CRETACEOUS OSTRACODA OF THE SUPER FAMILY CYTHERACEA FROM IRAQ, THEIR BIOSTRATIGRAPHY AND CORRELATION WITH ADJACENT REGIONS

By

JENAN MOHAMMAD TAHA AL-BASHIR, B.S.C.

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University of Glasgow

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To:

- My Mother and Father
- My Dear Husband Khalil
- My Sons Anas and Anmar

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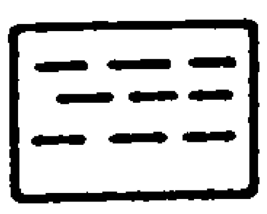
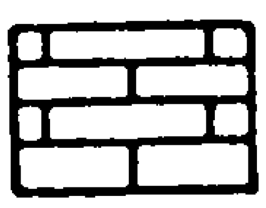
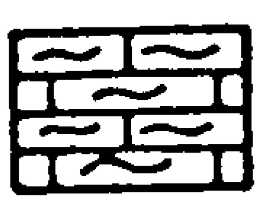
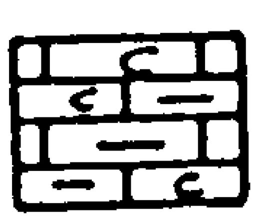
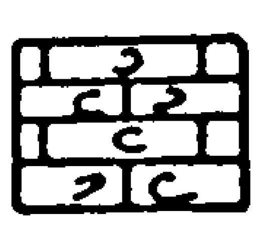
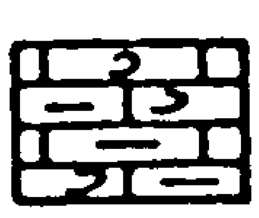
 Shale

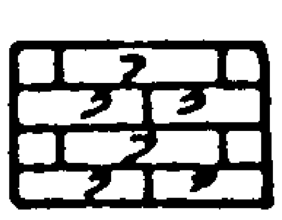
 Limestone

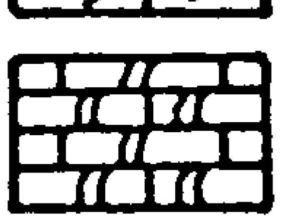
 Marly limestone

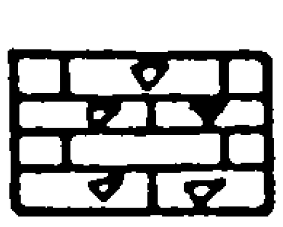
 Argillaceous chalky limestone

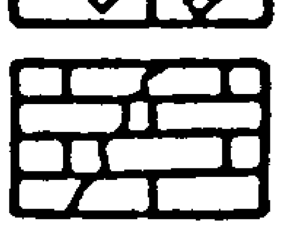
 Detrital chalky limestone

 Detrital argillaceous limestone

 Detrital limestone

 Clayey limestone

 Cherty limestone

 Stylolitic limestone

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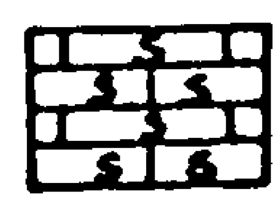
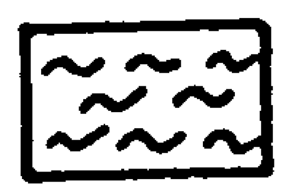
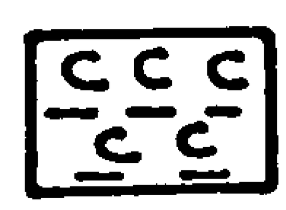
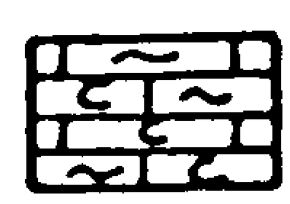
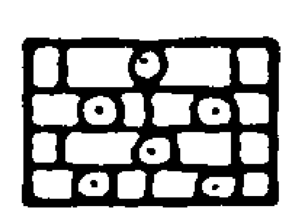
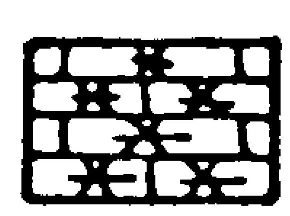
 Sulphurous limestone

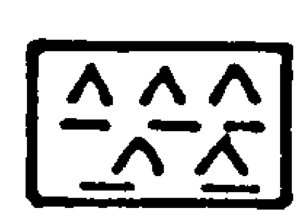
 Marl

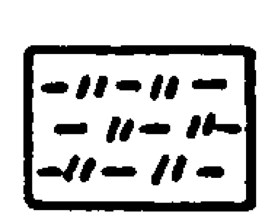
 Chalk and shale

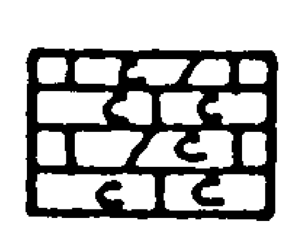
 Marly chalky limestone

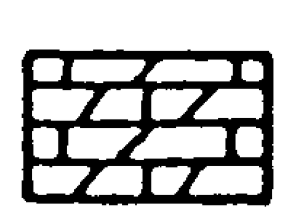
 Oolitic limestone

 Glauconitic limestone

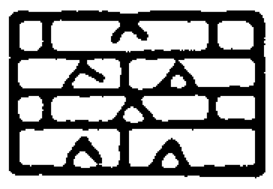
 Anhydrite with shale

 Silty shale

 Chalky dolomitic limestone

 Dolomitic limestone


Glauconitic clayey limestone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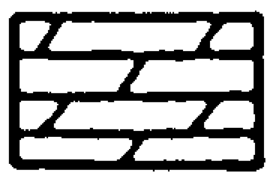
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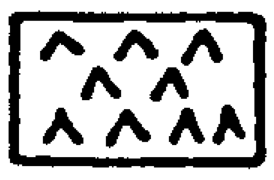
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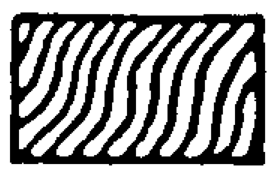
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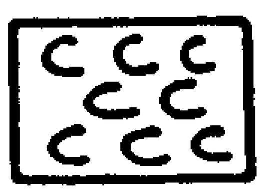
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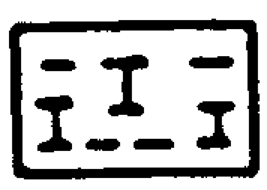
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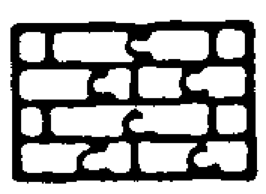
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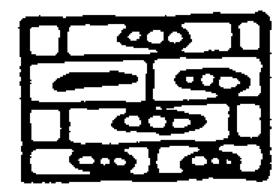
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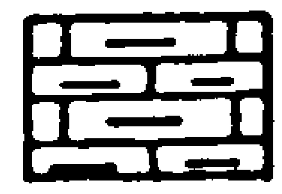
Argillaceous limestone

unconformity

Probable disconformity (small time duration)

Range of species

Individual sample

ABBREVIATION:

I.N.O.C.	Iraq National Oil Company
B.p.c.	Basrah Petroleum Company
U.CENO.	UPPER CENOMANIAN
L.TUR.	LOWER TURONIAN
SANT.	SANTONIAN
Cut.	Cutting
CENOM.	CENOMANIAN
U.MUD.	UPPER MUDDUD FORMATION
TUR.	TURONIAN
TANU.	TANUMA
AH.	AHMADI FORMATION
SAD.	SADI FORMATION
UP.CON.	UPPER CONIACIAN
U.TUR.	UPPER TURONIAN
U.M.	UPPER MUDDUD FORMATION
L.CON.	LOWER CONIACIAN
SAN.	SANTONIAN
TAN.	TANUMA FORMATION
SUB.	SUBZONES.

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SUMMARY

The cretaceous ostracods of Iraq are poorly known, so the aim of the project was to study their taxonomy and to discover their value in correlation between wells in Iraq and between Iraq and neighbouring countries. The Cenomanian-Santonian ostracods of the superfamily Cytheracea were studied in detail from five wells in central and southern Iraq (East Baghdad Well-3, South Rumaila Well-104, Safawi Well-1, Ghalaisan Well-1, and Kifl Well-2). 5 families, 6 subfamilies, 28 genera, 4 subgenera and 74 species were discovered. Two new genera, *Iraqicythereis* and *Archeocosta* (the latter published by Al-Bashir and Keen in 1984 during the preparation of this thesis) and one subgenus *Peloriops* (*Hemipeloriops*) are proposed; of the 74 species described 58 are new.

Four ostracod biozones and three subzones are proposed for the areas studied on the basis of the Cytheracea ostracods; these are arranged from the base to the top as follows:

Veeniacythereis streblolophata - Veeniacythereis maghrebensis - Total Range Zone (A-1); *Dumontina ? mdaouerensis - Partial Range Zone* (A-2); *Veeniacythereis ibnalhaithami - Partial Range Zone* (A-3); *Peloriops (Peloriops) alrazii - Partial Range Zone* (A-4).

The *Veeniacythereis streblolophata - Veeniacythereis maghrebensis - Total Range Zone* is subdivided into three subzones: A - *Glenocythere bahreinensis - Total Range Subzone* (A-1a), B - *Soudanella ? alkhansai - Assemblage Subzone* (A-1b), and C. *Cythereis alfarazdaki - Assemblage Subzone* (A-1c).

The ages of the zones and subzones have been determined from a study of the diagnostic ostracod species and stratigraphic position. A Cenomanian age is assigned to A-1 zone; the A-1a and A-1b subzones are of Lower Cenomanian age; a Lower Turonian age is suggested for the A-2 zone; Upper Turonian-Coniacian for the A-3 zone; and a Santonian age for the A-4 zone.

The ostracod zones and subzones have been recognised in each of the wells studied.
The age of the formations studied has been determined on the basis of the ostracod fauna and stratigraphic position. The upper part of the Mauddud Formation, and the Ahmadi Formation are assigned to the Lower Cenomanian; the Rumaila Formation is placed in the Upper Cenomanian; the Mishrif Formation is placed in the Upper Cenomanian to Lower Turonian; the Kifl Formation is placed in the Lower Turonian; the Khasib Formation is placed in the Upper Turonian-Lower Coniacian; the Tanuma Formation is placed in the Upper Coniacian, although it may include strata of Santonian age in some localities; and the Sadi Formation is assigned to the Santonian.
The Ahmadi/Rumaila contact in Ghalaisan Well-1 is placed at the top of the Soudanella ? alkhansai Subzone.
The lower part of the Rumaila Formation in East Baghdad Well-3 is contemporaneous with the Ahmadi Formation on the basis of the occurrence of the Glenocythere bahreinensis Subzone, and is considered to be of Lower Cenomanian age.
In Kifl Well-2 the Maotsi Formation is probably of Upper Cenomanian age and the Mahilban and Fahad Formations may be of Lower Cenomanian age.
The base of the Khasib Formation is marked by the appearance of many new ostracod species and genera such as Acanthocythereis, Brachycythere, Buntonia, Paracytheridea, Protobuntonia and Phymacythereis.
This indicates a major faunal break between the Mishrif/Kifl Formation below and the Khasib Formation above. This faunal break is marked by an unconformity referred to as the Aruma-Wasia unconformity which is recognised throughout the Arabian Gulf.

The ostracod biozones of Iraq have been correlated with corresponding zones in other Middle Eastern and North Africa countries.

Problems of variation in the size of some ostracods have been studied. There is a considerable range in size of Peloriops (Peloriops) ulosa, Rehacythereis arabica,

Brachycythere basrahaensis sp. nov., Archeocosta alkhazwinii, Veeniacythereis maghrebensis, and Veeniacythereis ibnalhaithami sp. nov.
The size range appears to be continuous, and the smaller specimens are considered to be adult. This size variation appears to exclude precocious sexual dimorphism as well as the possibility of larger and smaller forms belonging to two closely related species. It is difficult to determine whether the size variation is due to environmental or genetic causes.
Intra-specific variation in ornamentation of the following species has been studied: Iraqicythereis Kadisiya gen.et sp.nov., Veeniacythereis ibnalhaithami sp. nov., Cythereis ? ibnyunusi sp. nov., Peloriops (Peloriops) sphaerommata, Peloriops (Hemipeloriops) djabirbnhaiyani sp. nov. and Metacytheropteron berbericus.
This variation may be continuous or discontinuous. In the first case it is difficult to recognise distinct morphotypes, but in the second case it is possible to separate them into distinct morphotypes. The morphotypes appear to represent a case of stable polymorphism. The variation is believed to be genetically controlled.
The environments of deposition have been determined by using the characteristic ostracod species and other fauna (e.g. foraminifera), and type of sediment. The Ahmadi Formation was deposited in an open, shallow, neritic environment with restrictions in some areas. The Rumaila Formation is distinguished by its low species diversity and poor fauna, but this is considered to be due to preservation rather than environmental conditions. Generally the Rumaila Formation represents deeper water conditions than those of the Ahmadi Formation, becoming shallower with restrictions from the sea in some areas. The Mishrif Formation indicates open shallow water neritic conditions followed by a shallowing phase associated with oscillations of sea level, or with an influx of fresh water. The Kifl Formation represents shallow water conditions partly connected with the open sea, accompanied with the development of lagoonal areas. The Khasib and the Tanuma Formations indicate open shallow marine

conditions (infra-neritic), but in some areas (in East Baghdad Well-3 and Kifl Well-2) coastal conditions are suggested, perhaps with restricted access to the open sea because of the presence of a poor ostracod fauna dominated by *Ovocytheridea*.

CHAPTER - 1

INTRODUCTION

INTRODUCTION

The areas studied in the present work are located in south eastern, south western and central Iraq.

The material of cuttings and cores was obtained from two oil wells drilled by the Iraqi National Oil Company (South Rumaila Well-104, and East Baghdad Well-3) and three wells of the Basrah Petroleum Company (B.P.C.) (Ghalaisan Well-1, Safawi Well-1, and Kifl Well-2).

The samples studied are from the Middle Cretaceous upper part of the Mauddud, Ahmadi, Rumaila, Mahilban, Fahad, Maotsi, Mishrif and Kifl Formations ~~and lower part of the Khasib Formation~~ and from the lower part of the Upper Cretaceous namely ~~the upper part of~~ the Khasib Formation, the Tanuma Formation and the lower Sadi Formation.

In order to check the identification of species the Sayyab collection in the British Museum (Nat. Hist.) has been examined and specimens have been borrowed for examination from Dr. Athersuch (of B.P.).
No previous work has been carried out on the Cretaceous ostracods of this area.

Previous studies of the ostracods ofIraq are by Al-Sheikhly (M.s., 1980) who studied the Upper Maastrichian-Upper Eocene ostracods of northern and western Iraq and Khalaf (M.s., 1984) on the Miocene ostracods of northern and western Iraq. Three other relevant studies concerning the Arabian Gulf Coast regions are Sayyab (unpublished dissertation, 1956) who studied ostracods from the Middle and Upper Cretaceous strata of the Western Coast of the Arabian Gulf; Grosdidier (1973) who studied the distribution of ostracods in the Cretaceous of the Coastal Fars province; and Al-Abdul Razzaq (1977, unpublished Ph.D.thesis) who studied Middle and Upper Cretaceous ostracods from Kuwait. The ostracods from the Upper Cretaceous and Palaeogene of Saudi Arabia have been studied by Al-Furaih (e.g. M.s., 1977; 1980).

This study attempts to fill the gap in basic ostracods research in the area.

Many of the species found appear to have a wide stratigraphical distribution and are recorded from the Arabian Gulf and adjacent areas of the Middle East. Some of these are seen to be stratigraphically restricted, therefore a zonal scheme for the Middle and Upper Cretaceous of the region studied can be erected.

In this study several difficulties arose. The first concerns the state of preservation of the material even when open valves are found. Secondly the ratio of carapace to single valves is very great so the internal features are often not seen, lending and the uncertainty to generic assignments. Thirdly, contamination of well cuttings leads to problems concerning species ranges.
The material will be deposited in the Department of Palaeontology, British Museum (Nat. Hist), but as they have a policy of not giving catalogue numbers until the specimens are in their collections, an internal catalogue numbering system is used in this thesis.

CHAPTER - 2

LOCATION AND MATERIAL

LOCATION AND MATERIAL

Material:

The material used in this study is from five wells drilled by the Iraqi National Oil Company. South Rumaila Well-104, in south eastern Iraq; Safawi Well-1 and Ghalaisan Well-1 in south west Iraq; Kifl Well-2 in western central Iraq; East Baghdad Well-3, in eastern central Iraq (fig. 2.1). 1,000 rock-cutting samples and a few core samples have been studied from these five wells. In South Rumaila Well-104 and East Baghdad Well-3, samples were normally taken at 4 meter intervals, although samples were taken at 2 meter intervals, near stratigraphical contacts. In other wells, samples were taken every 10 feet, and 5 feet near stratigraphical contacts.

Location:

South Rumaila Well-104 has been taken as the reference well for this study.

The geographical coordinates, total drilling depths and depths studied are given in Table (2.1).

Well	Longitude	Latitude	Total Drilling depths	Depths studied
Ru-104	47°,23,11.4	30°,05,27.27	3487.8m (log.)	2325 - 2800m.
Si-1	43°,45,53.8	30°,00 , 00	6000ft. (Sch.Log.) 5996 ft.	3150 - 3680 ft
GH-1	43°,47,29.49	30°,57,43.78	6533 ft.(Sch. Log.)6531 ft.	3670 - 4400 ft.
Kf-2	44°,07,21.71	30°,09,38.57	6293 ft.	4344 - 5530 ft.
EB-3	44°,26,59.63	33°,38,02.14	3645m, (Sch. Log.)3646m.	2199 - 2900m.

Table 2.1 - Geographic Coordinates, Total drilling depths and Depths of the studied well sections.

