BIOSTRATIGRAPHY AND OSTRACOD FAUNAS OF THE MIOCENE MARADA FORMATION OF THE EASTERN SIRT BASIN, LIBYA.

by

Amar Mohamed Gammudi, B.Sc.

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Geology and Applied Geology

Glasgow University

Geology & Applied Geology

Glasgow University

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ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

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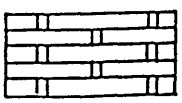

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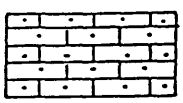

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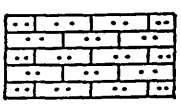

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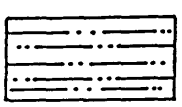

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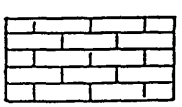

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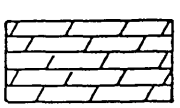

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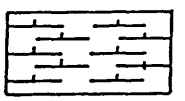

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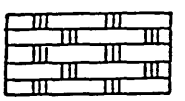

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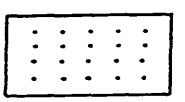

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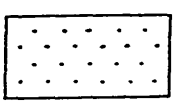
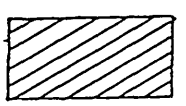


Sandstone



Gypsum

Oil well

Dry well

Key to Ostracod distribution

1-4 valves

4-8 valves

8-16 valves

> 16 valves

Note: one carapace considered as two valves

All numbered specimens are housed in the Hunterian Museum Glasgow.

ACKNOWLEDGMENTS

I would like to express my gratitude to Dr M. C . Keen for his supervision of this project; his encouragement and advice during my research, and critical review of this thesis have been of invaluable help. I would also like to thank Professor B. E. Leake for his constant interest in , and support, of my work.

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Finally, I would like to thank the National Oil Corporation for their policy of in training employees, and their encouragement of this research.

Summary

An attempt is made to define the biostratigraphy of the Marada Formation using the ostracod faunas for age determination and palaeoenvironmental analysis.

The material studied is ditch cutting samples from the Miocene Marada formation of three wells drilled in the eastern Sirt Basin by the Wintershall company in concession 97, zone 2. The Marada Formation has previously been studied by several authors such as Desio, (1935) who dated as Early-Middle Miocene, with fewer studies on the ostracods, e.g. Innocenti and Pertusati (1984) and Szchechura (1989).

28 genera and 55 species of ostracods have been recorded; six species are new: *Actinocythereis sirtensis* sp. nov, *Bythocypris tripoliensis* sp. nov, *Cyprideis maradaensis* sp. nov, *Cytheridea joshensis* sp. nov, *Hermanites zaltanensis* sp. nov, *Paijenborchellina keeni* sp. nov; 22 species have previously been described; 9 can be closely compared with described species; and 18 left under open nomenclature. Many of the species previously described have a wide ranging distribution in the Miocene to Pliocene of the Mediterranean region and North Africa; some of these are restricted to the Lower Miocene, others to the Upper Miocene while no species diagnostic of the Middle Miocene have been found.

Four ostracods biozones have been recognised in the Marada Formation: Biozone A is defined by the total range of *Pokornyella deformis minor* and indicates Lower Miocene (Aquitanian); Biozone B is defined as the interval between the last appearance stratigraphically of *Pokornyella deformis minor* and last appearance of *Aurila soummamensis* and is Lower Miocene (Burdigalian); Biozone C is an interval zone probably of Middle Miocene age, Biozone D is an assemblage zone indicating the base of

the Upper Miocene. The Biozones were present in all three Wells. The Burdigalian biozone can be correlated with biozones of the Miocene in Turkey. The palaeoenvironments indicated by the ostracods are shallow marine (Infralittoral zone) with significant brackish levels (probably lagoonal) in the Burdigalian.

DECLARATION

I declare that the contents of this thesis is my own work carried out in the Department of Geology and Applied Geology University of Glasgow from April 1988 to March 1990.

CHAPTER ONE

INTRODUCTION

INTRODUCTION

Purpose of the study:

The purpose of this study is to give a detailed account of the ostracods of the Miocene Marada Formation encountered in three wells from the eastern Sirt Basin, Libya and to determine the biostratigraphic age of the sediments and the palaeo-environmental conditions during deposition.

All previous workers have considered the Marada Formation to be Early to Middle Miocene in age on the basis of vertebrates, macrofossils, and microfossils such as foraminifera and ostracods.

Location:

Libya is situated on the central Mediterranean foreland of the African Shield (Fig1.1). The East Sahara craton has a number of basins such as the Ghadamis, Murzuk, Kufra, and Sirt Basins. These basins formed during a series of tectonic movements of Caledonian and Hercynian age, and in the late Cretaceous to middle Tertiary (Oligocene through to Miocene), and Recent times (Conant, L., & Goudarzi, G., 1964). The wells studied here were drilled by the Wintershall Company on the onshore concession 97 in the eastern Sirt Basin. This basin formed during the late Cretaceous through the collapse of the northern crest of the Tibesti-Sirt uplift, giving a series of tilted horsts and graben. Subsidence of the Sirt Basin continued from the late Cretaceous to the Tertiary (Hea,1971). The sediments which accumulated in deep troughs have a thickness of more than 20,000 ft, thinning over structural highs as well as southwards towards the Tibesti-Sirt uplift. Large quantities of organic material, terrigenous clastics and evaporites accumulated in the troughs while reefs,

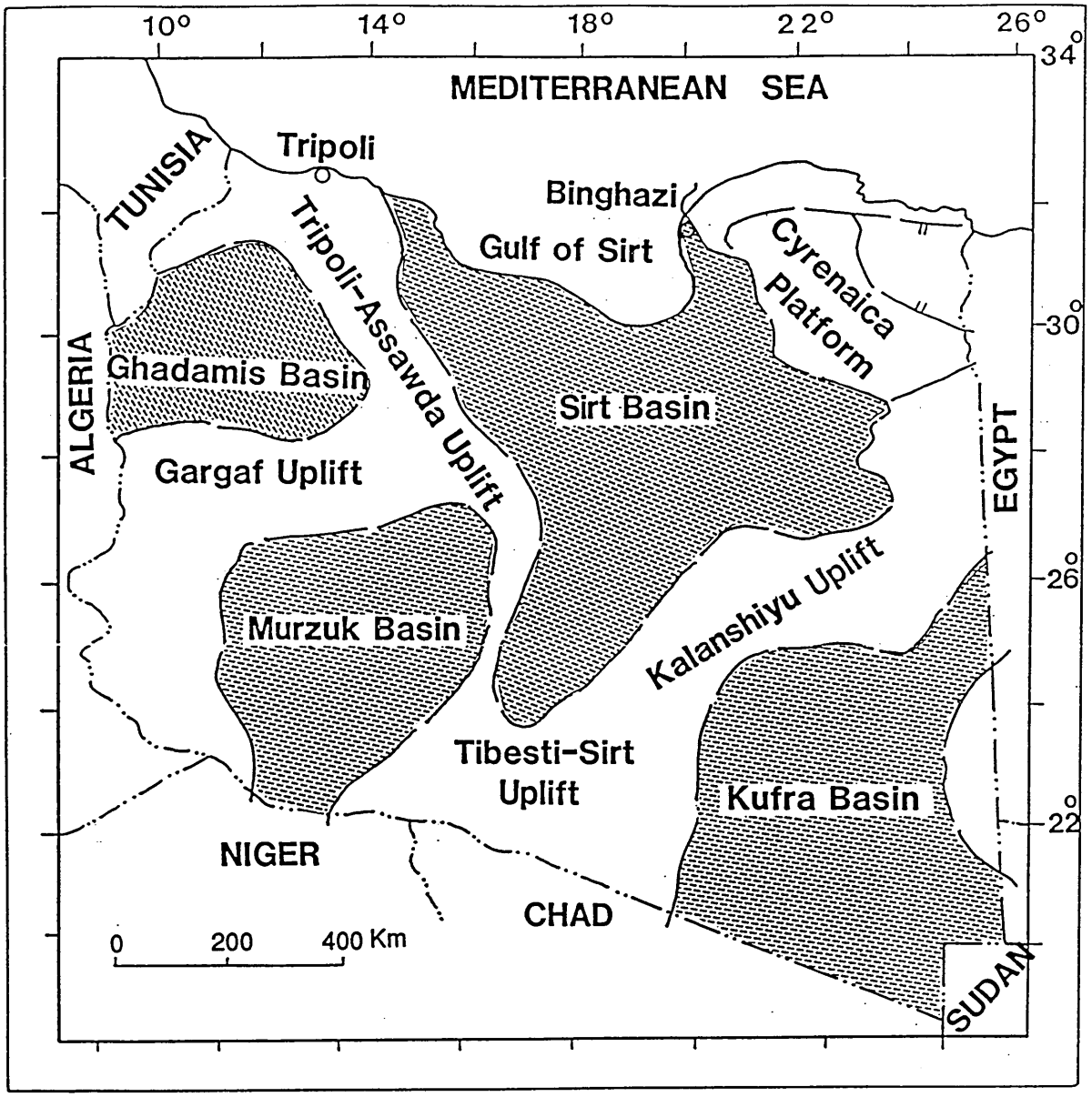


Figure 1. 1- Geographical location and Geological structural units of Libya.

and carbonates accumulated on the flanks and over the crests of the horsts. Large quantities of oil and gas have been discovered in the basin.

The wells studied here penetrate 1200ft of the Marada Formation, and are located as follows (Table 1.1)

Well No	intervals	Latitude	Longitude
C1a-97	650'-1850'	28° 51′ 34″	21° 59′ 09″
G1- 97	640'-1700'	28° 53′ 40″	21° 37′ 50″
F1- 97	600′-1800′	28° 52′ 13″	21° 17′ 00″

Table 1.1- Geographic coordinates of wells

General geology of the Miocene of Libya:

The Miocene sediments are only present in the northern Sirt Basin, adjacent areas of the Cyrenaica Platform, and a small area around Al khums 120km east of Tripoli. The deposits of the Cyrenaica Platform are shallow marine carbonates, while the thicker sediments of the Sirt Basin include shales as well as clastics and carbonates. During the Early-Mid Miocene a shallow marine gulf, fringed by lagoons existed over the northern Sirt Basin (Fig 1.2); this was bordered by a coastal plain. The Miocene of the Cyrenaica Platform is entirely Middle Miocene in age (Desio, 1928) and has been named the Al-Jaghbub Formation in eastern Cyrenaica, and the Regma Formation in northern Cyrenaica. These formations continue across the border into Egypt where they are known as the Marmarica Limestone (Said, 1962). The

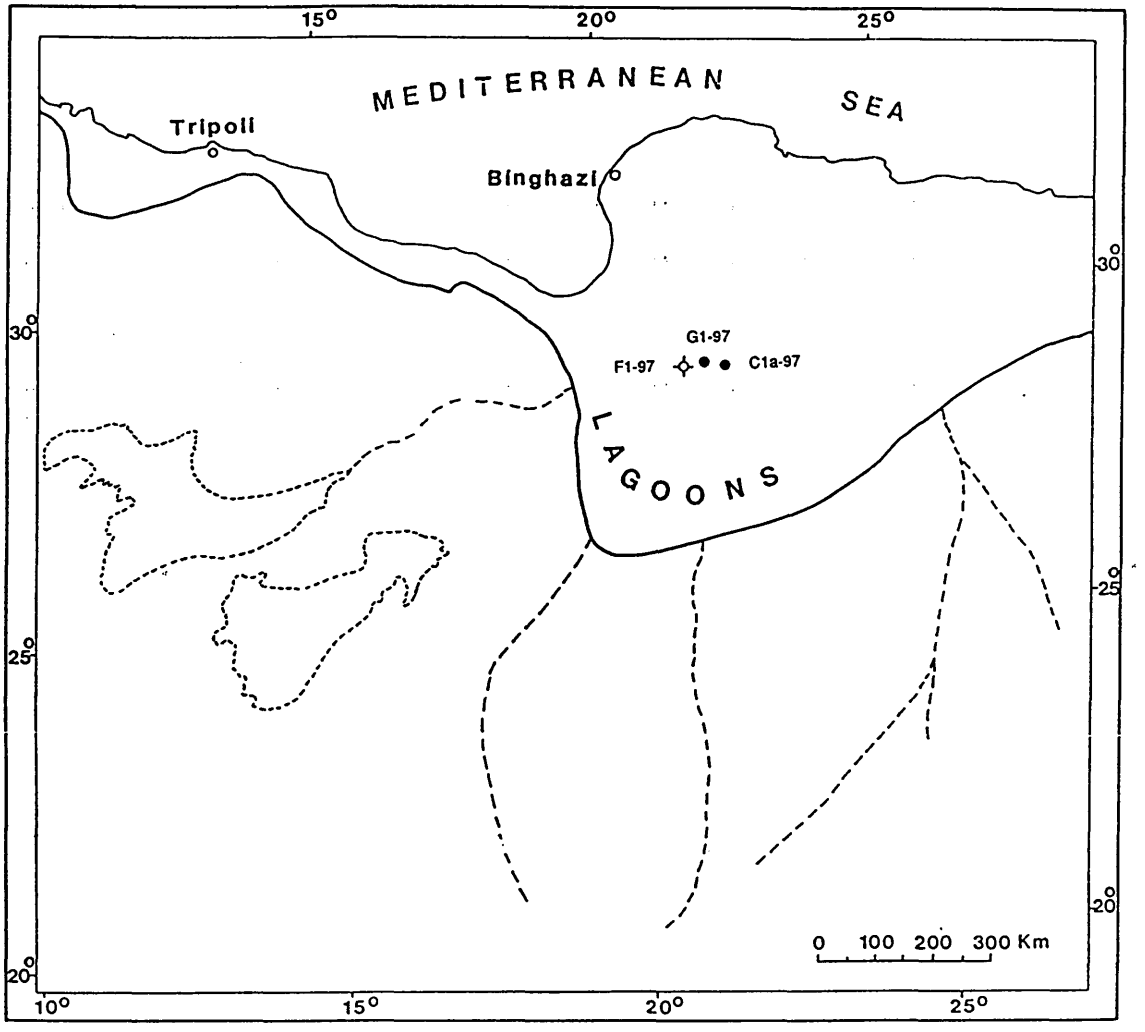


Figure 1. 2 - The Paleogeography of northern Libya during the early Miocene (After Desio 1971). The shallow marine Sirt gulf was bordered by a lagoonal area grading landwards into low-lying coastal plains with lakes, rivers, and marshes; two large lakes are indicated on the reconstruction. The position of the three wells are indicated.

small area of Miocene sediments around Al Khums (Al khums Formation) has recently been dated on the basis of foraminifera as Upper Miocene (Tortonian), by Innocenti and Pertusati (1984), although it was previously thought to be Middle Miocene. In some places in western Libya the Upper Miocene overlies Cretaceous rocks of the Sidi As Sid Formation, while in the Sirt Basin the Marada Formation lies unconformably upon various Oligocene rocks, except in the south central Basin where it is conformably with the Oligocene Diba Formation. On the northern Cyrenaica Platform the Regma Formation overlies unconformably the Eocene Apollonia and Derna Limestones and the Oligocene Cyrene Formation.

Previous studies of the Marada Formation:

Many studies have been conducted on the various aspects of the Marada Formation. Desio (1935) introduced the name Marada Series for the succession of Dor Marada about 50km north west of Jabal Zaltan. The type section was measured on Dor Marada at Garet el Mazzala, where it consists of 80m of shale interbedded with sand and limestone, with some gypsum layers, and has a marine fauna of invertebrates and fish. Desio (ibid) considered the Marada Series to be Langhian (Burdigalian) and Helvetian in age on the basis of the shelly fauna. He also considered the Jabal Zaltan sandstone succession to be equivalent in age with the Marada Formation and to be Lower Miocene in age.

Selley (1969) studied the outcrop of the Marada Formation in the Marada Oasis and Jabal Zaltan area, where it is well exposed and undisturbed by folding or faulting. It has a gentle northward dip towards the centre of the Sirt Basin. Selley changed the name from Marada Series to Marada Formation and described a large number of stratigraphic cross sections in this central part of the Sirt Basin. In this

region the Formation consists of alternating limestone, sandstone and shale with a thickness of 150m. In general, limestones become more abundant northward towards the centre of the basin, while the calcareous sandstone and unconsolidated sands increase southward towards the basin margins. Five sedimentary facies were recognised in the central part of the Sirt Basin:

a- Detrital limestone (Barrier bar & Beaches).

b- Laminated shale (Lagoon).

c- Interlaminated shale and sand (Intertidal).

d- Cross bedded sand and shale (Fluviatile).

e- Calcareous sand stone (Estuarine channels).

In subsurface studies of the Marada Formation Barr and Weegar (1972) described the formation in the south eastern Sirt Basin. In this region the sediments include interbedded green and grey laminated shale, sandstone, sandy limestone, calcarenites and gypsiferous beds with a maximum thickness of 490ft. It overlies various Oligocene rocks disconformably.

Savage and White (1965) studied mammalian faunas from the lower Marada Formation of Jabal Zaltan, suggesting a Burdigalian age (Lower Miocene).

El-Hawat (1980) studied the Marada formation of Dor Marada, Dor Zaggot and central Jabal, and Jabal Zaltan (Fig 1.3) recognising seven sedimentary facies (some of them described by Selley). In ascending order the facies are:

1- Calcareous sandstone (Estuarine Channel).

2- Calcareous shale (Lagoon).

3- Cross bedded sandy grainstone (Tidal inlet Channel and delta).

4- Cross bedded grainstone (Barrier bars and beach).

5- Dolomitic limestone (Tidal flat).

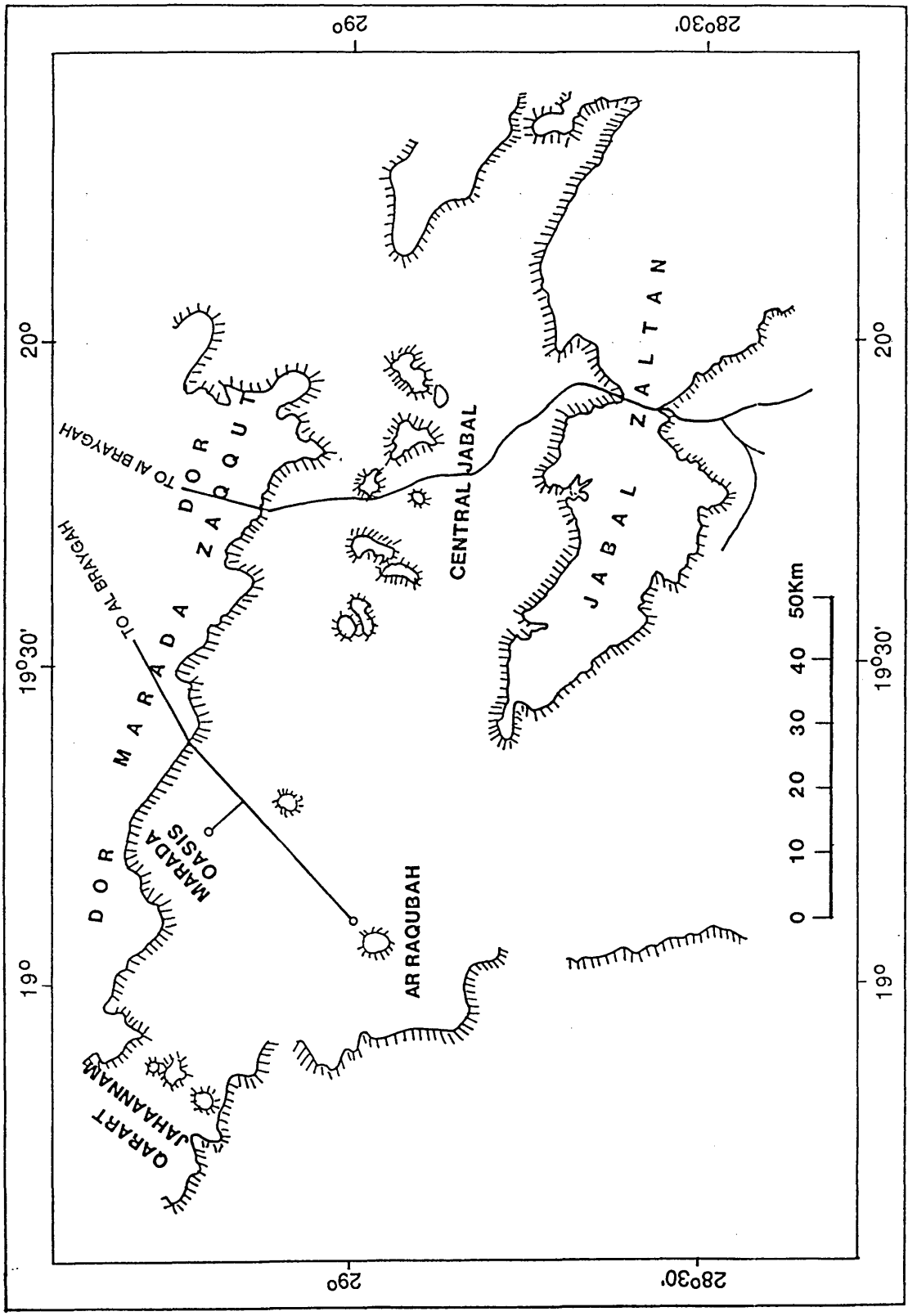


Figure. 1. 3- Localities in the type area of the Marada Formation.

6- Wackestone (marine bank).

7- Marl (Marine Delta fans).

Conant and Goudarzi (1964) mapped the Miocene sequences in the Sirt Basin, considering the Marada Formation to be Lower Miocene, with a maximum thickness of 150m.

More detailed studies of the Marada Formation were given by Innocenti and Pertusati (1984) in a study of the sheet Al Aqaylah (between Latitude 30°-31° N and Longitude 18°-19° 30′ E). In this region the formation is conformable with the upper Oligocene Buhashish Formation and in turn is unconformably overlain by either the Wadi Younis or the Quayrat Al Jibs Members of the Upper Miocene of Al Khums Formation. The Marada Formation is widely distributed and well exposed in the area covered by the sheet, with a maximum thickness of about 80m. It has a fairly homogeneous lithology, but can be subdivided into three parts. The basal part is 20-30m thick and consists of thick bedded marl, sandy marl, chalky limestone and chalks with abundant macrofossils, (pelecypods, echinoderms, bryozoans and corals). This is overlain by 30m of sediments dominated by thick bedded skeletal limestones very rich in macrofossils such as pelecypods and gastropods, with subordinate bryozoans, corals and echinoid fragments. The upper part is only present in the southern central area, being mostly eroded away elsewhere. It is 20-30m thick and consists of chalky limestone, micritic limestone, sometimes with chert nodules, and sandy limestone; crossbedded biocalcarenite are locally present.

The Marada Formation in the wells studied:

The exposures of the Marada Formation in the type area vary in thickness between 80-150m; the formation increases in thickness northwards into the centre of the deposition with Maximum recorded thickness of 853m (2800ft) (Wright and

Benfield 1980). The area in which the wells studied here were drilled is to the east of the type area, and during the Miocene was a trough allowing the accumulation of some 365m (1200ft) of sediment. The sediments penetrated by the wells differ from those of the type area; the majority of the succession consists of fossilifeous limestones (marly calcarenites, some calcilutites) with common shale horizons (see Appendix 1 for details). It is not easy to correlate these sediments with the facies described by Selley (1969) and El-Hawat (1980). The fauna (see below, and chapters 3 and 4) indicates the predominance of shallow marine condition, probably infralittoral, throughout the succession. Brackish water ostracods such as *Cyprideis* and *Neocyprideis* occur commonly in the lower part of the Marada Formation in the wells studied, but there is no correlation between their abundance and type of sediment; they are found in samples dominated by limestone as well as samples dominated by shale, and some individual specimens of *Cyprideis* have been found with limestone matrix attached. Therefore they cannot be regarded as representative of the lagoonal shale facies of Selley and El-Hawat. Lagonal facies however were clearly present in the vicinity of the wells (See Chapter 4). There is no evidence of barrier bar, beach, tidal flat, estuarine channels or fluviatile facies.

Previous studies of Miocene ostracods of Libya:

The Miocene ostracods of the Mediterranean area have been widely studied during the past 100 years (See Fig 3.1 for important recent work relevant to the Libyan faunas). However there are fewer studies published on the Miocene ostracods of Libya. The first data were presented by Van Hinte, Colin and Lehmann (1980) who recorded ostracod faunas from the side wall core in the offshore well B1-NC35A, located about 140Km north east of Tripoli on the Pelagian platform. The lithology of the core shows intercalation of anhydrite between marl beds. The marls above the

anhydrite were considered to be Pliocene in age, and marls below the anhydrite are Miocene. The evaporites are probably evidence of the Messinian event in the area. 41 species of ostracods were recorded, including 23 named species. 11 species were only present above the evaporites, and of 30 species recorded from the Tortonian only *Acanthocythereis hystrix*, *Chrysocythere cataphracta* and *Neomonoceratina laskarevi* have been found in this study of the Marada Formation. The reason for this great difference in faunas is partly due to stratigraphy in that the faunas of Van Hinte *et al* are mostly younger than those of the Marada Formation, and partly due to facies differences whereby the samples of Van Hinte *et al* indicate predominantly circalittoral-upper bathyal (75-500m) conditions.

El-Waer (unpublished thesis 1985) described the ostracod fauna of the Al Khums Formation, recording 39 species including eight new species. El-Waer published the main conclusions of his work in 1988, describing four new species, listing the remainder, and concluding that the Al Khums Formation is of late Miocene age. The following species are in common between the Al Khums and Marada Formation: *Actinocythereis spinosa, Actinocythereis libyaensis, Carinovalva carinata, Chrysocythere alkhumia, Cistacythereis qabilatashurfahensis, Cnestocythere truncata, Keijella africana, Neomonoceratina mouliana, Ruggieria tetaptera tetraptera,* The difference between the faunas can be accounted for by the difference in age.

In a study of the middle Miocene Al-Jhaghbub Formation of eastern Cyrenaica, Bellini (1969) gave a list of ostracods identified by Ascoli (in Bellini 1969). These species are: *Neomonoceratina* aff. *N. helvetica* Oertli, *Miocyprideis* sp, *cytherella* sp, *Ruggieria* aff. *Ruggieria tetraptera tetraptera* Seguenza, *Loxoconcha* aff. *L. punctatella* Reuss, *Aurila* sp, *Chrysocythere* aff. *C. cataphracta* Ruggieri, *Hermanites* sp, *Krithe* sp, *Cytheretta* aff. *C. jurinei* Muenster, *Quadracythere* sp, *Loxoconcha* sp, *Aurila* ? aff.

A. deformis Reuss, *Cuneocythere* ? sp, *Quadracythere* sp, *Trachyleberis* ? sp, *Paijenborchella* ? sp. The identifications are not accurate enough to allow any comparison with the ostracods of the Marada Formation.

Innocenti and Pertusati (1984) recorded 19 ostracod species from the Marada Formation: *Aurila cicatricosa* (Reuss), *Aurila diecii* (Sissingh), *Aurila impressa* (Ruggieri), *Aurila longa* Ruggeiri, *Aurila Punctata* (Von Munster), *Aurila trigonella* (Reuss), *Bairdia subdeltoidea* (Von Munster), *Bairdoppillata octopunctata* Ruggieri, *Chrysocythere cataphracta* (Ruggieri), *Cletocythereis minor* (Ruggieri) *Cnestocythere truncata* (Reuss), *Cytheridea acuminata* Bosquet, *Kangarina coarctata* Ruggieri, *Loxoconcha punctatella* (Ruggieri), *Loxoconcha variesculpata* (Ruggieri) *Neomonoceratina mediterranea* (Ruggieri), *Neomonoceratina mouliana* (Sissingh), *Ruggieria tetraptera tetraptera* (Seguenza), *Tenedocythere mediterranea* (Ruggieri). This list of species is so different from that recorded in this study, and because they are not illustrated, it is impossible to make any valid comparisons.

Szczechura and Abd-Elshafy (1989) studied the ostracods and foraminifera from the ?middle Miocene of the western coast of the Gulf of Suez, Egypt, and from the Marada Formation of the central Sirt Basin. They recorded 55 species of ostracods from the Hommath Formation, although only 14 species are positively identified to specific level and include four new species described by Szczechura *Cytherelloidea sissinghi, Neomonoceratina keiji, Neomonoceratina ruggierii, Hemicyprideis aegyptiaca.* All of these new species were also recorded from the Marada Formation. In this study only *Neomonoceratina keiji* has definitely been found, together with another 11 species recorded by Szczechura and Abd-Elshafy.

Szczechura and Abd-Elshafy state that about 70% of Egyptian species are present in the Marada Formation of Libya. This is not found to be the case with the

species recorded in this study where there is a considerable difference. The species in common between Egypt and Libya are: *Chrysocythere cataphracta*, *Cistacythereis* cf *caelatura*, *Cnestocythere truncata*, *Cytherella* sp. B, *?Cytheridea*, *Falsocythere maccagnoi*, *Hermanites haidingeri*, *Keijella africana*, *Neomnoceratina keiji*, *Neomonoceratina ruggierii*, *Pokornyella deformis minor*, *Ruggieria tetraptera tetraptera*.

The fauna described from the Hommath Formation suggests the presence of Lower Miocene sediments.

Previous studies on palaeoenvironments of the Marada Formation:

Few publications deal with the palaeoenvironments of the Marada Formation. Selley (1969) interpreted the succession as indicating rivers flowing northwards across intertidal flats similar to the present day Texan coast, with a shoreline in the area of Marada and Jabal Zaltan, where detrital limestones formed offshore bars and beaches. A coastal area of lagoonal and intertidal environments is represented by laminated shales and sands, while to the south cross-bedded sands indicate fluviatile deposition. These facies are crossed by north trending calcareous sandstones interpreted as estuarine channels. Doust (1968) suggested that the environment of the Marada Formation was closely related to the tropical Atlantic on the basis of its shelly marine fauna. Savage & Hamilton (1973) recorded the remains of fish, reptiles, and sea cows. The fish are not abundant, but are mainly sharks and rays indicating marine and brackish water, while the crocodiles and turtles suggest tropical temperatures. Land mammals such as Mastodon, *Deinotherium*, Giraffes, anthracothers, rhinoceroses and pigs and rare carnivores (gigantic hyaenodonts) suggest a forest belt along a river.

El-Hawat (1980) distinguished a number of facies similar to those of Selley :

Facies 1, estuarine channels; Facies 2 & 3, lagoonal environments; Facies 4, barrier bars and beaches; Facies 5, tidal flats; facies 6 &7, interpreted as open marine environments.

More detailed studies were carried out by Innocenti and Pertusati (1984) on the lithology and palaeontology of the Marada formation. They concluded that the depositional environment changed during sedimentation. The basal part of the Formation was considered to be shallow water with highly terrigenous sediment input; the terrigenous supply of sediment decreases upwards, and the environment became progressively more marine. Beds of skeletal limestone with abundant fossils of pelecypods, gastropods, corals and algae indicate shallow to open marine environments with warm water of normal marine salinity. The upper part of the formation is characterised by crossbedded grainstone suggesting a gradually shallowing environment.

