cythereis dallasensis Alexander; Chalor Silli limestone, locality A<sub>3</sub>, No. A3-26.  
Right valve view of shell.
10. Cythereis bicornis Israelsky; Chalor Silli limestone, locality A<sub>3</sub>, No. A3-27.  
Right valve view of shell.
11. Cythereis costatana Israelsky; Chalor Silli limestone, locality A<sub>3</sub>, No. A3-28.  
Right valve view of shell.
12. Cythereis wintoni Alexander; Chalor Silli limestone, locality A<sub>3</sub>, No. A3-29.  
Right valve view of shell.
13. Cythereis hawleyi Alexander; Chalor Silli limestone, locality A<sub>3</sub>, No. A3-30.  
Right valve view of shell.
14. Cythereis eaglefordensis Alexander; Chalor Silli limestone, locality B<sub>2</sub>, No. B2-6.  
Right valve view of shell.

## Plate 8 (Cont.)

## Figure

15. Cythereis sp. aff. C. fessa Lúbimova; Kurram formation, locality J, No. J-2.

Right valve view of shell.

16. Cythereis sp. aff. C. divisa Damotte; Chalor Silli limestone, locality A<sub>3</sub>, No. A3-31.

Right valve view of shell.

17. Cythereis dentonensis Alexander; Chalor Silli limestone, locality E, No. E-10.

Right valve view of shell.

18. Cythereis sp. aff. C. fredericksburgensis Alexander; Chalor Silli limestone, locality E, No. E-11.

Left valve view of shell.

## PLATE 9

All figures X50

1. Cythereis sp. aff. C. hannai Israelsky; Chalor Silli limestone, locality E, No. E-12.

Right valve view of shell.





## Plate 9 (Cont.)

## Figure

2. Cythereis alexanderi abbreviata Morrow; Chalor

Silli limestone, locality A<sub>3</sub>, No. A3-32.

Right valve view of shell.

3. Hermanites tschoppi (van den Bold); limestone lens

of Hangu sandstone, locality B<sub>1</sub>, No. B1-8.

Left valve view of shell.

4. Cythereis sp. A; Tandora formation, locality Q,

No. Q-2.

a. Left valve view of shell.

b. Dorsal view of the shell.

5. Cythereis sp. B; Lockhart limestone, locality F,

No. F-2.

a. Left valve view of shell.

b. Dorsal view of the shell.

6. Hermanites alata n. sp.; limestone lens of Hangu

sandstone, locality B<sub>1</sub>, holotype, No. B1-9.

a. Right valve view of holotype.

b. Ventral view of holotype.

## Plate 9 (Cont.)

## Figure

7. Isocythereis sp. aff. I. sp. Swain and Brown;  
Chalor Silli limestone, locality A<sub>3</sub>, No. A3-33.  
Right valve view of shell.
8. Xestoleberis seminulata Crane; Chalor Silli limestone, locality A<sub>3</sub>, No. A3-34.  
Left valve view of shell.
9. Xestoleberis sp.
  - a. Right valve view of shell, No. L-5 from Mulla Bata limestone, locality L.
  - b. Ventral view of shell, No. N-5 from Shakalai shale, locality N.
10. Bairdia gracilis truncata n. subsp.; Chalor Silli limestone, locality A<sub>3</sub>, holotype, No. A3-42.  
Right valve view of holotype.

## PLATE 10

All figures X50

## Figure

1. Bairdia meqista n. sp.; Lockhart limestone, locality A<sub>1</sub>, holotype, No. A1-11.

Right valve view of holotype.

2. Cytherella ovata n. sp.; Chalor Silli limestone, locality H<sub>1</sub>, holotype, No. H1-12.

a. Right valve view of holotype.

b. Dorsal view of holotype.

3. Cytherelloidea ozanana Sexton; Chalor Silli limestone, locality E, No. E-25.

Right valve view of female carapace.

4. Cytherelloidea sp. aff. C. triebeli Munsey; Tarkhobi shale, locality A<sub>1</sub>, No. A1-18.

Left valve view of shell.

5. Cytherelloidea crafti Sexton; Chalor Silli limestone, locality E, No. E-26.

Left valve view of shell.

6. Cytherelloidea sp. aff. C. umbonata Edwards; Tarkhobi shale, locality A<sub>1</sub>, No. A1-19.

Right valve view of shell.

## Plate 10 (Cont.)

## Figure

7. Cytherelloidea sp. A; Chalor Silli limestone,  
locality A<sub>3</sub>, No. A3-57.

Right valve view of shell.

8. Cytherelloidea sp. B; Chalor Silli limestone,  
locality A<sub>3</sub>, No. A3-58.

Left valve view of shell.

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