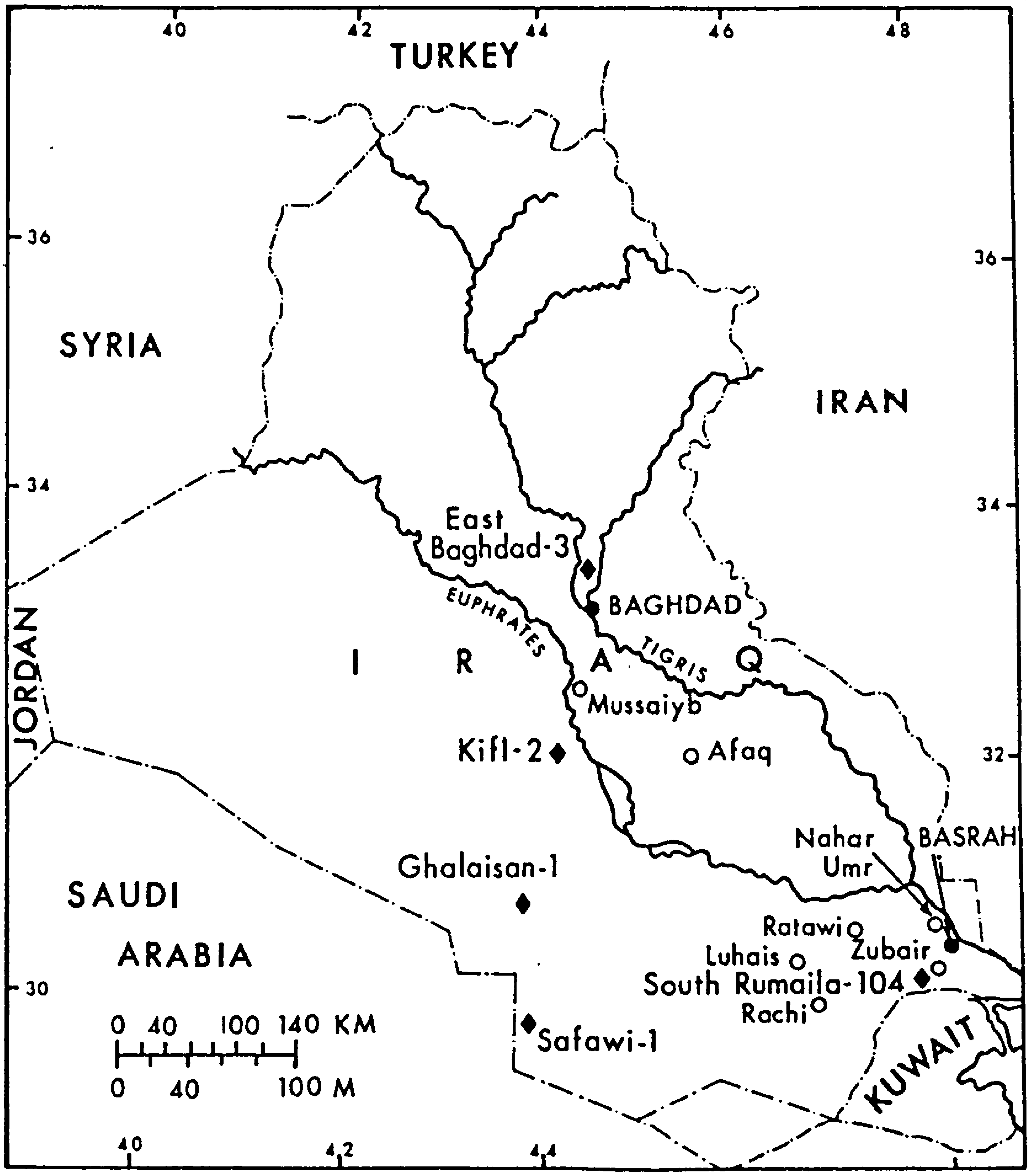


Fig. 2.1 :- Locality Map.

CHAPTER - 3

STRATIGRAPHY OF FORMATIONS STUDIED

STRATIGRAPHY OF FORMATION STUDIED

1. Mauddud Formation

In the wells studied only the upper part of the Mauddud has been sampled,. in South Rumaila Well-104 (Table 3.1), the upper part of this formation is 9m (29.5ft) thick, and is dated as basal Cenomanian. It consists of beige-brown limestone.

In Safawi Well-1 (Table 3.2) the upper part of the formation is 11.6m (38 ft) thick and dated as basal Cenomanian. It consists of brown-buff, hard, fine crystalline to porous dolomite changing to limestone at the top of the formation.

In Ghalaisan Well-1 (Table 3.3) the upper part of the Mauddud Formation is 23 m (77 ft) thick and dated as basal Cenomanian. It consists of buff to grey, crystalline, dolomitic limestone, occasionally chalky near the top.

In Kifl Well-2 (Table 3.4) the upper part of the Mauddud Formation is 7 m (24 ft) thick. It is dated as basal Cenomanian, and consists of marly, chalky limestone becoming a buff moderately hard limestone at the top.

In East Baghdad Well-3 the upper Mauddud Formation is 37 m thick and dated as basal Cenomanian. It consists of brown-grey, moderately hard, finely crystalline dolomite.

The Mauddud Formation was defined by Henson (1940) in Dukhan Well-1 of Qatar, but the definition was revised and amended by Sugden (1958). The reference section of the Mauddud Formation in the Basrah area was described by Owen and Nasr (1958) in Zubair Well-3, drilled between 8457 to 8910 ft giving a thickness of 453 ft. Al-Naqib (1967) recorded that the Mauddud Formation lies between drilling depths of 8517 and 8923 ft based on lithological evidence, and he mentioned that the drilling depths given by Owen and Nasr (1958) were based on electric logs.

Diagnostic Fossils:

The type Mauddud Formation is rich in fossils, particularly in the limestones, but rare fossils occur in the dolomitized components (Buday, 1980).

Age:

The age of the Mauddud Formation has been discussed in the *Glenocythere bahreinensis* Sub zone (A-1a) (Biostratigraphy Chapter 7).

Contacts:

In the Basrah area and south eastern Kuwait the Mauddud Formation is overlain by the Wara Formation with a slight disconformity according to Owen and Nasr (1958) and Dunnington et al. (1959), but according to Al-Abdul-Razzaq (M.s., 1977) and Loutfi and Jaber (1970) the Mauddud Formation is overlain by the Wara Formation conformably in Kuwait and the Kuwait-Saudi Arabia Neutral Zone off shore area.
In the type area in Qatar the formation is overlain by the Khatiyah Formation (Sugden, 1958, M.s. in Dunnington et al. 1959).
Dunnington et al. 1959 pointed out that when the Wara Formation overlies the Mauddud Formation with a slight disconformity this is evidence for the Mauddud Formation being of pre Cenomanian age (Albian) in the Basrah Kuwait area.
For further details see the Ahmadi Formation.

Equivalent Units and Comparisons: (Table 3.6)

In the extreme north west of Iraq, at S'faiya Wells 1,2 studied by Kadouri (1978), the Upper Qamchuqa Formation is lithologically and practically identical with the Mauddud Formation.

In the Rutbah area, the Mauddud Formation is cut out by pre Cenomanian emergence and erosion.

In this study the basal part of the Balambo Formation of north-east Iraq studied by Youhanna (M.s., 1976) is correlated with the upper part of the Mauddud Formation.

In Saudi Arabia the Mauddud Formation is regarded as a Member of the Wasia Formation (Powers, 1968).

In the Fars Province of Iran, James and Wynd (1965) indicated that the Mauddud Member of the Sarvak Formation is correlated with the Mauddud Formation in the Basrah-Kuwait areas; they described the Mauddud Member as consisting of prominent-weathering, thick bedded, grey to brown, Orbitolina-rich limestone, with a thickness of 200 to 400 ft; it overlies the Kazhdumi Formation conformably.

In Oman, the Mauddud Formation is almost equivalent with 'e' + 'f' + 'g' Members of the Natih Formation.

2. Ahmadi Formation:

In the South Rumaila Well-104 section (Table 3.1), south eastern Iraq this formation is 155m (508.5ft) thick, and is dated as Lower Cenomanian. The formation can be divided into three, shale units at top and bottom with a thick sequence of grey shaley limestones between. The lower shales are green-grey, pyritic and fossiliferous, the upper shales are dark grey and fossiliferous.

In general, and in all the sections studied, the base of the Ahmadi Formation probably lies disconformably on the underlying Mauddud Formation and is overlain conformably by the Rumaila Formation.

In Safawi Well-1 section (Table 3.2), south western Iraq, the formation is 8 m (27 ft) thick, and is dated as Lower Cenomanian. It is composed predominantly of brown, red and green, fissile and fossiliferous shale, the latter somewhat silty, contains glauconite towards the base.

In Ghalaisan Well-1 section (Table 3.3), south western Iraq, the Ahmadi Formation was not distinguished from the Rumaila Formation by the oil company geologists, belonging to a unit referred to as Rumaila/Ahmadi Formation. However in this study the contact between the two formations has been recognised on the basis of the ostracod fauna (see Biostratigraphy chapter 7), and the top of the Ahmadi Fm has been placed at a depth of 1230 m (4100 ft). The Ahmadi Formation is dated as Lower Cenomanian with a thickness of 68 m (223 ft). The lower half of the sequence consists of chalky limestones with occasional green and chocolate limy shales; this is followed by (46 ft) of green chocolate shales, and the top part of the sequence is limestone with occasional shales and marls.
The Ahmadi Formation grades into the overlying Rumaila Formation without any noticeable lithological change.

In Kifl Well-2 section (Table 3.4), middle western Iraq. The Ahmadi Formation is 7 m (24 ft) thick, dated as Lower Cenomanian, and is composed of grey, greenish, soft and plastic marl. It passes upwards into the Mahilban Formation without any noticeable lithological change.

In East Baghdad Well-3 section (Table 3.5), middle eastern Iraq, the Ahmadi Formation cannot be separated from the

Rumaila Formation, although in this study the Ahmadi Formation is regarded as contemporaneous with the lower part of the Rumaila Formation on the basis of the ostracods.

The Type section of the Ahmadi Formation is in Burgan Well-62, drilling depths between 4257 - 4497 ft, in south eastern Kuwait. In its type section the Ahmadi Formation is composed of grey shales in the lower part and green, greenish-grey, or chocolate brown shales in the upper part. At the base of the Ahmadi shale is a marly limestone distinguished by the presence of abundant specimens of the ostracod Cythereis bahraini and referred to as the "Cythereis bahraini Limestone" (Owen and Nasr, 1958; Dunnington et al. 1959).
The Ahmadi Formation in the Basrah oil field of south eastern Iraq is not important as a Cap-rock (Owen and Nasr, 1958).
The reference section in the Basrah oil field is the Zubair Well No.3 at drilling depths between 8072-8420 ft where it consists of black silty shales at the top with ostracods, followed by a fine-grained, unfossiliferous limestone member, grading downwards into a grey detrital spicular limestone with occasional Praealveolina. The limestone member of the Ahmadi Formation has been called the "Tuba Limestone Member" by Dunnington et al. 1959) but this term has not generally been used.

Diagnostic Fossils:

Fossils are abundant and were found mainly from the Kuwait wells. The fauna consists of high-spired gastopods, pelecypods, Corals, Exogyra conica, Exogyra columba, E. luynesi, the ammonite Neolobites sp., Parasmilia sp., Metoicoceras sp., Turritella sp., Aspidiscus juv. cf. A. sembae; assemblages of foraminifera and ostracods species are found such as Haplophragmoides sp., Flabellina sp., Vaginulina sp., Ammobaculites sp., Gumbelina sp., Lenticulina sp., Frankeina sp., Haplophragmium sp., Praealveolinea sp., and Cythereis bahraini (Dunnington et al. 1959; Owen and Nasr, 1958; and Al-Naqib, 1967). Several species belong to the foraminiferal genera of Ovalveolinea, Praealveolina, and Nezzazata are characteristic of the Lower Ahmadi Limestone member and species of Dexia, Trochamminoides and Trochammina are identical with those of the Upper Ahmadi Shale member in the Kuwait-Saudi Arabia Neutral Zone off shore area (Loutfi and Jaber, 1970). Al-Siddiki (1978) also recorded several species of foraminifera in the Ahmadi Formation.

Age, Thickness, Contacts, Equivalent Units and Comparisons:

Age:

Generally the age of the Ahmadi Formation has been regarded as Cenomanian on the basis of the fossil assemblages, stratigraphic position and correlation with other formations e.g. Owen and Nasr, 1958; Dunnington et al. 1959; Al-Naqib, 1967; Al-Siddiki, 1978; Loutfi and Jaber, 1970; Buday, 1980; James and Wynd, 1965. For further details see the Biostratigraphy chapter.

Thickness: (Fig. 3.1)

In this study the Ahmadi Formation has a maximum thickness of 155 m (509 ft) in South Rumaila Well-104, thinning westwards to 68 m (223 ft) at Ghalaisan Well-1 and 8 m (27 ft) at Safawi Well-1, and to 7 m (24 ft) in the north west at Kifl Well-2. In East Baghdad Well-3, in the extreme north west of the South Rumaila area, the formation is not recognised and is merged with the Rumaila Formation. Al-Siddiki (1978) indicated that the Ahmadi Formation in the south eastern area of Iraq has its greatest thickness 160 m (525 ft) in Zubair Well-No. 39 and the formation thins gradually towards the north and west to 8 m (26 ft); the formation is more of a limestone in the east and north, whereas it is more shaly towards the south west.

Buday (1980) believed that the Ahmadi Formation has a maximum thickness of 160 m (525 ft) in southern Iraq, but its thickness is reduced northward and eastward where the formation is progressively replaced by the Rumaila Fm. The formation disappears to the north of Mussaiyb, where it is totally replaced by the contemporaneous Mahilban facies of the Rumaila Formation.Al-Naqib (1967) indicated that the Ahmadi Formation reaches a maximum thickness of 122-168 m (400-550 ft) in Basrah area of south eastern Iraq; and he pointed out that the shaley components of the Ahmadi Formation are replaced eastwards by the increasing thickness of the limestone member (Tuba Limestone Member), until it cannot be distinguished from the Rumaila Formation eastward towards the centre of the basin.

Contacts:

Al-Abdul-Razzaq (1977, M.s.) placed the top of the Ahmadi Formation at the top of fossiliferous, brown-maroon, pyritic, fissile, shales with abundant ostracods; the overlying basal Rumaila Formation consists of poorly fossiliferous greenish-grey limestones.
In Kuwait and the Neutral Zone the Ahmadi Formation lies conformably on the Wara Formation which is composed of a series of alternating fine-grained sand stones and siltstone with interbedded grey shales, with a thickness of 155-180 ft (Owen and Nasr, 1958; Loutfi and Jaber, 1970).
In the Basrah area of south eastern Iraq, the Wara Formation is represented by black silty unfossiliferous shales and siltstones 50-60 ft thick, which decrease in thickness in the Ratawi and Rumaila areas to some 10 ft of thin bedded fine-grained sand stones (Owen and Nasr, 1958).
The Wara Formation cannot be distinguished in most wells and fields in southern Iraq and other parts and it disappears towards the north. Thus the Ahmadi Formation overlies the Mauddud Formation unconformably in most areas, although in some parts of southern Iraq the Ahmadi Formation overlies the Wara Formation (Al-Naqib, 1967; Buday, 1980; Dunnington et al. 1959).

Buday (1980) considered the silty shales component of the Wara Formation to be part of the basal Ahmadi Formation as it is difficult to distinguish them from these components of the basal Ahmadi Formation, so he assigned them to the Ahmadi Formation.
Al-Siddiki (1978) recognised a probable unconformity of small time duration between the Ahmadi and the underlying Mauddud Formation based on the evidence of microfossil assemblages. The name "Asara Formation" (originally established by Rabanit, 1952, unpublished report in Dunnington et al. 1959; and Buday, 1980) was formerly used in the Basrah area for the combined Wara and Ahmadi Formation. The Ahmadi Formation is conformable and intergradational with the overlying Rumaila Formation (Al-Naqib, 1967; Buday, 1980; Owen and Nasr, 1958; Dunnington et al. 1959).

Equivalent Units and Comparison: (Table 3.6)

In the Rutbah area of the western desert of Iraq, the age equivalent of the Ahmadi Formation are the sandstones of the Rutbah Formation; this is overlain conformably by limestones of the M'Sad Formation (Dunnington et al. 1959; Buday, 1980; Al-Naqib, 1967).

In the extreme northwest of Iraq, at S'faiya Wells. 1,2 a survey of the report by Kadouri (1978), suggests that the Ahmadi Formation corresponds to part of the hiatus between the Upper Qamchuqa Formation of Albian age and the Gir Bir Formation of Upper Cenomanian-Turonian age.

In Kuwait-Saudi Arabia Neutral Zone area the Ahmadi Formation has been subdivided into two members, at the base the Lower Ahmadi Limestone Member, above it the Upper AhmadiShale Member (Loutfi and Jaber, 1970; and Al-Abdul-Razzaq, M.S., 1977; 1981). Al-Abdul-Razzaq divided the Ahmadi Formation into three biostratigraphic zones on the basis of ostracod assemblages, two in the Lower Ahmadi Limestone Member and one in the Upper Ahmadi Shale Member.

Loutfi and Jaber (1970) assigned a Lower Cenomanian age to the Ahmadi Formation, while Al-Abdul-Razzaq suggested a Lower Cenomanian age for the Lower Ahmadi Limestone Member and an Upper Cenomanian age for the Upper Ahmadi Shale Member.

In Qatar the Ahmadi Formation is correlated with the lower part of the Khatiyah Formation which is attributed to the Upper Albian (in Dunnington et al. 1959; Al-Naqib, 1967 from Sugden, M.S., 1958).

In Oman, the Ahmadi Formation can be approximately correlated with the parts of the "c&d" Members of Natih Formation (Athersuch, Personal Commun.).

In Saudi Arabia, Powers (1968) indicated that the Wasia Formation, is divided into seven members,the Ahmadi Member being equivalent to the Ahmadi Formation.