CHAPTER TWO

SYSTEMATIC DESCRIPTIONS

SYSTEMATIC DESCRIPTIONS

The systematic order used follows that of the Treatise on Invertebrate Palaeontology (Q)1961 with the exception of the genera *Acanthocythereis, Carinovalva, Chrysocythere, Cistacythereis, Falsocythere, Keijella* which is not included in the 1961 edition.

Subclass Ostracoda Latreille, 1806.

Order Podocopida Müller, 1894.

Suborder Platycopa Sars 1866.

Family Cytherellidae Sars, 1866.

Genus *Cytherella* Jones, 1849

Cytherella cf. *pulchella* Ruggieri,1967

pl. 10, figs. 11-13.

Material- Three carapaces and three valves; No A12653-655.

Locality and Horizon- Well F1-97, at depth 1590-1740ft.

Diagnosis- A species of *Cytherella* elongate to oblong-ovate in lateral view; surface ornamented by coarse pits except in the centre of the carapace; muscle scar area marked by small shallow depression in central dorsal area.

Description- Carapace elongate to oblong-ovate in lateral view; right carapace larger than left; maximum height at about 1/5 length from anterior; anterior margin broadly rounded; posterior margin obliquely rounded posterodorsally; dorsal margin straight to slightly concave at 1/3 length from anterior; ventral margin straight; dorsal and ventral margins subparallel; lateral surface ornamented by coarse

pits although central area is smooth; the position of central muscle scar area indicated externally by small shallow depression in dorso-central area; posterior end tapering in dorsal view, anterior end narrowly pointed. The greatest width is situated at 1/3 length from posterior. In dorsal view the sides of carapace more or less straight altgough sinuate in the area of shallow depression.

Dimensions of figured specimens (μm).

	Length	Height	L / H
Female left carapace; No A121654	625	350	1.78
Male left carapace; No A12653	637	337	1.90
Left valve juvenile; No A112655	529	313	1.70

Remarks- The specimens studied here are similar to *C. pulchella* Ruggieri recorded from the Upper Tortonian of Italy (Ruggieri, 1967), but differs in the arrangement of pits and also the fact that the carapace of Ruggieri's material is smooth and truncated posteriorly in dorsal view. The present species is more similar to *C. pulchella* described from the middle to upper Miocene of Palermo, Italy, by Aruta (1982), but differs in the postero-ventral area which is broadly rounded in our specimen rather than slightly truncated in *C.pulchella* and also smaller than Aruta's specimens. This also shows some similarities to *Cytherella (Cytherella) vandenboldi* Sissingh (1972) from upper Miocene Apostoli Formation in the south Aegean Island Arc, but the latter differs in having the entire carapace punctate and having a truncated posterior end in dorsal view. One specimen differs from the others in being unornamented , otherwise its similar; this feature has been reported in other species of *Cytherella* (see Keen 1982), and is here regarded as a case of polymorphism.

Occurrence- Occurs in Well F1-97.

Cytherella sp A.

pl.10, figs. 3-5.

Material- Two carapaces; No A12646-647.

Locality and Horizon- Recorded in the Well C1a-97 at depth of 770ft.

Description- The carapace is ovate in lateral view; right valve larger than left; in dorsal view sides are almost parallel. The lateral surface is covered by coarse pits with smaller pits around the margins; the muscle scar area is indicated by an elongate shallow depression. Internal features not known.

Dimensions of figured specimen in (μm).

	Length	Height	L / H	Width
Left carapace; No A12646	519	324	1.67	____
Same right carapace	526	335	1.56	____
Dorsal view; No A12647	555	____	____	244

Remarks- This is identical to *Platella* sp. cf *P. vandendoldi* (Sissingh) 1972 described by Al-Waer (M.S. 1985) from the Upper Miocene Al khums Formation; Al-Waer regarded this as a species of *Platella* because of its ornamentation. *Cytherella vandenboldi* differs in having a truncate posterior margin in dorsal view. It is also similar to *C. pulchella* Ruggieri, but has coarser punctae.

occurrence- Well Cia-97.

Cytherella sp.B

pl.10, figs. 1-2.

1989 *Cytherella* sp. Szczechura and Abd-Elshafy p. 290, pl. 2a-b,7?

Material- Four carapaces; No A12644-645.

Locality and Horizon- Wells C1a-97 at depth 770 ft and F1-97 at depth 1530ft.

Description- Carapace ovate to egg shaped in lateral view; posterior margin broadly rounded and higher than anterior end; anterior margin broadly rounded; dorsal margin sinuate and convex in antero-dorsal area and slightly concave in the central dorsal area; ventral margin almost straight; maximum height behind the middle of carapace; right valve larger than left, over lapping along the entire margin. In dorsal view the carapace is wedge-like with maximum width 1/3 from posterior end; anterior end pointed while posterior end subtruncated. Surface of carapace smooth. Internal features not known. Sexual dimorphisim is not pronounced.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Left carapace;No A12644	673	413	1.62	____
Dorsal view; No A12645	675	____	____	310

Remarks- *Cytherella* sp. B resembles *Cytherella* sp. described from the Oligocene-Miocene of the Mejias Quarry of southern Trinidad (Van Den Bold 1957), but the latter species has a convex ventral margin while the specimen illustrated here is straight. This species is also recorded as *Cytherella* sp from the ?middle Miocene of the central Sirt Basin and the western coast of the Gulf of Suez ,Egypt (Szczechura and Abd-Elshafy 1988).

Occurrence- This species is recorded in wells F1-97 and C1a-97.

Genus *Cytherelloidea* Alexander, 1929.

Cytherelloidea sp.

pl.10, fig. 10.

Material- One carapace; No A12652.

Locality and Horizon- Well G1-97 at depth 1230 feet of Marada formation.

Description- Carapace elongate ovate in lateral view; dorsal margin slightly concave in the middle and sloping posteriorly; ventral margin slightly concave in the middle; anterior margin broadly rounded; posterior margin obliquely rounded; right valve larger than left and overlapping all around. Surface characterized by two ridges parallel to anterior and posterior margins, the posterior ridge being thicker than the anterior ridge. Surface punctae smaller in central areas of valve; the location of central muscle scar is indicated externally by a small vertical shallow depression. Internal features unknown.

Dimension of figured specimen (in μm).

	Length	Height	L / H
Left carapace; No A12652	600	329	1.82

Remarks- *Cytherelloidea* sp. shows some similarities to *Cytherelloidea chaasraensis* (Guha, 1961) in lateral outline of the carapace and pattern of anterior and posterior ridges; but it differs in shape and smaller size of the punctae.

Suborder Podocopina Sars,1866

Superfamily Bairdiacea Sars, 1888

Family Bairdiidae Sars, 1888

Genus *Bairdoppilata* Coryell, Sample & Jennings, 1935

Bairdoppilata triangulata Edwards, 1944

pl.15 ,fig. 13.

1944 *Bairdoppilata triangulata* Edwards, p. 507, pl. 85, figs. 5-7.

1955 *Bairdoppilata triangulata* Edwards, Keij, p. 100, pl. 14, fig. 5,6.

1957 *Bairdoppilata triangulata* Edwards, Lean, p. 69, pl. 7, fig. 1, a-d.

1965 *Bairdoppilata triangulata* Edwards, Moyes, p. 16-17, pl. 2, fig. 1-2.

Diagnosis- A species of *Bairdoppilata* with high dorsal margin, posterior half of which has a distinct angular caudal process.

Material- Two valves; No A12718.

Locality and Horizon- Well C1a-97 at depth 1730 feet.

Dimension of figured specimen (in μm).

	Length	Height	L / H	Width
Left valve; No A12718	728	521	1.39	____

Remarks- This species was originally described from the Miocene Duplin Marls of North Carolina U.S.A. (Edwards, 1944) and subsequently recorded from the Lower Aquitanian of South west France (Keij, 1955 and Moyes, 1965). The specimens described here are similar to the French specimens, and the identification is based upon Keij and Moyes interpretation of the species.

Occurrence- Occurs in well C1a-97.

Bairdoppilata sp. A.

pl. 15, fig. 11.

Material- Two carapaces; No A12716.

Locality and Horizon- Wells G1-97 at depth 1260ft and F1-97 at 1530 ft.

Description- Ventral margin convexly curved at anterior and posterior margin narrow and lower than anterior margin; dorsal margin convex with maximum height at the centre of carapace; carapace is smooth. Internal features not observed.

Dimension of figured specimen (in μm).

	Length	Height	L / H
Right carapace; No A12716	909	563	1.61

Remarks- *Bairdoppilata* sp. A. has some similarities with *Bairdoppilata* sp. A. described from the Lower Miocene of India by Khosla (1978), but differs in having a less arched dorsal margin and more pointed posterior.

Occurrence- Occurs in wells G1-97 and F1-97.

Bairdoppilata sp. B.

pl.15, fig. 12.

Material- Two carapaces; No A12717.

Locality and Horizon- Wells G1-97 at depth 1540ft and F1-97 at 1110ft.

Description- Carapace subtriangular in lateral outline, maximum height slightly anterior of centre; left valve larger than right and distinctly over lapping around dorsal and ventral margins. Dorsal margin broadly convex, ventral margin slightly convex. Anterior margin broadly rounded and higher than posterior margin which is pointed. Surface of carapace is smooth. Internal features not observed.

Dimension of figured specimen (in m).

	Length	height	L / H
Right carapace; No A12717	650	375	1.73

Remarks- This species differs from *Bairdoppilata* sp.A. in having a more evenly curved dorsal margin, more pointed posterior, and postero-ventral area less curved upward than in *Bairdoppilata* sp. A.

Occurence- Occurs in well G1-97.

Genus *Bythocypris* Brady,1880

Bythocypris tripoliensis sp. nov

Pl.12, figs. 1-4.

Derivation of name- After capital of Libya.

Diagnosis- Carapace elongate in lateral outline; dorsal margin arched; surface smooth.

Holotype-Female right carapace; No A12671, pl.12, fig. 2, well G1-97 at depth of 1540ft.

Material- Twenty five carapaces and one valve; No A12670-673.

Locality- Recorded throughout the studied wells.

Horizon- Marada Formation.

Description- Carapace elongate in lateral view, with greatest height near centre of carapace. Left valve larger than right, over lapping all around margin, dorsal margin arched; ventral margin slightly convex in the left valve & relatively straight in the right, anterior margin broadly rounded; posterior margin obliquely rounded; carapace ovoid in dorsal view; maximum length centrally. The surface of the carapace is smooth. Internal features not observed. Sexual dimorphisim is distinct with smaller and more elongate males.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Female right carapace; No A12671	869	459	1.85	____
Female left carapace; No A12672	816	432	1.88	____
Female dorsal view; No A12673	870	____	____	387
Male right carapace; No A12670	800	368	2.17	____

Remarks- This shows some simillarty to the specimens described as *Bythocypris alejo* Reyment by Carbonnel (1986), although outline is not quite the same, the species described here being more elongate. It is also similar in size to *Disopontocypris schwejeri* Van Den Bold (1966), but differs from the latter in the outline of the dorsal and anterior margins; in *B. tripoliensis* the dorsal margin slopes downwards towards the anterior giving a more tapered anterior in the female, and has a more humped dorsal margin.

Occurrence- Throughout the studied wells.

Superfamily Cypridacea Baird, 1845

Family Cyprididae Baird, 1845

Subfamily Disopontocypridinae Mandelstam, 1956

Genus *Disopontocypris* Mandelstam, 1956

Disopontocypris schwejeri Van Den Bold, 1966

pl. 12, fig. 5-7.

1966 *Disopontocypris schwejeri* Van Den Bold, p.159, pl. 4, figs. 3a-b.

1974 *Disopontocypris schwejeri* Van Den Bold, Coutelle & Yassini, p. 87, pl.1, figs.2,8.

1986 *Aglaiocypris schwejeri* Van Den Bold, Carbonnel, p. 83, pl. 11, fig.9.

Material- Nine carapaces and one valve; No A12674-676.

Locality and Horizon- Recorded only in the Borehole C1a-97 at depth of 770-950 feet.

Diagnosis- A species of *Disopontocypris* with smooth elongate Carapace; maximum height at middle of carapace, left valve overlaps the right all around margins; carapace ovoid in dorsal view.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	width
Right carapace; No A12674	984	468	2.1	____
Left carapace; No A12675	934	436	2.1	____
Dorsal view; No A12676	961	____	____	390

Remarks- This was originally described from the Neogene of the Gabon (Van Den Bold 1966), and subsequently from the Burdigalian of Algeria (Coutelle and Yassini, 1974) and from the Neogene of Senegal (Carbonnel 1986). The specimens described here are larger than those listed above.

Dimensions of previously described specimens (in μm).

	Length	Height
Coutelle and Yassini(1974)	620	430
Van Den Bold (1966)	790	370
Carbonnel(1986)	850	420

There seems to be an error in the dimensions given by Coutelle and Yassini according to the photograph. The Libyan specimens are very similar in outline to those illustrated by Carbonnel.

Occurrence- This species is recorded from the Well C1a-97.

Family Paracyprididae Sars, 1923

Genus *Paracypris* Sars, 1866

Paracypris aff *P. polita*

pl.12, figs. 14,15.

Material- One carapace; No A12683.

Locality and Horizin- Recorded in Well C1a-97 at depth 1730 feet.

Description- Carapace elongate in lateral view; maximum height to anterior of the centre; dorsal margin slightly arched, ventral margin concave, anterior margin broadly rounded, posterior margin tapering. Left valve larger than right and overlapping all of the right valve except at anterior margin. Surface of carapace is smooth. Internal features not known.

Dimensions of figured specimens (in μm).

	Length	height	L / H
Right carapace; No A12683	979	597	1.63
Same left carapace	980	459	2.28

Remarks- This species resembles *Paracypris polita* Sars (1866), described from the Burdigalian of South West Anatolia, Turkey, by Gokçen (1985/86); the latter differs in lateral outline, being more elongate and having a more tapered posterior margin and more obliquely rounded anterior margin. *Paracypris polita* described from the Upper Oligocene-Helvetian of the Aquitaine Basin (Keij, 1955 and Moyes 1965), differs in being more elongate and having a highly tapered posterior.

Occurrence- Occurs in Well C1a-97.

Paracypris sp. A

pl. 12, figs. 8,9,13.

Material- Five carapaces; No A12677-679.

Locality and Horizon- Well F1-9 at 990 , 1170 ft.

Description- Carapace elongate to subtriangular in lateral outline; anterior margin rounded; posterior margin tapered; dorsal margin arched with prominent highest point, ventral margin straight to slightly concave centrally; maximum height near centre of carapace. Carapace surface is smooth. Internal features not known. Sexual dimorphism not pronounced.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Right carapace; No A12678	797	374	2.13	____
Left carapace; No A12677	784	361	2.17	____
Dorsal view; No A12679	809	____	____	296

Remarks- *Paracypris* sp. A shows similarities with *Paracypris rosefield-ensis* described from the lower Miocene of Southern Trinidad (Van Den Bold, 1957) but the latter has a more pointed posterior and it is larger. *P.* sp. A differs from *Propontocypris* sp. in the pointed posterior margin and smaller size.

Paracypris sp.

pl.12, fig. 10.

Material- One carapace; No A12680.

Locality and Horizon- Well F1-97 at depth 1290 ft.

Description- Carapace elongate in lateral view; maximum height at the centre of carapace; dorsal margin gently convex in anterior half, posterior strongly tapered; anterior margin broadly rounded; ventral margin concave towards anterior; right carapace larger than left and clearly over lapping along the postero-dorsal and much of the ventral margins apart from the anterior region. The carapace is smooth. Internal features not known.

Dimension of figured specimen (in μm).

	Length	Height	L / H
Left carapace; No A12680	644	300	2.10

Remarks- *Paracypris* sp. shows some similarities to *Paracypris sp* described from the Neogene of Rhodes (Mostafawi, 1989), but the latter differs in having maximum height at 1/3 length of carapace from anterior, dorsal margin is slightly rounded, and postero-dorsal margin slightly curved rather than straight. This species also shows some similarities with *Paracypris polita* Sars described from the Burdigalian of south west Anatolia, Turkey (Gokçen1985/86), but differs in having a longer and curved antero-dorsal margin.

Family Pontocyprididae G. W. Müller, 1894

Genus *Propontocypris* Sylvester-Bradley , 1947

Propontocypris sp.

pl.12, fig. 11,12.

Materials- Two carapaces; No A12681-682.

Locality and Horizon- Well C1a-97 at depth of 1340 ft.

Description- Carapace elongate to subtriangular in lateral view, with

maximum height nearly at the centre, anterior margin broadly rounded, posterior margin slightly tapered, dorsal margin acutely arched just behind the middle, ventral margin relatively straight to slightly concave in the middle, left valve larger than right and overlapping all around margin. The surface is smooth. Internal features not known.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Right carapace; No A12681	869	434	2.00
Left carapace; No A12682	900	436	2.06

Remarks- This resembles *Propontocypris* sp from the Upper Miocene of the Al khums Formation of North west Libya recorded by El-Waer (M.S.1985) but differs from the latter in having a more arched dorsal margin, and less tapered posterior.

Superfamily Cytheracea Baird,1850

Family Cytheridae Baird, 1850

Genus *Cnestocythere* Triebel, 1950

Cnestocythere truncata (Reuss, 1850)

pl. 5, figs. 1,2.

1850 *Cypridina truncata* Reuss, p.79, pl.10, Fig. 15.

1950 *Cnestocythere truncata* (Reuss), Triebel, p.319, pl.2, figs. 9-11.

1955 *Cnestocythere truncata* (Reuss), Keij, p.133, pl.18, Fig. 16.

1962 *Cnestocythere truncata* (Reuss), Ruggieri, p.54, pl.2,figs. 10 -11.

1969 *Cnestocythere truncata* (Reuss), Carbonnel, p. 91-93, pl. 5, fig. 1

1985 *Cnestocythere truncata* (Reuss) , El-waer, p.24, pl.1, Fig. 7

1989 *Cnestocythere truncata* (Reuss), Szczechura & Abd-Elshafy, p.291, pl.5, figs.11,12

Material - One carapace and one valve; No A12592-593.

Diagnosis- A species of *Cnestocythere* with subquadratic carapace in lateral view and surface ornamented by coarse ridges and reticulation

Dimensions of figured specimens in (μm).

	Length	Height	L / H
Female right valve; No A12593	524	286	1.83
Female left carapace; No A12592	473	273	1.73

Remarks- This species was first described from the Tortonian of the Vienna Basin (Reuss 1850); it is also recorded from the Aquitanian-Burdigalian of France (Keij 1955, Moyes 1965, and Carbonnel 1969) from the Tortonian of central Sicily (Ruggieri 1962), from the Upper Miocene Al khums Formation of Libya (El-Waer,1985) and from the ?middle Miocene Marada Formation and Hommath Formation of Egypt (Szczechura and Abd-Elshafy 1989). Triebel (1950) described two species from the Tortonian of the Vienna Basin: *Cnestocythere lamellicosta* n.sp. and *C. truncata* (Reuss); the former has sharp and high ridges while the latter has low rounded ridges, our species has low and rounded ridges.

Occurrence- Occurs only in Wells G1-97 and F1-97.

Family Cytherettidae Triebel, 1952

Genus *Cytheretta* G. W. Müller, 1894

Cytheretta cf. *semipunctata* Bornemann, 1885

pl. 11, fig. 13-15.

Material- Three carapaces; No A12667-669.

Locality and Horizon- Recorded from Well F1-97 at 1230 ft.

Description- Carapace elongate to ovate in lateral view; maximum height at the centre of carapace; dorsal margin nearly straight; ventral margin straight curved upward posteriorly; left valve larger than right valve, overlapping most of the margins. Surface of carapace ornamented by variable sized punctae forming four rows in the postero-central area; these punctae extend both posteriorly and anteriorly as scattered and smaller sized punctae; the remainder of the carapace is smooth. Sexual dimorphism is distinct, male smaller and slightly more elongate than females. Internal feature not known.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Male right carapace; No A12667	769	384	2.00
Female left carapace; No A12668	816	450	1.80
Female right carapace;No A12669	810	436	1.85

Remarks- This species is similar to *Cytheretta* aff *semipunctata* described from the Lower Miocene of the Rhone Basin in France (Carbonnel 1969), but differs in shape and arrangement of punctae.

Occurrence- Occurs in Well F1-97.

Cytheretta sp. A.

pl.11, fig. 9-12.

Material- Six carapaces; No12663-666.

Locality and Horizon- Well C1a-97 at depth of 770 feet.

Description- Carapace elongate to ovate in lateral view; maximum height at the centre of the carapace; dorsal margin of left valve convex with small posterior hinge-ear; anterior and posterior margins obliquely rounded; right valve with straight to slightly convex dorsal margin, ventral margin concave towards anterior. The ornamentation consists of seven longitudinal ridges in the posterior part of the carapace, with very weakly developed reticulation between them; one specimen also has very indistinct rows of punctae in the antero-ventral part of the valve. The rest of the carapace is smooth. Internal features not known. Sexual dimorphisim is distinct, males being more elongate than females.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Female right carapace; No A12663	753	461	1.63
Female left valve; No A12665	755	444	1.70
Male right carapace; No A12664	833	450	1.85
Male left carapace; No A12666	833	450	1.85

Remarks- This species is very similar to *Cytheretta* sp. B figured by El-Waer (M. S.1985) but the latter differs in having two rows of punctae in the antero-ventral area although this feature may show intraspecific variation because one specimen described here has weak anterior punctae.

Occurrence-Occurs in Well C1a-97.

Family Cytherideidae Sars, 1925

Subfamily Cytherideinae Sars, 1925

Genus *Cytheridea* Bosquet, 1852

Cytheridea joshensis sp. nov

pl.15, figs. 6-9.

Derivation of name- After Josh village, Libya.

Diagnosis- A species of *Cytheridea* with surface ornamented by large deep rounded pits.

Holotype- Female right carapace; No A12711, pl. 15, fig. 6, well C1a-97 at depth 770ft.

Material- Twenty carapaces; No A12711-714.

Locality- Wells C1a-97, G1-97 and F1-97.

Horizon- Throughout the Marada Formation .

Description- Carapace subovoid in lateral view; with greatest height near anterior; anterior margin evenly rounded, some specimens have very fine spines in the antero-ventral area; posterior margin obliquely rounded; dorsal margin slightly convex and gently sloping posteriorly; ventral margin straight in left valve while in right valve it is slightly concave centrally; maximum height at dorsal cardinal angle. Surface of carapace ornamented by large deep rounded pits; the area of the muscle scars has fossae arranged in a group like the petals of flowers. In dorsal view carapace has almost parallel sides, with bluntly rounded anterior, and posterior margins widest near posterior. Internal features not known. Sexual dimorphisim is pronounced, males being more elongate than females.

Dimensions of figured specimens (in μm).

	length	Height	L / H	Width
Female right carapace; No A12711	566	305	1.85	____
Male right carapace; No A12713	612	315	1.94	____
Male left valve; No A12712	588	308	1.92	____
Female D.View; No A12714	525	____	____	250

Remarks- This species shows slight similarities with *Cytheridea fourniei* described by (Carbonnel,1969), from the Lower Miocene of the Rhone Basin, especially with the surface ornamentation, anterior and ventral margins. The lateral outline differs from typical *Cytheridea* in being less tapered towards the posterior and with a posterior cardinal angle which is quite angular.

Occurrence- Occurs throught out the studied Wells.

Cytheridea sp.

pl.15, figs.10.

Material- Five carapaces; No A12715.

Locality and Horizon- Wells C1a-97 at depth 1220ft, G1-97 at 670, 970 and 1010ft and F1-97 at 1530ft.

Description- Carapace subtrapezoidal in lateral view; anterior margin broadly rounded and higher than posterior; posterior margin obliquely rounded; dorsal margin slightly convex in the right valve; left valve has two distinct cardinal angles, one at the centre of carapace, the second located at the postero-dorsal area; ventral margin slightly concave in the posterior half while anterior half slightly convex; left valve larger than right; maximum height at the centre of the carapace. Carapace is ornamented by different sized weak punctae situated in the centre of the valves, the remainder of carapace is smooth. Internal features not known. Sexual dimorphisim not recognised.

Dimensions of figured specimen (in μm).

	Length	Height	L / H
Right carapace; No A12715	520	306	1.70

Remarks- The figured specimen shows some similarities to *Cytheridea josephinae* Kollmann 1960, which is recorded from the middle Tortonian of Austria, but our species differs in the postero-ventral area being broadly rounded and also differs in the carapace ornamentation.

? *Cytheridea* sp.

pl.15, figs.1-5.

1989 ?*Miocyprideis* cf *italiana* Szczechura, p. 94-95, pl. 4, figs.1-11.

Materials- 13 carapaces and seven valves; No A12707-710.

Locality and Horizon- This species is recorded throughout the studied wells.

Description- Carapace subtrapezoid to subrectangular in lateral outline; anterior margin broadly rounded; posterior margin obliquely rounded; dorsal margin straight or slightly convex with distinct cardinal angle; ventral margin sinuate, concave in posterior half and slightly convex anteriorly; left valve larger than right and strongly overlapping the whole margin except central anterior. The anterior and posterior ends are flattened; there are 9-10 anterior denticles. Surface of carapace ornamented by rounded pits, the marginal pits are very fine and arranged in rows parallel to the carapace margins. The hinge is tripartite; in the left valve there is an anterior elongate crenulate socket with a thickened vertical wall, a prominent crenulate median element which is sharply defined both to anterior and posterior and situated on a thickened part of the dorsal wall, and a posterior crenulate groove deepening posteriorly; the anterior and posterior elements are of approximately the same length, the median element slightly shorter. Muscle scars typical of the genus.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Male right carapace; No A12707	618	357	1.73	____
Female left valve; No A12708	558	388	1.43	____
Male left carapace; No A12709	624	351	1.77	____
Female Dorsal view; No A12710	566	____	____	272

Remarks- The generic assignment of this species is difficult. Lateral outline suggests *Cytheridea*, i.e. the highest point is towards the anterior rather than the centre or posterior as in *Cyprideis*, *Neocyprideis* and *Miocyprideis*. The hinge however is not that of typical *Cytheridea*, the posterior element cannot be subdivided into two parts. The tripartite hinge resembles that of *Miocyprideis*, but differs in having a short median element and in the massive nature of the anterior and median elements.

Occurrence- Occurs throught out the studied wells.

Genus *Cyprideis* Jones, 1857

Cyprideis maradaensis sp. nov.

Pl.4, figs. 1-6.

Derivation of name- After Marada Oasis 120km south Sea shore.

Diagnosis- Massive carapace ovate to reniform and smooth with scattered seive pore canals gives the surface a punctate appearance.

Holotype- Female left valve; No A12581, pl. 4, fig. 1, well F1-97 at depth of 1320ft.

Materials- Sixteen carapaces and one valve; No A12581-585.

Locality- Wells C1a-97 , G1-97 and F1-97 . give exact location of holotype

Horizon- Marada Formation Lower Miocene at different horizon

Description- Carapace ovate to reniform in lateral view, left valve markedly larger than the right; dorsal margin of left and right valves differ in outline, left valve is almostly straight while the right is arched; maximum height at the centre of the carapace; anterior margin broadly rounded with some seven small spines on both valves; posterior margin obliquely rounded; ventral margin nearly straight but slightly concave in the antero-ventral area while in the left valve weakly convex; Surface of carapace has scattered punctae; some of these are seen to be sieve type normal pore canals, others are too ill preserved to be sure whether they are pore canals. Internal feature very clear and typical of the genus. Males smaller and slightly more elongate than females.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	width
Female left valve; No A12581	670	445	1.50	____
Female right carapace; No A12582	735	442	1.66	____
Male right carapace; No A12583	639	379	1.68	____
Female dorsale view; No A12584	728	____	____	371
Female ventral view; No A12585	651	____	____	316

Remarks- This species from the lower part of the Marada Formation differs from any described species.

Occurrences- Occurrence throughout the lower part of Marada Formation.

Cyprideis . sp. A

Pl.4, figs.7-9.

Material- Eight carapaces; No A12586-588.

Locality and horizon- Well C1a-97 at depth 1340 feet.

Description- Carapace elongate to subrectangular in lateral view; with almost straight to subparallel dorsal and ventral margins; maximum height at the middle of the carapace; anterior margin broadly rounded; posterior margin obliquely rounded; left valve overlaps right on all the margins except the central dorsal area; small flange present at postero-ventral margin of right valve. Carapace surface slightly pitted to smooth. Internal features not known. Sexual dimorphisim not pronounced.

Dimensions of figured specimens (in μm).

	Lenght	Height	L / H
Left carapace; No A12587	721	400	1.80
Right carapace; No A125876	658	374	1.75
Juvenile left carapace; No A12588	545	324	1.68

Remarks- This species is placed in *Cyprideis* on the basis of lateral outline as no internal feature have been observed. Also this species has some similarities with *Cyprideis similis* (Bradely) figured by Van Den Bold. (1963) from the Upper Miocene and Pliocene of Trinidad. The latter species differs in having a more truncated posterior end and lacks the postero-ventral flange.

Occurrence- Well C1a-97.

Cyprideis sp . B.

Pl.4, fig.10.

Materials- Three Carapaces; No A12589.

Locality and Horizon- Well G1-97, 1510-1570 ft.

Dimension of figured specimen (in μm).

	Length	Height	L / H
Right carapace; No A12589	668	372	1.80

Remarks- This species is very similar to *Cyprideis* sp. A in lateral outline; it differs in having an ornamentation of prominent pits; finer pits arranged in four rows parallel to the anterior and posterior margins, and coarse pits over the remainder of the carapace; it is also has a small posteroventral spine in the right valve. No internal features have been observed.

Occurrence- Well G1-97.

Genus *Neocypridies* Apostolescu,1956

Neocyprideis sp

Pl.4, figs.11,12.

Materials- Five carapaces; No A12590-591.

Locality and Horizon- Recorded in the studied Wells at different levels.

Description- Carapace subovate to subrectangular in lateral view; maximum height at 1/3 length from posterior; anterior margin broadly rounded; posterior margin almost straight in dorsal half with prominent cardinal angle in left valve; dorsal margin slightly convex; ventral margin concave at anterior, convex at posterior. The surface of the carapace is smooth. Internal features not known. Sexual dimorphisim not recognised.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Right carapace; No A12590	740	451	1.64

Left carapace; No A12591 755 444 1.7

Remarks- This species is placed in the genus *Neocypridies* on the basis of lateral outline; no internal feature have been observed. It shows some similarity to *Neocyprideis rara* Goerlich,1953 subspecies *cerestel* in Carbonnel (1969) recorded from the upper Oligocene of France, but differs in having a more rounded postero-dorsal margin.

Subfamily Krithinae Mandelstam in Bubikan, 1958

Genus *Krithe* Bradely, Crosskey & Robertson, 1874

Krithe papillosa (Bosquet),1852

pl.7, figs. 8-12.