In Iran, the Ahmadi Formation is correlated with the upper part of the Kadzhumi Formation of the eastern Zagros of Iran (Furst, 1970). In the Coastal Fars Province of Iran, the Ahmadi Formation is equivalent to the Ahmadi Member of the Sarvak (James and Wynd, 1965). In most areas of the Fars Province, the Santonian Ilam Formation lies disconformably over the Ahmadi Member of the Sarvak Formation, although in some areas there is an "Oligostegina" bearing limestone resting conformably on the upper part of the Ahmadi Member. The Ahmadi Formation can also be correlated with the basal Clayey-marly members of Lower Judea Formation in Syria and Jordan (Buday, 1980) and the Lower Mardin Formation of Turkey (Buday, 1980).

3. Rumaila Formation:

In South Rumaila Well-104 section (Table 3.1) the Rumaila Formation is 85 m thick and dated as Upper Cenomanian. The lower part of the formation consists of a light grey marly limestone, the upper part a more shaley buff to grey compact limestone. The Mishrif Formation rests conformably on the Rumaila Formation.

In Safawi Well-1 section (Table 3.2) the Rumaila Formation is 102 m (336 ft) thick, and dated as possibly Lower Cenomanian-Upper Cenomanian. The sequence consists essentially of limestone with a few shale and marl horizons near the middle of the sequence. The upper half of the succession is a white to buff, hard, fossiliferous limestones with Oligostegina sp. and Globigerind sp., and the top of the formation is formed by a brown dolomite. The Rumaila Formation is overlain conformably by the Mishrif Formation.

In Ghalaisan Well-1 section (Table 3.3) the Rumaila Formation is 80 m (263 ft) thick and is dated as Upper Cenomanian.
Most of the formation consists of marly and chalky limestones with the development of dolomites; the top 13 m (44 ft) or so consists of a white recrystallised limestone, sulphurous and cherty near the top.
The overlying Kifl Formation is conformable with the Rumaila Formation.

In Kifl Well-2 section (Table 3.4) the Mahilban, Fahad and Maotsi Formations are equivalent in age and facies to the Rumaila Formation (Al-Naqib, 1967; Buday, 1980).
The Mahilban and Fahad Formations are probably of Lower Cenomanian age, but the Maotsi Formation is probably of Upper Cenomanian age.

At the base is the Mahilban Formation which is 62 m (202 ft) thick and is composed of buff to white soft chalk with Praealveolina crelaceo.
The Fahad Formation is 115 m (378 ft) thick. The lower part of the formation is a limestone which is marly, chalky and glauconitic at the base, becoming dolomitic upward.
The main part of the formation is a soft white chalk with Praealveolina crelaceo and Cuneolina pavania; with marly limestone forming the top of the sequence.
The Maotsi Formation is 74 m (244 ft) thick and consists of buff-white, soft chalk with a few marls near the base.
The contacts between these three formations are conformable and the Maotsi Formation is overlain conformably by the Kifl Formation.

In East Baghdad Well-3 section (Table 3.5) the Rumaila Formation has a thickness of 370 m (1214 ft) and is dated as Lower-Upper Cenomanian.
The sequence consists of various limestones; near the base is a thin blue-grey clay; the lower 50-60 m of the formation is glauconitic and argillaceous in places; bulk of the formation is a fine crystalline limestone which is occasionally dolomitic, cherty, stylolitic or argillaceous.
The contact of the Rumaila Formation with the overlying Kifl Formation is conformable.

The Rumaila Formation was first described by Rabanit (1952, unpublished data) in the Zubair area. The type locality is in south eastern Iraq in the Zubair Well-3 between drilling depths of 7720 and 8072 ft giving a thickness of 352 ft (from Owen and Nasr, 1958).
In the type section the formation is composed of white, fine grained, chalky limestones below, passing into fine grained, marly, oligosteginal limestone and buff slightly dolomitic marls of a deep water facies upwards (Owen and Nasr, 1958; Dunnington et al. 1959; and Buday, 1980).

In some areas around the type area and in the studied wells, dolomites, dolomitised limestone and subordinate shale occur.
Al-Naqib (1967) and Buday (1980) indicated that the Rumaila Formation has a similar age and facies to the Mahilban, Fahad, and Maotsi Formations of central Iraq. Chatton (1961, unpublished data recorded in Al-Naquib, 1967) proposed replacing the names of these three formations by the name Rumaila Formation. These observations are supported in this study, but the formation names of central Iraq are retained.

Diagnostic Fossils:

The fauna of the Rumaila Formation and its equivalents mostly consist of minute foraminifera and abundant *Oligostegina* (Buday, 1980; Dunnington et al. 1959). Dunnington et al. (1959) and Owen and Nasr (1958) reported the existence of diagnostic fossils in the type sections of the Rumaila, Mahilban, Fahad and Maotsi Formations as following : *Globigerina* sp. (Rumaila, Maotsi, Fahad), *Globorotalia* sp. (Mahilban, Maotsi, Fahad), *Orbitolina concava* var. *qatarica* (Rumaila), *Beggia* sp. (Mahilban, Fahad, Maotsi), *Cuneolina* sp. (Mahilban), *Cyclammina* sp. (Mahilban, Fahad, Maotsi), *Dicyclina qatarica* (Mahilban), *Gumbelina* sp. (Fahad, Maotsi), *Praealveolina cretacea tenuis* (Mahilban), *Praealveolina* sp. (Mahilban, Fahad), *Pseudochrystalidina* sp. (Mahilban), *Textularia* sp. (Mahilban), *Trocholina lenticularis* (Mahilban), *Rotalia* sp. (Mahilban), *Tro-cholina* sp. (Mahilban and Fahad), *Valvulammina* sp. (Mahilban, Fahad), *Ostrea* sp. (Maotsi), *Pecten* sp. (Maotsi), *Alectrionya* cf. sifa (Maotsi), *Exogyra flabllata* (Mahilban), *Cardium Productum* (Fahad), *Limageinitzi* (Fahad), *Nummoloculina* sp. (Rumaila), *Spondylus calcaratus* (Fahad), *Oligostegina* (Rumaila, Mahilban, Fahad, Maotsi); *Miliolids*, *valvulinids*, *Rotalids* (Rumaila); Ostracoda dif. sp. (Mahilban and Fahad), *Cythereis* sp. (Maotsi).

Al-Siddiki (1978) identified microfossils mostly foraminifera in south eastern Iraq which included Ostracods, Miliolidae, Textularidae, *Globigerina* spp., *Heterohelix* spp., *Alveolina* sp., *Oligostegina* spp., *Globigerinelliodea* spp.

Loutfi and Jaber (1970) reported that the Lower Rumaila Limestone Member contains a rich fauna of planktonic microfossils which include *Oligostegina*, *Hedbergella planispira*, *H. delrioensis*, *H. amabilis*, *H.* ssp. and *Heterohelix* ssp. with associated *Lenticulina macrodisca*, *L.* ssp. and *Haplophragmoides* sp., *Praealveolina cretacea* and rare *Orbitolina concava* occur in the basal part of the member; they also recognised rare *Haplophragmoides* sp. in the Upper Rumaila Shale Member of Kuwait-Saudi Arabia Neutral Zone off shore area. In Kuwait, Al-Abdul-Razzaq (M.s., 1977) recorded rare and deformed ostracods in this formation.

Age, Thickness, Contacts, Equivalent Units and Comparisons:

Age:

The Rumaila Formation was regarded as Cenomanian-Turonian in age by Owen and Nasr (1958), Al-Naqib (1967), and Chatton and Hart (unpublished report, 1961). Dunnington et al. (1959) gave a Cenomanian age for the Rumaila. On the basis of the stratigraphic position and microfossils, Al-Siddiki (1978) concluded that the Rumaila Formation is Upper Cenomanian in age. The Rumaila Formation was considered to be of Upper Cenomanian age on the basis of fossil assemblages by Loutfi and Jaber (1970) in the Kuwait-Saudi Arabia Neutral Zone off shore area. El-Naggar and Al-Rifaiy (1972) as mentioned by Al-Abdul-Razzaq (M.s., 1977) attributed this formation to the Middle-Early Upper Cenomanian on the evidence of faunal assemblage and stratigraphical position in Kuwait.

Al-Abdul-Razzaq (M.s., 1977) regarded the Rumaila Formation as probably being Upper Cenomanian in Kuwait based only on its stratigraphical position.

Dunnington et al. (1959) considered that the Mahilban Formation to be of Upper Cenomanian age; and suggested an Early Turonian rather than Late Turonian age for the Fahad Formation; The Maotsi Formation was determined to be of Turonian age based on its stratigraphic position and analogy with equivalent units.
Al-Rawi (1979) gave an Upper Cenomanian age for the Mahilban Formation and a Turonian age for the Fahad and Maotsi Formations of the western desert of Iraq. For further details see the Biostratigraphy Chapter.

Thickness: (Fig. 3.1)

The Rumaila Formation shows considerable variation in thickness. In the type area it is 100-120 m thick; in the areas studied here it is 390 m in East Baghdad Well-3. The formation is thickest in central Iraq where it represents the whole of the Cenomanian; it is thinner in southern Iraq where it forms only part of the Cenomanian, being part of the threefold division Ahmadi, Rumaila, and Mishrif Formations. In the Basrah oil fields of south eastern Iraq it is 43-122 m thick. In the wells studied here it is 85 m (280 ft) in South Rumaila Well-104, south eastern Iraq; it increases in thickness towards south western Iraq at Safawi Well-1 where it is 102 m (336 ft). It is approximately 80 m (263 ft) at Ghalaisan Well-1. In the area of Kifl Well-2 the equivalents of this formation attain the exceptional thickness of about 251 m (824 ft). The Rumaila Formation reaches its greatest thickness in the East Baghdad Well-3, central Iraq, where it is 390 m (1280 ft).

Contacts:

The Rumaila Formation is overlain conformably by the Mishrif Formation, the contact between the Oligosteginal limestones of the Rumaila Formation which lack large foraminifera, Miliolids, etc. and the richly fossiliferous limestones of the Mishrif Formation (Dunnington et al. 1959). In the type area of south eastern Iraq, the upper boundary of the formation is conformable with the overlying Mishrif

Formation (Owen and Nasr, 1958); Loutfi and Jaber (1970) recorded that the Rumaila Formation is also conformable with overlying Mishrif Formation in Kuwait-Saudi Arabia Neutral Zone off shore area.
The Rumaila Formation in the southern and south western areas of Iraq is usually overlain conformably by the Mishrif Formation, but sometimes it is overlain by the Kifl Formation (Al-Naqib, 1967; Buday, 1980).

<u>Equivalent Units and Comparisons:</u> (Table 3.6)

In north western Iraq, in the area of S'faiya Wells-1,2, the Rumaila Formation is probably contemporaneous in part with the hiatus between the Qamchuqa Formation and the Gir Bir Formation.

In north-eastern Iraq, the Rumaila Formation could be contemporaneous in age and partly in facies with the upper part of the Balambo Formation. Youhanna (M.s., 1976) suggested that the upper Balambo Formation is of Cenomanian age based on the occurrence of planktonic and benthonic foraminifera.
Part of the Mishrif Formation is equivalent in age to the upper part of the Rumaila Formation.

In south eastern Kuwait the Rumaila Formation cannot be separated from the Mishrif Formation, but these two are progressively represented by the Magwa Formation.
The Magwa Formation was eroded in the high areas of the Burgan, Magwa, and Ahmadi structures, but it progressively increases in thickness towards their flanks.

In the Kuwait-Saudi Arabia Neutral Zone off shore area, Loutfi and Jaber (1970) divided the Rumaila Formation into two members on the basis of their facies and microfauna, a Lower Rumaila Limestone Member and an Upper Rumaila Shale Member.

In Abu Dhabi (Fox and Brown, 1968) the "<u>Oligostegina</u>" limestone is correlated with the Rumaila Formation.

In Saudi Arabia (Powers et al. 1966) the Rumaila Member is equivalent to the Rumaila Formation, consisting of neritic limestone and shale components.

In Oman (Athersuch, Personal Commun.) the Rumaila Formation is approximately correlative with parts of "c&d" Members of the Natih Formation.

In central Syria there are some similarities with beds of Cenomanian age, mainly in the areas surrounding the western and north western margins of the Khleisia-Deir Ez Zor uplifts (Ponikarov et al. 1967, in Buday, 1980).

In Iran the Rumaila Formation is the closest equivalent in age to the shaley-calcareous parts of the Kadzuhumi Formation (Furst, 1970), probably the Oligosteginal Sarvak Formation of the Iranian eastern Zagros should also be correlated with the Rumaila Formation (Furst, 1970).
In parts of the Coastal Fars province of Iran, the Rumaila Formation is equivalent to the "Oligostegina" bearing limestone which rests conformably on the Ahmadi Member, forming the upper parts of the Sarvak Formation; this is dated as Cenomanian-Turonian? and contains a similar microfauna to that found in the Rumaila Formation; it consists of deep water sediments including soft dense argillaceous limestones with interbedded calcareous shale.
In the Lurestan Province of Iran, the upper 1,000 ft of limestone which is rich in the 'Oligostegina" fauna probably shows similarities and equivalence with the Rumaila Formation; the presence of the "Oligostegina" fauna gives these beds a Cenomanian age (James and Wynd, 1965).
In the Khuzestan province of Iran, at the type locality of the Sarvak Formation, Tang-e Sarvak, there are similarities in facies and fauna between the Rumaila Formation and the lower deep water facies of the Sarvak Formation which consist of marly, argillaceous limestones with an abundance of Oligostegina - Globigerina fauna.

4. <u>Mishrif Formation</u>:

In South Rumaila Well-104 section (Table 3.1) this formation is 124.5 m (408 ft) thick and dated as Upper Cenomanian - Lower Turonian in age.
The formation consists of limestones which in the lower part are of fossiliferous reefal limestones which are detrital, porous and argillaceous in places; the upper half of the succession is a white limestone with rare fossils, and pyritic in places; the top of the formation is formed by a limonitic limestone.
The Mishrif Formation is overlain unconformably by the Khasib Formation.

In Safawi Well-1 section (Table 3.2) this formation is 8 m (27 ft) thick and dated as Upper Cenomanian - Lower Turonian.
It consists of white to yellow, fossiliferous limestone with chert nodules at the top.
The upper contact of the Mishrif Formation with the overlying Tanuma Formation is unconformable.

The Mishrif Formation was first described by Rabanit (1952) in the Zubair area of southern Iraq as a complex of detrital limestones, containing algal, rudist, and coral-reef limestones, terminated by limonitic fresh water limestones (unpublished data, mentioned by Buday, 1980).
At the type section, Zubair Well No.3 in south eastern Iraq (Owen and Nasr, 1958; Dunnington et al. 1959) the formation is 516 ft thick, occurring between drilling depths of 7204 - 7720 ft.
The type Mishrif Formation has at the base a compact marly limestone, grading into brown, detrital, porous, sometimes very shelly limestone with foraminifera and banks of Rudists; this changes to grey-white, dense, fractured or stylolitic algal limestone with gastropods and shell

fragments; the top of the formation is formed by a fine grained limonitic fresh water limestone containing Charophytae.'

Chatton and Hart (1961, unpublished data, in Buday, 1980) considered the limonitic fresh water limestone with Chara at the top of the type Mishrif Formation in Zubair as being a part of the Kifl Formation. Buday stated that "Chatton and Hart defined the new terminal, partly fresh water, partly evaporitic Kifl Formation, the beds of which were originally included as fresh water limestone members into the Mishrif Formation" (p. 150).
Buday (1980) agreed with the opinions of Chatton and Hart.

Diagnostic Fossils:

The Mishrif Formation contains abundant fossils: Chara sp. at the top of the type Mishrif Formation; Permocalculus sp., Cisalveolina sp., Begia sp. in the upper algal limestones. The very shelly and foraminiferal limestones are richly fossiliferous in the most important species being : Cisalveolina fallax, C. lehneri, Coxites zubairiensis, Cuneolina pavania parva, C, cylindrica, Cyclammina whitei, Discyclina qatarica, Dictyoconus arabicus, Dictyoconella cf. minima, Multispira iraniensis, Ovalveolina ovum, Praealveolina cretacea, P. cretacea var. tenuis, pseudo chrysaldina conica, P. arabica, Taberina bingistani, Trocholina sp., Radiolites trigeri, Eoradiolites liratus, Caprinulina sp., Nerinae cochlaeformis, N. cretacea, N. cf. gemmifera, Meandropsina vidali (Owen and Nasr, 1958; Dunnington et al. 1959).
Loutfi and Jaber (1970) described the Mishrif Formation as being rich in microfaunas in the Kuwait-Saudi Arabia Neutral Zone off shore area with Nezzazata gyra, Coxites zubairensis, Rabanitina basraensis, Dicyclina sp., and Rotalia sp. Discorbis turonicus occurs in the basal part of the formation. Al-Siddiki (1978) reported the microfauna and microflora in the Mishrif Formation of south eastern Iraq as including : Chara sp.,Miliolidae, Textularidae,

Algae, Rotalia cayeuxi, Cuneolina pavonia, pseudotextulariella sp., Coxites zubairensis, Troeholina sp., Nezzazata sp., Deuterospira pseudodaxia, Orbitolina sp., Pseudolituonella reicheli, Qataria dukhani, Dicyclina schlumbergerre, Praealveolina cretacea, Cisalveolina lehneri, Praealveolina sp., Multispirina iranensis, Rhapydionina sp., Taberina bingistani, Nezzazata cf. gyra, Nezzazata simplex, N. conica, Chrysalidina sp., Globigerinidae, Rotalidae, Pithonella sp., Rudist debris, Ethelia alba, Heterohelix sp., Foram indetermined, Nezzazata concava ....etc.

Age, Thickness, Contacts, Equivalent Units and Comparisons.

Age:

Owen and Nasr (1958) favoured a Middle Cretaceous age (Turonian) for the Mishrif Formation in Kuwait, and south eastern Iraq on its fossil content. Dunnington et al. (1959) attributed this formation to the Cenomanian on the basis of its fossils and stratigraphic position. Chatton and Hart (1961-1962), (unpublished data as reported by Al-Naqib, 1967) regarded the Mishrif Formation as Cenomanian-Early Turonian. Loutfi and Jaber (1970) assigned the formation to the Upper Cenomanian. El-Naggar and Al-Rifaiy (1972) as mentioned by Al-Abdul-Razzaq, (M.s., 1977) dated the Mishrif Formation as Late Cenomanian to Early Turonian. Buday (1980) attributed an Upper Cenomanian - Early Turonian age for the Mishrif Formation based on its stratigraphic position. Smout (1956) in Dunnington et al. (1959) and Al-Naqib (1967) argued for a Turonian age for the Mishrif Formation on the basis of its fossils. Al-Abdul-Razzaq (M.s., 1977) assigned a ? Turonian age for the formation on the evidence of its stratigraphic position. Al-Siddiki (1978) placed the lower part of the formation in the Upper Cenomanian and the upper part in the early Turonian on the basis of its microfossils and stratigraphic position. For further details (see the Biostratigraphic chapter).

Thickness: (Fig. 3.1)

In South Rumaila Well-104, the formation has a thickness of 124.5 m (408 ft); thins towards the west in the area of Safawi Well-1, where it is only 8 m (27 ft) thick.
In the Basrah oil field the thickness of the Mishrif Formation lies between 122 - 152 m (400 - 500 ft) (Owen and Nasr, 1958). To the west the Mishrif Formation is a few feet thick, and its lithology becomes poorly distinguished consisting of tight fine dolomite with some Miliolids (Al-Naqib, 1967). According to Al-Siddiki (1978) the Mishrif Formation of south eastern Iraq is more argillaceous in the east, more argillaceous and chalky in the south and more porous and reefal towards the north. According to Buday (1980) the thickness in southern Iraq is variable. The maximum thickness for the formation is recognised along the buried Paleouplift roughly coinciding with the Mussaiyb-Nahr Umr Paleouplift of Ditmar et al. (1972), with its axis extending from east of Afaq in the north, towards Nahr Umr in the south (Homic, 1975); the thickness in this area ranges between 150 - 160 m. The formation thins towards the west and north west where it is partly or fully replaced by the contemporaneous uppermost parts of Rumaila Formation. The limestones of the Mishrif Formation become dolomitized with different degree of dolomization towards the west and north west of the type area.
In the Kuwait-Saudi Arabia Neutral Zone off shore area (Loutfi and Jaber, 1970), and in south eastern Kuwait at the reference section Burgan No. 342 (Al-Abdul-Razzaq M.s., 1977) the Mishrif Formation has a thickness of 325 ft, and 36 ft respectively.

Contacts:

The Mishrif Formation is overlain disconformably by the Khasib Formation, marked by a considerable sedimentary haitus (Dunnington et al. 1959, Al-Naqib, 1967). However, Owen and Nasr (1958) indicated that the contact between the Mishrif Formation and the overlying Khasib Formation is disconformable without hiatus in sedimentation. Al-Siddiki

(1978) believed that a break in sedimentation occurs within the Turonian between the Mishrif Formation and the overlying Khasib Formation. The evidence for this unconformity is seen in the presence of limonite, conglomerates in places, and extensive recrystallization of the limestones below the clayey limestone of the Khasib Formation.

The Mishrif Formation is overlain conformably by the Kifl Formation in some of the western desert subface sections (Al-Naqib, 1967).

Buday (1980) indicated that the upper contact of the Mishrif Formation is very variable. In parts of southern Iraq where the Kifl Formation is present, the Mishrif Formation is conformably overlain by the Kifl Formation; but where the Kifl is absent, the upper contact is unconformable, and the Mishrif Formation forms the terminal formation of the Cenomanian-Turonian depositional subcycle.

In Kuwait, Al-Abdul-Razzaq (M.s., 1977) pointed out that the upper part of the Mishrif Formation was cut out by the Wasia-Aruma unconformity. In the Kuwait-Saudi Arabia Neutral Zone off shore area, Loutfi and Jaber (1970) indicated that the contact of the Mishrif Formation with the overlying Gudair Formation (Santonian-Campanian) is unconformable.

In this study the boundary of the Mishrif Formation or Kifl Formation with the Khasib Formation is unconformable and is marked by a distinct break in the ostracod faunas between the Cenomanian and Lower Turonian below and Upper Turonian and Upper Cretaceous Succession above. This unconformity is well known and recognised throughout the adjacent areas of the Arabian Gulf and Iran. It is referred to as the Aruma-Wasia unconformity, which occurs between the Aruma Group (Upper Cretaceous) and the Wasia Group (Middle Cretaceous).

Owen and Nasr (1958) defined the Wasia Group as including the Middle Cretaceous formations and the Aruma Group as including the Upper Cretaceous in the Kuwait-Basrah area. The Aruma-Wasia unconformity is of variable magnitude in the Arabian Gulf. As an example, in south eastern Kuwait, Owen and Nasr pointed out that the magnitude of the unconformity increases towards the high structures, but decreases towards the flanks as well as to the north, i.e. the Mishrif, Rumaila Formations and upper parts of the Ahmadi Formation are absent due to this erosional unconformity which preceded the upper Cretaceous depositional cycle. In the Basrah area, the erosional unconformity seems to be significantly diminished and its only effect seems to be limonitized fresh water limestone at the top of the Mishrif Formation. This limestone is overlain conformably by the transgressive Khasib Formation (Owen and Nasr, 1958, fig. 5). Dunnington et al (1959) pointed out that the Chara limestone present in the uppermost part of the Mishrif Formation in the wells of the Zubair field disappear in most other areas. The presence of limonitic limestone at the top of the formation and algal limestone underlying the globigerinal marly limestone of the Khasib suggests a period of non-deposition and uplift with erosion of the top of the Mishrif Formation. Some wells do not show any signs of this erosional unconformity however. The erosional unconformity also had been observed to vary in intensity in Iran by James and Wynd (1965) and Setudehnia (1978). According to Al-Siddiki (1978) and supported in this study an unconformity of small magnitude is observed representing the middle part of the Turonian.

Equivalent Units and Comparisons: (Table 3.6)

In the area of the Rutbah uplift of the western desert of Iraq the equivalent of the Mishrif Formation is probably the M'sad Formation which contains a similar microfauna to that of the Mishrif Formation (Dunnington et al. 1959); Al-Naqib, 1967). Buday (1980) considered the M'sad as an aberrant equivalent of the Mishrif Formation because it contains some terrigenous clastic components near the base.

In the north western part of Iraq in the S'faiya area the Mishrif Formation is considered here to be equivalent in age to the Gir Bir Limestone Formation; Kadouri (1978) pointed out that the Gir Bir Formation overlies the Albian Upper Qmchuqa Formation unconformably, while the Gir Bir is overlain unconformably by the Kometan Formation which is of

Upper Turonian-Lower Campanian age. Kadouri considered the Gir Bir Formation to be Upper Cenomanian-Lower Turonian in age based on the fauna, including large foraminifera.

The upper part of the Balambo Formation of north eastern Iraq has traditionally been assigned to the Cenomanian and Turonian although Youhanna (M.s., 1976) has suggested mainly the Turonian strata into the overlying Kometan Formation. Thus the age equivalents of the upper part of the Mishrif Formation occur in either the upper Balambo or lower Kometan Formations.

In south eastern Kuwait, Owen and Nasr (1958) pointed out that the Mishrif Formation is not represented, but both the Mishrif and Rumaila Formation of the Basrah area can be correlated with the Magwa Formation of Kuwait. The upper part of the Magwa Formation is equivalent to the Mishrif Formation.

In Qatar (Fox and Brown (1968) in Al-Abdul-Razzaq (M.s., 1977)) the "Mishrif" limestones lie between the "Oligosteginal" limestones (Rumaila Formation) and the Turonian-Santonian unconformity.

In Abu Dhabi the Mishrif Formation is composed of white and cream lime mudstones with *Praealveolina cretacea* and *Orbitolinella depressa* (Fox and Brown, 1968).

In Oman the Mishrif Formation is approximately correlative with 'a' + 'b' Members of the Natih Formation (Athersuch, Personal Commun.)

In Saudi Arabia, the Mishrif Formation is equivalent to the Mishrif Member which is the youngest member of the Wasia Formation. The contact of the Wasia Formation with the overlying Aruma Formation is unconformable (Powers, 1968).

In central and north eastern Syria the Mishrif Formation is correlated with the widespread Lower Judeo Formation (Ponikarov et al. 1967 in Buday, 1980).

In Turkey, parts of the Mardin Formation are equivalent to the Mishrif Formation (Beer, 1966 in Buday, 1980).

In Iran the Mishrif Formation is correlated with the neritic development of the Sarvak Formation of the Coastal ranges of the eastern Zagros (Furst, 1970 in Buday, 1980).
In the Coastal Fars province of Iran a thick Alveolinid - Nezzazata limestone in the upper part of the Sarvak Formation is correlated with the Mishrif Formation (James and Wynd, 1965).
The upper contact of the Sarvak Formation with the overlying Ilam Formation (Santonian-Campanian) is disconformable in the Coastal Fars province.
In the type locality of the Sarvak Formation at Tang-e Sarvak in Khuzestan Province, the Mishrif Formation is correlated with the upper neritic water facies of the Sarvak Formation which consists of a massive limestone containing Rudists, gastropods, Pelecypods and a rich microfauna including *Nezzazata* sp., *Praealveolina cretacea*, *Ovalveolina* sp., *Dictyoconella* sp., *Dicyclina* sp.
The upper contact of the Sarvak Formation with the overlying Ilam Formation is represented by a significant disconformity in Khuzestan Province.
In the Lurestan province of Iran, the highest 350 ft of the Sarvak Formation might be of the same age as the Mishrif Formation. The Sarvak Formation is overlain disconformably by the Surgah Formation although this disconformity is less apparent in Lurestan province.

5. Kifl Formation:

In Kifl Well-2 section (Table 3.4) this formation is 20 m (66 ft) thick and is dated as Lower Turonian.
At the base of the formation is a buff-coloured, moderately hard anhydritic limestone; the main part of the sequence consists of hard, white crystalline anhydrite with grey fissile shales and soft white chalk.

The Khasib Formation overlies the Kifl Formation unconformably with a sedimentary break placed at the change from anhydrite below to shale and chalk of the Khasib Formation above.

In Ghalaisan Well-1 section (Table 3.3) the formation is 10 m (34 ft) thick and dated as Lower Turonian. It consists predominantly of detrital limestone. There is an unconformity with the overlying Khasib Formation.

In East Baghdad Well-3 section (Table3.5) the formation is 46 m thick and dated as Lower Turonian. It consists of anhydrite, dolomite, limestones, anhydritic limestones, and dolomitic limestones.
The top of the Kifl Formation is placed at the top of the anhydrite, and is overlain unconformably by the Khasib Formation.

The Kifl Formation is not present in southern Iraq; the ostracod fauna suggests it is equivalent to the upper part of the Mishrif Formation of southern Iraq (South Rumaila Well-104, S.E. Iraq; Safawi Well-1, S.W. Iraq).
Chatton and Hart defined the Kifl Formation in 1961 (unpublished report); prior to this rocks of this age were referred to parts of the Mishrif and Fahad Formations.

The type section of the Kifl Formation is in Kifl Well-1, at drilling depths between 4738-4830 ft; it is 28 m (92 ft) thick.
In the type section the formation consists of lagoonal evaporitic and partly fresh water sediments (Buday, 1980), it being "white crystalline anhydrite with streaks of green marl and chalky pelletal limestone locally having an anhydritic matrix; cream-coloured porcelaneous anhydritic marly limestone occurs at the base". (Al-Naqib, 1967).

Dolomitic limestones, marly limestones and subordinate shales occur in the other areas besides the studied wells.

Diagnostic Fossils:

Fossils are rare in the Kifl Formation; Al-Naqib (1967) reported Miliolids and Textularids; Buday (1980) stated that no fossils had been reported apart from Chara in the Zubair oil field. Ostracods have been found in this study.

Age, Thickness, Contacts, Equivalent Units and Comparisons:

Age:

Al-Naqib (1967) and Al-Rawi (1979) regarded the Kifl Formation as probably being Late Cenomanian and Early Turonian in age. Buday (1980) determined the age of Kifl Formation as top Cenomanian-Early Turonian based on its stratigraphic position and on its gradual development from the underlying Cenomanian Formations. For further details see the Biostratigraphy Chapter.

Thickness: (Fig. 3.1)

The thickness of the Kifl Formation is between 15-20 m in the type area and in the Mussaiyab, Afaq areas, but elsewhere its average thickness is about 10 m (Buday, 1980). In the studied areas, the formation has a thickness of 20 m (66 ft) at Kifl Well-2; it diminishes to 10 m (34 ft) towards the south west in the Ghalaisan Well-1; but reaches a maximum of 46 m (151 ft) at East Baghdad Well-3 in central Iraq.

Contacts:

The contact of the Kifl Formation with the overlying Khasib Formation is unconformable with a sedimentary break (Al-Naqib, 1967).

The Rumaila Formation underlies the Kifl Formation in most of southern Iraq, but in some parts of the southern area the Kifl Formation is underlain by the Mishrif Formation (Buday, 1980).

Equivalent Units and Comparisons: (Table 3.6)

In Iraq, Buday (1980) pointed out that no facies correlatives are recorded and any equivalents were probably eroded during the intra-Turonian orogeny, or their deposition coincides with the time of uplift and erosion of the shelf areas. However, the Balambo Formation is age correlative with the Kifl Formation in north and north eastern Iraq.

In Kuwait the equivalent of the Kifl Formation is absent either due to the intra-Turonian erosional unconformity or by non deposition.
No equivalents are reported from the adjacent areas apart from an evaporitic facies of late Cenomanian age in the Syrian Palmyrides i.e. in the Jebel Abu Dhour and Jebel el Balas gypsum beds (Ponikarov et al, 1967 as reported in Buday, 1980).

6. Khasib Formation:

In South Rumaila Well-104, section (Table 3.1), the Khasib Formation is 47.7 m thick and dated as Upper Turonian-Lower Coniacian.
The formation consists predominantly of grey shaley and detrital limestone.
The upper contact of the Khasib Formation with the overlying Tanuma Formation is conformable.

In Ghalaisan Well-1 section (Table 3.3) the Khasib Formation is 23 m (77 ft) thick and dated as Upper Turonian-Lower Coniacian. The basal part of the formation consists of grey marly limestone, followed to the top by white-buff chalky limestone.
The Khasib Formation is overlain conformably by the Tanuma Formation and the contact is marked by a change from chalky limestone to the shales of the Tanuma Formation.

In Kifl Well-2 section (Table 3.4) the Khasib Formation is 55 m (182 ft) thick and dated as Upper Turonian-Lower Coniacian.
The lower half of the formation consists mainly of white-buff, soft chalk and grey, green, fissile shale; the upper half is predominantly white-buff, soft to moderately hard chalk with streaks of marl, with a fauna including *Gumbelina* sp., and *Globigerina* sp.
The boundary of the Khasib Formation with the overlying Tanuma Formation is conformable.

In East Baghdad Well-3 section (Table 3.5) the Khasib Formation is 117 m thick and dated as Upper Turonian-Coniacian.

The formation is composed of brown-grey, finely crystalline limestone with some chert nodules; there are some argillaceous, detrital and stylolitic limestones towards the top.
The upper boundary with the Tanuma Formation is conformable.

The Khasib Formation is absent in Safawi Well-1.

The Khasib Formation was originally described by Owen and Nasr (1958) with the type section in the Zubair Well-3 and in south eastern Iraq, where it occurred between drilling depths of 7040-7204 ft with a thickness of 164 ft.
In the type section, the formation is divided into two lithological divisions. The lower division is 69 feet thick, and composed of dark grey and greenish-grey fissile shales alternating with grey, fine grained marly limestone. This is followed by the upper division 95 feet thick, consisting of grey fine grained marly limestone.
Buday (1980) noticed that the two divisions of the Khasib Formation cannot be found throughout the whole area of the formation's occurrence. The shale component in many wells is completely absent and the formation is composed of limestones mostly chalky, shaley, marly or oligosteginal. This observation is also true of the wells studied here.
Darmoian (1975) regarded the Khasib and Tanuma Formations to be members of his new stratigraphical formation the Shat Al Arab Formation.

Diagnostic Fossils:

Few fossils were recorded by Owen and Nasr (1958) in the type section, those that were found coming from the lower division of the Khasib Formation i.e. *Globigerina* sp., *Gumbelina* sp., and *Oligostegina* sp. Buday (1980) regarded the fossils in the type section to be rare, but in other wells the fauna is relatively rich; *Oligosteginas* are found throughout. Dunnington et al. (1959) recognised

Globotruncana lapparenti sub sp. and G. leupoldi from Zubair Well-1 and G. stuarti, from Nahr Umr Well-1.
Al-Siddiki (1978) recognised microfossils which included Rotalipora sp., Textularidae, Miliolidae, Heterohelix spp., Rotalia spp., Globigerinelloides spp., Oligostegina spp. and Globigerinidaeas as well as ostracods from subsurface sections of south eastern Iraq. Darmoian (1975) reported the important foraminifera species which occur in the Khasib Formation in most wells of south eastern Iraq: Heterohelix moremani, H. pseudoguembeliniformis, H. pulchra, H. striata, Globotruncana cretacea, G. marginata, G imbricata, G. renzi, G. schneegansi, Praeglobotruncana helvetica. Darmoian (1975) also reported the characteristic benthonic foraminifera from the Khasib Formation as following: Ammobaculites, Ceratobuliminella, Miliolidae, Valvulinera, Virgulina, Spiroplectamina, Discorbis, Marssonella turris and Rotalia.