1852 *Cytheridea papillosa* Bosquet, p.42, pl.2, fig.3.

1955 *Krithe papillosa* (Bosquet), Keij, p.115, pl.17,figs. 11-13.

1957 *Krithe papillosa* (Bosquet), Keij, p.85, pl.8, figs. 1-4 .

1960 *Krithe papillosa* (Bosquet), Bhatia and Mandwel, p.282, pl.41, fig.11.

1965 *Krithe papillosa* (Bosquet), Moyes, P.43, pl.5, fig.7.

1978 *Krithe papillosa* (Bosquet), Khosla, p.273, pl.2, fig. 21.

Materials-Thirty carapaces and eight valves; No A12619-623.

Locality and horizon- Recorded in the studied Wells at different levels.

Description- Carapace elongate in lateral view; anterior end evenly rounded; posterior margin truncate; left valve larger than right surface of carapace is smooth; in dorsal view anterior end tapering while posterior end obliquely rounded; ventral and dorsal margins nearly parallel; maximum width and maximum height at

mid-length. Sexual dimorphisim distinct with more elongate males.

Dimensions of figured specimens (in μm).

	Length	height	L / H	Width
Male right carapaceNo A12619	685	328	2.00	____
Male left carapace; No A12620	689	338	2.00	____
Female right carapace; No A12621	588	294	2.00	____
Female left carapace; No A12622	600	312	1.92	____
Female dorsal view; No A12623	606	____	____	281

Remarks- These species from the Marada formation of the eastern Sirt Basin are identical with *Krithe papillosa* described from the Lower Miocene of the Aquitaine Basin France (Moyes, 1965). This species has been recorded from the Lower Miocene of India (Bhatia & Mandwal,1960) and also from the lower Miocene of Jamnager & Porpandar districts, Gujarat, India (Khosla, 1978).

Occurrence- Occurs in the Lower Miocene

Family Cytheruridae G. W. Müller, 1894

Genus *Paijenborchellina* Kuznetsova, 1957

Paijenborchellina libyca Szczechura, 1980

pl.13 , fig. 8,9.

1980 *Paijenborchellina libyca* Szczechura, p. 225-232, pl. 21-22.

Material- Five carapaces and one valve; No A12688-689.

Locality and Horizon- Wells C1a-97 at depth 1400, 1610ft, G1-97 at 1470ft and F1-97 at 780,810 ft.

Description- Carapace coarsely punctate; pits arranged in rows parallel to

the valve margin; a prominent depression is present in the antero-dorsal area running parallel to the anterior margin and disappearing half way towards the ventral margin; there is no eye tubercle, although the area in front of the depression appears swollen; the caudal process is directed downwards; the maximum height is at one third length of carapace from anterior. Sexual dimorphisim is pronounced, males being more elongate.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Female right carapace No A12688 (broken speciemen)	588 ?	305	1.92
Female left valve; No A12689	703	337	2.0

Remarks- This species was first described from outcrops of the Upper Miocene of the north Sirt Basin between Marada Oasis and the Dahra oil fields (Szczechura, 1980).

Paijenborchellina keeni sp. nov

pl.13, fig. 4-7.

Derivation of name- In honour of Dr. M.C. Keen.

Diagnosis- Caudal process relatively short; whole carapace reticulate; central area with weak longitudinal ribs, the ventral most of which is clearly defined at the posterior where it bends sharply downwards.

Holotype- Male right carapace; No A12691. pl.13,fig. 5, well F1-97 at depth of 810ft.

Material- Ten carapaces; No A12690-93.

Locality and Horizon- Recorded in the studied Wells at different levels.

Horizon- Miocene of the Marada Formation.

Description- Carapace pear shaped in lateral view; anterior margin slightly obliquely rounded; dorsal margin rounded and saddle like; ventral margin straight; maximum height at antero-dorsal area one third from anterior, i.e. at maximum curvature dorsally; reticulation over entire carapace surface. One specimen (pl.13, fig. 4) is poorly reticulate but has well developed reticulation around the anterior margin; this may be due to preservation or for infraspecific variation. Central area with longitudinal ribs, ventral most of which is clearly defined at posterior where it bends sharply downwards; there is a weak depression parallel to the anterior margin. Internal features not known. Sexual dimorphisim is distinct, with more elongate males.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Male right carapace; No A12691	650	258	2.5	____
Male right carapace; No A12692	666	253	2.63	____
Female right carapace; No A12690	638	316	2.00	____
Juvenile dorsale view; No A12693	556	____	____	284

Remarks- *Paijenborchellina keeni* shows some similarities with *Paijenborchellina libyca* (Szczechura,1980) described from the outcrops of the northern part of the Sirt Basin, but differs in having relatively short caudal process, in lateral outline, as well as having differently shaped reticulation.

Occurrence- Occurs in the studied wells

Family Hemicytheridae Puri, 1953

Genus *Aurila* Pokorny, 1955

Aurila soummamensis Coutelle & Yassini, 1974

pl. 2, figs.1-7.

1974 *Aurila soummamensis* n sp Coutelle & Yassini, 1974. p.93, pl.1, figs.10, 11, 13, 14, 17, & pl.3, fig.11.

1979 *Aurila soummamensis* Coutelle & Yassini, Bassiouni, p.123, pl. 20, figs.12-15.

1984 *Aurila soummamensis* Coutelle & Yassini, Gokcen, p.47-48, figs.1-5.

Diagnosis- A species of *Aurila* with triangular lateral outline; dorsal margin broadly arched and ornamented with fine to medium punctae.

Material- Twenty five carapaces and two valves; No A12558-564.

Locality and Horizon-

Description- Carapace triangular in lateral view; left valve larger than right; dorsal margin strongly arched, forming an obtuse angle with caudal process; maximum height at the centre of carapace; ventral margin slightly convex and swollen; anterior margin obliquely rounded; posterior margin subtriangular with caudal process situated in postero-ventral area. A small tubercle is present on the upper part of the caudal process. Eye tubercle spherical and distinct. Surface of carapace has fine to medium punctae. Sexual dimorphisim is pronounced with more elongate males.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Female right carapace; No A12562	685	406	1.68	____
Female left carapace; No A12563	645	387	1.66	____
Female left valve; No A12564	600	388	1.54	____
Male right carapace; No A12558	693	408	1.70	____

Male left carapace; No A12559	711	408	1.74	____
Female dorsal view; No A12561	629	___	____	364
juvenile right carapace; No A12560	490	290	1.68	____

Remarks- *Aurila soummamensis* Coutelle & Yassini (1974) is recorded from the Lower Miocene of Algeria (Coutelle & Yassini1974) and Turkey (Bassiouni, 1969, Gokcen 1984).

Occurrence - Throughout the studied wells.

Aurila gr *convexa* Baird, 1850

pl. 2, figs. 8-13.

Material- Fifteen carapaces and four valves; No A12565-570.

Locality and Horizon- Recorded throughout the studied Wells.

Description- Carapace is triangular in lateral view; dorsal margin rounded to arched; maximum height slightly behind centre of carapace; anterior margin obliquely rounded; posterior margin truncate with very short caudal process; ventral margin concave in the anterior part and slightly convex posteriorly; left valve larger than right valve and strongly overlaps the right; the surface is ornamented by variable sized punctae; anterior margin with four parallel rows of quadrate reticulation. No internal feature were observed. Sexual dimorphisim is distinct, males being more elongate than females.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Female right carapace; No A12565	475	316	1.50	____
Female left carapace; No A12566	510	350	1.45	____

Female dorsal view; No A12567	500	____	____	305
Male right carapace; No A12570	482	292	1.65	____
Male left carapace; No A12569	556	355	1.50	____
Male dorsal view; No A12568	593	____	____	284

Remarks- *Aurila* gr *convexa* is similar to *Aurila* (*Aurila*) *maculosa* (Uliczny 1969) in lateral outline but the latter has its maximum height located at the mid length of the carapace while in our specimens the maximum height is situated just to the posterior of mid length.

Occurrence- occurs throughout the studied Wells.

Genus *Caudites* Coryell and Field, 1937

Caudites sp.

pl. 5, fig. 12.

Material- One carapace unfortunately lossed after photography.

Locality and Horizon- Well C1a-97 at depth of 1070 feet.

Description- Carapace elongate to subrectangular in lateral view; left valve slightly larger than right valve; maximum height slightly posterior to the eye tubercle, which is not very well pronounced; anterior margin broadly rounded; posterior margin with strongly produced caudal process; dorsal margin sloping posteriorly; ventral margin slightly concave in the centre. Surface of carapace is strongly ornamented by coarse punctae and a series of ribs. A short antero-dorsal rib starts from the eye tubercle and runs parallel to the anterior margin ending at mid height; a second rib starts from the postero-cardinal angle in a curved form to the position slightly anterior of centre; a third rib starts from antero-ventral area and

appears to bifurcate towards the centre of the valve, although the postero-ventral area could be viewed as being coarsely reticulate; a short ventral rib is also present. Internal features not known,

Dimension of figure specimen (in μm).

	Length	Height	L / H
Right carapace	765	429	1.78

Remarks- This species differs from any species described so far

Occurrence- Occurs in well C1a-97.

Genus *Pokornyella* Oertli, 1956

Pokornyella deformis minor (Moyes, 1965)

pl.8, fig. 1-6

1955 *Hemicythere deformis* Reuss, Keij, p.123, pl. 8, figs. 5-7.

1965 *Hemicythere deformis minor* Moyes n ssp p.99, pl.13, figs. 1-4

1977 *Pokornyella deformis minor* (Moyes), Ruggieri, Russo , Bossio, pl. 1, figs, 2-4b.

1979 *Pokornyella deformis minor* (Moyes), Bassiouni, p.112-113. pl.19, figs. 18-21.

1985/86 *Hemicythere deformis minor* Moyes, Gokçen, p. 47, pl. 3, figs. 11-21.

1989 *Pokornyella deformis minor* (Moyes), Szczechura and Abd-Elshafy, p. 306-307, pl. 6, Fig. 1,2a ,2b.

Material- Twenty five carapace and Four valves; No A12624-629.

Locality and Horizon- Recorded from different Levels of the studied Wells.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Female right carapace; No A12625	725	475	1.53	____
Male right carapace; No A12624	689	427	1.60	____
Female left carapace; No A12626	714	472	1.51	____
Juvenile right carapace; No A12627	577	332	1.70	____
Male dorsal view; No A12628	714	____	____	407
Female ventral view; No A12629	625	____	____	350

Remarks- *Pokornyella deformis minor* Moyes is smaller than the nominate subspecies. It is recorded from the lower Miocene of the Aquitain Basin in France (Moyes, 1965), the lower Miocene of Turkey (Bassiouni, 1979), the lower Aquitanian to Burdigalian of the Kale-Yensehir region of Turkey (Gokçen 1985-86) and is described from ?middle Miocene of the central Sirt Basin and western coast of the Gulf of Suez, Egypt (Szczechura and Abd-Elshafy 1989).

Occurrence- Occurs throughout the studied Wells.

Pokornyella cf *P. deformis* (Reuss) 1850.

pl.8, figs. 9-11.

Material- Eight carapaces; No A12632.

Locality and Horizon- Well C1a-97 at depth of 770 to 1160 ft, G1-97 at 640, 910-970ft and F1-97 at 1120-1150, 1200-1230ft.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	width
Right carapace; No A12632	748	503	1.48	____

Same left carapace	748	503	1.48	____
Same dorsale view	748	___	___	414

Remarks- The specimens differ from *Pokornyella deformis minor* in having a more arched dorsal margin, especially at the posterior, and having a stronger ventral ridge. Ruggieri, Russo and Bossio (1977), have illustrated topotype material of both *Pokornyella deformis deformis* and *Pokornyella deformis minor*. The diagnostic features of *P. deformis minor*, apart from smaller size, is the presence of a short ridge at the postero-dorsal angle.

Pokornyella sp.

pl. 8, figs. 7,8.

Material- Twelve carapaces and two valves; No A12630-631.

Localiy and Horizon- Wells C1a-97 at depth 950,1010, 1280 ft, G1-97 at 1160ft and F1-97 at 690 and 720ft

Description- Carapace subquadratic in lateral view; left valve larger than right; dorsal margin of left valve almost straight while that of the right valve is arched; anterior margin broadly rounded; ventral margin sinuate; posterior margin vertical in the upper part with ventral caudal process; maximum height slightly behind the eye tubercle. Surface of carapace reticulate with a series of riblets; two of these riblets are present in the postero-ventral area while another four are situated in the central and postero-dorsal area; nine angular depressions are present along the anterior margin. The carapace is also ornamented with polygonal fossae arranged more or less parallel to the carapace margin; a prominent small ridge is present at the posterior cardinal angle. Internal features not known. Sexual dimorphisim is

pronounced, males being more elongate.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Female right carapace; No A12630	653	433	1.50
Male left carapace; No A12631	680	433	1.57

Remarks- This species is similar to *Procythereis sulcatopunctatus* described from the middle Miocene of Turkey (Bassiouni,1979), but differs in having a more curved dorsal margin, and a more obliquely rounded anterior margin. This is the same as the species described as *Procythereis sulcatopuntatus* by El-Waer (M.S.1985) from the Upper Miocene Al khums Formation of Libya.

Genus *Urocythereis* Ruggieri, 1950

Urocythereis cf. *U. sorocula* Uliczny,1969

Pl. 14, Fig.9-11.

Material- One carapace; No A12706.

Locality and horizon- Recorded from Borehole G1-97 at depth of 1190 ft.

Description- Carapace elongate to subrectangular in lateral view; maximum height at 1/3 length from anterior; anterior margin broadly rounded; posterior margin with well developed caudal process situated at 2/3 height and extending into the ventral margin, while upper part is concave; dorsal and ventral margins subparallel; left valve larger than right, overlapping throughout postero-dorsal area. Surface ornamented by coarse reticulation with differently shaped foveoles. Eye tubercle is weak. Internal features not known. This is placed in *Urorocythereis* on the basis of general appearance.

Dimensions of figured specimens (in μm).

	Length	height	L / H	Width
Right carapace; No A12706	541	308	1.75	____
Same Left carapace	541	308	1.75	____
Same dorsal view	541	____	____	285

Remarks- This species shows great similarities in lateral outline with *Urocythereis sorocula* described from the Pliocene of Reggio di Calabria (Sissingh, 1972) but the latter differs in having elongate groove more or less parallel to the anterior margin which is weakly developed in our species, as well as differences in the pattern of reticulation. *Urocythereis sororcula* is also described from the Pliocene of Spain by (Carbonnel and Magne, 1977).

Family Loxoconchidae Sars, 1925

Genus *Loxoconcha* Sars,1866

Loxoconcha gr *ovulata* (Costa), 1853

pl.10,figs. 6-9.

1853 *Cytherina ovulata* Costa, p.177,pl.16, fig.7.

1984 *Loxoconcha* gr *ovulata* (Costa), Bonaduce and Russo, p. 434, pl. 5, fig. 9.

Material- Eight carapaces; No A12648-651.

Locality and Horizon- Recorded throughout the studied Wells at different levels.

Description- Carapace is swollen, rhomboidal in lateral view; surface ornamented with fine to coarse pitting arranged more or less parallel to the margins of the carapace; eye tubercle is very clear and distinct; maximum height is nearly at

the mid length of the carapace. Sexual dimorphisim is pronounced males, being more elongate.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Male right carapace; No A12650	600	352	1.70	____
Male left carapace; No A12648	612	362	1.69	____
Female right carapace; No A12651	544	355	1.53	____
Female dorsal view; NoA12649	566	____	____	288

Remarks- This species is very similar to the *Loxoconcha* gr *ovulata* Costa (Bonaduce and Russo,1984) described from the lower Tortonian-Early Messinian of the Capo S. Marce section of central western Sardinia. Our specimens differ in having a dorsal margin less curved than the specimen illustrated by Bonaduce and Russo and presumably identical to the Cost's specimens.

Family Schizocytheridae Howe, 1961

Genus *Neomonoceratina Kingma*, 1948

Neomonoceratina keiji Szczechura, 1989

pl.6, figs. 5-11.

1989 *Neomonoceratina keiji* Szczechura p. 921-992, pl. 8, fig. 2-7 & 10, 11.

Material- 190 Carapaces and 20 valves; No A12606-611.

Locality and Horizon - Recorded throughout the studied Wells at different levels.

Diagnosis- A species of *Neomonoceratina* with reticulation present but poorly

developed; reticulation is strongest to the posterior of dorsal sulcus and below the ventral ridge; much of the surface is smooth with prominent pore cones.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Male right valve; No A12610	581	303	1.91	____
Male left carapace; No A12607	574	316	1.81	____
Male right carapace; No A12606	588	305	1.92	____
Female left carapace; No A12609	497	331	1.50	____
Female right carapace; No A12608	468	292	1.60	____
Female dorsal view; No A12611	507	____	____	263

Remarks - This species is similar to *Neomonoceratina miocaenica* (El-Waer 1988) described from the Upper Miocene Al khums formation of N.W Libya.

El-Waer's species differs in having stronger reticulation which is present over the whole surface, a less accentuated ventral ridge, antero-dorsal ridge running from eye tubercle to join with the median ridge, and a slightly more broadly rounded anterior margin. The nature of the reticulation in figured species compared with *N. miocaenica* is suggestive of ecophenotypic variation; however, no variation has been observed in the specimens studied and this common species is found throughout the sections studied, occurring with typical marine genera, so this is regarded as a genuine character for differentaiting species.

This species occurs throughout the Marada Formation in the studied Wells, as well as in the Hommath formation of ?middle Miocene age of the western coast of the Gulf of Suez (Egypt).

Occurrence- Throughout the studied Wells.

Neomonoceratina laskarevi Krstic & Pietrzeniuk,1972

pl. 6, figs. 1-4.

1972 *Neomonoceratina laskarevi* Krstic & Pietrzeniuk, p.110, pl.1-3.

1973 *Neomonoceratina mouliana* Sissingh, Doruk Stereo Atlas of Ostracod shell, vol, 1, part,3.

1980 *Neomonoceratina laskarevi* Krstic & Pietrzeniuk, Van Hinte p.212, pl.2, fig. 5.

1982 *Neomonoceratina laskarevi* Krstic & Pietrzeniuk, Aruta, p.118, pl. 4, figs. 15-17.

1985 *Neomonoceratina mouliana* Sissingh, El-Waer, p.40, pl. 4, figs 36.

1988 *Paijenborchellina laskarevi* Krstic & Pietrzeniuk,Bonaduce *et al*, pl. 1, fig. 5.

1989 *Neomonoceratina ruggierii* Szczechura ,p.293-294, pl. 8, figs. 1, ?8,9,12-15.

Material- Thirty four carapace & four valves; No A12602-605.

Locality and Horuzon- Recorded throughuot the studied wells

Description- In lateral view the maximum height is at the eye tubercle; dorsal margin relatively straight or slightly sinuous; ventral margin slightly convex and curving upward in posterior direction; anterior margin is broadly rounded with five small tubercles parallel to the anterior margin; posterior margin with distinct caudal process. The eye tubercle is very clear and distinct. The lateral surface is characterized by a rather deep subcentral vertical sulcus and two longitudinal ridges; the median ridges starts from one third height behind anterior margin and runs upward posteriorly, passing through the centre and ending in the postero-dorsal area; the ventral ridge is parallel to the ventral margin, running from near anterior margin

ending about 3/4 of way to posterior at a node; a minor ridge runs from the middle of the median ridge towards the antero-dorsal angle. Surface of carapace has indistinct reticulation better seen in some specimens than in others. Five tubercles (pore conuli ?) are developed around the anterior margin, some seven are present in the ventral area, and others are present in the dorsal area. The internal feature are those of the genus. Sexual dimorphisim is pronounced, males being more elongate than females.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	width
Female right carapace; No A12604	469	264	1.77	____
Male right carapace; No A12602	561	288	1.94	____
Male left carapace; No A12603	533	266	2.00	____
Male dorsal carapace; No A12605	566	____	____	300

Remarks- The reticulation is not as prominent as that of *N. laskarevi* illustrated by most workers, while the pore conuli are more prominent. The specimens figured by Van Hinte (1980) and Bonaduce, *et al.* (1988) are very similar to the specimens studied here, it is not clear whether the differences noted warrant specific or subspecific separation. The figured specimen differs from typical *N. laskarevi* in having a more ornamentated posterodorsal area, and a more prominent median ridge.

Occurrence- Throughout the studied wells.

Family Trachyleberididae Sylvester-Bradley, 1948

Genus *Acanthocythereis* Howe, 1963.

Acanthocythereis hystrix (Reuss, 1850)

pl. 9 fig. 1-3.

1850 *Cypridina hystrix* Reuss, p.74, pl. 10, fig. 6 .

1979 *Acanthocythereis hystrix* (Reuss), Bassiouni, p.131,pl.17, fig._11.

1979 *Acanthocythereis hystrix* (Reuss), Yassini, p. 99, pl.6, fig. 2,11.

1981 *Acanthocythereis hystrix* (Reuss), Mostafawi, p.159, pl.10, fig.12-14.

1987 *Acanthocythereis hystrix* (Reuss), Keen, pl.2, fig.6.

Material- Two adult carapace and one Juvenile carapace; No A12633-635.

Locality and horizon- Well F1-97 at depth 1590 and 1800ft

Diagnosis- A species of *Acanthocythereis* with elongate to subrectangular carapace in lateral view and surface ornamented with spines and reticulation.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Female left carapace; No A12634	742	428	1.78
Male right carapace; No A12633	850	425	2.03
Juvenile right carapace; No A12635	645	335	1.98

Remarks- This species has a long stratigraphic range from the Miocene to Recent, and is widely distributed in the Mediterranean area and other adjoining regions. A complete synonymy can be seen in Athersuch (1979) and Mostafawi (1981). It was first described from the Badenian (Middle Miocene) of the Vienna Basin (Reuss 1850); it is also recorded from Bulgaria (Stancheva,1962), the upper Pliocene of Turkey (Bassiouni 1979), the Upper Miocene to Pleistocene of Italy (Ruggieri, 1962) and Romania (Olteno 1971), the Pliocene to Pleistocene of Greece (Uliczny 1969 & Sissingh 1972), Pliocene of Algeria (Yassini 1979), the Middle Miocene of north west Czechoslovakia (Athersuch 1979) and the middle Miocene of Malta (Keen 1987).

Occurrence- This species is only recorded in well F1- 97.

Genus *Actinocythereis* Puri, 1953

Actinocythereis libyaensis El-Waer, 1985

pl.1, fig. 3-5.

1985 *Actinocythereis libyaensis* El-Waer, p.4, pl. 5, fig. 1-3.

Material- Four carapaces; No A12551-553.

Locality and Horizon - Well C1a-97 at depth of 770 feet.

Diagnosis- Carapace elongate to subrectangular in lateral view; surface has large prominent spines arranged in a dorsal row, a ventral row, an irregular grouping of spines in the central area of the valve, and spines arranged parallel to the antero-ventral and posterior margins; the area between the spines is smooth.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Male right carapace; No A12552	728	385	1.89	____
Female right carapace; No A12553	714	428	1.66	____
Male dorsal view; No A12551	853	_____	____	368

Remarks- This was described from the Upper Miocene Al Khums Formation of North west Libya (Al-Waer M.S. 1985). The species has some similarities to *Actinocythereies khariensis* (Khosla & Pant 1981) from the Eocene of Kutch, India but differs in lacking the prominent ventral spines seen in *Actinocythereis libyaensis.*

Occurrence- Well C1a-97.

Actinocytheries spinosa El-Waer, 1988.

pl.1, fig. 1,2.

1988 *Actinocytheries spinosa* El-Waer, p.50 , pl.1, fig.7-9.

Material- One left valve; No A12550.

Locality and Horizon- Well G1-97 at depth of 1040 feet.

Diagnosis- A species of *Actinocythereis* characterized by blunt spines and reticulation behind anterior and posterior margins and in the muscle scar area; eye tubercle distinct; maximum height at anterior cardinal angles.

Dimension of figured specimen (in μm).

	Length	Height	L / H
Left valve; No A12550	815	421	1.93

Remarks- El-Waer based his new species on 3 left valves from the Late Miocene Al khums Formation of Qabilat Ashurfah, North West Libya. These are all more elongate than the specimen described here, so there is the possibility of sexual dimorphisim, those figured by El-Waer being male while that described here is female. Comparison between this specimens. Although El-Waer did not mention it, his specimens and those described here have reticulation developed at the posterior as well as anterior.

Occurrence- This species recorded in well G1-97.

Actinocythereis sirtensis sp. nov

pl.1, figs. 6-9.

Derivation of name- After the Sirt Basin

Diagnosis- A species of *Actinocythereis* characterized by well developed

surface reticulation as well as three longitudinal rows of spines.

Holotype- Female right carapace; No A12557. pl. 1, fig. 9, well F1-97 at depth of 1490ft.

Material- five carapaces; No A12554-557.

Locality- Wells C1a- 97 & F1- 97.

Horizon- Marada Formation, Lower Miocene.

Description- Carapace subrectangular in lateral view; with maximum height at anterior cardinal angle; dorsal margin straight; ventral margin slightly convex and curved upward posteriorly; anterior margin broadly rounded, with marginal denticles and a row of eight small tubercles around the anterior rim; posterior margin subtriangular, with spines. Carapace surface ornamented by three longitudinal rows of spines or nodes; dorsal row consists of six spines, some being bifid; median row starts from antero-central area and consists of six spines formed into two groups of three spines separated by a small gap; seven spines form the median row which ends in a central posterior position; ventral row is the shortest, consists of eight spines starting at the middle of the ventral margin runnings backwards ending in the postero-ventral area. The remainder of carapace reticulate with subrounded pits. Internal features not known. Sexual dimorphisim is distinct, males being more elongate.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Male right carapace; No A12554	700	365	1.91
Male left carapace; No A12555	672	342	1.96
Male left carapace; No A12556	638	341	1.87
Female right carapace; No A12557	658	332	1.98

Remarks- The present species differs from *Actinocythereis spinosa*

(El-Waer, 1988) in having a well defined median row of spines, while *A. spinosa* lacks the well defined reticulation of *A. sirtensis*; *A. libyaensis* differs in the arrangement of the median large spines as well as having a smooth carapace.

Occurrence- This species is recorded from wells C1a-97 & F1-97.

Genus *Carinovalva* Sissingh, 1973

Carinovalva carinata (Moyes), 1965

pl.5, figs. 6-11.

1965 *Ruggieria carinata* n. sp. Moyes, p. 91-93, pl.11, figs. 10-12.

1969 *Ruggieria* (Keij) *carinata* Moyes, Carbonnel, p.128-129, pl.16, figs.5-8.

1985 *Carinovalva carinata* (Moyes) , Carbonel, pl, 95. figs, 6,7. ?

1988 *Carinovalva carinata* (Moyes), Al-Waer, p. 51, pl.2, figs.1,2.

Material- Thirty carapaces and two valves; No A12597-601.

Locality and Horizon-Recorded throughout the studied wells

Diagnosis- carapace subtrapezoidal in lateral view; anterior margin broadly rounded, with variable shaped marginal spines; maximum height at the mid length of the carapace. Ventral margin has a prominent ventral wing-like ridge parallel to the ventral margin. Surface of carapace is smooth with scattered pore canals. Some specimens have spines at the central posterior. Sexual dimorphisim distinct, males being more elongate than females.

Dimensions of figured specimens (in μm).

	lenght	height	L / H	Width
Female right carapace; No A12599	588	364	1.61	____

Male left carapace; No A12598	637	362	1.75	____
Male right carapace; No A12597	637	356	1.78	____
Female dorsal view; No A12601	560	____	____	308
Female inside left valve; No A12600	600	358	1.67	____

Remarks- This species was first described from the Upper Miocene of the Aquitain Basin and is also recorded from the Rhone Basin (Carbonnel, 1969), from the Upper Miocene Tortonian of Portugal (Nascimento, 1983) and from the Upper Miocene of Al Khums Formation of North West Libya (El-Waer, 1988).

Occurrence- Occurs throughtout the studied wells.

Genus *Chrysocythere* Ruggieri, 1962

Chrysocythere cataphracta Ruggieri,1962

pl. 3, fig. 2-5.

1962 *Chrysocythere cataphracta* n sp. Ruggieri, p. 26-28, pl.12, figs. 11-13.

1966 *Chrysocythere cataphracta* Ruggieri, Van Den Bold. p. 161-162, pl. 1. fig. 6 a-c.

1973 *Chrysocythere cataphracta* Ruggieri Sylvester-Bradley and G, Ruggieri Stereo-Atlas of ostracod shells,1: 4: 31-34.

1986 *Chrysocythere cataphracta* Ruggieri, Carbonnel, p. 35-245, pl. 12, fig.4.

1989 *Chrysocythere cataphracta* Ruggieri, Szczechura and Abd-Elshafy, p.299- 300, pl.10, figs. 10,11,12,13.

Material- Fifteen carapaces and one valve; No A12572-575.

Locality and Horizon- Recorded from wells C1a-97, G1-97, and F1-97.

Dimensions of figured specimens (in μm).

	Length	Height	L / H
Female right carapace; No A12573	716	405	1.76
Female right carapace; No A12575	657	387	1.70
Female left valve; No A12574	750	433	1.75
Male right carapace; No A12572	730	385	2.03

Remarks- Species of *Chrysocythere* are separated on the basis of lateral outline, the exact pattern of the median longitudinal ridge, and details of the intercostal ornamentation. Using these criteria three distinct species can be recognized in the material studied. The first of these is regarded as being conspecific with Ruggieri's *Chrysocythere cataphracta*, in which the median ridge ends before reaching the posterior, and the intercostal ornamentation is dominated by vertical connecting ribs giving rise to vertically oriented elongate reticulation. The second species is placed in *C. paradisus* (Doruk,1973); the ornamentation is identical, although the posterior dorsal angle is less rounded than in Doruk's illustration. *C. paradisus* differs from *C. cataphracta* in having smaller, more even reticulation between the longitudinal ridges. *C. cataphracta muricata* El-Waer M. S. (1985) differs from *C. paradisus* in being slightly elongated and in details of ornamentation. The third species is identified as *C. alkhumia* El-Waer M.S (1985) which is similar to *C. cataphracta*, but has a prominent downturned median ridge at the posterior giving a very characteristic outline to the median ridge.

Chrysocythere cataphracta of Bassiouni (1979) differs from all these Libyan specimens in details of longitudinal ridges and intercostal ornamentation.

It should be mentioned that variation is seen in the intercostal ornament in illustrations of *C. cataphracta* given by various authors. The longitudinal ridges are

connected by a series of vertical ribs giving the impression of very coarse vertically orientated elongate reticulae; in Ruggieri's original illustration these elongate reticulae can be seen to be subdivided by weak horizontal reticulation; this character appears to vary in strength, i.e. in Aruta (1982), the intercostal ornamentation seems to consist of small even reticulation, while in Carbonnel (1986), the reticulation is almost non existent as in the Libyan specimens. The dorsal margin of the left valve is parallel to the ventral margin and does not show the slight posterior tapering seen in the illustration of Ruggieri (1962) and of Aruta (1982) but is similar to those of Sissingh (1972) and Carbonnel (1986).