Age, Thickness, Contacts, Equivalent Units and Comparisons:

Age:

The age of the Khasib Formation is controversial. Owen and Nasr (1958) attributed the Khasib Formation to the Lower Senonian. Dunnington et al. (1959) proposed an upper Campanian age for the Khasib Formation on the basis of its microfauna. Chatton and Hart (unpublished data, 1961) reported by Al-Naqib (1967) argued that the formation is of middle Turonian-early Coniacian age.
Buday (1980) favoured a Turonian-Lower Campanian age for the Khasib Formation on the basis of its stratigraphic position. Al-Siddiki (1978) claimed a Turonian-Coniacian age for the Khasib on the basis of its microfauna and stratigraphic position. Darmoian (1975) established the age of the Khasib Formation as basal Late Turonian-Coniacian. For further details see the Biostratigraphic Chapter.

Thickness: (Fig. 3.1)

In south eastern Iraq in the Basrah area the formation ranges between 117-195 ft thick (Owen and Nasr, 1958). In this study the Khasib Formation at South Rumaila Well-104 is 47.7 m (156 ft); the formation thins towards the west to 23 m (77 ft) at Ghalaisan Well-1, and is completely absent at Safawi Well-1; towards the north west the thickness of the Khasib Formation increases to 55 m (182 ft) at Kifl Well-2; and the formation reaches a thickness of 117 m (384 ft) at East Baghdad Well-3.
Al-Naqib (1967) pointed out that the greatest thickness of the Khasib Formation is towards the north-east of his study area in south western Iraq, indicating basin conditions, where it is about 300 ft thick; it is 200 ft thick between the Kifl and Nahr Umr areas; in the Basrah and surrounding areas, the thickness of the Khasib Formation ranges between 117-195 ft; the thickness is reduced towards the west where it ranges between 77-95 ft. Buday (1980) indicated that the greatest thickness of the Khasib Formation in its type area and the surrounding areas is 60 m (197 ft), increasing towards the south east and north-north west where the formation sometimes wedges out completely.

Contacts

The upper contact of the Khasib Formation is regularly conformable and gradational according to Buday (1980). According to Owen and Nasr (1958); Al-Siddiki (1978) the contact of the Khasib Formation with the overlying Tanuma Formation is conformable, and is placed at the change from the grey, marly limestone of the Khasib Formation to the black, fissile shales of the Tanuma Formation.

Equivalent Units and Comparions: (Table 3.6)

In north eastern Iraq the Khasib seems to be almost identical to the lower limestones of the middle Turonian-lower Coniacian Kometan Formation and Gulneri shales (Al-Naqib, 1967).

In north western Iraq at Sfaiya Wells-1,2, the Khasib Formation is correlated with the lower limestones of the Kometan Formation; the Kometan Formation was considered by Kadouri (1978) to be Upper Turonian-Lower Campanian on the basis of its microfauna. Kadouri showed that the boundary between the Kometan and overlying Shiranish Formation is conformable.

In the Rutbah area, western Iraq, the Khasib Formation equates in part with the erosional unconformity which overlies the M'sad Formation. This unconformity involves erosion with and no deposition of sediments of Turonian to intra Maastrichtian ages (Dunnington et al. 1959).

In north eastern Kuwait, the Khasib and overlying Tanuma and Sadi Formations are recognised (Fox, 1957 in Dunnington et al. 1959).

In south eastern Kuwait, the Khasib Formation and the overlying Tanuma Formation are not distinctive; they probably have equivalents represented in the lower part of the Gudair Formation (Dunnington et al. 1959). In the Burgan structural uplift of south eastern Kuwait, the Gudair Formation is diminished in thickness and the equivalent sediments of the Khasib and Tanuma Formations disappear by progressive overlap (Owen and Nasr, 1958). The Gudair Formation in the Burgan, Magwa, and Ahmadi areas of south eastern Kuwait is equivalent to the Hartha and Sadi Formations of Iraq (Owen and Nasr, 1958).

In Syria no suitable correlatives of the Khasib Formation have been found.

In Iran the neritic facies of Surgah Formation might be the equivalent of the Khasib Formation, although the lithofacies of that formation are rather different (Furst, 1970 in Buday, 1980).

In the Lurestan Province of Iran, the Khasib Formation is considered to be age equivalent to the lower half of the

Surgah Formation. The Surgah Formation of Turonian ? - early Santonian age overlies the Sarvak Formation disconformably and its upper contact is with the Ilam Formation of Santonian-Campanian age which is marked by a minor disconformity.

In the Fars and Khuzestan province of Iran, the equivalents of the Khasib Formation were eroded during a period of general regional emergence during Turonian-Maastrichtian times.

7. Tanuma Formation:

In South Rumaila Well-104 section (Table 3.1) the Tanuma Formation is 47.3 m thick and dated as Upper Coniacian -? Santonian.
The formation is mainly composed of black-brown fissile shale.
The contact of the Tanuma Formation with the overlying Sadi Formation is conformable.

In Safawi Well-1 section (Table 3.2) the Tanuma Formation is 25 m (82 ft) thick and dated as Upper Turonian-Coniacian.
The formation consists essentially of shales with a bed of white, soft chalk in the lower half. The shales are mostly green, red, chocolate and fossiliferous.
The Tanuma Formation is overlain conformably by the Sadi Formation, the contact placed at the change from the shale of the Tanuma Formation below to grey marly limestone of the Sadi Formation.

In Ghalaisan Well-1 section (Table 3.3) the Tanuma Formaiton is 5 m (15 ft) thick, and dated as Upper Coniacian.
The formation is composed of shales.
Its contact with the overlying Sadi Formation is conformable and drawn at the boundary of the Tanuma shale below and the grey, marly limestone of the Sadi above.

In Kifl Well-2 section (Table 3.4) the formation is 20 m (66 ft) thick and dated as Upper Coniacian-? Santonian.
The lower half of the Tanuma Forma ton is composed of grey, to green, plastic marl followed by a grey moderately hard, pyritic oolitic limestone, and finally a green, fissile, pyritic shale at the top.
The overlying Sadi Formation is conformable with the Tanuma Formation.

In East Baghdad Well-3 section (Table 3.5) the formation is 131 m thick, and is dated as Coniacian-? Santonian. It is essentially limestone, with a grey-brown, calcareous claystone (25 m) thick near the base. The limestones are mostly fine grained and detrital in places.
The boundary between the Tanuma and overlying Sadi Formation is conformable.

This formation was defined by Owen and Nasr (1958) from the type section at Zubair Well-3 in south eastern Iraq, where it occurred between drilling depths of 6943-7040 ft, giving a thickness of 97 ft.
In its type section the formation is composed of black, fissile shale with streaks of grey, microcrystalline marly, detrital, pyritic spotted limestone with glauconite and dolomite crystals throughout. In the upper part oolitic limestone streaks appear; the ooliths have a core of pyrite or glauconite.

The lithology of the Tanuma Formation is relatively constant throughout the whole area of its occurrence (Buday, 1980).

Diagnostic Fossils:

Fossils are rare, the detrital limestone of the type Tanuma Formation has yielded *Monolepidorbis* sp., *Cristellaria* sp., *Globotruncana linneri*, *Rotalia skourensis*, *Guembelina* spp., Ostracods and Bryozoa (Owen and Nasr, 1958; Dunnington et al. 1959; Darmoian, 1975). Al-Siddiki (1978) reported some microfauna from the formation in south eastern Iraq's sub surface sections, which included Ostracodes; *Heterohelix* spp., *Oligostegina* spp., *Praeglobotruncana* sp., and *Hedbergella dolrjaensis*.
Darmoian (1975) pointed out that the characteristic planktonic foraminifera of the Tanuma Formation are similar to those of the Khasib Formation apart from *Sigalia*

deflaensis and rare of Globotruncana concavata concavata which appears in the uppermost part. Darmoian concluded that the presence of Monolepidorbis Bryozoa and Rotalia skourensis in the type Tanuma Formation are due to contamination from the younger overlying strata of Upper Santonian age.

Age, Thickness, Contacts, Equivalent Units and Comparisons:

Age:

The age of the Tanuma Formation is controversial.
Owen and Nasr (1958) claimed that the formation is Upper Senonian; Dunnington et al. (1959) assigned this formation to the Upper Campanian on the basis of its fossils.
Chatton and Hart (1961 unpublished data) considered it to be Upper Coniacian; Diatmar et al. (1971) attributed a Turonian-Lower Campanian age for the Tanuma Formation; the age of the formation is given as Coniacian by Darmoian (1975) on the basis of its fossil content. Al-Siddiki (1978) determined the age of the formation as Coniacian (Upper Coniacian). The Tanuma Formation as well as the Khasib Formation are assigned to the Turonian-Lower Campanian sedimentary subcycle by Buday (1980). Al-Naqib (1967) remarked that the formation has a wide stratigraphic range because of its diachronous sedimentation. For further details see the Biostratigraphic Chapter.

Thickness: (Fig. 3.1)

Al-Naqib (1967, p.27) gives different thickness and depths for the type Tanuma Formation in its type locality. He stated "that the formation lies between drilled depth of 6900 and 7040 ft (140 thick)". It appears that Al-Naqib included 43 feet of the overlaying Sadi Formation in the Tanuma Formation.
Al-Siddiki (1978) reported a different thickness for the type Tanuma Formation, 38 m (125 ft).

Dunnington et al. (1959); and Owen and Nasr (1958) reported that the thickness of the Tanuma Formation ranges between 20-170 ft in the Basrah oil field area.
Buday (1980) pointed out that around the type area in southern Iraq the thickness of the Tanuma Formation reaches up to 60 m (197ft). In south eastern Iraq the thickest sequences of the Tanuma Formation are found in the Luhais, Rachi and Ratawi areas, from where the formation gradually thins eastwards and thins more abruptly westwards; towards the south and south east it thickens at the Iraq-Kuwait border (Darmoian, 1975).
In this study the thickness of the Tanuma Formation in the area of the South Rumaila Well-104 is 47.3 m (155 ft); from this area towards the north west at Kifl Well-2, the Tanuma Formation shows a thining to 20 m (66 ft); while there is appreciable thinning towards the west at Ghalaisan Well-1 (5 m = 15 ft); however at Safawi Well-1 the Tanuma Formation has a thickness of 25 m (82 ft). The greatest thickness of the Tanuma Formation occurs in East Baghdad Well-3, where it amounts to 131 m (430 ft).

Contacts:

The contact of the Tanuma Formation with the overlying Sadi Formation is conformable and gradational from black shales below to globigerinal marly limestone above (Al-Naqib, 1967, Dunnington et al. 1959). According to Buday (1980) both the lower and upper boundaries of the Tanuma Formation are gradational; but in some areas (Safawi) the base of the Tanuma Formation is probably unconformable, and it certainly transgresses over the underlying Cenomanian (mostly the Mishrif or the Kifl Formations).

Equivalent Units and Comparisons: (Table 3.6)

In the Sfaiya area of north western Iraq studied by Kadouri (1978), the Tanuma Formation is equivalent in age to parts of the Kometan Formation.

In the area of north-eastern Iraq studied by Yohanna (M.s., 1976) the Khasib and Tanuma Formations are equivalent in age to parts of the Kometan Formation and Gulneri shale unit. Youhanna indicated a Turonian-Santonian age for the Kometan Formation based on its foraminiferal fauna.
In this study it is considered that the Tanuma Formation might be correlated with lower parts of the Gudair Formation which are of Santonian age in the Kuwait-Saudi Arabia Neutral Zone off shore area (Loutfi and Jaber, 1970); and might be equivalent to the Gudair Formation (Santonian) of Kuwait (Al-Abdul-Razzaq, M.s., 1977).

In Saudi Arabia (Powers et al. 1966) the Tanuma Formation may be correlated with one of the Aruma shales (in Al-Naquib, 1967).

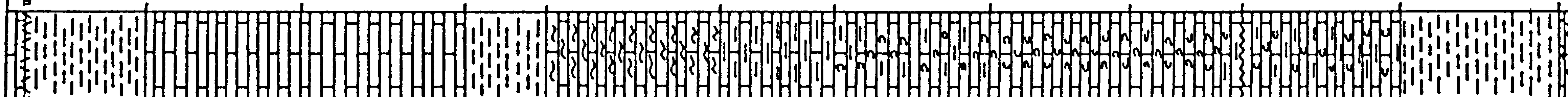
In Iran the Tanuma Formation is correlated with the neritic facies of the Surgah Formation and the lower parts of the Gurpi Formation (Furst, 1970 in Buday, 1980).
In the Lurestan province of Iran, the Tanuma Formation is equivalent in age to the upper half of the Surgah Formation (Turonian? - Lower Santonian).
In the Khuzestan and Fars Provinces of Iran, the Tanuma Formation corresponds in part to an erosional or depositional hiatus lying between the Sarvak Formation and either the Ilam Formation or Gurpi Formation.

Sadi Formation:

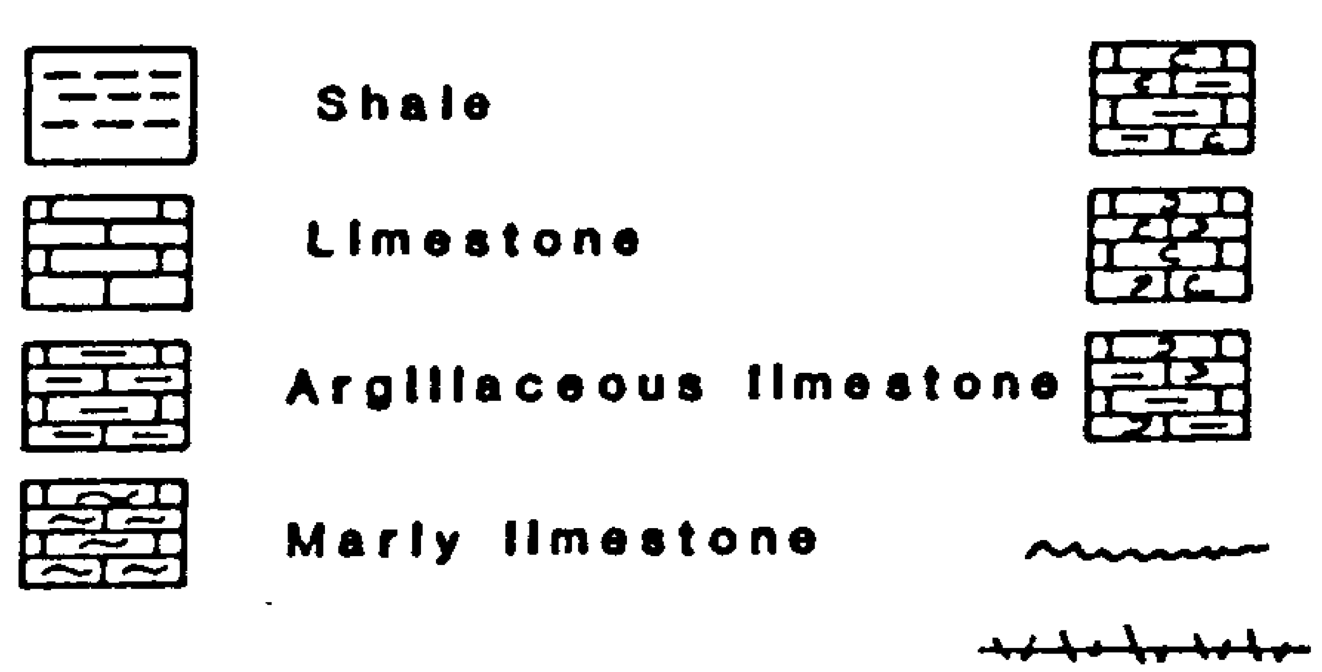
Few samples have been collected and studied from the basal part of the Sadi Formation in this study, so this formation will not be discussed in detasil.
The basal part of the Sadi Formation generally consists of marly limestone in five wells studied.
The type section of the Sadi Formation is in Zubair Well-3. The Formation lies between drilling depths of 6013 and 6943 ft, with a thickness of 930 ft (Owen and Nasr, 1958).

Darmoian (1975) promoted the Sadi Formation to the status of a group, dividing it into three formations.
Owen and Nasr (1958) gave an Upper Senonian age for the Sadi Formation; Dunnington et al. (1959) proposed an Upper Campanian age; Al-Siddiki (1978) suggested a Santonian age on the basis of the fossil content.
Fossils are abundant in the Sadi Formation (Dunnington et al. 1959, and Buday, 1980).

AGE	FORMATN.	THIKNES	DEPTH	SAMPLES NUMBERS
SAN	SAD	6.5 m	2325.0	3 Cut.
U. CONIACIAN-? SANTONIAN	TANUMA	47·3m.	2331.5 m	24 cuttings
U. TURONIAN-L. CONIACIAN	KHASIB	47·7m.	2378.8 m	24 cuttings
U CENOMANIAN—LOWER TURONIAN	MISHRIF	124·5 m.	2426.5 m	9 cuttings
UPPER CENOMANIAN	RUMAILA	85·0 m.	2551.0 m	20 cuttings
LOWER CENOMANIAN	AHMADI	155·0m.	2636.0 m	62 cuttings
	U.MA	9 m	2791.0 m – 2800.0 m	5 Cut.



KEY



ABBREVIATIONS

I.N.O.C. Iraq National Oil Company
Cut. Cutting
U.MUD. Upper Mauddud Formation
SANT. Santanian

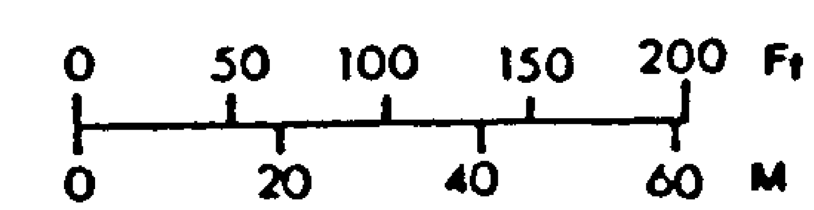


Table 3.1 :- SOUTH RUMAILA WELL-104 STRATIGRAPHIC SECTION.drilled and sampled by I.N.O.C.

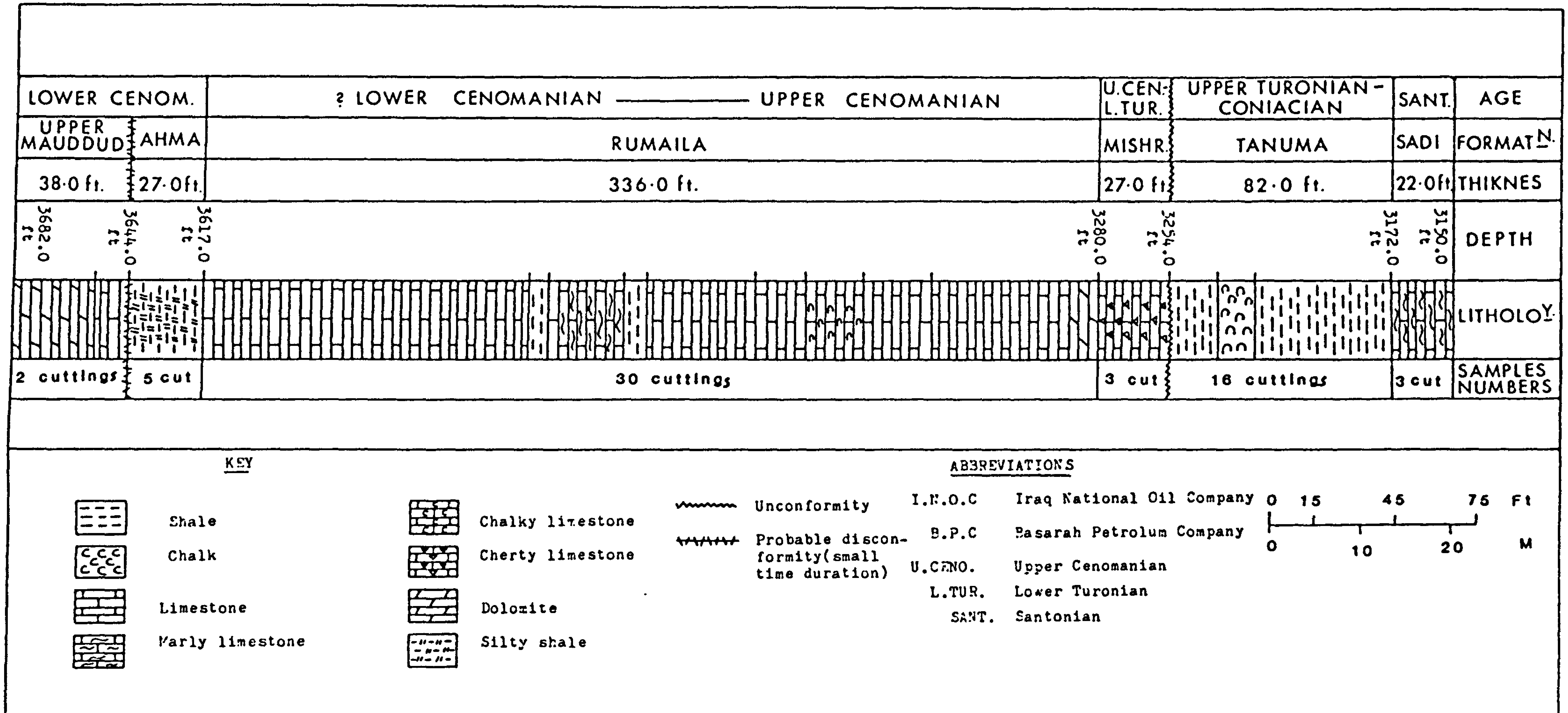


Table 3.2 :- SAFAWI WELL-1 STRATIGRAPHIC SECTION,drilled and sampled by B.P.C.,stored atI.N.O.C.

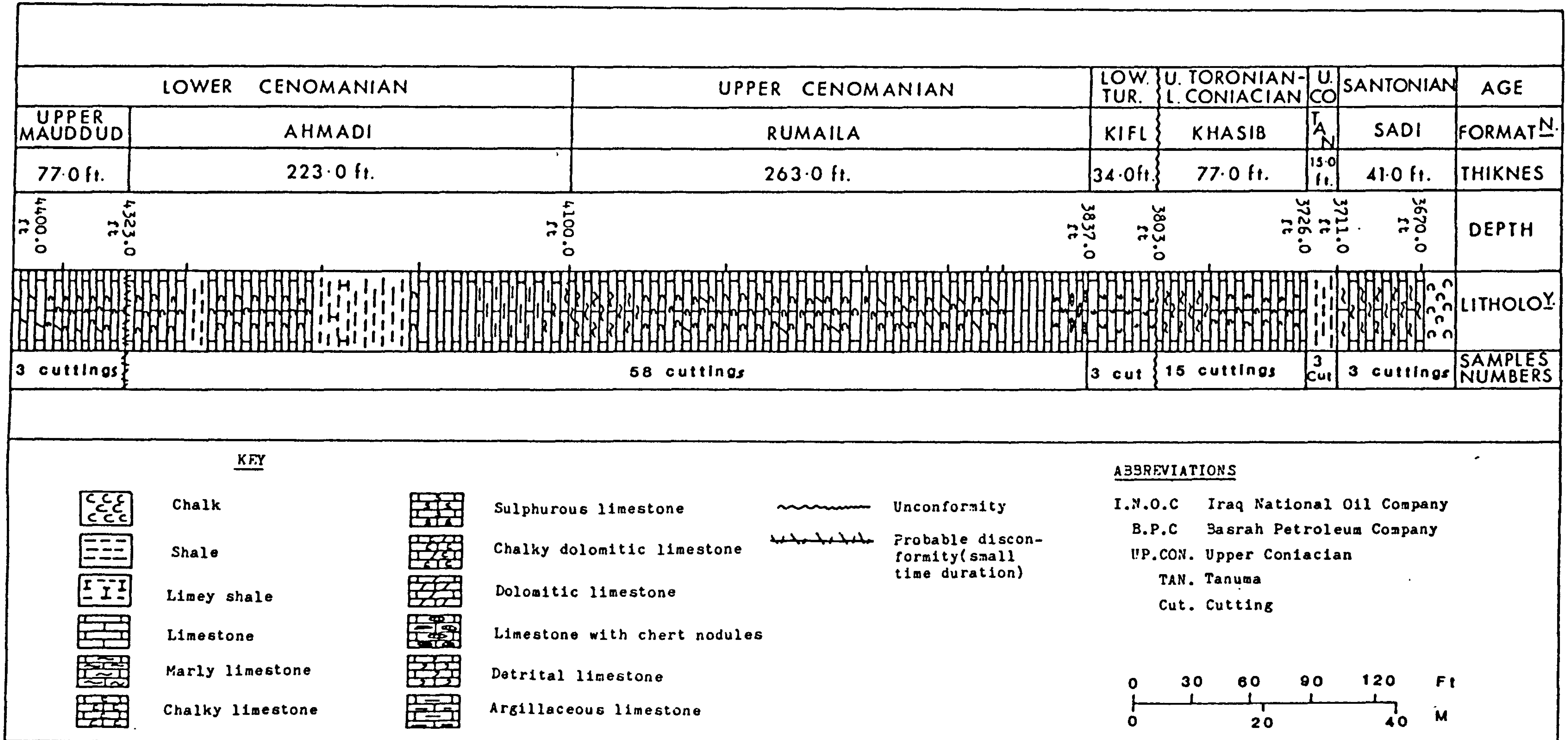


Table 3.3 :- GHALAISAN WELL-1 STRATIGRAPHIC SECTION,drilled by B.P.C.,stored at I.N.O.C.

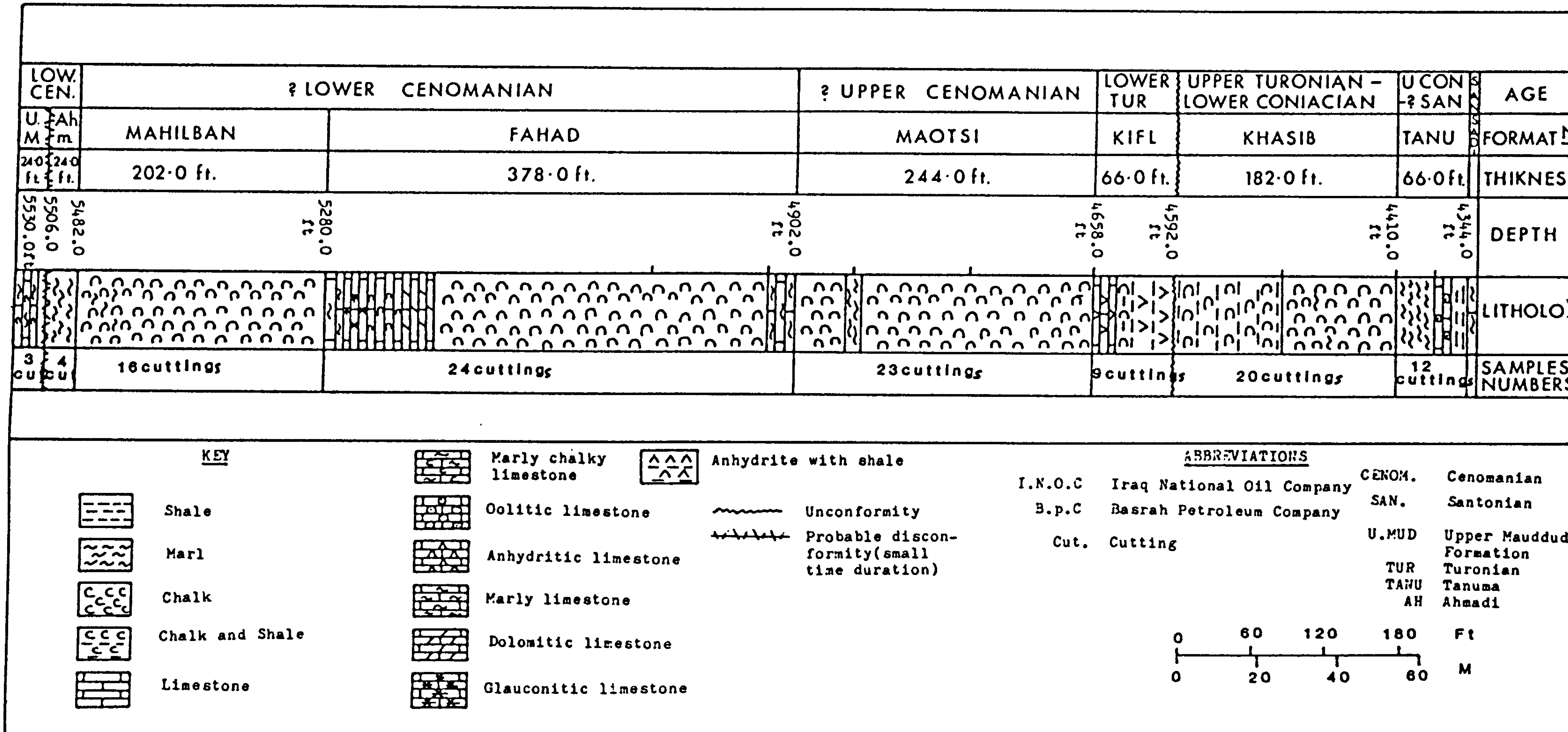


Table 3.4 :- KIFL WELL-2 STRATIGRAPHIC SECTION, drilled and sampled by B.P.C., stored at I.N.O.C.

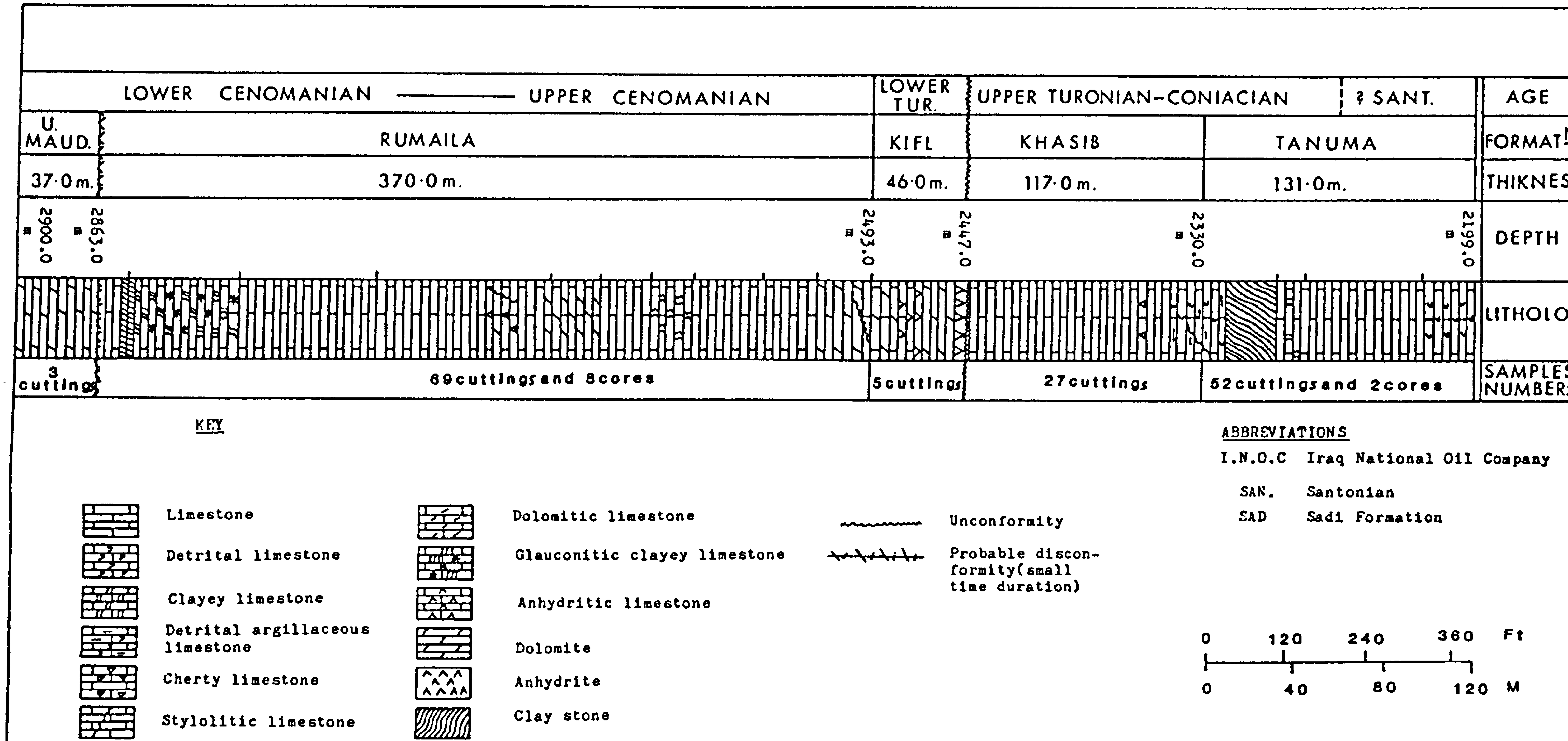
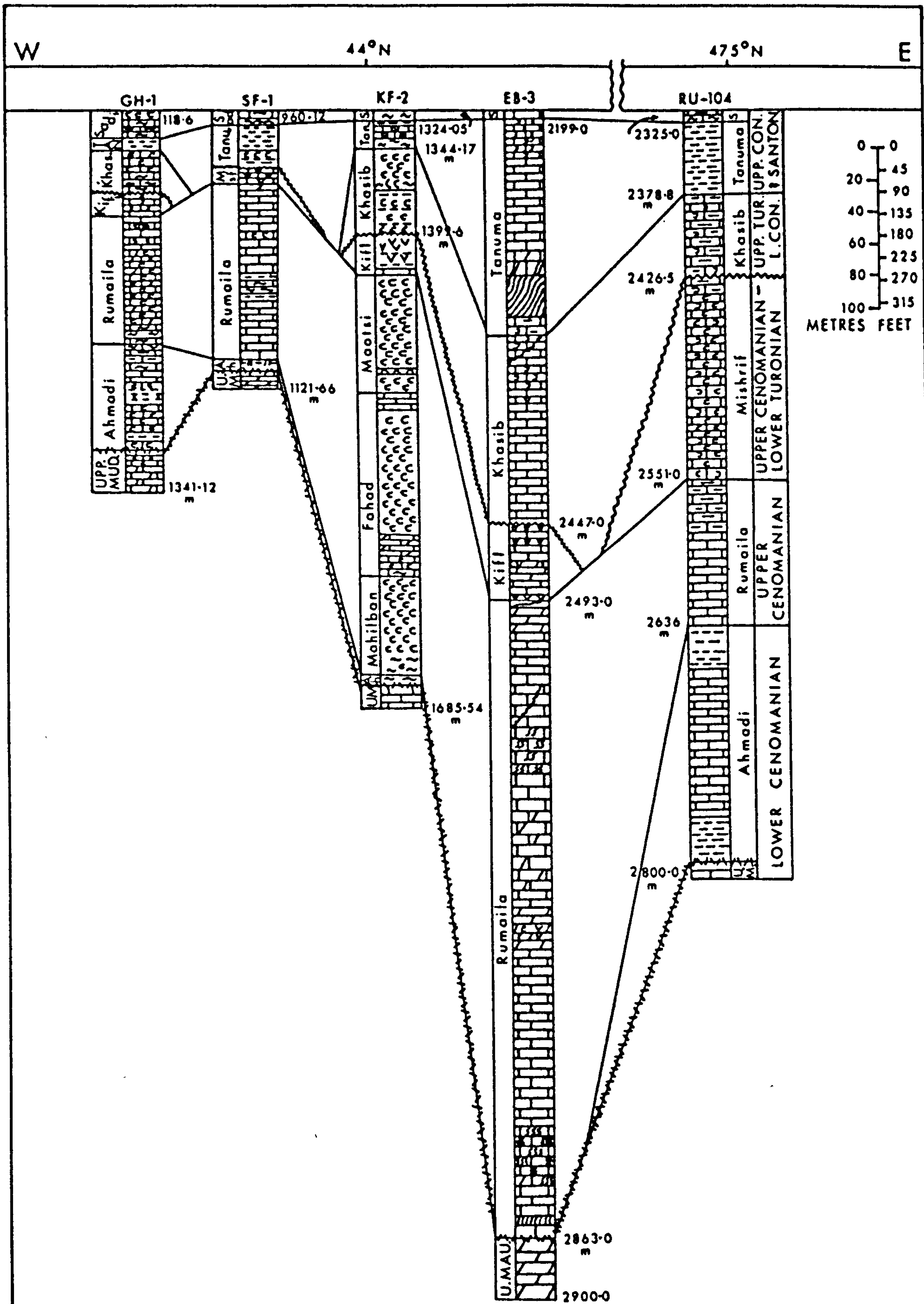


Table 3.5 :- EAST BAGHDAD WELL-3, STRATIGRAPHIC SECTION, drilled and sampled by I.N.O.C.