Occurrence- This species were recorded in the studied wells.

Chrysocythere paradisus Doruk, 1973

pl. 3, fig. 6-10.

1973 *Chrysocythere paradisus* Doruk, Stereo-Atlas of Ostracod Shells, 1: 16: 89-92.

1988 *Chrysocythrere paradisus* Doruk, Bonaduce *et al*, pl. 1, fig.10.

Material- Eight carapaces and one valve; No A12576-580.

Locality and Horizon- Well C1a-97 at depth of 770 & F1-97 depth interval 600-1140 ft.

Diagnosis- A species of *Chrysocythere* with subrectangular carapace in lateral view; surface ornamented by three longitudinal ridges, and an anterior ridge; polygonal reticulation present present between these ridges; maximum height at eye tubercle.

Dimensions of figured specimens (in μm).

	Lenght	height	L / H
Male right carapace; No A12578	869	439	1.97
Female right valve; No A12577	784	448	1.50
Female right carapace; No A2576	769	434	1.77
Female right carapace; No A12579	772	426	1.77
Female right carapace; No A12580	762	418	1.82

Remarks- See *Chrysocythere cataphracta.*

Occurrence- occurs in the wells C1a-97 & F1-97.

Chrysocythere alkhumia El-Waer, M. S. 1985.

pl. 3, fig. 1.

1985 *Chrysocythere alkhumia* El-Waer, p. 47, pl. 5, fig. 4-5.

Material- One right valve; No A12571.

Locality and Horizon- Well F1-97 at depth of 930 ft.

Diagnosis- A species of *Chrysocythere* with subrectangular outline in lateral view; area just behind eye tubercle is smooth; lateral surface ornamented with vertical connecting ribs between the longitudinal ridges.

Dimension of figured specimen (in μm).

	Length	Height	L / H
Right valve; No A12571	599	333	1.80

Remarks- See *Chrysocythere cataphracta* Ruggieri.

Occurrence- Occurs in well F1-97.

Genus *Cistacythereis* Uliczny, 1969

Cistacythereis qabilatashurfahensis El-Waer, 1985.

pl. 5, fig. 3-5.

1985 *Cistacythereis qabilatashurfahensis* El-Waer, p.52, pl.6, figs.2-4 .

Material- Six carapaces; No A12594-596.

Locality and horizon- Wells C1a-97 at 770 and 1160 ft and F1-97 at 1260-1290 ft

Diagnosis- A species of *Cistacythereis* with three strong longitudinal ridges and a fourth ridge parallel to the anterior margin; prominent deep fossae and strong muri.

Dimensions of figured specimens (in μm).

	Lenght	Height	L / H	Width
Female right carapace; No A12594	566	300	1.88	____
Female left carapace; No A12595	555	277	2.00	____
Female dorsal view; No A12596	585	____	____	245

Remarks- *Cistacythereis qabilatashurfahensis* (El-Waer,1985) was first described from the Upper Miocene of the Al khums Formation exposed in the area 2km to the north of Qabilatashurfah in N.W. Libya.

Occurrence- Occurs in wells C1a-97 & F1-97.

Cistacythereis cf. *C. caelatura* Uliczny,1969

pl.11, figs.1-8.

1989 *Cistacythereis* cf *C. caelatura* Szczechura, p. 298-99, pl.1, fig.2, pl.3,

figs. 10-12.

Material- Twenty carapaces and six valves; No A 12656-662.

Locality and Horizon-Wells C1a-97 and F1-97 at different levels.

Description- Carapace subrectangular in lateral view; maximum height anteriorly at eye tubercle; dorsal margin not clear due to weak dorsal ridge overhanging in the potero-dorsal area; ventral margin straight to slightly concave at 1/3 from anterior; anterior margin broadly rounded with some 12 margin denticles; posterior margin obliquely rounded also with some five denticles. Surface of carapace has three prominent ridges clearly formed from reticulation walls, which give a zig zag effect. Dorsal ridge starts below eye tubercle and curves backwards parallel to the median ridge, ending in the postero-dorsal area; the median ridge is curved running from near posterior margin to the antero-central area; ventral ridge runs from near the anterior margin curving upward at the posterior to join the median ridge. The surface of the carapace is reticulate. Internal features not known. Sexual dimorphism is pronounced, males being more elongate than females.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Male left carapace; No A12658	742	385	1.92	____
Male right carapace; No A12656	755	407	1.85	____
Female right carapace; No A12657	666	400	1.66	____
Female left valve; No A12659	637	387	1.64	____
Female dorsal view; No A12661	680	____	____	346
Female ventral view; No A12662	666	____	____	333
Female inside left valve; No A12660	685	400	1.71	____

Remarks- This is similar to *C. caelatura* originally described from the Pliocene of Greece (Uliczny,1969), but differs in having weaker lateral longitudinal

ridges and more numerous intercostal reticulation. *C. caelatura* has also been recorded from the Pleistocene of South Aegean area (Sissingh, 1972), the Burdigalian of Algeria (Coutelle and Yassini, 1974), the Recent of Tripoli, Libya (Bonaduce and Pugliese, 1975) and the Upper Pliocene of Turkey (Bassiouni,1979). The specimens described by Szczechura and Abd-Elshafy (1989) from the ?Miocene Hommath Formation of Egypt and the Marada Formation of Libya shows variation in ornamentation but include specimens identical to those described here.

Occurrence- This species is recorded in wells C1a-97 and F1-97.

Genus *Falsocythere* Ruggieri, 1972

Falsocythere maccagnoi Ciampo, 1971

pl. 13, figs.1-3.

1971 ?*Occultocythereis maccagnoi* Ciampo, p.27, pl.2, fig.7-9, pl. 3,fig.1.

1975 *Falsocythere maccagnoi* Ciampo, Bonaduce *et al*, p. 51, pl. 26, fig. 6-9.

1979 *Falsocythere maccagnoi* Ciamp, Yassini, p. 100 , pl.2, fig. 22.

1980 *Falsocythere maccagnoi* Ciampo, Bonaduce *et al*, pl. 4, fig. 5,6.

1989 *Falsocythere maccagnoi* Ciampo, Szczechura and Abd-Elshafy, p.307, pl.11, fig.8a-b.

Material- Four carapaces; No A12684-686.

Locality and Horizon- Wells C1a-97 at depth of 1730 feet and F1-97 at depth of 1590 ft.

Description- Surface of carapace is weakly reticulate with very small scattered tubercles, pore conulae and punctae; the median rib runs obliquely from antero-central area to join the posterior vertical ridge; there are two depressions on

the surface of the carapace, the larger situated dorso-centrally while the smaller lies in the ventro-central area. Sexual dimorphisim is distinct, males being more elongate than females.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Female right carapace; No A12684	538	288	1.86	____
Male left carapace; No A12685	600	294	2.04	____
Female dorsal view; No A12686	507	____	____	165

Remarks- This species is similar to the specimen from the Upper Miocene (Messinian), of the Borehole B1-NC35A, situated in north east Tripoli figured by Van Hinte (1980) as *Occultocythereis dhorni* Puri it differs in the dorsal ridge which is strongly curved rather than straight as Van Hinte's figure as well as in the surface ornamentation. Van Hinte's material differs from *Occultocythereis dhorni* as described and figured from the Mediterranean area by Puri (1968 , pl.1 fig. 8), in having a straight ventral margin instead of a convex margin and lacks the prominent swelling in the antero-central area illustrated by Puri. *Falsocythere maccagnoi* has been described from the Pliocene of Algeria (Yassini 1979) the Marada Formation of the central Sirt Basin, and the Hommath Formation Egypt (Szczechura and Abd-Elshafy 1989).

Occurrence- This species occurs in the wells C1a-97 and F1- 97.

Falsocythere sp.

pl. 13, fig. 10.

Material- One carapace; No A12687.

Locality and Horizon- Well F1-97 at depth 1590 ft.

Description- Carapace elongate in lateral view; maximum height at eye tubercle; anterior margin broadly rounded and decorated with twelve spines, posterior margin subtriangular and smooth with only traces of spines in the postero-ventral area; dorsal margin straight to slightly curved; ventral margin straight. Surface of carapace between ridges is smooth. Dorsal ridge starts from eye tubercle and runs backwards, slightly sloping posteriorly until joined to small vertical ridge at posterior cardinal angle; median ridge starts from antero-central area, runs backwards towards the posterior cardinal angle to join short vertical ridge, anterior ridge starts from eye tubercle, runs along anterior margin and continues as a thin ridge ending in the central ventral area. A rib runs from the centre of the ventral ridge connecting with the median ridge, and bearing a small tubercle or pore conulae. Internal features not known.

Dimension of figured specimen (in μm).

	Length	Height	L / H
Right carapace; No A12687	637	287	2.21

Remarks- This species has some similarities in lateral outline with *Falsocythere maccagoni*, but differs in the anterior margin being broadly rounded rather than obliquely rounded, dorsal ridge less curved, vertical ridge is straight instead of curved, carapace ornamentation is smooth rather than slightly punctate. This species also has some similarities with *Occultocythereis dhorni* described from the Upper Miocene-Pliocene in Borehole B1-NC35A north east Tripoli. (van Hinte *et al*, 1980), but differs in lateral outline and surface ornamentation.

Occurrence- Occurs in the Borehole F1-97.

Genus *Hermanites* Puri, 1955

Hermanites haidingeri Reuss,1850

pl.14, fig. 6-8.

1850 *Cypridina haidingeri* Reuss, p. 68, pl. 10, fig, 13

1955 *Trachyleberis haidingeri* (Reuss), Keij, p. 126, pl.17, fig. 7, and pl. 20, fig. 2

1965 *Hermanites haidingeri* (Reuss), Moyes, p.84, pl. 10, fig. 12.

1979 *Hermanites haidingeri* (Reuss), Yassini p. 99 , pl. 5, fig. 11.

1981 *Hermanites haidingeri* (Reuss), Mostafawi, p. 149, pl. 6, fig. 6.

Material- Six carapaces; No A12703-705.

Locality and Horizon- Well F1-97 at depth 1020ft

Diagnosis- A species of the genus *Hermanites* characterized by ridges having spurs projecting into depressions.

Dimensions of figured specimens (in μm).

	Length	height	L / H
Male right carapace; No A12703	757	414	1.80
Female right carapace; No A12704	714	407	1.75
Juvenile left carapace; No A12705	653	386	1.70

Remarks- This species was first described from the Upper Miocene of the Vienna Basin (Reuss, 1850) and is also recorded from the Stampian to Burdigalian of the Aquitain Basin of south west France (Keij, 1955). The specimens studied here differ from *Hermanites haidingeri* described from the Pliocene of Algeria (Yassini, 1979-80) in having a slightly shorter dorsal ridge.

Occurrence- Occurs in the Borehole F1-97.

Hermanites zaltanensis sp. nov.

pl. 14, figs.1-5.

Derivation of name- After Jabal Zaltan, 60 km south of the Marada Oasis.

Diagnosis- A species of *Hermanites* with three longitudinal ridges; dorsal and median ridges curved and nearly parallel; dorsal ridge separated from eye tubercle by depression, joining the median ridge posteriorly; ventral ridge straight, surface ornamented by coarse reticulation.

Holotype- Male right carpaces; No A12698, pl. 14, fig. 1, well C1a-97 at depth of 770ft.

Material- Five carapaces; No A12698-702.

Locality - Wells C1a-97 at depth 770 ft and F1-97 at depth 660 ft.

Horizon- Marada Formation.

Description- Carapace elongate to subrectangular in lateral outline; the maximum height at anterior cardinal angle; dorsal margin appears to be humped at posterior due to the overhanging of the dorsal ridge; ventral margin straight to slightly concave in the middle; anterior margin broadly rounded; posterior margin concave in the upper part, while the ventral part possesses five short spines; three longitudinal ridges are present; the dorsal ridge is curved, ending in a slight node which connects the dorsal and median ridges; a weak median ridge runs from the subcentral tubercle towards the posterior and is nearly parallel to the dorsal ridge; the ventral ridge is strongly developed and almostly straight, starting from antero-ventral area and running backwards nearly parallel to the ventral margin, ending in a small node in the postero-ventral area. The surface of the carapace is reticulate, with deep fossae of different polygonal shapes. Rounded subcentral tubercle is prominent. The eye tubercle is very clear and rounded. Internal features could not

be observed. Sexual dimorphisim clear and distinct, with more elongate males

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Male right carapace; No A12698	952	467	2.03	____
Female right carapace; No A12699	841	483	1.74	____
Female left carapace; No A12700	875	475	1.8 4	____
Juvenile dorsal view; No A12701	781	___	___	375
Juvenile ventral view; No A12702	714	___	___	357

Remarks- This species resembles *H. abundans* (El-Waer M.S. 1985) described from the Upper Miocene Al Khums Formation of North west Libya. *H. zaltanesis* differs from the latter in having a broadly rounded anterior margin unlike the obliquely rounded margin of *H. abundans*, in having a stronger ventral ridge, and in details of the reticulation. *Hermanites transcostata* Khalaf, 1982 from the middle Miocene of Iraq differs in the outline of the ventral and anterior margins, and in having much coarser surface reticulation. *H. zaltanensis* is very similar in lateral outline to *H. tschopi* (Van Den Bold, 1946) described from the Neogene of Senegal and Guinea (Carbonnel, 1985), but the latter differs in being shorter than our specimens, and the ventral ridge connects with the anterior ridge.

Occurrence- This species is occurred in borehole C1a-97 and F1-97.

Genus *Keijella* Ruggieri,1957.

Keijella africana El-Waer, 1988

pl.7, figs. 1-3.

1988 *Keijella africana* El-Waer, p.50, pl.1, figs.10 & 11.

1989 *Keijella africana* El-Waer, Szczechura and Abd-Elshafy , p. 301, pl. 9, figs. 9-13.

Material- Ten carapaces and one valve; No 12612-614.

Locality and horizon- Recorded in wells C1a-97 at 770 and 1130 ft and F1-97 at 750 ft.

Diagnosis- A species of *keijella* with slit-like pits in the posterior and postero-median areas, scattered fine punctae, remainder of carapace smooth.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Female left carapace; No A12613	725	407	1.78	____
Male right carapace; No A12612	783	391	2.00	____
Female dorsal view; No A12614	700	____	____	432

Remarks- *Keijella africana* was described from the Upper Miocene Al khums Formation exposed 2km north of Qabilat ashurfah. This species is similar to *Keijella clauda* (Doruk, 1973), but the latter differs in having few pits and the dorsal margin slopes into the posterior. *Keijella africana* has some similarities to *K. hodgii* (Bradley, 1866) as figured by Ruggieri (1967) and Doruk (1973), but the latter differ in the anterior series of pits running in a single line behind the anterior margin: *K. africana* is also recorded from the?middle Miocene of Libya and Egypt (Szczechura Abd- Elshafy 1989).

Keijella punctigibba Capeder,1902

pl.7, fig. 4-7.

1902 *Cythere punctigibba* Capeder, pl. 14, figs. 26

1987 *Keijella punctigibba* Capeder, Keen, pl.2, fig.4.

Materials- Fourteen carapaces and two valves; No A12615-618.

Locality and Horizon- This species is recorded from the Wells C1a-97 at depth 770 & 950 ft and G1-97 at 750 ft.

Description- Carapace ovate to subrectangular in lateral view, with very distinct postero-ventral spine. Ornamentation consists of a series of slots arranged into 7-8 rows mainly located in the central-posterocentral area; ventral slots run from the antero-ventral area backwards into the postero-ventral area, and anterior slots are present in the central anterior area; remainder of carapace is smooth. Some specimens bear spines along the anterior and posterior margins. Sexual dimorphism is pronounced, males being more elongate than females.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Male right carapace; No A12615	707	342	2.06	____
Female right carapace; No A12617	653	360	1.81	____
Female left carapace; No A12616	632	348	1.81	____
Female dorsale carapace; No A12618	630	____	____	266

Remarks- This species was first described from the Tortonian of Scrivia, Italy (Capeder 1902) and is also recorded from the Upper Miocene of Malta (Keen 1987) this species is very similar to *Keijella hodgii* Bradley, but differs in having larger areas of ornamentaion, and also in lateral outline.

Occurrences- This species occurs in Wells C1a-97 and G1-97.

Family Xestoleberididae Sars, 1928

Genus *Xestoleberis* Sars, 1866

Xestoleberis cf. *reymenti* Ruggieri, 1967

pl.13, figs.11-14.

Materials- Thirty carapaces; No A12694-697.

Locality and Horizon- Throughout the studied wells.

Description- Carapace subovate in lateral outline; maximum height at the centre of carapace; posterior margin broadly rounded and higher than anterior margin, anterior margin obliquely rounded; dorsal margin convex; ventral margin slightly concave towards anterior end, left carapace larger than the right. The surface of the carapace is smooth. Internal feature not known. Sexual dimorphisim is distinct, males more elongate than females.

Dimensions of figured specimens (in μm).

	Length	height	L / H	Width
Female right carapace; No A12695	547	336	1.62	____
Female left carapace; No A12696	515	326	1.57	____
Male right carapace; No A12694	526	300	1.75	____
Female dorsal view; No A12697	521	___	___	302

Remarks- This resembles *Xestoleberis reymenti* described by Ruggieri (1967), from the Miocene of Alloctono Dell val Marecchia of Italy, but differs in having a slightly concave ventral margin.

Family uncertain

Genus Ruggieria Keij, 1957.

Ruggieria tetraptera tetraptera Sequenza, 1869

pl.9, fig. 4-8.

1879 *Cythere tetraptera tetraptera* Sequenza, p.125, pl. 12, fig. 19.

1964 *Ruggieria tetraptera tetraptera* (Sequenza), Dieci & Russo, p.68-69, pl.11.fig. 6.

1979 *Ruggieria tetraptera tetraptera* (Sequenza), Bassiouni,p.133, pl.17, fig.3-8.

1985 *Ruggieria tetraptera tetraptera* (Sequenza), El-Waer, p. 57, pl.7, fig.1-3.

1989 *Ruggieria tetraptera tetraptera* (Sequenza), Szczechura and Abd-Elshafy , p.302, pl. 10, figs. 1-4.

Material- Forty one carapaces and two valves; No A12636-640.

Locality and horizon- Throughout studied wells.

Diagnosis- A species of *Ruggieria* with two main longitudinal ridges while the rest of the carapace is smooth.

Dimensions of figured specimens (in μm).

	Length	Height	L / H	Width
Female left carapace; No A12640	700	385	1.8	____
Male right carapace; No A12639	816	383	2.1	____
Male left carapace; No A12638	833	383	2.17	____
Female ventral carapace; No A12637	748	____	____	355
Male Dorsal view; No A12636	800	____	____	336

Remarks- The figured specimen is close to *Ruggieria tetraptera tetraptera* figured by Keen (1987) from the upper Miocene of Malta, and to the specimen figured by El-Waer (M.S. 1985) from the Upper Miocene of Al Khums Formation. Szczechura and Abd-Elshafy (1989) described this species from ?middle Miocene Marada Formation of the central Sirt Basin and western coast of the Gulf of Suez, Egypt.

Occurrence- Occurs throughout the studied wells.

Ruggieria aff *dorukae* Bassiouni, 1979

pl. 9, figs. 9-11.

Material- Two carapaces and one valve; No A12641-643.

Locality and Horizon- Recorded from Well G1-97 at depth 1260 ft.

Description- Carapace subtriangular to subovate in lateral view; left valve larger than right and overlapping all of the margin; anterior margin broadly rounded; posterior margin subtriangular and has five spines in the lower part, while the upper part is smooth and concave; dorsal margin sinuate, i.e convex in the antero-dorsal area and concave in postero-dorsal area; ventral margin straight and curved upward posteriorly. The surface is reticulate with coarse pitting between longitudinal ridges; ventral ridge starts from antero-ventral area at 1/5 height then runs backwards parallel to ventral margin ending in postero-ventral area; maximum height at eye tubercle. Sexual dimorphisim is very clear, males being more elongate than female.

Dimensions of figured specimens (in μm).

	Lenght	Heigth	L / H
Female right carapace; No A12642	653	373	1.75
Female left carapace; No A12643	666	400	1.67
Male right valve; No A12641	669	358	1.86

Remarks- *Ruggieria dorukae* was recorded from Lower Miocene of Turkey (Bassiouni,1979) and subsequently recorded from the Burdigalian of south west Anatolia, Turkey (Gokçen,1985-86). The Libyan specimens differ from those from Turkey in the presence of a smooth area in the anterior region; this feature is

original, but preservation in two of the specimens makes it difficult to describe. It is not clear whether this is of specific importance or not, and lack of material makes it impossible to discern whether or not variation exists within the Libyan material. Mostafawi(1987) figured specimens of *Ruggieria dorukae* from the Middle Miocene of Kos, Greece, which also have a smooth area at the anterior, although this area is smaller than in the Libyan specimens.

Occurrence- Well G1-97

CHAPTER THREE

BIOSTRATIGRAPHY

the Marada Formation in Borehole J(C1-95) (Lat, 27° 27′′, Long, 20° 43′′), located 85km North West of the well F1-97 studied here. On the basis of foraminiferal species such as *Borelis melo* (Fichtel and Moll) he suggested a Middle Miocene age for this part of the Marada Formation.

Innocenti and Pertusati (1984) studied the Marada Formation of the sheet Al-Aqaylah, and gave more details on the sedimentology and palaeoentology, using both macro and microfossils, including ostracods (see chapter1) They recognised two foraminiferal assemblages. The first of these indicates an Early Miocene age, with *Miogypsina gunteri* Cole, *Miogypsinoide bantamensis* Drooger, *Archias aduncus* (Fichtel & Moll), *Miogypsinoides* aff *dehaarti* Van Den Fleak, *Miogypsinoides* cf *complanatus* Schlumberger, *Miogypsina* sp, and *Miogypsinoides* sp. An Early Miocene age is also supported by the occurrence of rare *Operculina, Heterostegina*, and *Lepidocyclina*, genera which range across the Oligocene-Miocene boundary. The second Assemblage contains *Borelis melo* the first appearance of this species is considered to be a good indicator for the base of the Middle Miocene, although the species ranges from the Middle Miocene to the Messinian. It was originally described from the Vienna basin (Fichtel and Moll 1878) but has subsequently been recorded from many localities around the Mediterranean, e.g. Late Tortonian-early Messinian of the Po Plain and Sicily (Eames *et al.* 1962), the Tortonian of the Levantine coast of the Eastern Mediterranean (Reiss & Gwirtzman, 1966), the Middle Miocene of the Al Jaghbub formation in Eastern Cyrenaica, Libya (Bellini 1969), and the Miocene of Cyprus (Rouchy *et al.* 1980). Thus the second assemblages is taken to indicate Middle Miocene.

Ostracod faunas from the eastern Sirt Basin

The ostracod fauna described here from the Marada Formation differs from previously described Miocene faunas from Libya (Bellini 1969; Van Hinte *et al* 1980;

Innocenti and Pertusati 1984; El-Waer 1985, 1988) due to age differences and Facies differences (see chapter 1). It is also differs from the fauna described by Szczechura and Abd-Elshafy (1989) from the Miocene of Egypt and the Marada Formation of the north central Sirt Basin. It is difficult to account for this latter difference, but slight differences in facies and geographical location are presumably involved. The presence of *Pokornyella deformis minor* and *Aurila* cf *soummamensis* in their samples suggests an Aquitanian age , i. e Lower Miocene. If this is correct, this could be a further factor in accounting for the differences, i.e their fauna is of Aquitanian age while the majority of the species recorded here come from Burdigalian or later sediments.

Fifty five species have been identified in this study; twenty two of these have been described from various localities in the Mediterranean area and north Africa; six species are new; the remainder are left in open nomenclature, although some of them are very similar to described species. Sixteen species are important for stratigraphical age determination (Tab 3. 1); four of these are restricted to the Lower Miocene, nine to the Upper Miocene, while three species have longer ranges but still provide stratigraphical information. The stratigraphic range charts and ostracod distribution in the studied wells are shown in Tables 3. 1, 2, 3, 4. In general the species recorded here are part of a widespread Mediterranean fauna, and most of the remainder are closely related to widespread species. The fauna is markedly different from that described from Iraq (Khalaf,1982) where there are no species found in common to the two countries. The Libyan fauna also differs from those of central and northern Europe.

The stratigraphic range of the ostracods is based on published records from localities in Algeria, Austria, Belgium, Cyprus, Egypt, France, Greece, Italy, Libya, Malta, Tunisia, and Turkey (fig. 3. 1). Detailed distribution are given for each species

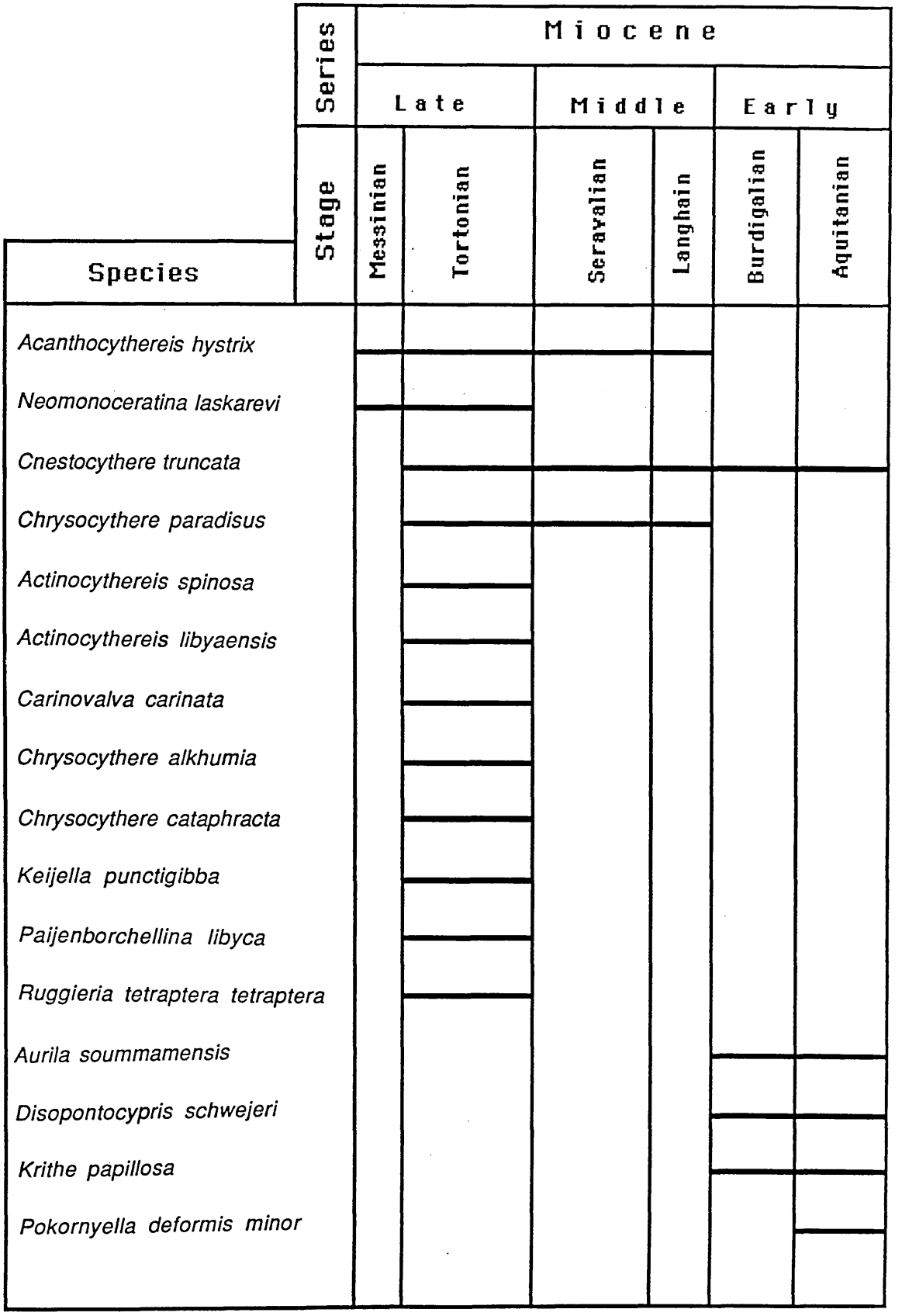


Table 3. 1 - Stratigraphic range chart of ostracods in the Marada Formation.

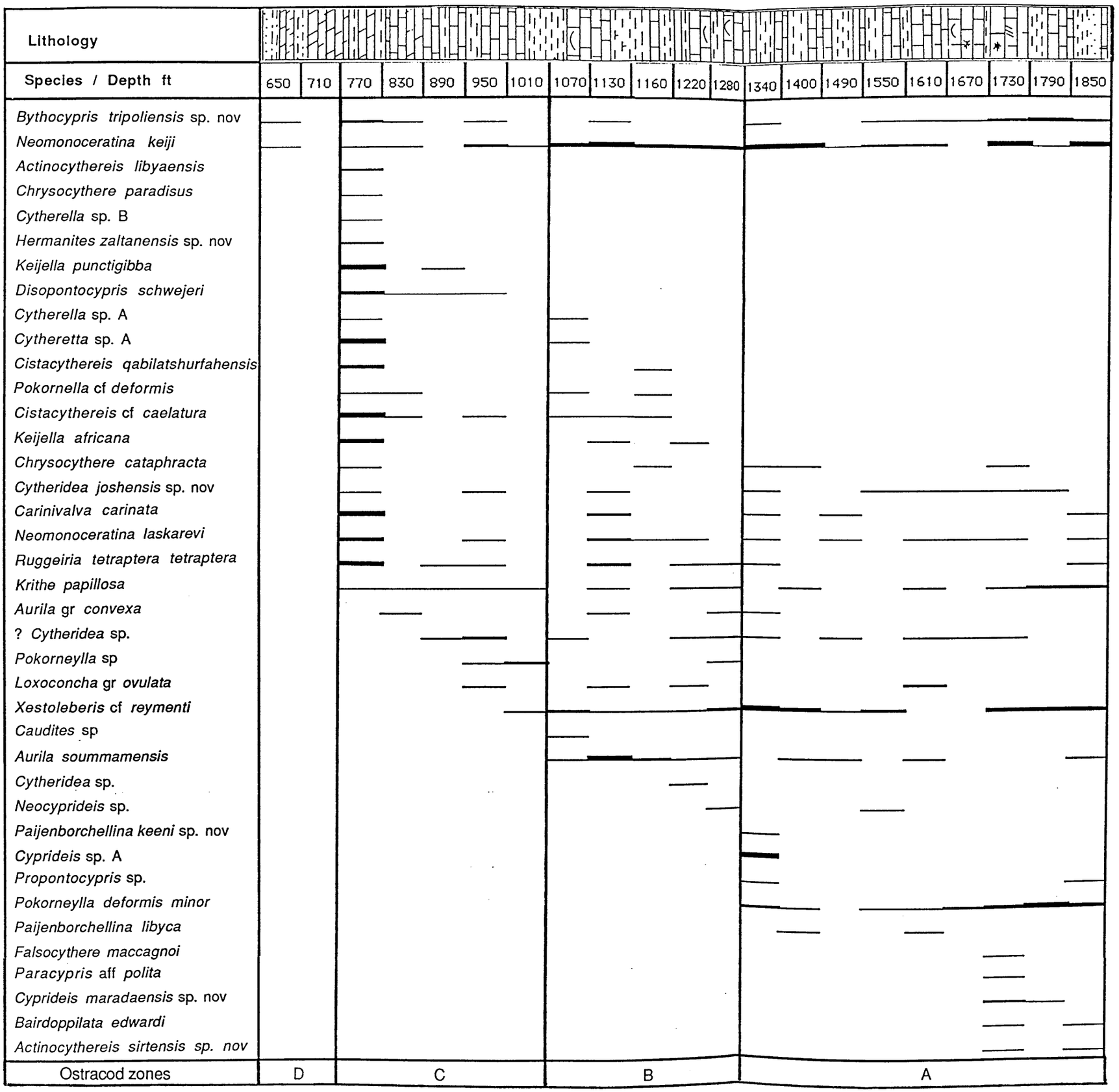


Table 3. 2 - Ostracod distribution in Well No C1a-97.