Table 3.6:-Correlation of Middle and Upper Cretaceous Successions of Iraq and the Adjacent areas.

Description								Author & Locality
Middle Cretaceous					U.Cretaceous		Series	The Present
Lower Cenomanian			U.Cenomanian	U.Cenomanian -L.Turonian	U.Turon. &L.Coniac	U.Coniac -?Santon	Stage	Work
Wasia					Aruma		Group	Iraq
Mauddud	Ahmadi		Rumaila	Mishrif	Khasib	Tanuma	Format-ion	
							Member	(1)
Cenomanian			Turonian		Senonian (?lower)	Upper Senonian	Stage	Southeastern
Wasia					Aruma		Group	Iraq
Mauddud	Wara	Ahmadi	Rumaila	Mishrif	Khasib	Tanuma	Format-ion	Owen &Nasr
							Member	(1958) (2)
Albian	Cenomanian				Upper Campanian		Stage	Southeastern
Wasia					Aruma		Group	Iraq
Mauddud	Wara	Ahmadi	Rumaila	Mishrif	Khasib	Tanuma	Format-ion	Dunnington et.al.
							Member	(1959) (3)
Cenomanian and Lower Turonian					U.Turon.& L.Coniac.	Upper Coniac	Stage	Southeastern
Wasia					Aruma		Group	Iraq
Mauddud	Ahmadi		Rumaila	Mishrif	Khasib	Tanuma	Format-ion	Al-Siddiki (1978)
							Member	(4)
					Upper Turon.	Coniacian	Stage	Southern Iraq
					Aruma		Super Group	
					Sadi		Group	Darmoian
					Shatt al Arab		Format-ion	(1975)
					Khasib Limes.&Shale	Tanuma Shale	Member	(5)
Albian	Cenomanian			U.Cenomanian L.Turonian	Upper Turonian & Coniac - Santon.		Stage	Southern Iraq and area between
Wasia					Aruma		Group	Mussaiyb-
Mauddud	Ahmadi		Rumaila	Mishrif	Khasib	Tanuma	Format-ion	Nahrumr Buday
							Member	(1980) (6)
	Cenomanian			U.Cenomanian			Stage	Rutbah area of western
							Group	desert west-ern
absent	Rutbah Sandstone			M'Sad	absent		Format-ion	Iraq Dunnington
							Member	et.al. (1959)(7)
Albian				U.Cenomanian-Turon.(lower?	U.Turonian and L.Campanian		Stage	Northwestern
							Group	Iraq
Upper Qamchuqa	absent			Gir Bir	Kometan		Format-ion	Kadouri (1978)
							Member	(8)
Albian - Cenomanian					Turonian - Santonian		Stage	Northeastern
							Group	Iraq
Balambo				?	Kometan		Format-ion	Youhanna
							Member	(1976,M.S.) (9)

Description								Author & Locality
Cenomanian			Turonian	Coniacian-Campan.			Stage	Southeastern
Wasia				Aruma			Group	Kuwait
Mauddud	Wara	Ahmadi	Magwa	Gudair			Format-ion	Owen&Nasr (1958)
							Member	(10)
U.Albian	Lower Cenomanian	Upper Cenomanian	Santonian-Campan.				Stage	Kuwait-Saudi Arabia Neut-
Wasia				Aruma			Group	ral Zone, off shore area
Mauddud	Wara	Ahmadi	Rumaila	Mishrif	Gudair		Format-ion	Lautfi&Jaber (1970)
		L.Ahma. Limes.	U.Ahma. Shale	L.Ruma. Limes.	U.Rumaila Shale		Member	(11)
Albian	?	Cenomanian	?	Turonian	Santonian ?		Stage	Kuwait
Wasia				Aruma			Group	Al-Abdul-
Mauddud	Wara	Ahmadi	Rumaila	Mishrif	Gudair		Format-ion	Razzaq (1977, M.S.)
		L.Ahma Limes.	U.Ahma Shale				Member	(12)
Cenomanian-Turonian		?Campa.					Stage	Oman
Wasia				Aruma			Group	Pres.Comun.
Natih				absent	Fiqa		Format-ion	Athersuch
'g' + 'f+e'	'd' - 'c'	'b' - 'a'		L.	U.		Member	(13)
Cenomanian	Turonian		L.Camp.-Maast.				Stage	Saudi Arabia
Wasia				Aruma			Group	Powers
		Wasia	Absent	Aruma			Format-ion	(1968)
Mauddud	Wara	Ahmadi	Rumaila	Mishrif			Member	(14)
Cenomanian		Coniacian?	Santon.				Stage	Coastal Fars
							Group	Province Iran
Mauddud	Ahmadi	Mishrif	Laffan	Ilam			Format-ion	Grosdidier (1973)
							Member	(15)
Cenomanian	Turonian?		Santon.-Campan.				Stage	Coastal Fars
Bangestan							Group	Province Iran
Saravak		absent	Ilam				Format-ion	James&Wynd (1965)
Mauddud	Ahmadi						Member	(16)
Cenomanian - Turonian ?		Santon.-Campan.					Stage	Khuzestan
Bangestan							Group	Province Iran
Sarvak	absent	Ilam					Format-ion	James&Wynd (1965)
							Member	(17)
Albian - Cenomanian	Turonian-?L.Santon.	Santo.-Campan					Stage	Lurestan
Bangestan							Group	Province Iran
Sarvak	Surgah	Ilam					Format-ion	James&Wynd (1965)
							Member	(18)
Albian - Turonian		Santo.-Maast.					Stage	Zagros area (NE, SW Zones)
							Group	Iran Sampo
Sarvak	absent	Gurpi					Format-ion	(1969)
							Member	(19)



Unconformity	ABBREVIATIONS		L. Lower	CON. Coniacian
	GH–1	Ghalaison Well–1	U. Upper	TUR. Turonian
Probable discon formity (small time duration	SF – 1	Safawi Well – 1	MUD. Mauddud Formation	
	KF – 2	Kifi Well – 2	TAN. Tanuma Formation	
	EB – 3	East Baghdad Well–3	AH. Ahmadi Formation	
Line. of correlation	RU–104	South Rumaila Well – 104	MSF. Mishrif Formation	
			SAD. Sadi Formation	

Figure ; 3-1 Stratigraphic Correlation chart between the Wells; GH–1, SF–1, KF–2, EB–3 and RU–104.

CHAPTER - 4

SYSTEMATIC DESCRIPTIONS - A

Classification and Terminology used in description of ostracodes:

The classification followed is that of Moore in the Treatise (1961), with modifications after Apostolescu (1961), Hazel (1967), and Deroo (1966).

Descriptive terms used are mainly those in Moore (1961) and Morkhoven (1962, 1963), with Morkhoven's terms used in hinge description. The terminology of Liebau (1969, 1971), Benson and Sylvester-Bradley (1971), Benson (1972), and Liebau (1977) is used in the description of pore canals and reticulation patterns (fig. 5.1).

Sub class	OSTRACODA	Latreille, 1806
Order	PODOCOPIDA	Muller, 1894
Suborder	PODOCOPINA	Sars, 1866
Superfamily	CYTHERACEA	Baird, 1850
Family	BYTHOCYTHERIDAE	Sars, 1926
Subfamily	BYTHOCYTHERINAE	Sars, 1926

Genus: Bythoceratina Hornibrook, 1953

Type species:

Bythoceratina mestayerae Hornibrook, 1953

Bythoceratina avnonensis Rosenfeld, 1974
pl.1, figs.1-6.

1974 - Bythoceratina avnonensis Rosenfeld, p.10-11, pl.2, figs.6-9.

Diagnosis:

A species of Bythoceratina with a long posterior caudal process pointed dorsally; a reticulate elevated median area divided by a central deep vertical sulcus, the posterior part bears two nodes, a postero-dorsal node and a ventral spinelike node. The anterior and posterior marginal areas are smooth and wide, the ventral margin is smooth.

Figured specimens:

J.T.1-J.T.4.

Material:

Total number of specimens 18. In South Rumaila Well-104 10 specimens have been found: 9 (including 4 broken valves from the Ahmadi Formation at depths between 2636-2750 m; one specimen from the upper part of the Rumaila Formation at depth of 2584 m. 7 specimens are recorded from Ghalaisan well-1, from the lower part of the Ahmadi Formation, at depth of 4185-4300 ft; and one specimen from the uppermost Rumaila Formation, at depth of 3870 ft.

Type Locality:

Hamakhtesh Haqatan (Northern Negev).

Type stratum:

Lower part of the Avnon Mbr (Hazera Fm).

Stratigraphic range:

Upper Cenomanian.

Dimensions:

	L.	H.	W.	L/H.
J.T.1	0.490	0.240	0.330	2.041
J.T.2	0.490	0.240	0.305	2.041
J.T.3	0.520	0.260	0.305	2.0
J.T.4	0.560	0.260	0.305	2.153

Discussion:

Sayyab (1956, M.S.) described this species as Monoceratina compressa from the upper zone of the Middle Cretaceous Strata of the Western Coast of the Arabian Gulf. Rosenfeld and Raab (1974) described the same taxon from the Upper Cenomanian of Palestine.

Bythoceratina avnonensis differs from Bythoceratina umbonella (Bosquet) illustrated by Deroo (1956) from the Upper Maastrichtian of Limbourg in the presence of the posterodorsal node on the posterior lobe, in having a longer and more pointed posterior caudal process proejcted dorsally; wide smooth anterior, posterior and ventral marginal areas, the anterior and posterior areas (lobes) of the mdedian region of valve are more elevated, and in its smaller size.

Occurrence:

Known from the Lower-Upper Cenomanian of South Rumaila Well-104 and Ghalaisan Well-1; "Cenomanian" upper zone of the Middle Cretaceous of the Arabian Gulf; and the Upper Cenomanian of Palestine.

Family CYTHERIDEIDAE Sars, 1925
Subfamily CYTHERIDEINAE Sars, 1925

Genus <u>Isohabrocythere</u> Apostolescu, 1961

<u>Type species</u>:

<u>Isohabrocythere</u> <u>teiskotensis</u> Apostolescu,1961, Pl.I, figs. 15-17; pl.XV, figs. 297, 298.

<u>Isohabrocythere</u> ? <u>aldinawarii</u> sp. nov. pl.2, figs. 1-8.

<u>Name</u>:

After Abu Hanifa al-dinawari, a famous Arabic philologist and scientist of the ninth century.

<u>Diagnosis</u>:

A subovate species of <u>Isohabrocythere</u> with a punctuate surface and a wide compressed crescent shaped anterior marginal zone especially in the right valve. The hinge bar is crenulate.

<u>Holotype</u>:

Male carapace, J.T.5, pl.2, figs.1 and 5.

<u>Paratype</u>:

J.T.6 - J.T.8.

<u>Material</u>:

Total number of specimens 16. 15 specimens have been found in Ghalaisan Well-1 : 3 (including 1 single valve) from the Ahmadi Formation at drilling depths of 4195-4265 ft, one single valve from the Rumaila Formation, at a depth of 3975 ft, one single valve from the Rumaila Formation, at a depth of 3975 ft, one single valve from the basal bed of the Kifl Formation, at a depth of 3835 ft, 7 specimens (including 2 single valves) from the Tanuma Formation at drilling depths of 3715-3725, 3 specimens (including one single valve) from the highest beds of the Khasib Formation at drilling depths of 3730-3745 ft. In South Rumaila

Well-104, one specimen was found in the highest part of the Mishrif, at a drilling depth of 2430 m.

Type Locality:

Ghalaisan Well-1, south western Iraq.

Type Horizon:

Tanuma Formation of Upper Coniacian age, depth of 3720 ft

Stratigraphic range:

Upper Turonian-Coniacian, Cenomanian ? - Lower Turonian ?.

Description:

Carapace subovate in outline. Maximum height lies at the mid length, maximum length at about mid-height. Dorsal margin is curved, sloping more steeply towards the posterior in the right valve than in the left valve; ventral margin is straight; both margins converge toward the posterior end. Anterior margin is broadly and evenly rounded; posterior margin is obliquely rounded, pointed near the ventral margin. No eye tubercle. Left valve larger than the right. Sexual dimorphism is pronouned with more elongate males.

The surface of the carapace is ornamented with fine to coarse dense punctuation, coarsest puncta in the median area of the valves. A wide, compressed crescent-shape antero marginal zone is especially developed in the right valve. The dorsal surface is possibly smooth or fainly punctate. No marginal denticulations are present.

In dorsal view, the carapace has two parallel sides, with a laterally compressed anterior end.

Internally, the anterior marginal area is broad, inner margin and line of concrescence coincide and lie parallel to the outer margin; selvage is pronounced. The hinge structure of the right valve is Priondont, consisting of a crenulate ridge; there are no terminal teeth or sockets. The pore canals and the muscle scars were not observed.

Dimensions: (In mm.)

			L.	H.	W.	L/H.
J.T.5	Male	(holotype)	0.520	0.330	0.260	1.575
J.T.6	Female		0.450	0.305	0.250	1.475
J.T.7	Female		0.450	0.305	0.240	1.475

Discussion:

This species is similar to species of Isohabrocythere Apostolescu (1961) in general outline and shape, and in the wide marginal zone; but it differs in having a crenulate hinge structure, so its generic assignment is still uncertain. Habrocythere Triebel (1940) differs in outline, in having a sinuous and much wider marginal zone and in having a smooth adont hinge.

This species resembles other genera of the subfamily Cytherideinae in general outline, but it differs in the diagnostic internal features.

Occurrence:

Known so far from the Cenomanian-Coniacian of Ghalaisan Well-1, and Lower Turonian (?) of South Rumaila Well-104.

Genus Kuwaitella Al-Abdul-Razzaq, M.S., 1977

Type species:

Kuwaitella turgida Al-Abdul-Razzaq, M.S.,1977 pl.3, figs. 1-8.

Kuwaitella turgida Al-Abdul-Razzaq, M.S.,1977

1977 - *Kuwaitella turgida* Al-Abdul-Razzaq,M.S.,p.215-217. Pl.56, figs. 3, 4; Pl. 57, figs. 1-5.

Diagnosis:

A species of *Kuwaitella* with a sub concentric reticulate surface.

Figured specimens:

J.T.9-J.T.13.

Material:

5 specimens have been found in the upper part of the Ahmadi Formation, at drilling depths of 2688 - 2704 m in South Rumaila Well-104.

Type Locality:

Magwa Field, south eastern Kuwait, Magwa, Well-8.

Type Stratum:

Ahmadi Formation.

Stratigraphic range:

Lower Cenomanian.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T.9	Female	0.540	0.295	0.282	1.830
J.T.10	Female	0.550	0.305	0.282	1.803
J.T.11	Female	0.520	0.305	0.260	1.704
J.T.12	Male	0.582	0.282	0.295	2.063
J.T.13	Male	0.652	0.305	0.350	2.063

Discussion:

This species has been described in the unpublished thesis of Al-Abdul-Razzaq (1977) where it is described as the type species of a new genus Kuwaitella.

The characteristic features of this new but unpublished genus are: a subtriangular outline in lateral view with maximum length at the centre, posterior end subacutely pointed at about mid-height, a distinctly and well developed reticulate surface and no eye tubercle and no marginal denticulations. The hinge is merodont/entomodont. In Al-Abdul-Razzaq's recently published paper (1983) Kuwaitella turgida is referred to as New genus A. Sayyab (1956) found in the lower zone of the Middle Cretaceous strata of the Arabian Gulf Coast specimens identical to this species described and assigned as Clithrocytheridea dunningtoni. Al-Abdul-Razzaq (M.S., 1977) indicated that Clithrocytheridea has a similar hinge to Kuwaitella, however the latter is different in the shape of the vales which in Clithrocytheridea is subtrapezoidal with a rounded posterior. Metacytheropteron Oertli (1957) differs in having a bluntly pointed posterior end, a weak eye tubercle and its surface ornamented with longitudinal ribs.

Haplocytheridea ? fabaformis (Berry, 1925) illustrated by Crane (1965) from Upper Cretaceous of the Gulf Coast area of Texas, Georgia, Arkansas, Alabama differs in surface ornamentation, in having denticulate posterior and anterior margins, greatest length lies ventrally and the posterior end drawn near the ventral margin.

Occurence:

Known from the Lower Cenomanian of South Rumaila Well-104; "Albian" lower zone of the Middle Cretaceous strata of the Arabian Gulf Coast; and Lower Cenomanian of Kuwait.

Genus Ovocytheridea Grekoff, 1951

Type species:

Ovocytheridea nude Grekoff, 1951.

Ovocytheridea baghdadia sp. nov.
pl.4, figs.1-6.

Name:

With reference to the Iraqi capital "Baghdad".

Diagnosis:

A medium sized species of Ovocytheridea with distinct and equally sized punctae on surface except for smooth areas at the anterior, posterior and dorsal margins; a wide distinct shallow sulcus is present in the antero-median area and another less distinct sulcus is present in the postero-median area.

Holotype:

Female left valve, J.T.18, pl.4, fig. 1.

Paratype:

J.T.14 - J.T.17 and J.T.19 - J.T.25.