Species / Depth ft	640	670	700	790	820	880	910	940	970	1010	1040	1070	1100	1130	1160	1190	1230	1260	1320	1350	1420	1470	1490	1510	1540	1570	1600	1630	1670	1700
Cytheretta sp. A																														
Keijella punctigibba																														
Pokorneylla cf *deformis*																														
Chrysocythere cataphracta																														
Ruggieria tetraptera tetraptera																														
Neomonoceratina laskarevi																														
Bythocypris tripoliensis sp. nov																														
Paijenborchellena keeni sp. nov																														
Carinovalva carinata																														
Cytheridea sp.																														
Krithe papillosa																														
Xestoleberis cf *reymenti*																														
Cythreridea joshensis sp. nov																														
?*Cythereidea* sp.																														
Neomonoceratina keiji																														
Neocyprideis sp.																														
Aurila soummamensis																														
Actinocythereis spinosa																														
Pokornyella deformis minor																														
Aurila gr *convexa*																														
Keijella africana																														
Pokornyella sp.																														
Urocythereis sp.																														
Loxoconcha gr *ovulata*																														
Cytherelloidea sp.																														
Cyprideis maradaensis sp. nov																														
Bairdopillata sp. A																														
Keijella aff *dorukae*																														
Paijenborchellina libyca																														
Bairdopillata sp. B																														
Cyprideis sp. B																														
Cnestocythere truncata																														
Ostracod zones	D	C	B	A																										

Table 3. 3 - Ostracod distribution in Well No G1-97.

Lithology	
Species / Depth ft	600 630 660 690 720 750 780 810 840 870 900 930 960 990 1020 1050 1080 1110 1140 1170 1200 1230 1260 1290 1320 1350 1380 1410 1440 1470 1500 1530 1560 1590 1620 1650 1680 1710 1740 1770 1800
Chrysocythere paradisus	
Ruggieria tetraptera tetraptera	
Hermanites zalatanensis sp. nov	
Neomonoceratina keiji	
Neomonoceratina laskarevi	
Pokornyella sp.	
Xestoleberis cf *reymenti*	
Cistacythereis cf *caelatura*	
Keijella africana	
Paijenborchellina keeni sp. nov	
Paijenborchellina libyca	
Neocyprideis sp.	
Bythocypris tripoliensis sp.nov	
Chrysocythere alkhumia	
Loxoconcha gr *ovulata*	
Paracypris sp.A	
Chrysocythere cataphracta	
Cytheridea joshensis sp. nov	
Carinovalva carinata	
Pokornyella cf *deformis*	
Aurila soummamensis	
? Cytheridea sp.	
Hermanites haidingeri	
Cnestocythere truncata	
Bairdopillata sp. B	
Aurila gr convexa	
Cytheretta cf *semipunctata*	
Cistacythereis qabilatshurfahensis	
Krithe papillosa	
Paracypris sp.	
Pokornyella deformis minor	
Cyprideis maradaensis sp. nov	
Cyprideis sp.B	
Bairdopillata sp. A	
Cytheridea sp.	
Cytherella sp. B .	
Actinocythereis sirtensis sp.nov	
Falsocythere sp.	
Falsocythere maccagoni	
Cytherella cf *pulchella*	
Acanthocythereis hystrix	
Ostracod zones	D C B A

Table 3. 4 - Ostracod distribution in Well No F1-97.

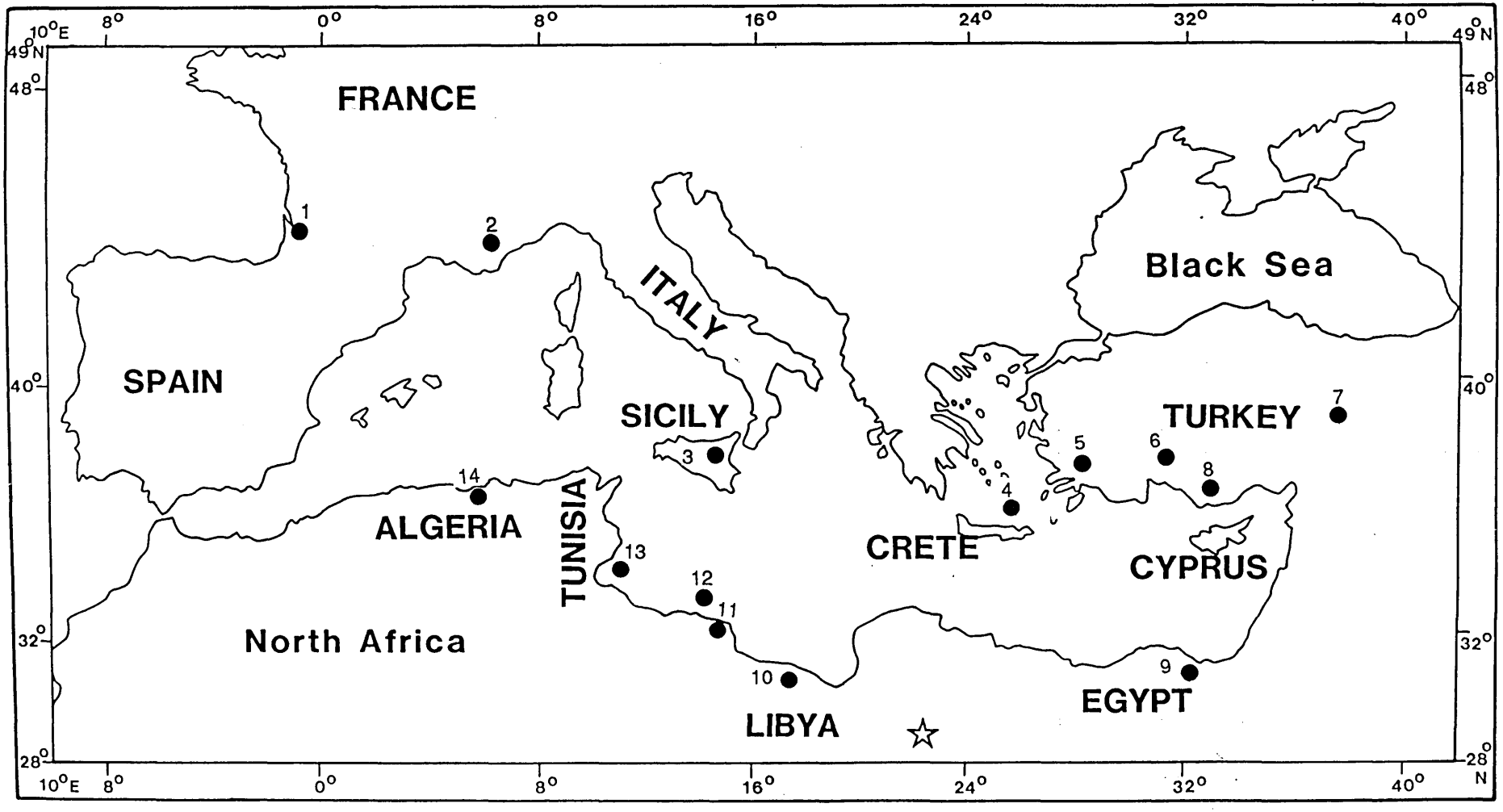


Figure 3. 1 - Location of some important studies of Miocene ostracods (●) in the Mediterranean area and the location of the present study area (☆).

1- Keij,1955, 2- Carbonnel, 1969, 3- Aruta, 1982, 4- Sissingh, 1972, 5, 6, 7- Gokcen,1984, 8- Bassiouni, 1979, 9,10- Szczechura, 1989, 11- El-Waer, 1988, 12- Van Hinte, 1980, 13- Bonaduce, G., *et al* 1988, 14- Coutelle and Yassini, 1974.

under the systematic description (chapter 2).

Lower Miocene species- The typical species is *Aurila soummamensis* (Coutelle and Yassini, 1974) described from the Burdigalian of Algeria, and from the lower Miocene of Turkey (Bassiouni, 1979). Gokçen (1984) used this species to define the Lower Miocene (Burdigalian) Biozone in the Neogene sequences of Turkey. *Pokornyella deformis minor* (Moyes 1965), described from the lower Miocene of Aquitain, France, and the lower Miocene of Turkey (Bassiouni, 1979 and Gokçen 1984) is also a useful marker species, restricted to the Aquitanian.

Middle Miocene- No species have been found in this study which are restricted to the Middle Miocene; three species are present which are recorded from the Middle Miocene, but range into later periods: *Cnestocythere truncata*, (Aquitanian-Tortonian), *Chrysocythere paradisus* (Langhain-Tortonian), and *Acanthocythereis hystrix* (Langhain-Pliocene). Thus, although they are not restricted to the Middle Miocene, their first appearance indicates Middle Miocene or later periods, and the interval between their first appearance and first appearance of typical Upper Miocene ostracods can be regarded as Middle Miocene.

Upper Miocene species- Most of the identified species in this study are restricted to the Tortonian (Upper Miocene) such as *Actinocythereis spinosa, Actinocythereis libyaensis, Chrysocythere alkhumia, Chrysocythere cataphracta, chrysocythere paradisus, Keijella punctigibba, carinovalva carinata*, while some species range into the Pliocene e.g. *Acanthocythereis hystrix, Neomonoceratina laskarevi, Ruggieria tetraptera tetraptera.*

OSTRACOD BIOZONES OF THE MARADA FORMATION

The samples used in this study are ditch cuttings representing between 30-60

feet of well drilling, which means that it is impossible to determine the true distribution of microfossils in the wells. However it is possible to recognise the first appearance of a species downhole, and features such as numerical abundance and nature of preservation give some clue as to the probability of species records being *in situ.*

Ostracod biozones are proposed for the Marada formation in the eastern Sirt Basin based on the first appearance downhole of one or more index species. The species chosen are known to have a wide geographical distribution, their stratigraphic ranges are short and well documented, they are easily identified, and they are reasonably abundant.

Different types of zones are defined in the International Stratigraphical Guide (Hedberg, 1976): these are the assemblage zone, a group of strata characterised by natural assemblages of fossils; the acme zone, characterised by the maximum abundance of a taxon; the range zone, which is the total range of a taxon; the concurrent range zone based on the ranges of two or more taxa; the oppel zone, which uses a more complex pattern of concurrent ranges of selected taxa; and the interval zone which lies between two biostratigraphic horizons such as the first and last appearance of species.

The biozone enables correlation between sedimentary successions by means of their fauna, giving a relative time scale based on the distribution of taxa. A chronozone may be based on a biozone, which is then the absolute time span defined by the maximum time span of the biozone using all means available and including all strata and all gaps equivalent in age to the maximum elapsed time in the zone.

Several biozonations based on ostracods have been published for different provinces of the Mediterranean Neogene: Carbonnel (1969) on the Aquitanian-Tortonian of the Rhone basin in France, Sissingh (1972) on the late Cenozoic of the south Aegean Islands, and Jircek (1974), on the Neogene sediments of the Czechoslovakia and Paratethys. Gokçen (1984) recognised a Burdigalian-early Langhain zone based on

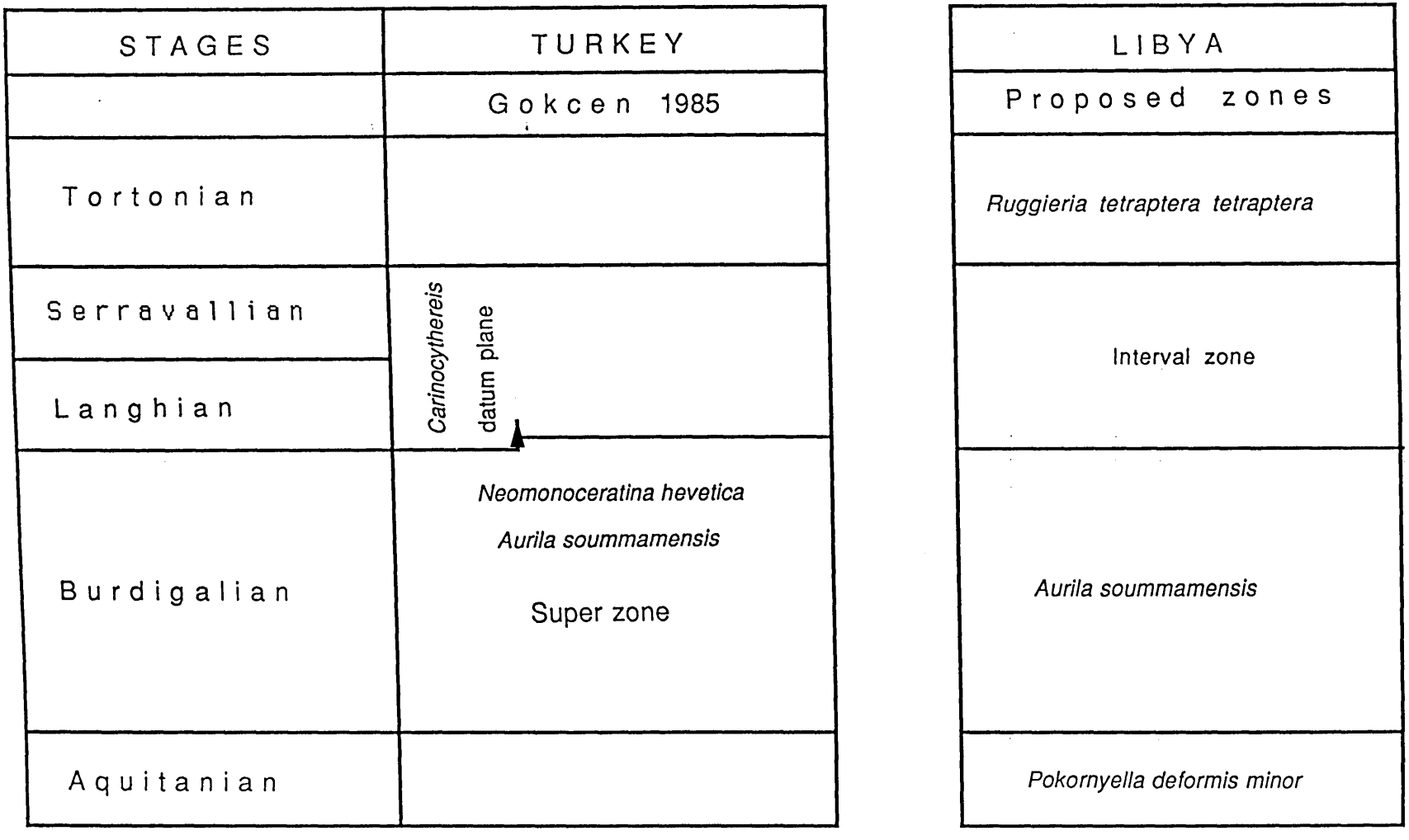
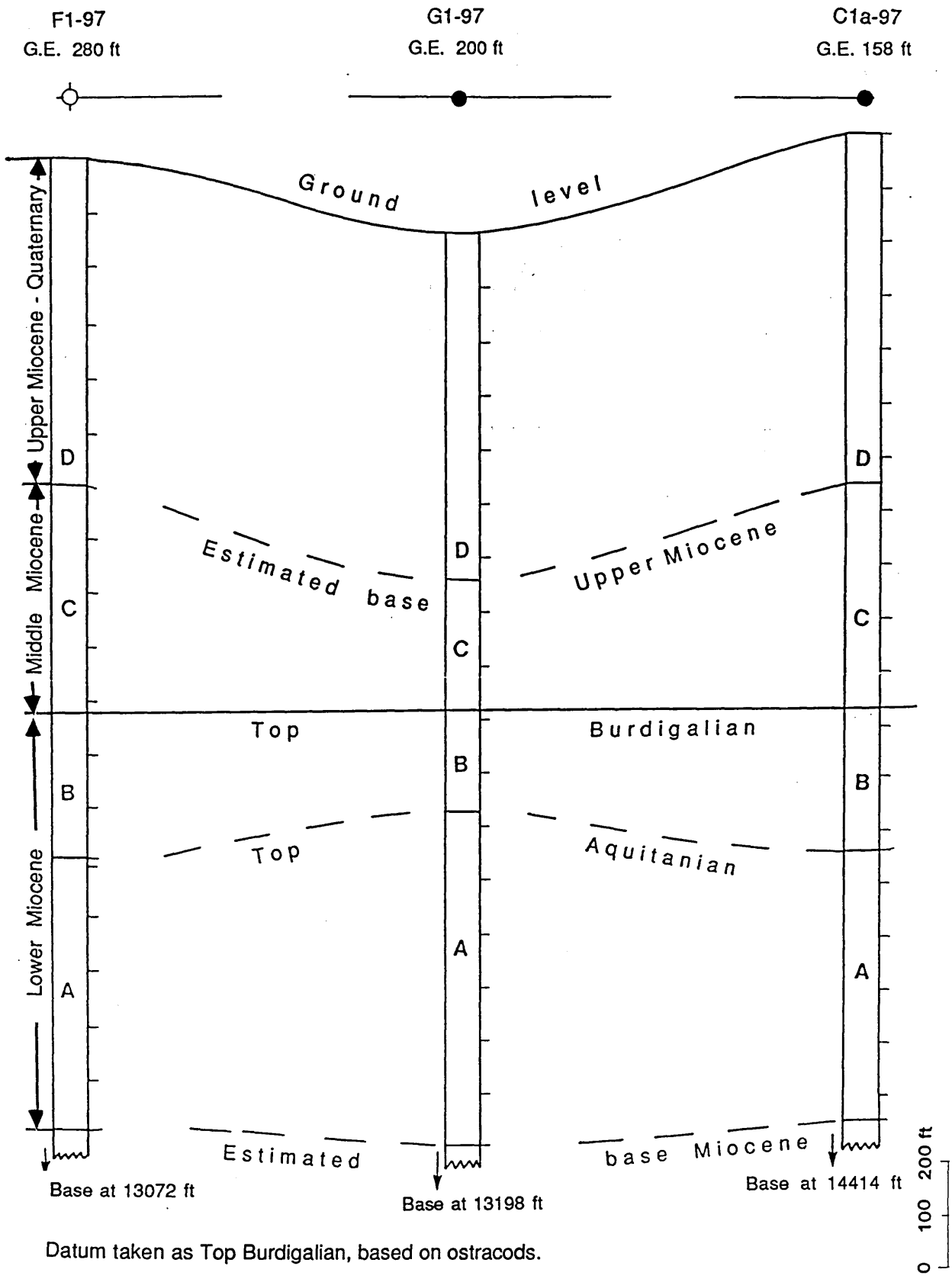


Table 3. 5 - Correlation between proposed Biozonation of the Miocene of Turkey and Libya.



Datum taken as Top Burdigalian, based on ostracods.

Figure 3. 2 - Proposed Biozones of the Marada Formation.

A, *Pokornyella deformis minor* Biozone; *Aurila soummamensis* Biozone;

C, Interval Biozone; D, *Ruggieria tetraptera teraptera* Biozone.

Neomonoceratina helvetica (Oertli) and *Aurila soummamensis* (Coutelle and Yassini) in the Neogene sequences of Turkey (table 3. 5).

The following four biozones have been recognised in the sequences studied of the Marada Formation in ascending order (Fig. 3. 2).

A- *Pokornyella deformis minor* Biozone. The top of this zone is recognised by the first occurrence downhole of *Pokornyella deformis minor;* its base has not been determined. This zone is probably equivalent to the Aquitanian.

B-*Aurila soummamensis* Biozone. The top of this zone is recognised by the first occurrence downhole of *Aurila soummamensis*; the base is defined by the first appearance downhole of *Pokornyella deformis minor.* This is equivalent to the Burdigalian.

C- An interval Biozone. This zone lies between the top of the *Aurila soummamensis* zone and the level taken to be the base of the *Ruggieria tetraptera tetraptera* Zone. This is taken to be equivalent to the Middle Miocene but as discussed earlier there is a lack of characteristic species.

D-*Ruggieria tetraptera tetraptera* Biozone. This assemblage zone is recognised by the abundance of characteristic Upper Miocene species.

Description of Biozones in terms of the wells.

Well C1a-97 This well(Table 3. 2) has four zones as follows.

A-*Pokornyella deformis minor* Biozone- The top of this zone is recognised by the first appearance downhole *Pokornyella deformis minor* at a depth of 1340 feet, the base is not defined.

B- *Aurila soummamensis* Biozone- The top of this zone is recognised by the first occurrence downhole of *Aurila soummamensis* at a depth of 1070 feet.

C- An interval Biozone- This lies between the base of the *Ruggieria tetraptera tetraptera* zone at a depth of 770 ft and the top of the *Aurila soummamensis* zone at a

depth of 1070 ft.

D-*Ruggieria tetraptera tetraptera* Biozone- from the ostracod distribution chart (Table 3. 2) the break in faunal succession between 650 and 710 feet may be considered to be a non fossiliferous interval, At a depth of 770 feet abundant fossils occur which may be due to an environmental change such as a transgression. This assemblage zone is recognised on the first appearance of several ostracod species near the top of the Marada formation in well C1a-97 at a depth of 770 feet. The most abundant species are *Keijella punctigibba, Disopontocypris schwejeri, Cytheretta* sp. A, *Cistacythreis qabilatshurafensis, Cistacythereis* cf *caelatura, Keijella africana, Carinivalva carinata, Neomonoceratina laskarevi, Neomonoceratina keiji, Actinocythereis libyaensis, Chrysocythere paradisus, Cytherella* sp. B, *Hermanites* sp. nov, *Pokornyella* cf *deformis, Chrysocythere cataphracta, Cythereidea* sp.nov, together with the most frequent occurance of *Ruggieria tetraptera tetraptera.* All of these species are recorded in the Mediterranean and North Africa region from the Upper Miocene (Tortonian), so that this zone may be considered to be of upper Miocene age.

Well G1-97. This well (Table 3. 3) has four zones as follows

A- *Pokornyella deformis* Biozone- This is recognised by the first occurrence of *Pokornyella deformis minor* downhole at a depth of 1070 ft; the base is not defined.

B- *Aurila soummamensis* Biozone- The top of this zone is recognised by the first appearance of *Aurila soummamensis* downhole at a depth of 880 feet.

C- An interval Biozone- This lies between depths of 880 ft and the base of the Upper Miocene at a depth of 640 ft.

D- *Ruggieria tetraptera tetraptera* Biozone- This assemblages zone is recog -nised at the top of the formation at a depth of 640 feet where many species are recognised such as *Cytheretta* sp. A, *Keijella punctigibba, Pokornyella* cf *deformis Chrysocythere cataphracta, Ruggieria tetraptera tetraptera, Neomonoceratina*

laskarevi, Paijenborchellina sp. nov.

Well F1-97. (Table 3. 4) also has the same zones as wells C1a-97 & G1-97.

A-*Pokornyella deformis minor* Biozone- The top of this is recognised by the first appearance of *Pokornyella deformis minor* downhole at a depth of 1290 ft; the base of this zone has not determined.

B- *Aurila soummamensis* Biozone- The top of this is recognised by the first appearance downhole of *Aurila soummamensis* in this section at a depth of 1020 ft.

C- An interval Biozone-This zone lies between the base of Upper Miocene at a depth of 600ft and the top of Burdigalian at a depth of 1020 ft.

D- *Ruggieria tetraptera tetraptera* Biozone- This assemblage is recognised at the top of the formation at a depth of 660 ft, where the following species are recorded *Chrysocythere paradisus, Ruggieria tetraptera tetraptera, Hermanites* sp. nov, *Neomonoceratina keiji* and *Neomonoceratina laskarevi.*

CHAPTER FOUR

PALAEOENVIRONMENTS

PALAEOENVIRONMENTS OF THE MARADA FORMATION

Ostracods are widely used for palaeoenvironmental reconstructions because of their wide range of habitats such as fresh, brackish water, marine, and even rarely terrestrial habitats.

The main factors controlling distribution are salinity, temperature, water depth, substrate, food supply, hydrogen-ion concentration and oxygenation.

Using the principle of uniformitarianism, the present as the key to the past, it is possible to determine the type of environment the fossil ostracod fauna was likely to have inhabited.

Authors who have used fossil ostracods in this way for Tertiary environments include Sissingh (1976, 1972) on the fauna of the South Aegean, Ascoli (1968) on the Tortonian ostracods of Italy, Russo and Bonaduce (1984) on Miocene ostracods of Sardina, Szczechura, (1987) on the Middle Miocene of central Poland, and Keen (1977) on the late Eocene of the Hampshire Basin.

It is important to know whether or not the species have been deposited *in situ* or have been transported from another environment; i.e whether the ostracods are autochthonous or allochthonous. The presence of adult male and female carapaces with juvenile carapaces are considered to indicate a high probability of an autochthonous fauna (see Whatley, 1983).

Some features of the ostracod carapace may be related to salinity levels; the presence of nodes or tubercles on brackish water genera such as *Cyprideis* are related to salinity, whether due to genetic or environmental control. Rosenfeld and Vesper (1977) indicated that in *Cyprideis torosa* Jones (1850) the different shapes of sieve pores could be correlated with different types of salinity; rounded pores indicate slightly saline water, while elongate and irregular shapes indicate higher salinities.

These ecophenotypic features together with others such as size of carapace, shell thickness of the valve, and degree of reticulation are useful for interpretation of palaeoenvironments.

Authors such as Pokorny (1965) Bordovsky (1965), and Oertli (1971) considered that high sedimentation rates are indicated if large quantities of carapaces rather than single valves are preserved in the sediments.

The following classification is used in the descriptions given below:

1- Neritic zone, from shoreline to continental shelf i.e. to a water depth of 200m.

2- The shelf area is divided into three benthonic zones; littoral (intertidal) infralittoral which ranges from 0-75m depth and circalittoral from 75-200m water depth.

3-Bathyal zone, 200-2000m depth.

4- Abyssal zone with depths of more than 2000m.

The material studied here is not ideal for palaeoenvironmental analysis, because the samples are ditch cuttings. Contamination of material may be caused by drilling operations as well as caving of the well. The samples were collected at 30 and 60 feet intervals so they are not accurately located. To try to mitigate this problem importance is given to first appearances downhole, abundance in samples, and observation on the preservation of the ostracods.

The Marada Formation has yielded species of brackish and marine ostracods, and palaeoenvironmental analysis is based on the species and genera previously studied in the Mediterranean and North African regions by authors such as Sissingh (1972, 1974) Ruggieri (1961,1962) Bassiouni (1979), Yassini (1979) and Bonaduce, *et al* (1988).

The wells studied indicate the presence of 2 clearly different environments, infralittoral and brackish water conditions, with a suggestion of a third environment

of circalittoral depth (Fig 4. 1).

The typical fauna indicates shallow water (infralittoral) marine conditions; *Cytheridea joshensis* sp. nov, *Keijella punctigibba*, *Neomonoceratina laskarevi*, *Neomonoceratina keiji*, *Carinovalva carinata*, *Aurila* gr *convexa* and *Ruggieria tetraptera tetraptera*, tend to be present throughout the sections studied. *Aurila soummamensis Neomonoceratina keiji*, *Neomonoceratina laskarevi* and *Pokornyella deformis minor* are common species which occurs as juvenile as well as adult species, suggesting an autochthonous fauna. Brackish water conditions are present in each of the studied wells, suggested by the presence of *Neocyprideis* sp, *Cyprideis maradaensis* sp. nov, *Cyprideis* sp. A, and *Cyprideis* sp. B, and seem to have occurred at similar times.

Certain features are common to all three wells. Brackish water ostracods are commonly present in the lower part of the succession at depth intervals of 1320-1790 feet in C1a-97, 1230-1700 feet in G1-97 and 1320-1620 in the F1-97.

Only in one well is there any suggestion of circalittoral depth; well F1-97 has yielded *Acanthocythereis hystrix*, *Cytherella* cf *C.pulchella*, *Cytherella* sp, at a depth of 1590 feet.

During the lower Miocene there is evidence of frequent brackish water episodes occurring within a predominantly shallow infralittoral area of deposition. These episodes suggest the presence of lagoonal areas around the shores of a shallow sea; during the Miocene the Sirt Basin was a shallow, partly enclosed gulf (see fig 1.2). The brackish episodes ceased towards the end of the Burdigalian when a transgressive event must have occurred. After this there is no evidence of brackish environments apart from the rare occurrence of *Neocyprideis* sp. which presumably suggests that lagoons were still present, but some distance away. The remainder of the Marada Formation was deposited in infralittoral conditions.

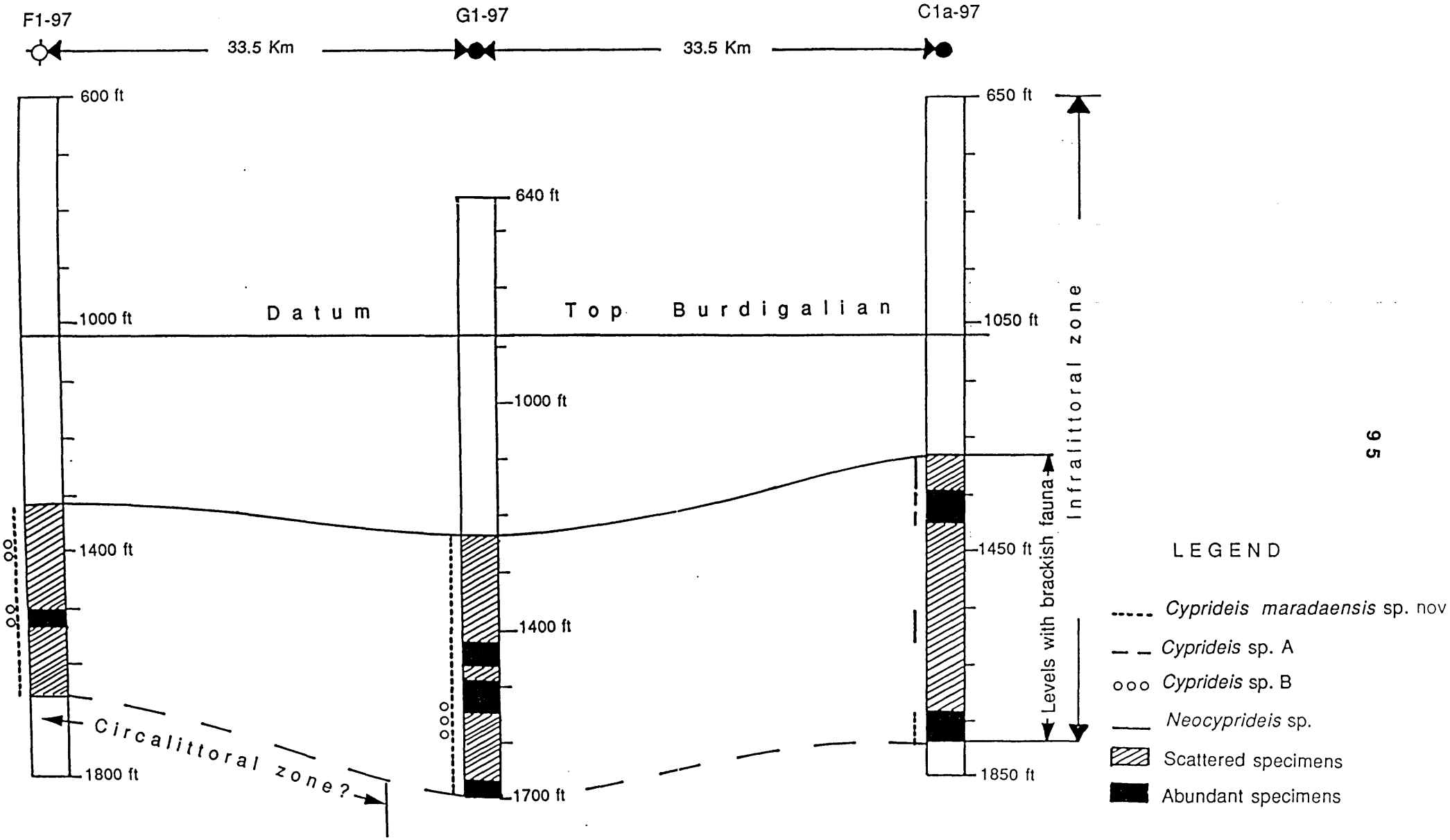


Figure 4. 1 - Palaeoenvironment deposition of the Marada Formation.

CHAPTER FIVE

CONCLUSIONS

CONCLUSIONS

Four ostracod biozones can be recognised in the Miocene Marada Formation from 3 Wells in the eastern Sirt basin, Libya. These indicate that the sequence ranges in age from Early Miocene to the base of the Late Miocene.

Biozone A is of Aquitanian age and recognised by the presence of *Pokornyella deformis minor.* Biozone B is Burdigalian, indicated by the presence of *Aurila soummamensis*, Biozone C is an interval zone probably of Middle Miocene age although lacking diagnostic fossils. Biozone D is an assemblage zone including the eponym *Ruggieria tetraptera tetraptera* marking the base of the Upper Miocene.

The ostracods indicate deposition in a shallow marine environment (Infralittoral zone), with brackish lagoonal horizons in the lower part of the sequences; there is a suggestion of circalittoral depths in well F1-97 at the base of the section.

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APPENDICES

Appendix-1

Description of ditch cuttings and wells:

Ditch cutting samples from the three Wells C1a-97, G1-97, F1-97 drilled by the Wintershall Oil Company, Libya, from the eastern Sirt Basin were studied. A total of 92 unprocessed samples were involved in the study, 21 samples from well C1a-79 collected at 60 feet intervals, 30 samples from well G1-97 collected at 30 feet intervals, and 41 samples from well F1-97 also collected at 30 feet intervals. These samples were processed as set out in Appendix 2.

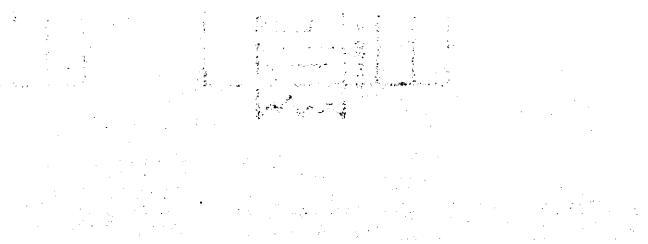
Location of Well C1a-97:

Latitude	28°	51'	34"
Longitude	21°	59′	09′

21 samples were obtained as follows:

Depth	Lithology
650ft	70% mainly unconsolidated sands, white to reddish in colour, coarse grain, well rounded, with 30% clays grey to light grey in colour with trace of grey shales.
710	mainly dolomite, dark grey in colour, medium hardness with bryozoan fossils fragments.
770	mainly calcarenite, whitish in colour, highly fossiliferous; interbedded soft marls with traces of dolomite and calcareous shale.
830	Similar to depth 770ft.
890	Mainly calcarenite, creamy white to light grey, highly fossiliferous; with glauconitic debris and interbedded shale, light grey to greenish in colour, partly calcareous.
950	Mainly shale, dark brown to brown, slightly calcareous with traces of gypsum and traces of calcarenites.
1010	Calcarenites, whitish in colour, highly fossiliferous; with clays, grey in colour, slightly calcareous, with traces of gypsum.
1070	Calcarenites, white to slightly grey in colour, rich in fossils fragments interbedded shale of brown to reddish colour.

1130	Similar to 1070ft with interbedded shale, soapy feeling, light grey, grey and brown in colour; highly fossiliferous.
1160	Similar to 1130ft.
1220	Calcarenites, whitish to light grey in colour, highly fossiliferous, with traces of shale and quartz grains.
1280	Mainly calcarenites, medium hardness, very rich in fossil fragments whitish to light grey in colour, with streaks of yellow marls.
1340	Calcarenites as above with 5% of light grey shale.
1400	Calcarenites, whitish in colour, highly fossiliferous; with 15% fissile shale, soft, light grey in colour.
1490	60% of calcarenites of whitish colour, with remains of *Ostrea* fragments; 40% blocky soft shale, light grey to grey in colour.
1550	Mainly calcarenites, moderately hard, whitish in colour, highly fossiliferous; with 15% shale, light grey, grey, reddish to brown in colour, with traces of gypsum.
1610	Similar to 1550ft, with higher percentage of shale.
1670	Mainly calcarenites of whitish colour, very highly fossiliferous, with streaks of grey and partly red coloured shale.
1730	Similar to 1670ft.
1790	Similar to 1670ft.
1850	Calcarenites, creamy to whitish in colour, with traces of sand grains and grey to green shale.



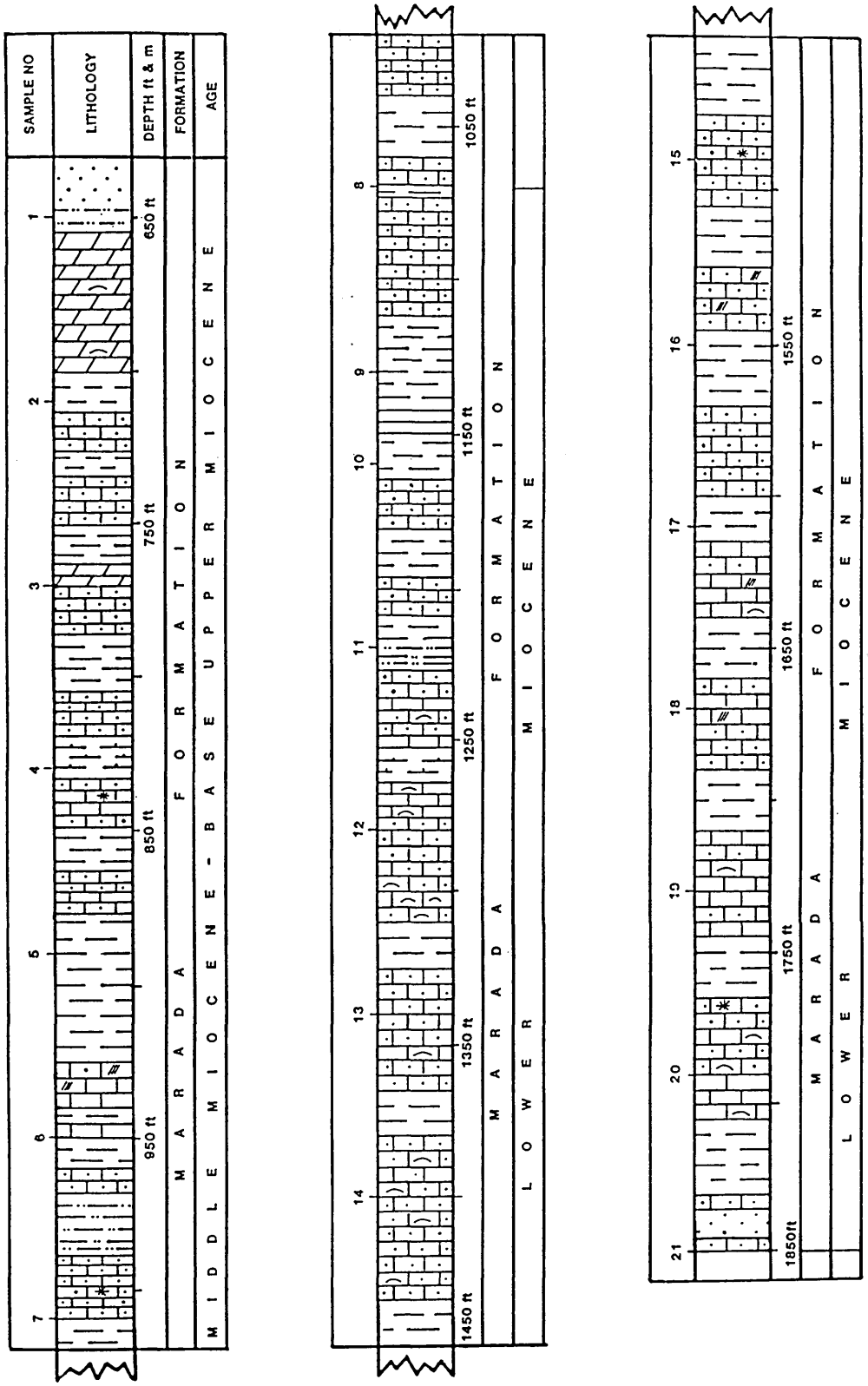


Figure 5. 1- Stratigraphic section of the Marada formation in the Well C1a-97.

Location of Well G1-97.

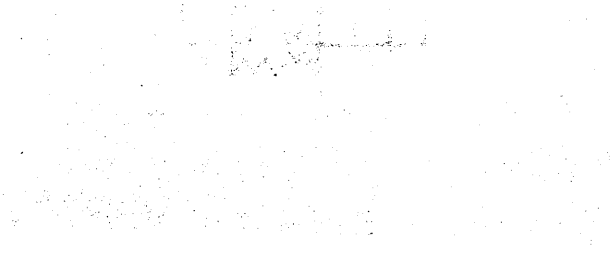
Latitude 28° 53′ 43″

Longitude 21° 37′ 35″

30 samples were obtained as follows:

Depth	Lithology.
640ft	Calcilutites, medium hardness greyish, light yellow, partly gypsiferous; some calcarenites, highly fossiliferous, with interbedded dark grey to to greenish marls.
670	Similar to 640ft with 50% of calcilutites.
700	Mainly soft fissile shale of light green to brownish colour.
790	Calcilutites, medium hardness, whitish to light grey colour, rich in fossils fragments; with 30% soft fissile light grey shale.
820	Calcilutite as above with a higher percentage of light grey to brown shale, with traces of calcarenites.
880	Mainly shale, light green to reddish in colour.
910	Similar to 880.
940	Mainly blocky shale, light green to light grey in colour, with 10% of calcilutite, rich in fossil fragments.
970	Mainly calcarenites of whitish colour, highly fossiliferous with 20% of light green to light grey and partly reddish shale.
1010	Biocalcarenites, whitish in colour, with 10% of light green to reddish shale.
1040	Similar to 1010ft.
1070	Similar to 1010ft.
1100	Similar to 1010ft with higher percentage of green to reddish shale.
1130	mainly biocalcarenites, whitish in colour.
1160	mainly shale, light grey to light green in colour, with 5% calcarenites and some well rounded quartz grains.
1190	70% fissile grey to light green shale, with 30% whitish calcarenites.
1230	Similar to 1190ft.
1260	mainly light green to light grey shale, with10% whitish calcarenites and some quartz grains.

1320	Similar to 1260ft with 50% shale and 50% calcarenites.
1350	Mainly whitish calcarenites with fissile light grey shale .
1420	mainly fissile light grey shale with 30% of whitish calcarenites.
1470	50% of whitish calcarenites, with 50% of fissile light grey to dark grey shale some times reddish in colour.
1490	Mainly shale, light grey to reddish in colour, with 30 % of calcarenites.
1510	Mainly calcarenites, light grey in colour, richly fossiliferous, with traces of glauconite.
1540	Sandy limestone, pale grey in colour, highly fossiliferous, and traces of shale
1570	Calcarenites, whitish to grey in colour; with greater than 30% shale, light grey to light green in colour, traces of marls and bryozoan fragments.
1600	Mainly shale, light grey to light green in colour, with traces of calcarenites and bryozoan fragments.
1630	Mainly shale, light grey to light green in colour, with traces of earthy to white in coloured calcilutites with fossils fragments.
1670	Similar to 1630ft.
1700	Similar to 1630ft, sometimes reddish in colour with traces of yellow marls.



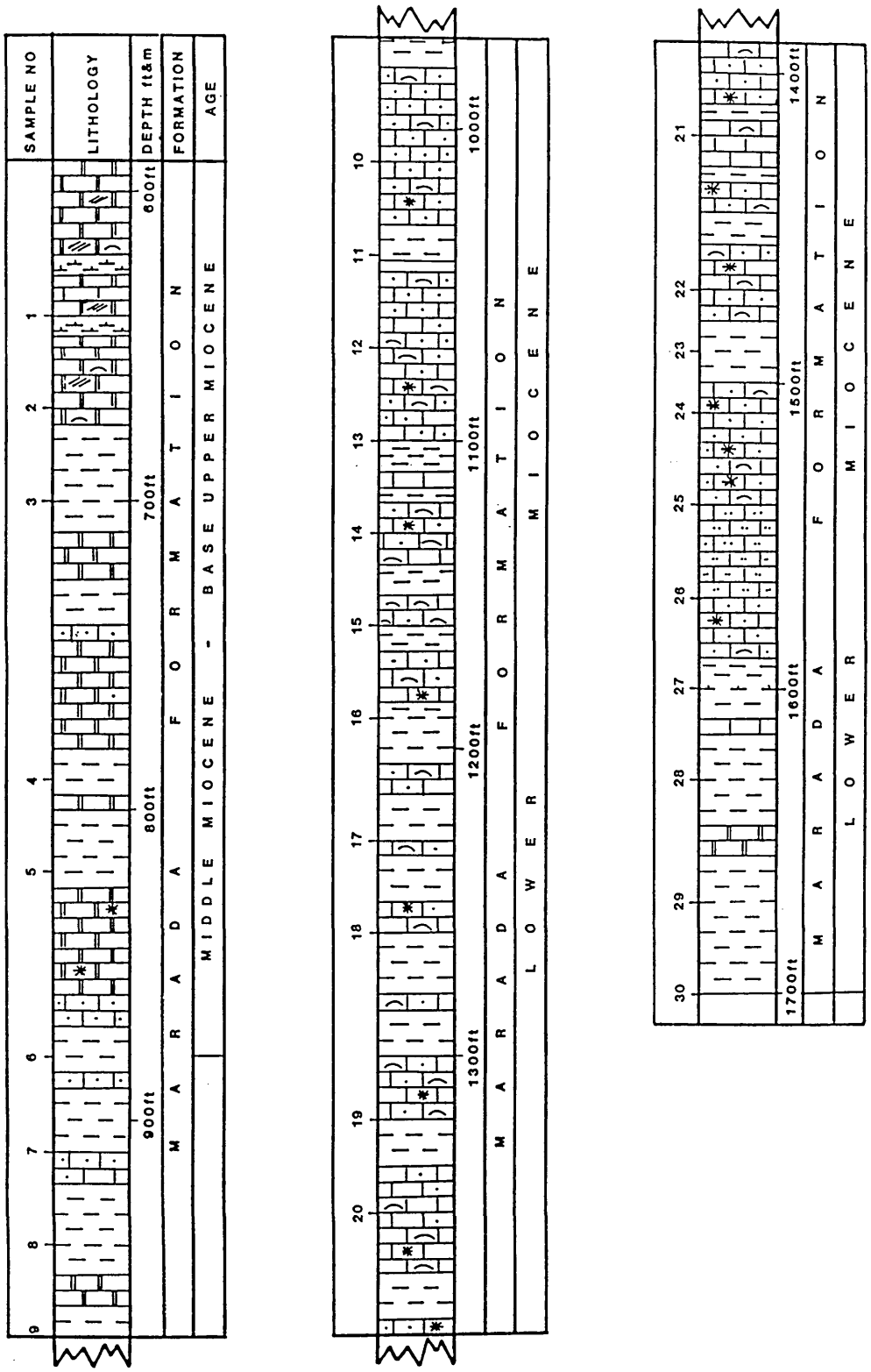


Figure. 5. 2- Stratigraphic section of the Marada Formation in the Well G1-97.

Location of well F1-97.

Latitude 28° 52′ 13″

longitude 21° 17′ 00″

41 samples were obtained as follows:

Depth	**Lithology.**
600ft	Calcarenites, light grey, partly yellowish in colour, with friable white chalk and traces of gypsum and sand grains, intercalations of clay, grey to greenish sometimes brownish in colour.
630	Similar to 600ft.
660	Similar to 600ft, with higher percentage of grey to green clays, with bryozoan fragments.
690	Mainly clay, grey partly yellowish to brownish in colour, with abundant bryozoan fragments and traces of calcite.
720	Mainly calcilutite, whitish to yellowish in colour, gypsiferous, bryozoan fragments grey dark grey clay and some white rounded grains.
750	Mainly clay, grey to dark grey partly reddish in colour with traces of white chalk and bryozoan fragments.
780	Mainly clays as above, with 20% earthy to whitish calcarenites.
810	Similar to 780ft with some white rounded quartz grains.
840	50% clay, light grey to dark grey partly reddish in colour and 50% calcarenites, moderately hard, white in colour and some quartz grains.
870	Similar to 840ft.
900	Similar to 840ft with bryozoan fragments.
930	Mainly calcarenites, whitish in colour, very rich in bryozoan fragments and clay, light grey to pale green sometimes reddish in colour .
960	Similar to 930ft with 40% greyish clay.
990	mainly clay light grey to dark grey partly reddish and yellowish in colour with particles of white calcarenite.
1020	Similar to 990ft.
1050	mainly calcarenites, moderately hard, whitish to pale

yellowish in colour, abundant fossil fragments with clay, light grey to dark grey some times reddish in colour.

1080 Mainly calcarenites, whitish to yellowish in colour, partly bioclastic, abundant well rounded sand grains, with calcareous sand stone and traces of glauconite.

1110 Similar to 1080ft, abundant fossil fragments and traces of glauconite.

1140 50% calcilutites, whitish in colour, abundant fossil fragments and 50% clays, light grey in colour.

1170 Similar to 1140ft, with light greenish shale; some rounded sand grains; some light yellowish marls.

1200 sandy limestone, hard, whitish to yellowish in colour, abundant bryozoan fragments; traces of light grey shale.

1230 Similar to 1200ft, with higher percentage of clays; trace of calcilutites.

1260 Similar to 1230ft.

1290 Similar to 1260ft.

1320 50% calcilutites, whitish in colour, richly fossiliferous; and 50% of clay, light grey to grey in colour.

1350 Similar to 1320ft.

1380 Similar to 1320ft, with traces of glauconite.

1410 Similar to 1380ft.

1440 Similar to 1380ft.

1470 Similar to 1380ft.

1500 sandy limestone, hard, light grey in colour.

1530 60% clays, light grey partly reddish to yellowish in colour; with 40% sandy limestone, rich in bryozoan fragments; some quartz grains.

1560 Similar 1530ft.

1590 Mainly shale, light grey to light green in colour, abundant fossil fragments, with 10% whitish sandy limestone, and some sand grains.

1620 Mainly calcarenites, light grey in colour, with fissile shale light green to grey in colour.

1650 Mainly calcilutites, whitish to earthy in colour, with well

rounded sand grains and fossil fragments.

1680 Cacilutites, moderately hard, whitish to light grey in colour.

1710 mainly calcilutites as above, partly reddish colour, rich in fossil bryozoan fragments; and 40% light grey fissile shale.

1740 mainly calcilutites, with high percentage of clays.

1770 50% calcilutites, moderately hard, whitish to light grey in colour, with reddish rounded sandgrains; and 50% fissile shale, light grey to light green in colour.

1800 70% fissile shale, light green in colour; with 30% calcilutite, moderately hard, whitish in colour; abundant fossil fragments; traces of marls.

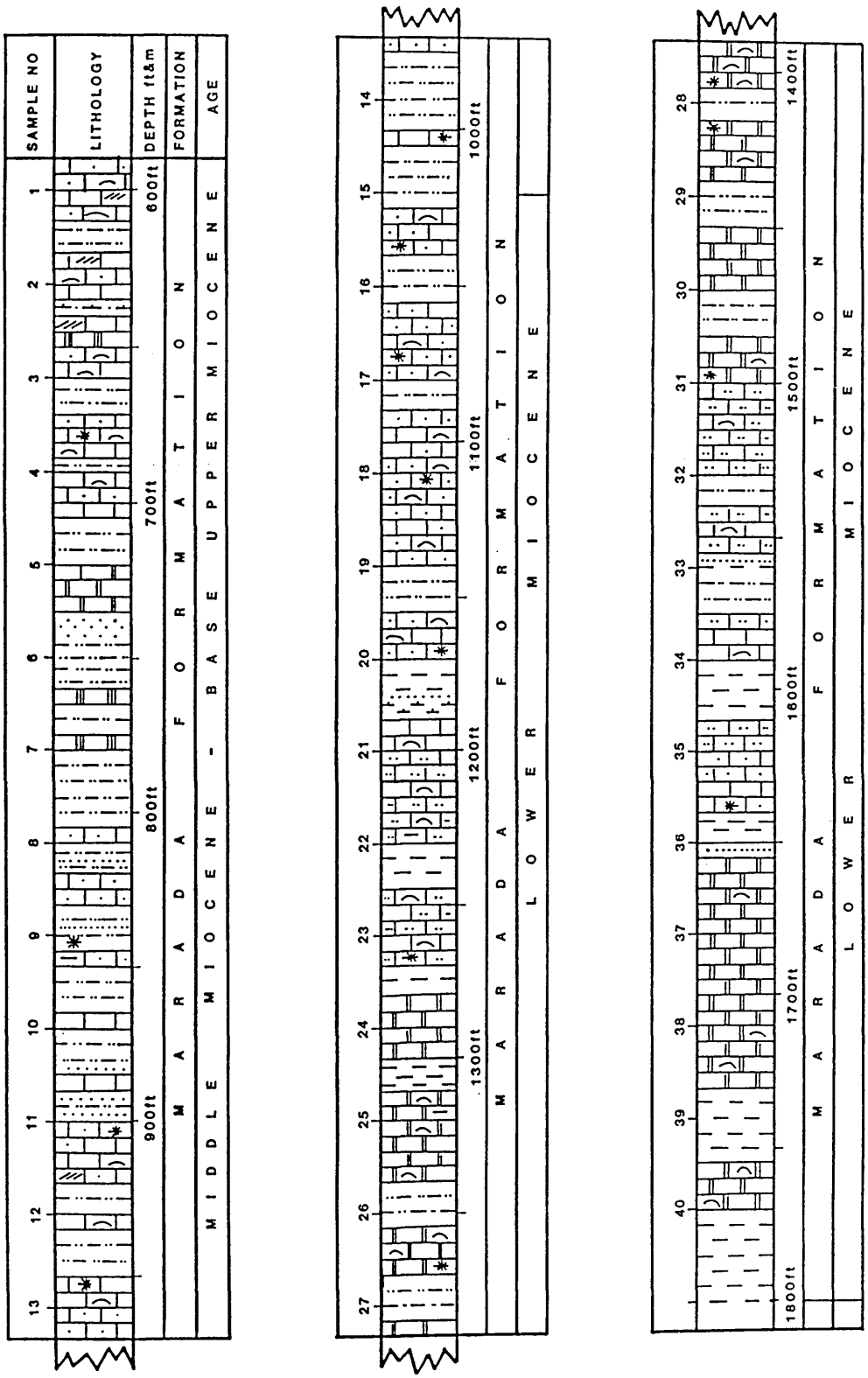


Figure. 5. 3- Stratigraphic section of the Marada Formation in the Well F1-97.

Appendix-2

Processing:

The techniques used in the processing of the ditch cutting samples was as follows.

Washing, sieving, and picking of the samples.

Each sample was soaked in dilute hydrogen peroxide (H_2O_2) 15% over night then sieved through brass sieves with apertures of 500μm, 250μm, and 75μm using hot water. The three residues obtained were transferred into evaporating basins and dried in an oven at 200 °c. These dried residues were then picked under a binocular microscope using a fine moistened sable brush. Most of the adult ostracod species were obtained from the medium residue, while a few juvenile ostracods found in the fine residue; rare ostracods were obtained from the coarse residue.

Treatment of individual specimens.

The specimens selected for examination under scanning electron microscope (S. E. M), were cleaned as follows.

A- Manual treatment:

This method was used to clean out sediment within the specimen. A fine tungsten needle mounted in a piece of wood and a fine sable brush were used with a drop of hydrogen peroxide (15%) added to soften the sediment and to prevent the specimen from being lost when being touched by the needle.

B- Ultrasonic method:

This was used for cleaning specimens which could not be cleaned manually. The specimens were placed in a small glass vial half filled with water, then the vial was held in an ultrasonic instrument set at 50-55,000 cycles per second for one second or less. This was repeated if necessary, each time the specimen was examined under the microscope until the specimen was properly cleaned. When using this method, great attention has to be paid to delicate carapaces and valves which could have been broken during treatment.

Photography:

In this study Cambridge Instruments S600 and S300 were used.

The specimens to be photographed were mounted on an aluminium stub of one centimetre diameter. Two types of mounting medium were used to fixed the specimens onto the S.E.M stubs as follows:

1- Pritt stick:

This type of adhesive is very cheap and it is very easy to use. The glue is applied to the S.E.M stub as a very thin film of adhesive, the specimens are placed on the glue under the binocular microscope. The stub plus specimens are then left under a lamp for about 30 minutes, the surface of the glue is scratched to improve the surface contact between the stub and gold coating. The specimens were coated with gold using a vacuum coater. Specimens are easily removed from the stub using water.

2- Tempfix:

This is a more complicated method, necessary for use with the more sophisticated S300 to prevent contamination of the chamber. An aluminium stub is placed in a stub holder and placed on a hot plate at 120°c for about 30 minutes. The stub holder is removed with clamps, and a thin layer of timp fix is applied to the stub. The timp fix is allowed to become slightly solidified, at about 40°C then the specimens are mounted onto it under a binocular microscope. When the timp fix is completely solidified, the specimen is coated with gold in a vacuum coating unit.

Plate 1.

Actinocythereis spinosa.

Fig 1. Left valve; No A12550, X 60.

Fig 2. Same left valve inside view X 60.

Actinocythereis libyaensis.

Fig 3. Male dorsal view; No 12551, X 65.

Fig 4. Male right carapace; No A12552, X 70.

fig 5. Female right carapace; No A12553, X 70.

Actinocythereis sirtensis sp. nov.

Fig 6. Male right carapace; No A12554, X 74.

Fig 7. Male left carapace ; No A12555, X 76.

Fig 8. Male stereoscopic paired photographs left carapace; No A12556, X 80.

Fig 9. Female stereoscopic paired photographs right carapace(Holotype);
No A12557, X 90.

PLATE 1

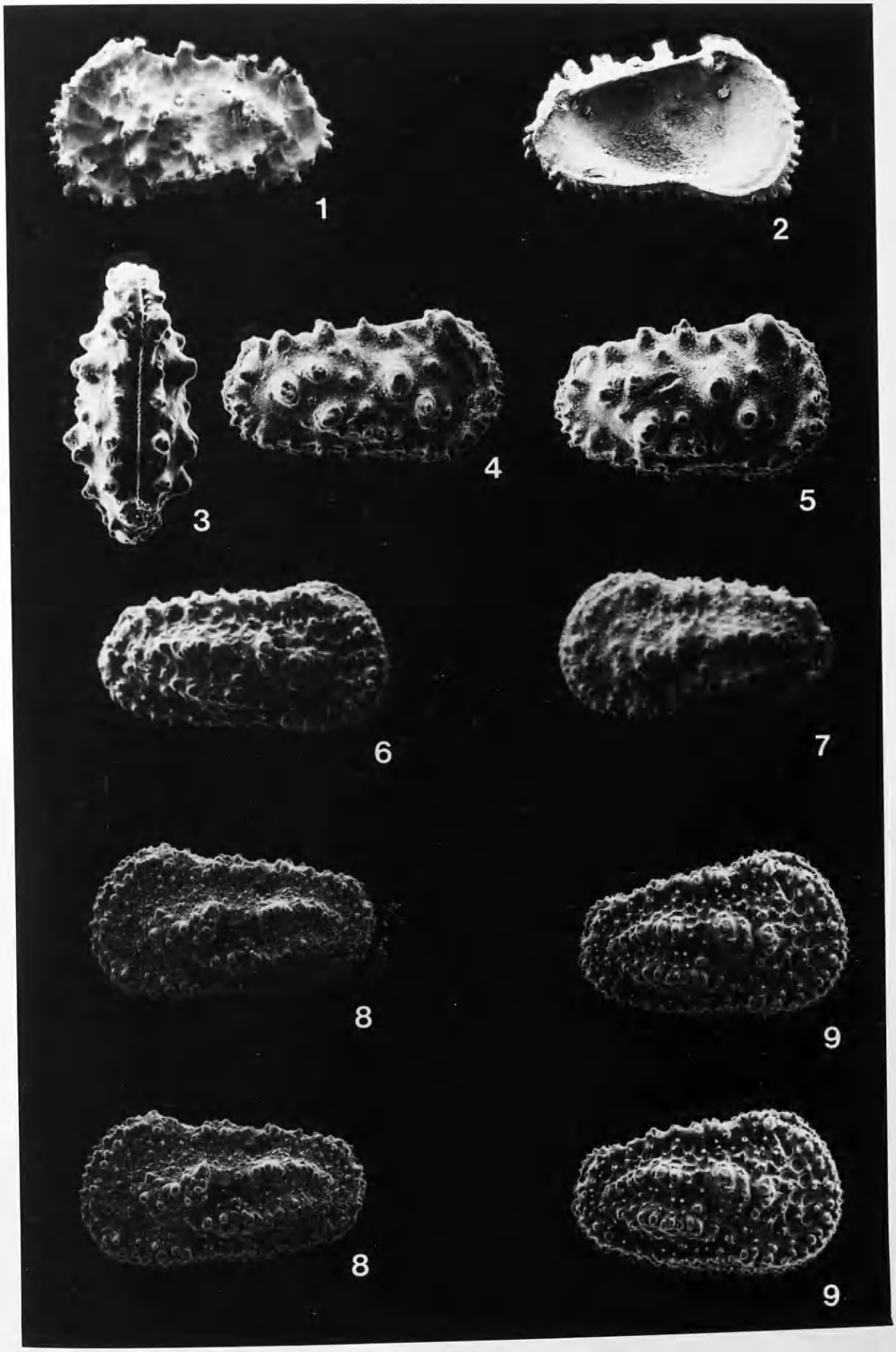


Plate 2.

Aurila soummamensis.

Fig 1. Male right carapace; No A12558, X 73.5

Fig 2. Male left carapace; No A12559, X 71

Fig 3. Juvenile right carapace; No A12560, X 100

Fig 4. Female dorsal carapace; No A12561, X 81

Fig 5. Female right carapace; No A12562, X 77.5

Fig 6. Female left carapace; No A12563, X 77.5

Fig 7. Female left valve; No A12564, X 85

Aurila gr *convexa.*

Fig 8. Female right carapace; No A12565, X 100

Fig 9. Female left carapace; No A12566, X 100

Fig 10. Female dorsal carapace; No A12567, X 100

Fig 11. Male ventral view carapace, No A 12568, X 82.5

Fig 12. Male left carapace; No A12569, X 90

Fig 13. Male right carapace; No A12570, X 102.5

PLATE 2

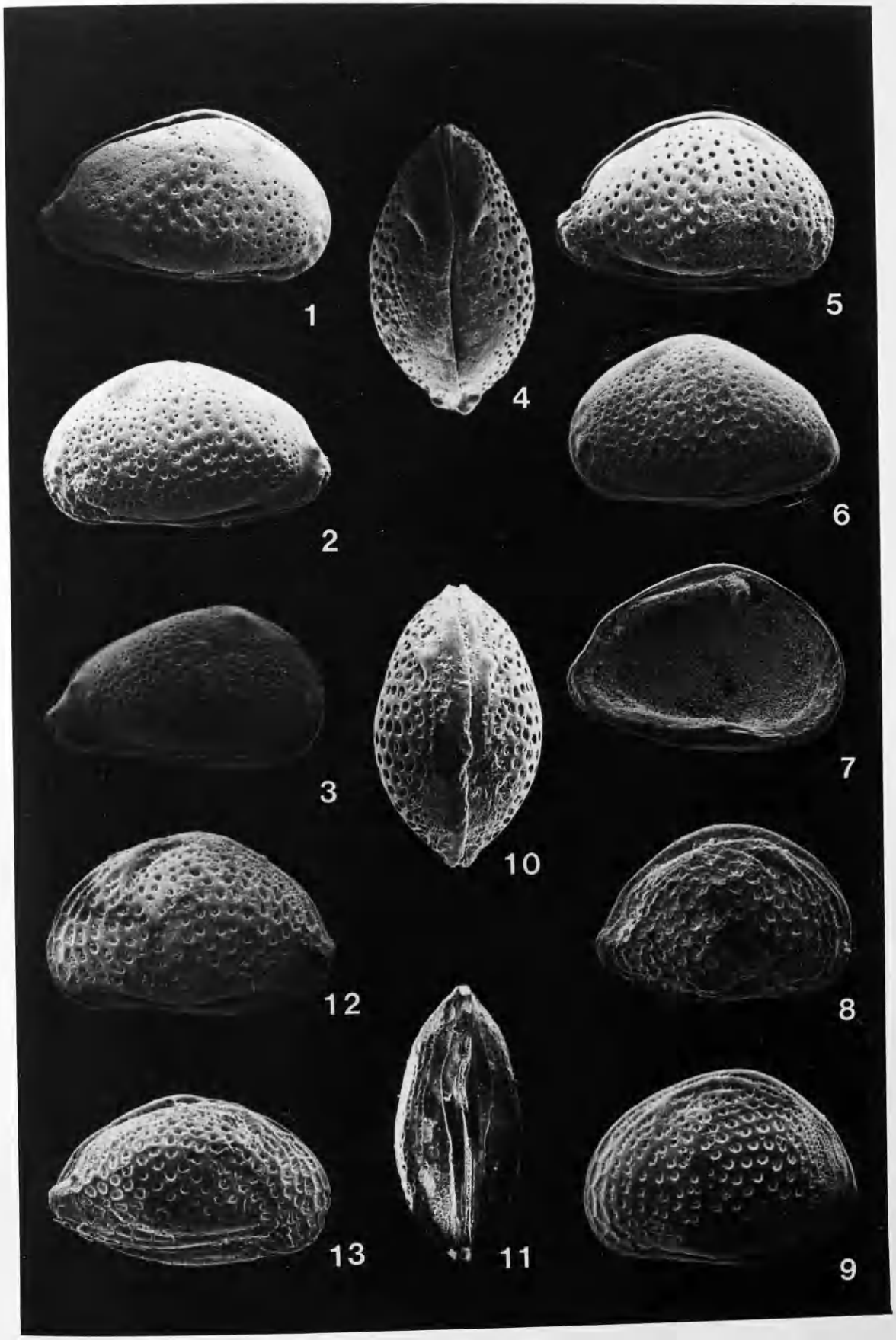


Plate 3.

Chrysocythere alkhumia.

Fig 1. Female right valve; No A12571, X 82.5

Chrysocythere cataphracta cataphracta.

Fig 2. Male right carapace; No A12572, X 67.5

Fig 3. Female right carapace; No A12573, X 70

Fig 4. Female left valve; No A1212574, X 60

Fig 5. Female right carapace; No A12575, X 75

Chrysocythere paradisus.

Fig 6. Female right carapace; No A12576, X 67.5

Fig 7. Female right valve; No A12577, X 62.5

Fig 8. Male stereoscopic paired photographs right carapace; No A12578, X 57.5.

Fig 9. Female right carapace; No A12579, X 67.5

Fig 10. Female right carapace; No A12580, X 67.5

PLATE 3

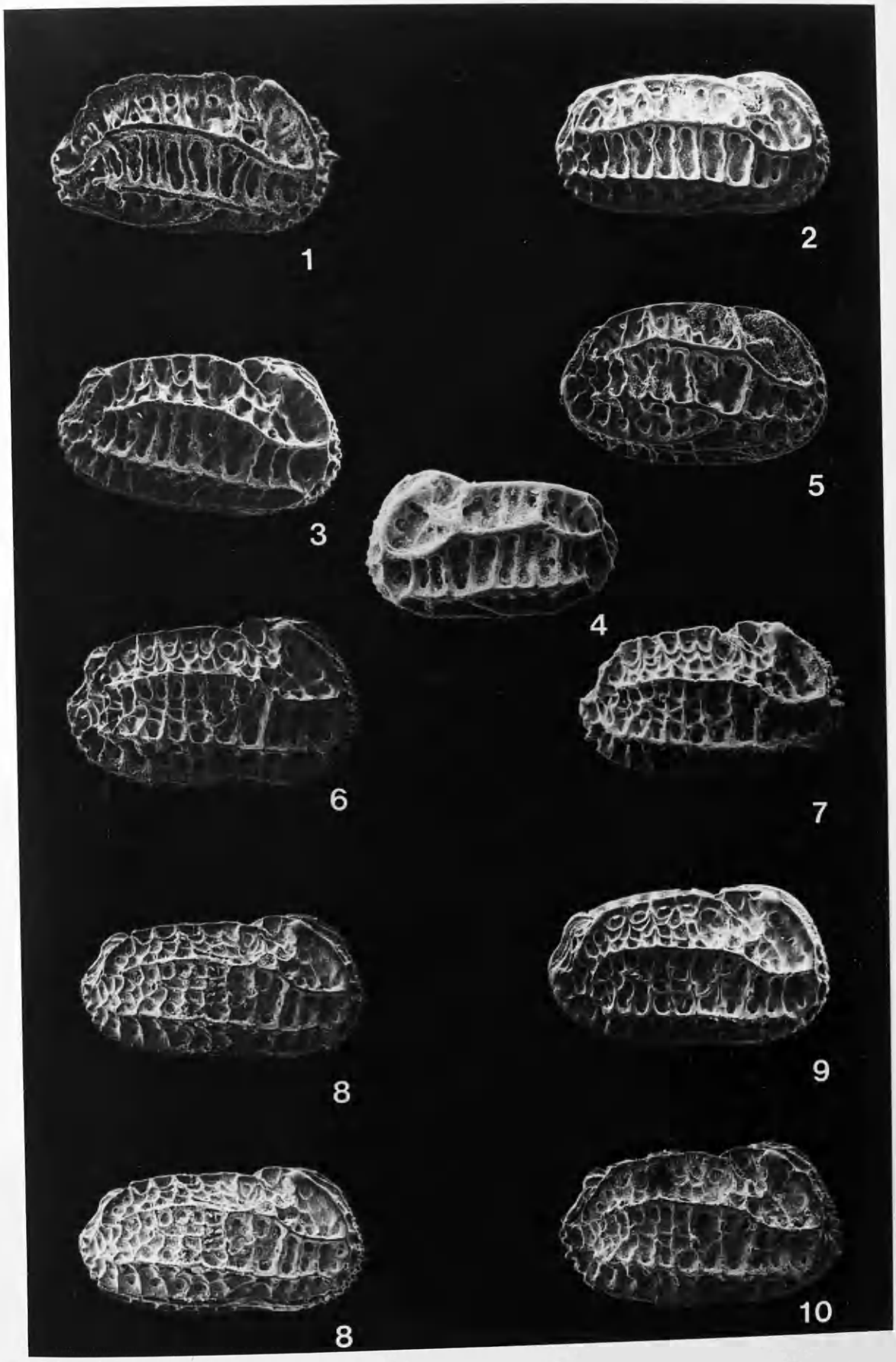


Plate 4.

Cyprideis maradaensis sp. nov.

Fig 1. Female stereoscopic paired photographs left valve (Holotype); No A12581, X 75

Fig 2. Female stereoscopic paired photographs right carapace; No A12582, X 72.5

Fig 3. Male right carapace; No A12583, X 79

Fig 4. Female dorsal view; No A12584, X 70

Fig 5. Muscle scare pattern X 312.5

Fig 6. Female ventral carapace; No A12585, X 77.5

Cyprideis sp. A

Fig 7. Right carapace; No A12586, X 77.5

Fig 8. Left carapace; No A12587, X 70

Fig 9. Juvenile right carapace; No A12588, X 92.5

Cyprideis sp. B

Fig 10. Right carapace; No A12589, X 72.5

Neocyprideis sp.

Fig 11. Right carapace; No A12590, X 67.5

Fig 12. Left carapace; No A12591, X 67.5

PLATE 4

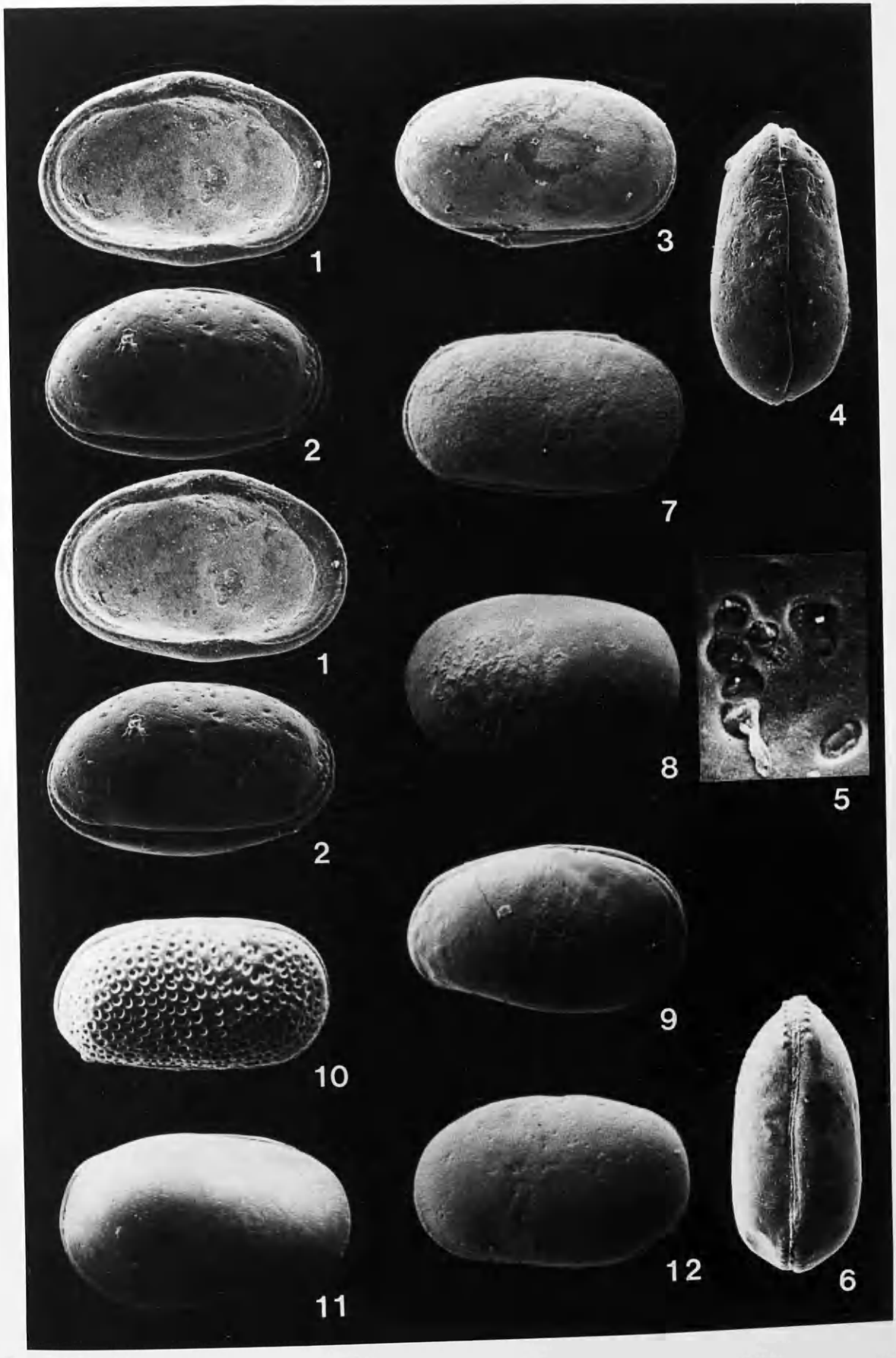


Plate. 5

Cnestocythere truncata.

Fig 1. Female stereoscopic paired photographs left carapace; No A12592, X 102.5

Fig 2. Female stereoscopic paired photographs right valve; No A12593, X 95

Cistacythereis qabilatshurfahensis.

Fig 3. Right carapace; No A12594, X 90

Fig 4. Left carapace; No A123595, X 90

Fig 5. Dorsal carapace; No A12596, X 87.5

Carinovalva carinata.

Fig 6. Male right carapace; No A12597, X 80

Fig 7. Male left carapace; No A12598, X 80

Fig 8. Female right carapace; No A12599, X 85

Fig 9. Female left valve inside view; No A12600, X 85

Fig10. Female dorsal carapace; No A12601, X 87.5

Fig11. Hinge type X 160

Caudites sp.

Fig.12. Right carapace X 64

PLATE 5

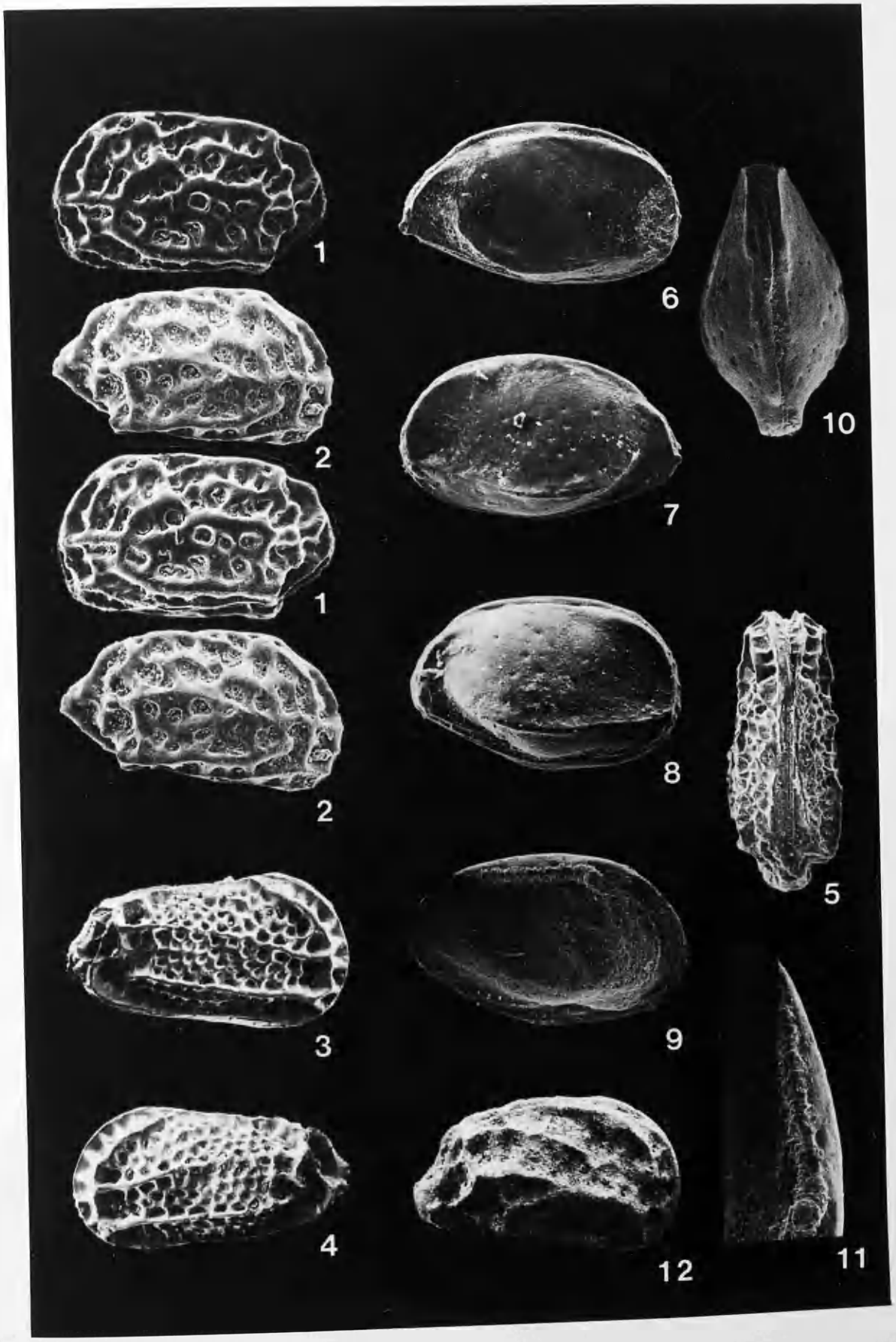


Plate 6.

Neomonoceratina laskarevi.

Fig. 1. Male stereoscopic paired photographs right carapace; No A12602, X 90

Fig. 2. Male stereoscopic paired photographs left carapace; No A12603, X 97.5

Fig. 3. Female right carapace; No A12604, X 105

Fig. 4. Male dorsale carapace; No A12605, X 87.5

Neomonoceratina keiji.

Fig. 5. Male right carapace; No A12606, X 87.5

Fig. 6. Male left carpace; No A12607, X 85.25

Fig. 7. Female right carapace; No A12608, X 102.5

Fig. 8. Female left carapace; No A12609, X 102.5

Fig. 9. Male right valve insideview; No A12610, X 82.5

Fig.10. Female dorsale carapace; No A12611, X 102.5

Fig. 11. Hinge right valve X 231.25

PLATE 6

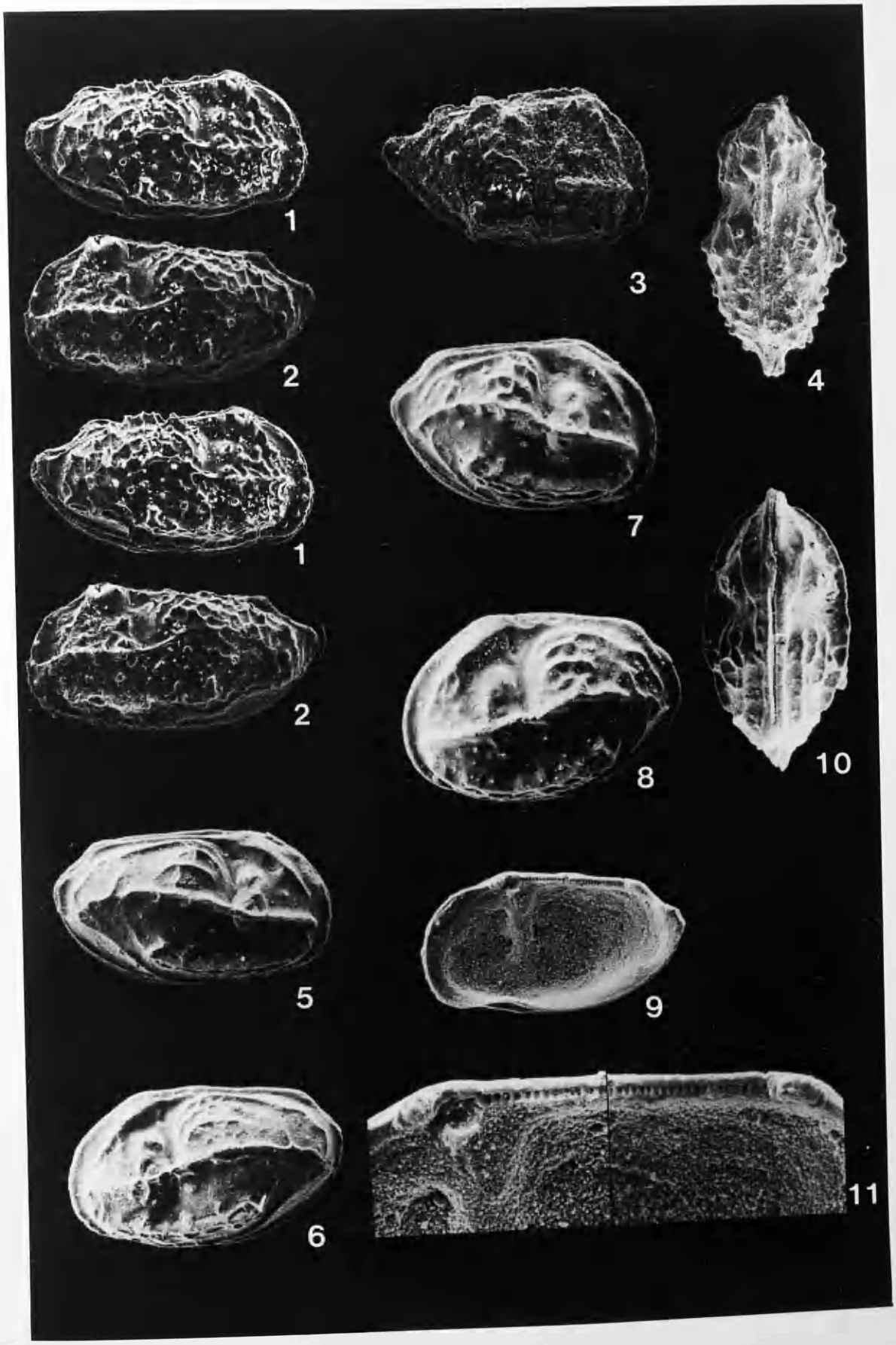


Plate 7.

Keijella africana.

Fig 1. Male stereoscopic paired photographs right carapace; No A12612, X 61.25

Fig 2. Female left carapace; No A12613, X 67.5

Fig 3. Female dorsal carapace; No A12614, X 70

Keijella punctigibba.

Fig 4. Male right carapace; No A12615, X 70

Fig 5. Female left carapace; No A12616, X 77.5

Fig 6. Female right carapace; No A12617, X 75

Fig 7. Male dorsal view; No A12618, X 82.5

Krithe papillosa.

Fig 8. Male right carapace; No A12619, X 70

Fig 9. Male left carapace; No A12620, X 72.5

Fig 10. Female right carapace; No A12621, X 85

Fig 11. Female left carapace; No A12622 X 80

Fig 12. Female dorsal carapace; No A12623, X 80

PLATE 7

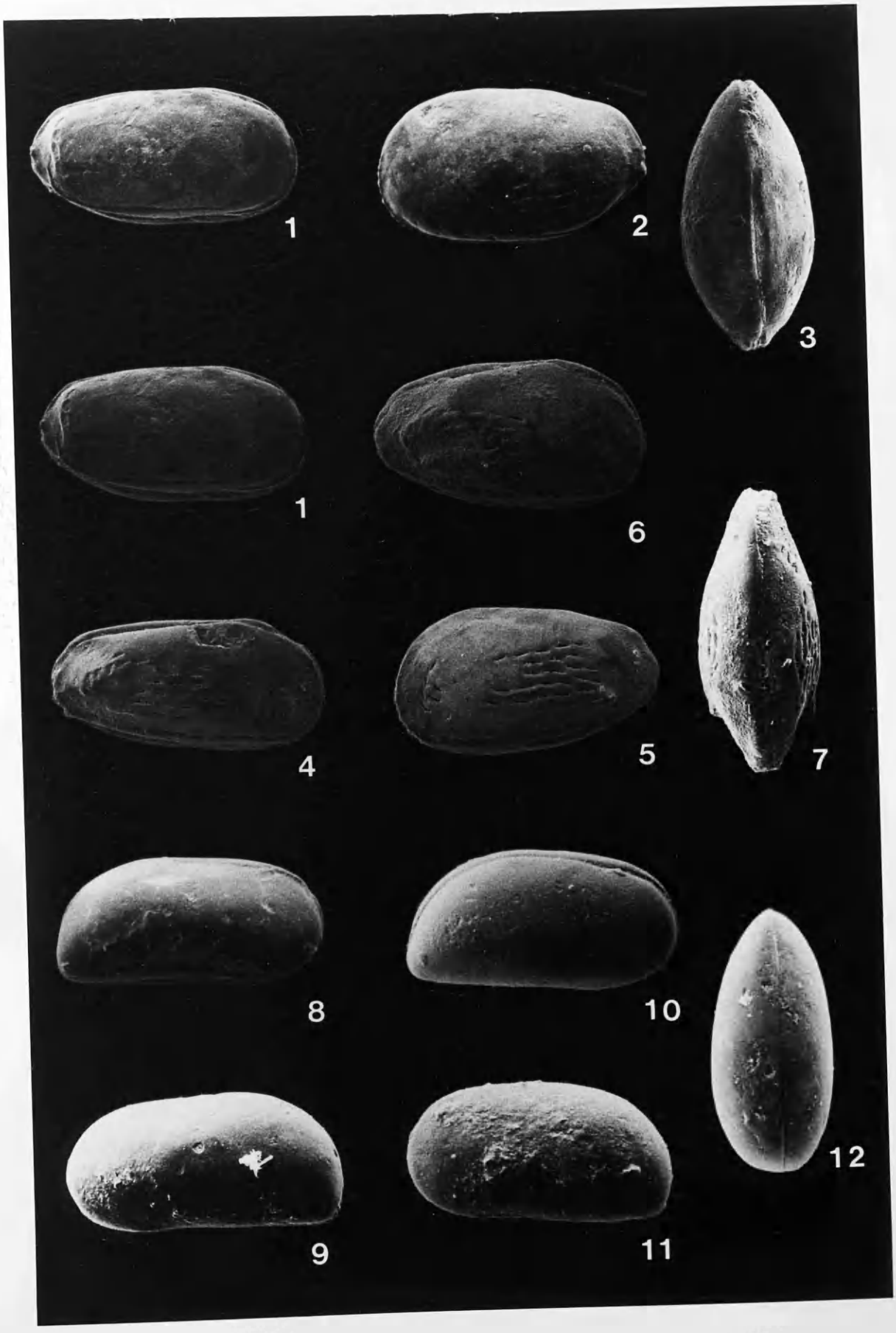


Plate 8.

Pokornyella deformis minor.

Fig 1. Male stereoscopic paired photographs right carapace; No A12624, X 72.5

Fig 2. Female stereoscopic paired photographs right carapace; No A12625, X 67.5

Fig 3. Female left carapace; No A12626, X 70

Fig 4. Juvenile right carapace; No A12627, X 90

Fig 5. Male dorsal carapace; No A12628, X 70

Fig 6. Female ventrale carapace; No A12629, X 80

Pokornyella sp.

Fig. 7. Female stereoscopic paired photographs right carapace; No A12630, X 75

Fig. 8. Male left carapace; no A12631, X 75

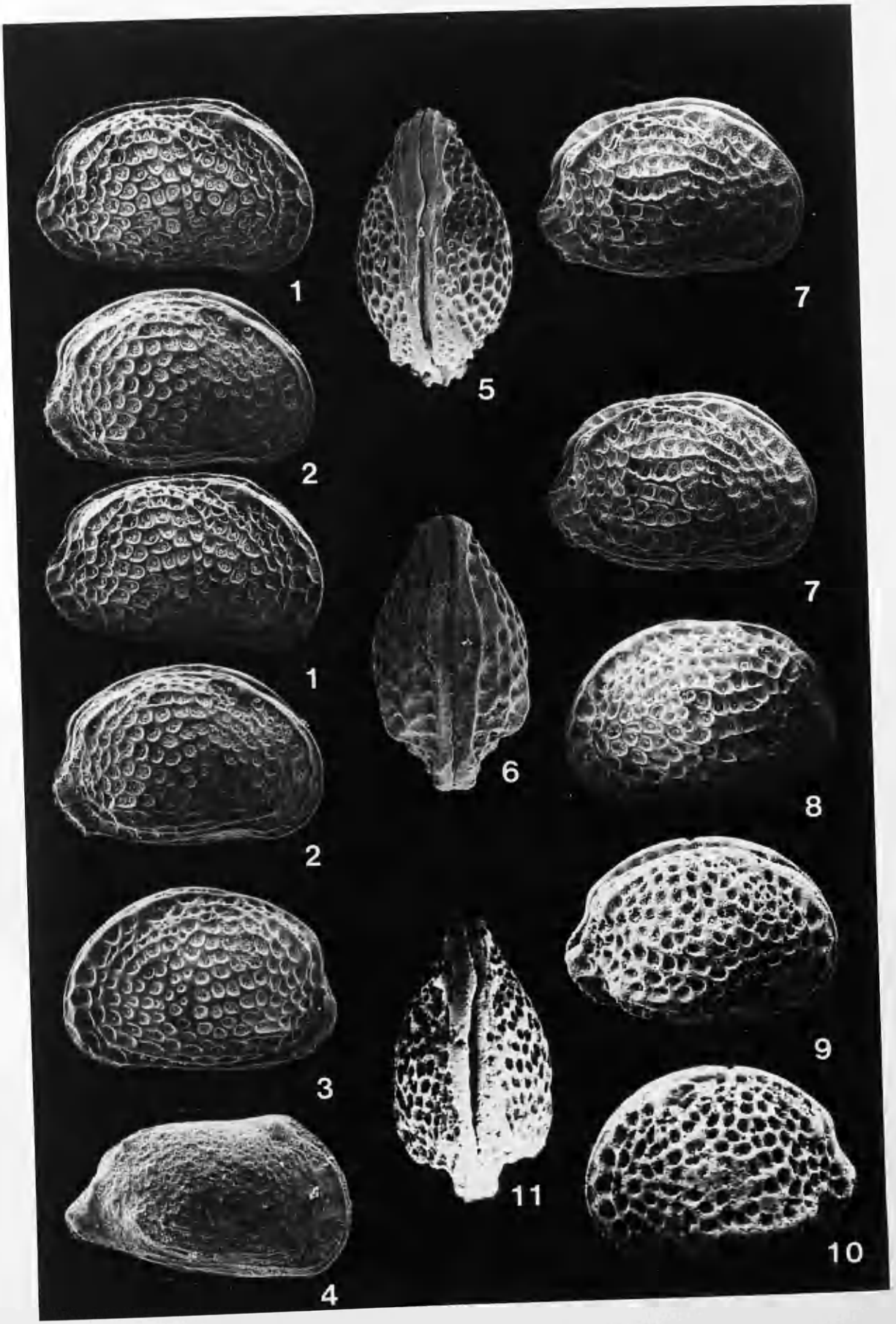
Pokornyella cf *deformis.*

Fig 9. Right carapace; No A12632, X 67.5

Fig 10. Left carapace same valve.

Fig 11. Dorsal carapace same valve.

PLATE 8



Pate 9.

Acanthocythereis hystrix.

Fig. 1. Male stereoscopic paired photographs right carapace; No A12633, X 60

Fig. 2. Female stereoscopic paired photographs left carapace; No A12634, X 70

Fig. 3. Juvenile right carapace; No A12635, X 77.5

Ruggieria tetraptera tetraptera.

Fig 4. Male dorsal carapace; No A12636, X 62.5

Fig 5. Female ventral carapace; No A12637, X 67.5

Fig 6. Male right carapace; No A12638, X 60

Fig 7. Male left carapace; No A12639, X 60

Fig 8. female left carapace; No A12640, X 70

Ruggieria aff *dorukae.*

Fig 9. Male right valve; No A12641, X 72.5

Fig 10. Female right carapace; No A12642, X 75

Fig 11. Female left carapace; No A12643, X 75

PLATE 9

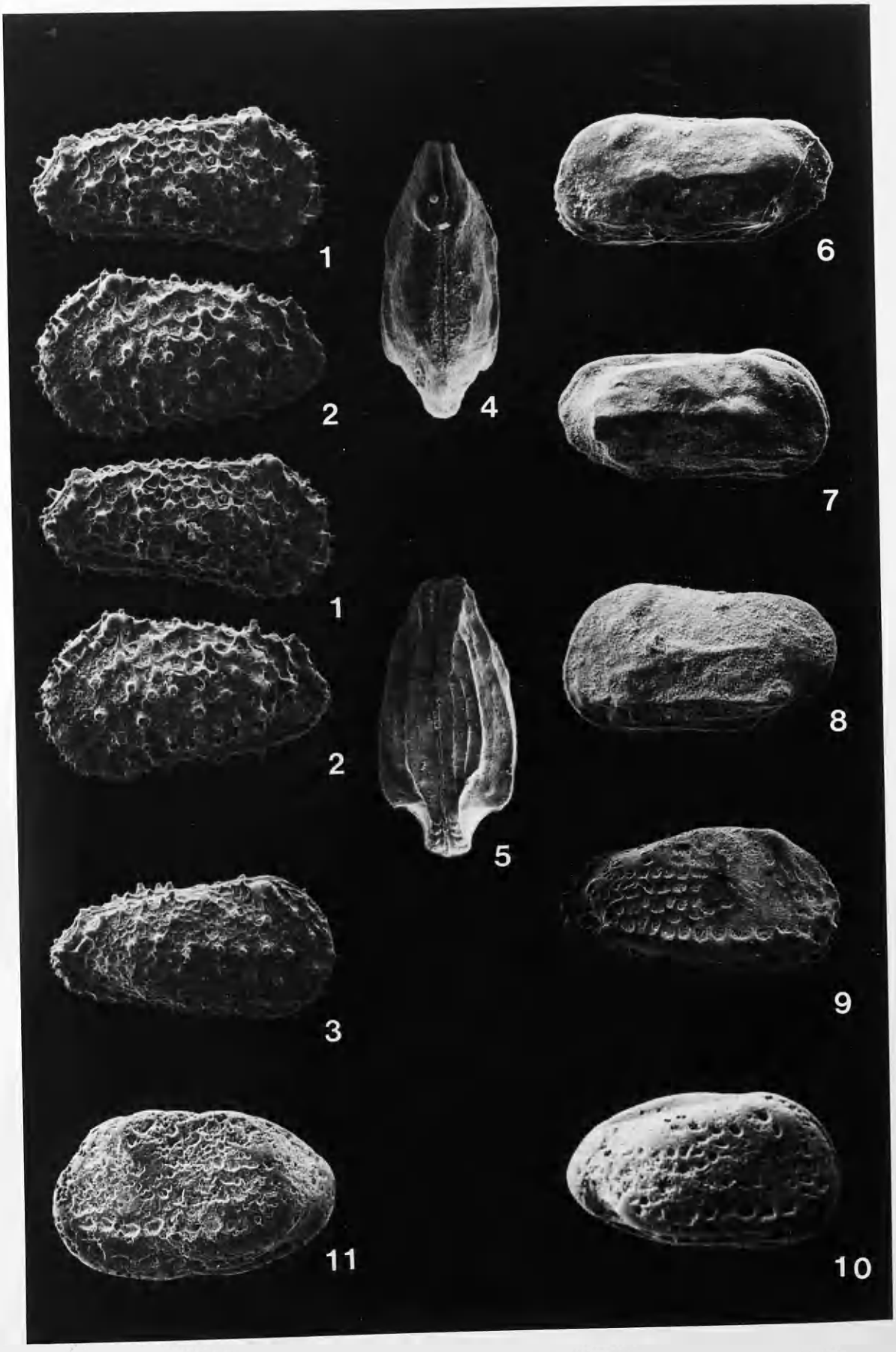


Plate 10.

Cytherella sp. B

Fig. 1. Left carapace; No A12644, X 75

Fig 2. Dorsale view; N A12645, X 75

Cytherella sp. A

Fig 3. Left carapace; No A12646, X 92.5

Fig 4. Same right carapace X 92.5

Fig 5. Dorsale view; No A12647, X 90

Loxoconcha gr *ovulata.*

Fig 6. Male left carapace; No A12648, X 80

Fig 7. Female dorsale view; No A12649, X 90

Fig 8. Male right carapace; No A12650, X 85

Fig 9. Female right carapace; No A12651, X 90

Cytherelloidea. sp

Fig 10. Left carapace; No A12652, X 85

Cytherella cf *pulchella.*

Fig 11. Male left carapace; No A12653, X 80

Fig 12. Female left carapace; No A12654, X 80

Fig 13. Juvenile left valve; No A12655, X 92.5

PLATE 10

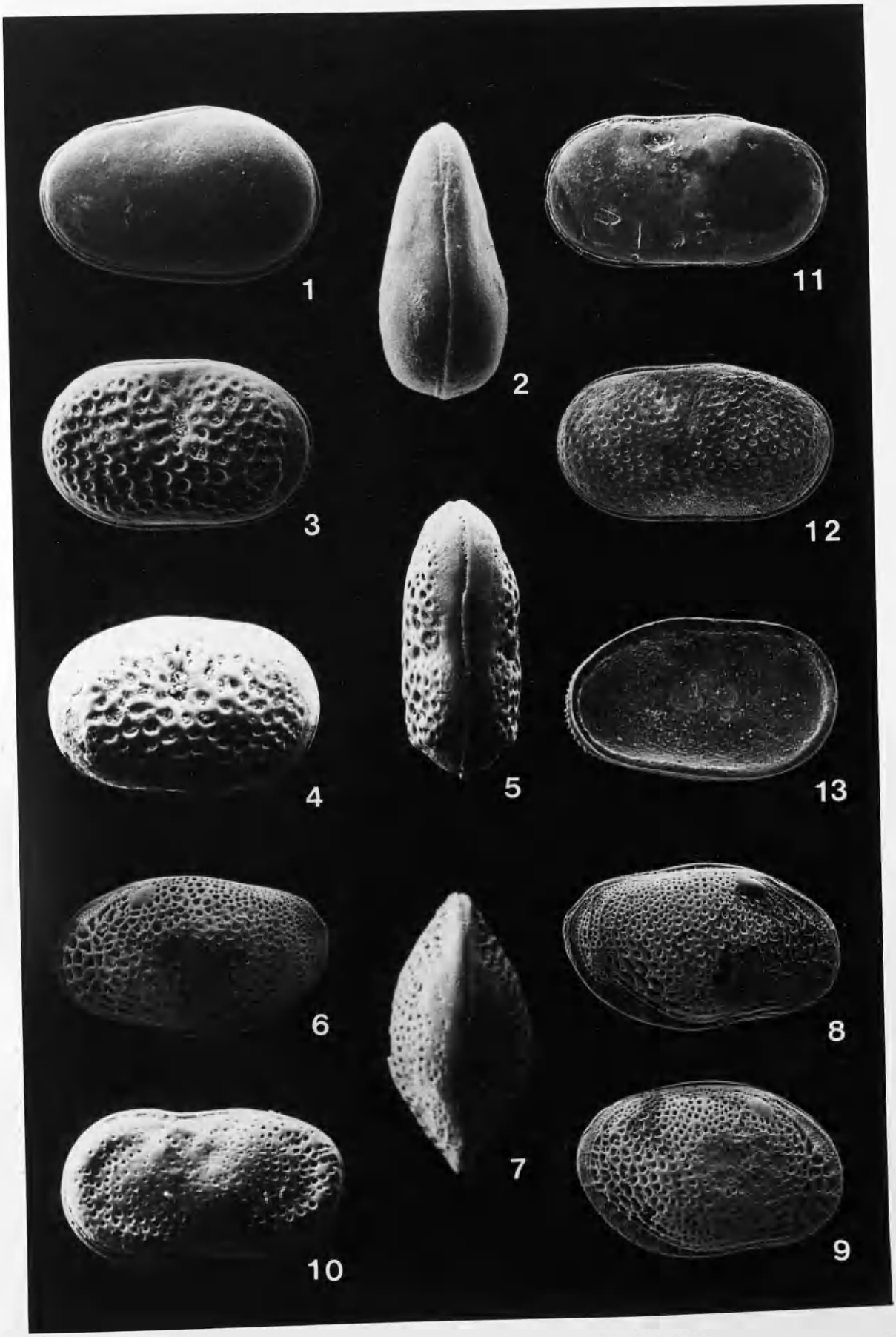


Plate 11.

Cistacythyreis cf *caelatura.*

Fig 1. Male right carapace; No A12656, X 67.5

Fig 2. Female right carapace; No A12657, X 75

Fig 3. Male left carapace; No A12658, X 70

Fig 4. Female left valve; No A12659, X 80

Fig 5. Female left valve inside view; No A12 660, X 70

Fig 6. Female dorsale carapace; No A12661, X 75

Fig 7. Female ventral carapace; No A12662, X 75

Fig 8. Hinge left valve X 145

Cytheretta sp. A

Fig 9. Female right carapace; No A12663, X 65

fig 10. Male right carapace; No A12664, X 60

Fig 11. Female left valve; No A12665, X 67. 5

Fig 12. Male left carapace; No A12666, X 60

Cytheretta cf *semipunctata*

Fig 13. Male right carapace; No A12667, X 65

fig 14. Female left carapace; No A12668, X 60

Fig 15. Female right carapace; No A12669, X 61

PLATE 11

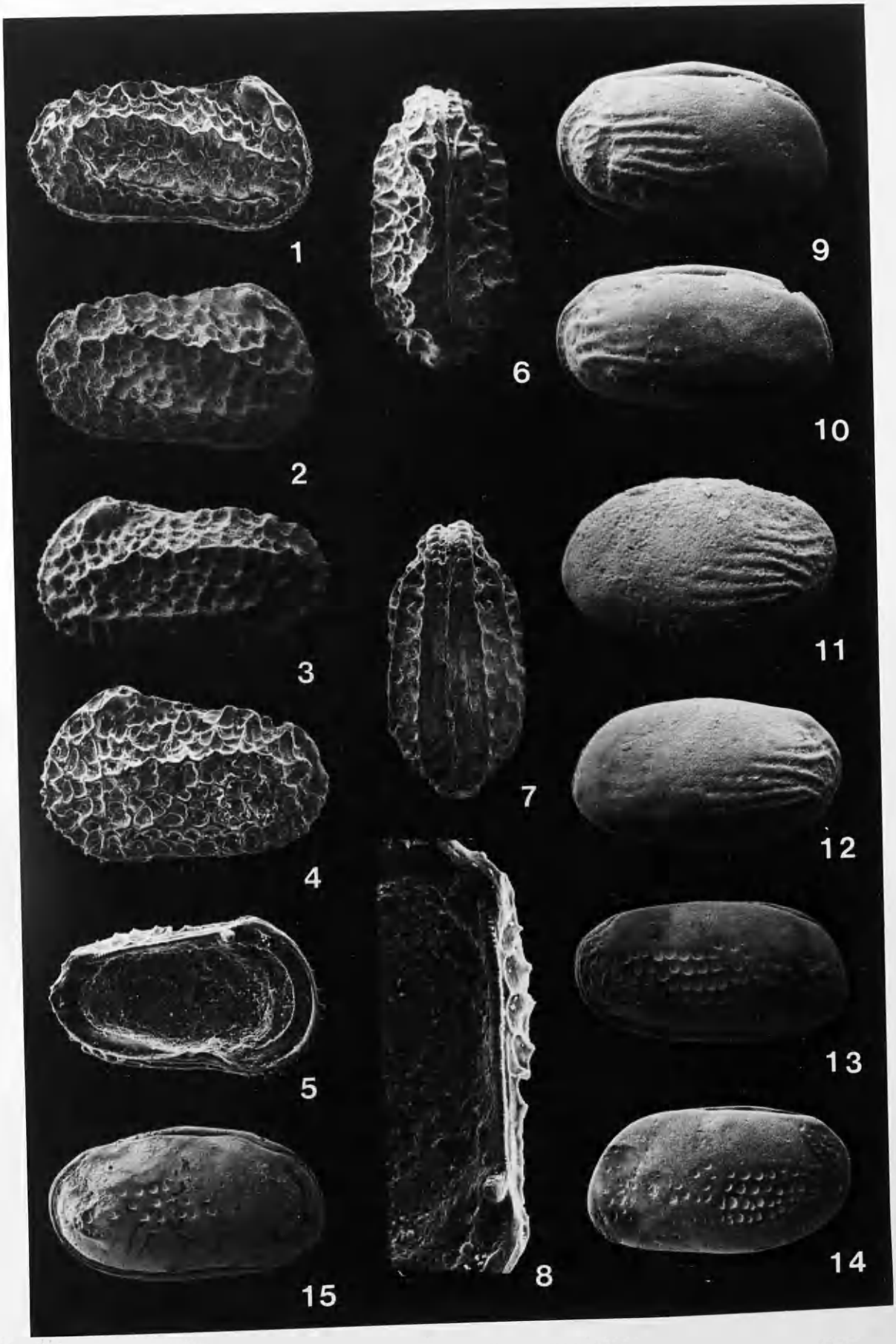


Plate 12.

Bythocypris tripoliensis sp. nov.

Fig 1. Male right carapace; No A12670, X 62.5

Fig 2. Female right carapace (Holotype); No A12671, X 57.5

Fig 3. Female left carapace; No A12672, X 62.5

Fig 4. Female dorsale view; No A12673, X 58

Disopontocypris schwejeri.

Fig 5. Right carapace; No A12674, X 52

Fig 6. Left carapace; No A12675, X 52.5

Fig 7. Dorsale view carapace; No A12676, X 54

Paracypris sp. A

Fig 8. Left carapace; No A12677, X 65

Fig 9. Right carapace; No A12678, X 62.5

Fig 13. Dorsale carapace; No A12679, X 62.5

Paracypris sp.

Fig 10. Left carapace; No A12680, X 80

Propontocypris sp

Fig 11. Right carapace; No A12681, X 57.5

Fig 12. left carapace; No A12682, X 55

Paracypris aff *polita.*

Fig 14. Right carapace; N A12683, X 49

Fig 15. Same left carapace X 51

PLATE 12

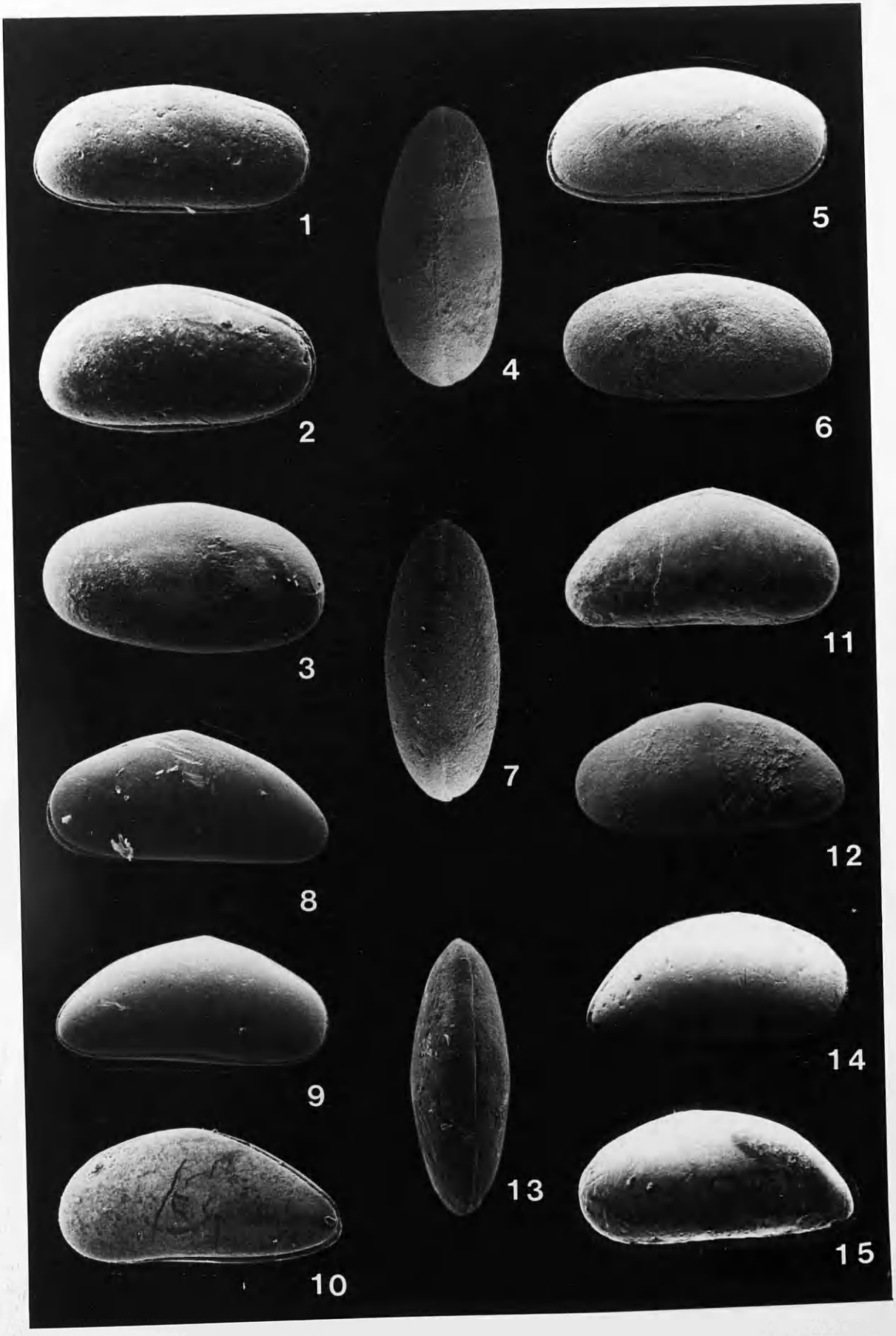


Plate 13.

Falsocythere maccagnoi.

Fig 1. Female stereoscopic paired photographs right carapace; No A12684, X 90.

Fig 2. Male Stereoscopic paired photographs left carapace; No A12685, X 85

Fig 3. Female dorsal view; No A12686, X 102.5

Falsocythere sp

Fig 10. Stereoscopic paired photographs right carapace; No A12687, X 80

Paijenborchellina libyca

Fig 8. Female right carapace ; No A12688, X 85

Fig 9. Female left valve; No A12689, X 72.5

Paijenborchellina keeni sp. nov

Fig 4 . Female right carapace; No A12690, X 77.5

Fig 5. Male right carapace (Holotype); No A12691, X 77.5

Fig 6. Male right carapace; No A12692, X 75.5

Fig 7. Juvenile dorsal view; No A12693, X 90

Xestoleberis cf *reymenti*

Fig 11. Male Right carapace; No A12694, X 95

Fig 12. Female right carapace; No A12695, X 95

Fig 13. Female left carapace; No A12696, X 95

Fig 14. Female dorsale view; No A12697, X 97.5

PLATE 13

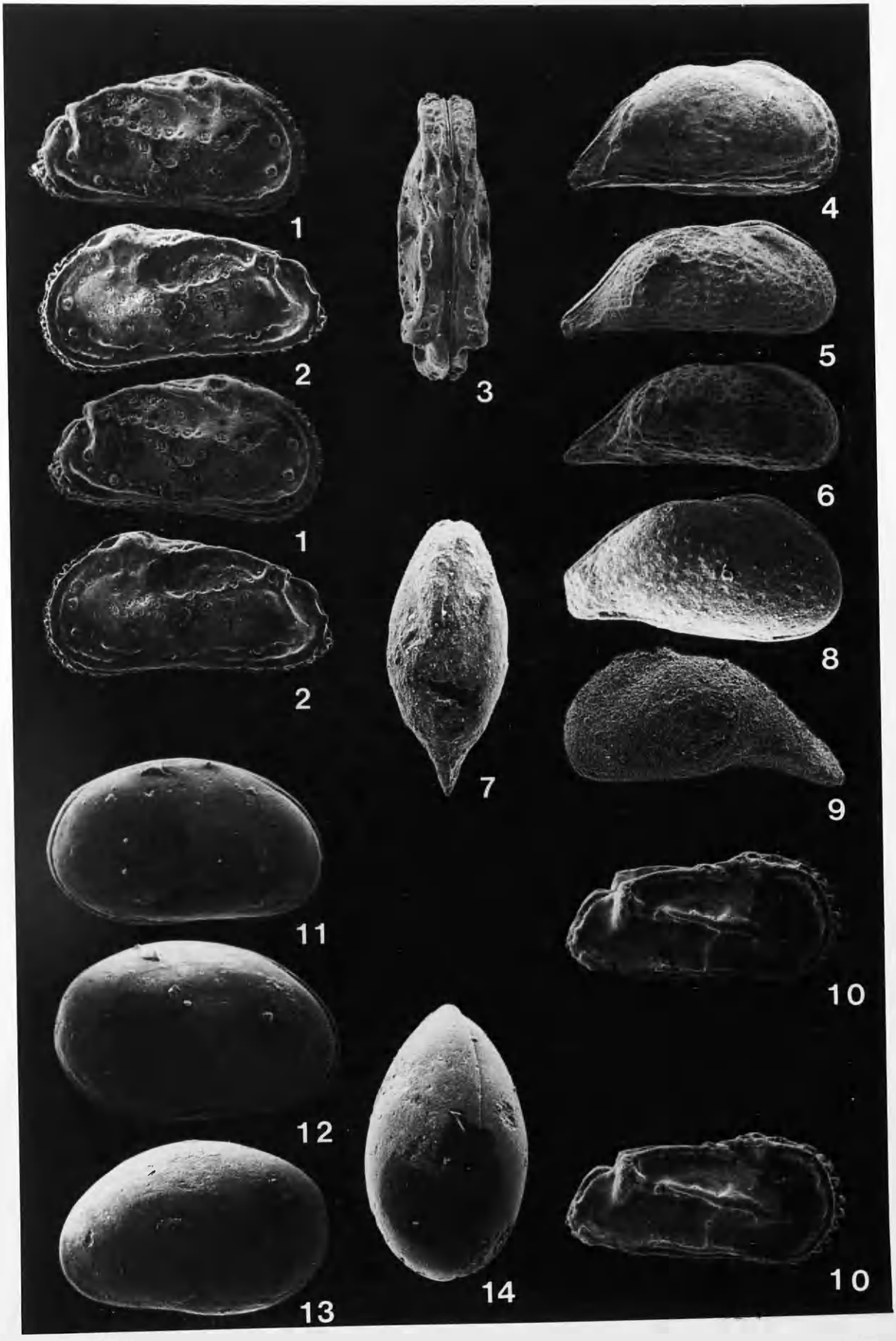


Plate 14.

Hermanites zaltanensis sp. nov.

Fig 1. Male stereoscopic paired photographs male right carapace (Holotype); No A12698, X 52.5

Fig 2. Female stereoscopic paired photographs right carapace; No A12699, X 60

Fig 3. Female left carapace; No A12700, X 60

Fig 4. Female dorsal carapace; No A12701, X 64

Fig 5. Juvenile ventral carapace; No A12702, X 72.5

Hermanites haidingeri.

Fig 6. Male stereoscopic paired photographs right carapace; No A12703, X 70

Fig 7. Female stereoscopic paired photographs right carapace; No A12704, X 70

Fig 8. Juvenile left carapace; No A12705, X 75

Urocythereis cf *sorocula* (Seguenza)

Fig 9. Right carapace; No A12706, X 90

Fig 10. Same left carapace X 92.5

Fig 11. Same dorsal carapace X 100

PLATE 14

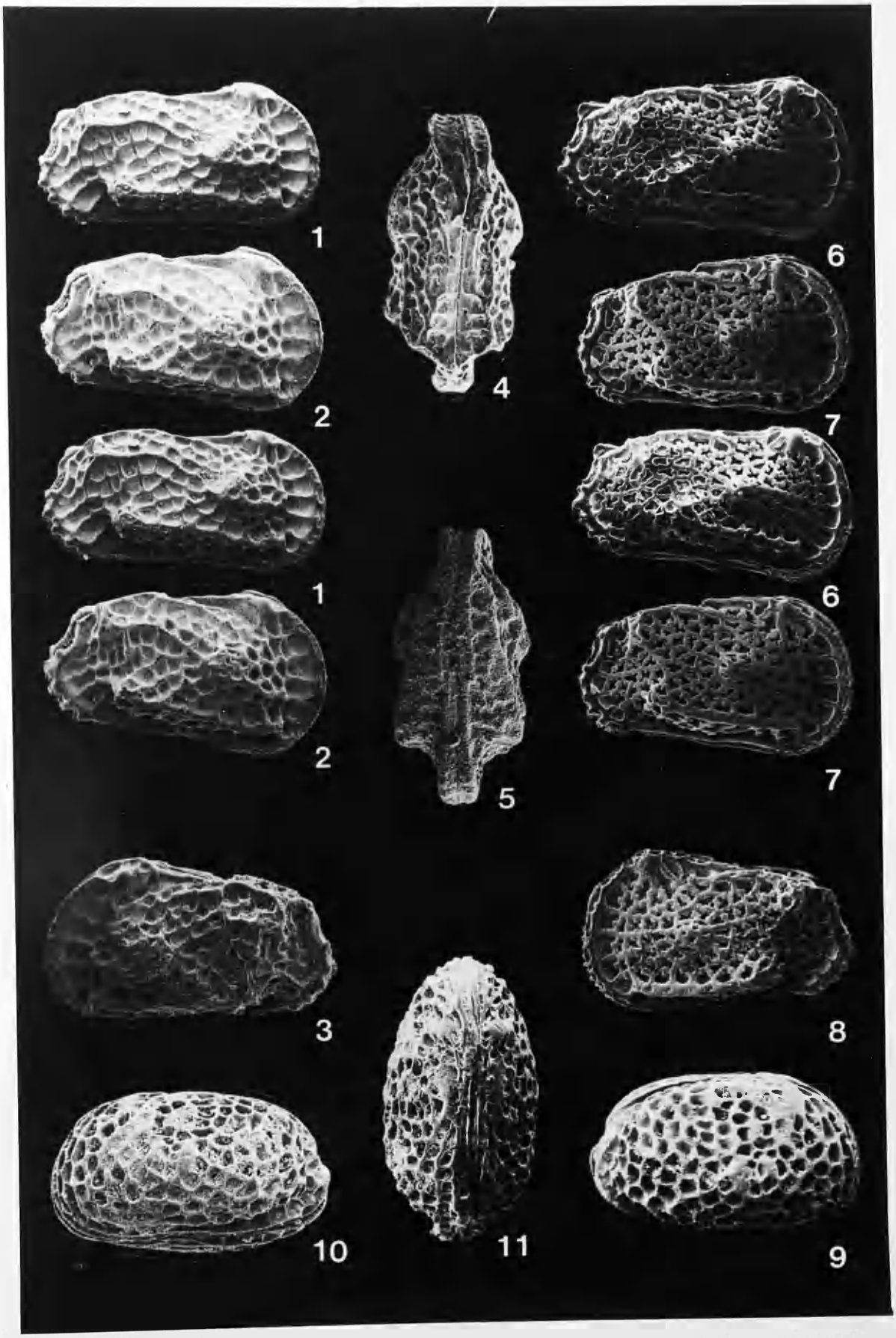


Plate 15.

?*Cytheridea* sp.

Fig 1. Male stereoscopic paired photographs right carapace; No A12707, X 82.5

Fig 2. Female stereoscopic paired photographs left valve; No A12708, X 87.5

Fig 3. Male left carapace; No A12709, X 82.5

Fig 4. Female dorsale view carapace; No A12710, X 90

Fig 5. Muscle scare pattern X 330

Cytheridea joshensis sp. nov.

Fig 6. Female right carapace (Holotype); No A12711, X 90

Fig 7. Male left valve; No A12712, X 87.5

fig 8. Male right carapace; No A12713, X 82.5

Fig 9. Female dorsale view; No A12714, X 98

Cytheridea sp.

Fig 10. Right carapace; No A12715, X 90

Bairdoppilata.

Fig 11. *Bairdoppilata* sp. A ; No A12716, X 55

Fig 12. *Bairdoppilata* sp. B; No A12717, X 80

Fig 13. *Bairdoppilata triangulata* EDWARDS; No A12718, X 70

PLATE 15