Material:

Total number of specimens 88; Kifl Well-2, 6 specimens (including 2 single valves and 2 broken valves) from the Tanuma Formation, at drilling depths of 4365-4380 ft; East Baghdad Well-3, 82 specimens, 56 (including 33 single valves mostly filled with sediment and one broken valve) from the lower part of the Tanuma Formation at drilling depths between 2288-2328 m, 5 specimens (including 2 single valves and one broken valve) from the highest and lower parts of the Khasib Formation at depths of 2334-2338 m, 2410-2446 m, 2 single valves from the Kifl Formation at depths of 2448 m, 2488 m and 19 specimens (including 3 broken valves and 2 single valves) from the upper half of the Rumaila Formation, at depths of 2495 m, 2570-2668 m.

Type Locality:

East Baghdad Well-3, middle-eastern Iraq.

Type Horizon:

Khasib Formation of Upper Turonian-Coniacian age, depth of 2300 m.

Stratigraphic range:

Upper Cenomanian-Coniacian.

Description:

Carapace medium sized and thick-shelled, subtriangular to subovate in lateral view. Maximum length runs slightly below the mid-height; maximum height slightly in front of mid-length. Dorsal margin strongly convex and obtusely angled at about the middle in the left valve, in both valves the posterior is slightly longer and steeper than the anterior. Ventral margin weakly convex to almost straight, that of the right valve being always straighter than that of the left; anterior margin is broadly and regularly rounded; posterior margin slightly pointed especially in the left valve. The left valve is very much larger than the right, overlaps it strongly around the entire margin. Sexual dimorphism is distinct with more elongate and larger males.

The shell surface is ornamented by distinct and equally sized puncta except for a smooth surface in the anterior, posterior, and dorsal marginal areas; the ventro-marginal area is nearly smooth with several faint puncta. In a few specimens the surface ornamentation is indistinct because of their poor state of preservation. A wide distinct and shallow sulcus or depression is present in the antero-median area and another narrower less distinct sulcus is present in the postero-median area. These sulci are weaker in the right valve than in the left valve.

Internally, the marginal area is narrow; the inner margin and line of concrescence coincide; selvage prominent. The hinge is Merodont/entomodont; the hinge elements of the left valve are all poorly crenulated with a median bar between a shallow elongate anterior socket and a posterior elongate socket. Above the hinge proper there is a deep and prominent accommodation groove. There is a distinct groove running along the inner margin nearly parallel to the border of the valve except along the mid-dorsal margin. The hinge of the right valve is not easily observed because of the presevation of the material, but appears to consist of elongate poorly crenulate anterior and posterior teeth separated by a finely crenulate median groove. Details ofthe muscle scars are not known.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 14	Male	0.930	0.560	0.450	1.660
J.T. 15	Male	0.910	0.560	0	1.625
J.T. 16	Female	0.700	0.450	0	1.555
J.T. 17	Female	0.790	0.540	0	1.462
J.T. 18	Female (holotype)	0.730	0.470	0	1.553
J.T. 19	Female	0.700	0.470	0	1.489
J.T. 20	Female	0.700	0.450	0.380	1.555
J.T. 21	Female	0.885	0.560	0.470	1.580
J.T. 22	Female	0.815	0.540	0.400	1.5092
J.T. 23	Female	0.770	0.530	0.380	1.452
J.T. 24	Female	0.790	0.530	0.450	1.4905

Discussion:

Ovocytheridea baghdadia sp. nov. shows some resemblance to *Ovocytheridea* IRO_{15} illustrated by Grosdidier (1973) from the Coniacian ? to basal Santonian of the coastal Fars Province in Iran, but it can be easily distinguished from the latter by the presence of prominent antero-median and postero-median sulci, more distinct and coarser punctuation, in having a larger left valve than right with distinct overlap, and larger size. *Ovocytheridea baghdadia* sp. nov. differs from *Ovocytheridea reniformis* Van Bold (1964) illustrated by Rosenfeld and Raab (1974) from the Lower Turonian of Palestine in shape, in having a well-developed

punctate surface with smooth marginal areas, and in the presence of antero and postero-median sulcus.
Ovocytheridea ibnalmutazzi sp. nov. differs from this species in shape and outline, in the presence of a distinct sulcus in the median area of the left valve, in having an almost smooth surface and in the absence of the p ostero-median sulcus.

Occurrence:

Known so far from the Upper Coniacian of Kifl Well-2, and the Cenomanian - Coniacian of East Baghdad Well-3.

Ovocytheridea harunalrashidi sp. nov.
pl.5, figs.1-4.

Name:

After Harun Al-Rashid, the most celebrated of the Abbasid Caliphs of the eigth and ninth centuries.

Diagnosis:

A small species of *Ovocytheridea* with steep posterior slope of the dorsal margin, and subrounded and slightly pointed posterior end. The lateral surface is punctate except for smooth areas along the anterior, posterior and dorsal margins; a shallow sulcus is present in the antero-median area.

Holotype:

Female left valve, J.T. 26, Pl.5, Fig.3.

Paratype:

J.T. 27 - J.T. 28.

Material:

17 specimens from East-Baghdad Well-3, 10 specimens (including 3 single valves) from the lower part of the Tanuma Formation, at depths of 2296-2328 m, one single valve from the basal bed of the Khasib Formation, at a depth of 2446 m, 6 single valves from the upper half of the Rumaila Formation, at depths of 2495-2684 m.

Type Locality:

East Baghdad Well-3, middle eastern Iraq.

Type Horizon:

Khasib Formation of Upper Turonian-Coniacian age, depth of 2328 m.

Stratigraphic range:

Upper Turonian-Coniacian, Cenomanian ? - Lower Turonian.

Description:

Carapace small, thick-shelled subtriangular to subovate in lateral view. Dorsal margin strongly arched with highest point near anterior, posterior slope is long and steep, ventral margin nearly straight; anterior margin rounded; posterior margin subrounded and slightly pointed in the left valve.

The surface of the valve is punctate except for a smooth surface in the anterior, posterior and dorsal marginal areas. A shallow sulcus is present in the antero-median area.

The internal features of the left valve are indistinct because there is another valve inside the sole specimen showing internal features. The hinge elements and the marginal zone are very poorly preserved; the selvage is prominent.

Dimensions: (In mm.)

	L.	H.	W.	L/H.
J.T.26 Female (holotype)	0.540	0.380	0	1.421
J.T.27 Female	0.560	0.380	0	1.473

Discussion:

This species shows some resemblance to Ovocytheridea baghdadia sp. nov.; but differs in being smaller, and in the general outline especially the posterior part of the dorsal margin which is steeper.

Occurrence:

Known so far from the Cenomanian-Coniacian of East Baghdad Well-3.

Ovocytheridea ibnalmutazzi sp. nov.
Pl.5, figs.5-6, Pl.6 figs.1-8.

Name:

After the Al-Mutazz, poet and prince, son of the Khalifa Al-Mutazz, of the ninth and tenth centuries.

Diagnosis:

A species of Ovocytheridea with a smooth surface apart from a few very weak and fine punctae. A distinct broad sulcus lies in the antero-median area in both valves and a broad sulcus is situated in the central area of the left valve.

Holotype:

Male carapce, J.T.31, Pl.6, fig.1, 7,8.

Paratype:

J.T.29 - J.T. 30 and J.T. 32 - J.T. 34.

Materials:

Total number of specimens 16. Kifl Well-2: 12 specimens (including 3 single valves and one broken valve) from the Tanuma Formation at depths of 4355-4380 ft, one single valve from the uppermost Khasib Formation at a depth of 4430 ft, one specimen from the basal part of the Kifl Formation at a depth of 4655 ft, and one specimen and one broken valve from the basal part of the Fahad Formation at depth of 5260-5270 ft.

Type Locality:

Kifl Well-2, middle western Iraq.

Type Horizon:

Tanuma Formation, Upper Coniacian, depth of 4365 ft.

Stratigraphic range:

Upper Coniacian, Cenomanian ? - Turonian ?.

Description:

Carapace thick-shelled, subovate in lateral view; dorsal margin strongly arched, obtusely angled at the middle, with the posterior slope steeper than the anterior in the left valve, anterior slope gently curved in the right valve, posterior slope curved and steeper in the right valve; ventral margin arched in the left valve, nearly straight in the right valve; anterior margin obliquely rounded; posterior margin pointed towards ventre in the left valve, evenly rounded in the right. Maximum length below mid-height; maximum height slightly in front of the mid-length. Sexual dimorphism not observed. Left valve much larger than right and overlaps strongly around the entire margin.

Shell surface is smooth apart from a few very weak and fine puncta. A distinct broad sulcus lies in the antero-median area from the antero-dorsal to the antero ventral areas in both left and right valves and a broad sulcus is situated in the central area of the left valve.

In dorsal view the carapace is inflated towards the posterior, the anterior end in each valve forms a thick lip, so the middle portion appears depressed; maximum width lies posterior to the middle of the carapce; antero-median sulcus of both valves can be clearly observed; the valves are strongly convex and inflated in the posterior half.

Internally, the anterior marginal area is of average width; inner margin and line of conscrescence coincide and run parallel to the outer margin; the selvage is prominent. Hinge is Merodont/entomodont. The terminal elements of the hinge of the right valve are massive and coarsely crenulate, with a thinner median groove between them. The anterior tooth has some 7 cusps, the posterior tooth about 5; the median groove is finely crenulate. The adductor muscle scars are poorly developed, consist of a verticalrow of four scars, although they appear to be two large rounded muscle scars; there is a rounded small depression in front of the adductor muscle scars, and two small antero-dorsal scars (antennal?). The other details are not observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 29		0.825	0.570	0	1.447
J.T. 30		0.790	0.560	0.470	1.4107
J.T. 31	(holotype)	0.780	0.560	0.450	1.392
J.T. 32		0.790	0.560	0.470	1.4107
J.T. 33		0.770	0.540	0.470	1.425

Discussion:

Ovocytheridea AUR 1496, Grekoff (1968) from the Upper Coniacian of Algeria and also recorded by Grosdidier in the Laffan Formation of Coniacian? age of the coastal Fars Province of Iran is similar to Ovocytheridea ibnalmutazzi sp. nov. in the right valve and in the dorsal view, but lacks the median horizontal sulcus of the left valve of Ovocytheridea ibnalmutazzi sp. nov. Sexual dimorphism may be indicated in the illustrations of Grosdidier with larger and more elongate males (♀ L.: 0.71, L/H = 1.314 pl. 4, fig. 27d; ♂ L: 0.75, L/H = 1.480 pl. 4, fig. 27a). The specimens of Ovocytheridea ibnalmutazzi sp. nov. are therefore more similar to Grosdidier's males rather than the females. Ovocytheridea apiformis Reyment (1960) from the Coniacian - Lower Santonian of Nigeria shows some resemblance to this species in outline but differs in having a more obliquely rounded anterior margin, in the absence of the median sulcus in the left valve and antero median sulcus in both valves, in having a shallow broad and vertical sulcus situated nearly in the middle of the right valve, a shallow rounded antero dorsal depression in the left valve, in the presence of large normal Pore Canal openings covering the surface and in its extremely large size.

Occurrence:

Known so far from the Cenomanian Santonian (?) of Kifl Well-2.

Family CYTHERURIDAE Muller, 1884

Subfamily CYTHEROPTERINAE Hanai, 1957

Genus *Eocytheropteron* Alexander, 1933

Type species:

Cytheropteron bilobatum Alexander, 1929

Eocytheropteron ? *ibnalrumii* sp. nov.
Pl.7, figs.1-4.

Name:

After Ali Ibn Al-Rumi, an Arab Poet, of the ninth century.

Diagnosis:

A subtrapezoidal species of *Eocytheropteron* with blunt, narrow posterior margin, lateral surface of strongly developed large retirculation and longitudinal ridgelets along the ventral margin; no eye tubercle.

Holotype:

Carapace, J.T.35, Pl.7, figs.1-4.

Paratype:

J.T. 36.

Material:

2 specimens only from the highest part of the Ahmadi Formation, at drilling depths of 2656-2662 m, from the type locality.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Type Horizon:

Ahmadi Formation of Lower Cenomanian age, depth of
2656 m.

Stratigraphic range:

Lower Cenomanian.

Description:

Carapace subtrapezoidal to subovate in lateral view; greatest length lies at about the mid-height; greatest height anteriorly. Dorsal margin slightly sinuous; ventral margin convex; anterior margin obliquely rounded; ventral margin converges with the dorsal margin posteriorly. Anterior margin obliquely and broadly rounded; posterior margin is narrow and blunt. Left valve is slightly larger than the right. Eye tubercle is absent.

Surface ornamentation consists mainly of a strongly developed reticulation of large subrounded meshes and ridgelets. In ventral view, reticulations are arranged in 3-4 prominent longitudinal rows along the ventral margin with separating ridgelets, the ridgelets are nearly parallel to the line of marginal contact on the ventral surface. A weak marginal rim extends along the anterior, ventral, and posterior margins.

In ventral view the carapace has almost parallel sides with a slightly compressed posterior end. No internal features could be observed.

Dimension: (In mm.)

		L.	H.	W.	L/H.
J.T. 35	(holotype)	0.540	0.330	0.305	1.636

Discussion:

The genetic affinity and definition of this species remains questionable since internal details such as hinge and muscle scar pattern could not be observed and there is an absence of a short posterior caudal process. However, on the basis of its lateral outline and in having an inflated ventrolateral portion of the valve it seems to be related to the genus Eocytheropteron. The lack of a wing-like ventrolateral expansion excludes it from Cytheropteron Sars (1866).

Eocytheropteron ? ibnalrumii sp. nov. is identical to forms found by Athersuch (personal commun.) in the middle part of the Cenomanian of Oman. It shows some resemblance to Eocytheropteron sp. A, but differs in having a strongly developed reticulate lateral surface, in the shape of the posterior end, and in its larger size. Eocytheropteron ? hammanaensis Damotte and Saint Marc (1972) from the Albian of Lebanon can be easily distinguished from Eocytheropteron ? ibnalrumii sp. nov. by its smaller shape and outline, especially the posterior margin, and details of reticulation.

Occurrence:

Known frofm the Lower Cenomanian of South Rumaila Well-104, and from the middle Cenomanian of Oman.

Eocytheropteron retroversicardinatum Al-Abdul-Razzaq, 1980.
Pl.7, figs. 6-10; Pl.8, figs. 1-3.

1980 - Eocytheropteron retroversicadinatum Al-Abdul-Razzaq, p.444-446, Pl.1, figs. 1-8; Pl.2, figs. 1-3.

Diagnosis:

A species of Eocytheropteron with pitted surface and rows of pits between ridgelets developed along the ventral surface; distinct ventrolateral swelling; eye spot weakly developed; posterior caudal process acute. This species is distinguished by a reversal of valve overlap.

Figured specimens:

J.T. 38- J.T.44.

Material:

Total number of specimens 11, all from South Rumaila Well 104. 10 specimens from the lower part of the Ahmadi Formation, at depths between 2704-2788 m; one specimen from the highest beds of the Mauddud Formation at depth of 2794 m.

Type Locality:

Magwa Field, south eastern Kuwait, Magwa Well-8.

Type stratum:

Ahmadi Formation, depth 4195 ft.

Stratigraphic range:

Lower Cenomanina.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 38	Male	0.490	0.260	0.282	1.884
J.T. 39	Female	0.460	0.270	0.282	1.703
J.T. 40	Female	0.425	0.260	0.260	1.634
J.T. 41	Female	0.470	0.295	0.282	1.593
J.T. 42	Female	0.450	0.282	0.305	1.595
J.T. 43	Female	0.490	0.330	0.295	1.484
J.T. 44	Female	0.450	0.282	0.282	1.595

Discussion:

The specimens described here from south eastern Iraq are identical to Eocytheropteron retroversicadinatum from Kuwait. There is variation within the Iraqi material: the posterior caudal process may be shorter and more rounded or longer and more acute; the ventro lateral swelling may be strong with a pronounced edge and showing reversal of valve overlap, other specimens have a less developed ventrolateral swelling and show normal overlap. These differences exist within the Kuwaiti material as shown in the figures 1-4 of Plate 1 (Al-Abdul-Razzaq, 1980). The Kuwaiti specimens also possess reversed hinge structure as well as a normal hinge, but the internal details of the hinge structure are not observed in the Iraqi material because no single valve was found. The specimens with the larger left valve are found together with a those with larger right valve at the same stratigraphic level in Iraq, unlike the situation in Kuwait where they are found at different stratigraphic levels; those at the bottom of the lower Ahmadi Limestone Member have larger left valves while those at the top of the member possess larger right valves.

Al-Abdul-Razzaq (1980) believed the valve reversal to be due to evolutionary changes and not to environmental influences. Al-Abdul-Razzaq indicated that Sayyab (1956) did not record this species. However, he described a new species Cytheropteron burganensis from the lower zone and basal upper zone of the Middle Cretaceous of the Arabian Gulf which is similar to Eocytheropteron retroversicadrinatum although it is slightly larger (L: 0.53 mm) and the ornamentation is better preserved, and is considered in this study to be synonymous with Eocytheropteron retroversicardinatum. Eocytheropteron aff. postilum Lubimova (1965) illustrated by Grosdidier (1973) from the Cenomanian of Iran shows some resemblances, but differs in the absence of valve reversal and in having a blunt posterior end.

Occurrence:

Known so far the Lower Cenomanian of South Rumaila Well-104; Lower Cenomanian of Kuwait; and from the "Albian" lower zone and the base of the Cenomanian upper zone of the Middle Cretaceous of the Arabian Gulf.

Eocytheropteron sp. A
Pl.7, fig. 5.

Figured specimen:

Carapace, J.T. 37, Pl.7, fig. 5.

Material:

One specimen has been found in the basal part of the Lower Cenomanian Ahmadi Formation, at a depth of 2788 m, South Rumaila Well-104.

Description:

Subovate to subrhomboidal in lateral view with a strongly inflated ventro lateral area; dorsal margin moderately arched, ventral margin concave but obscured by the ventrolateral swelling. The posterior end is bluntly pointed into a short caudal process; anterior margin obliquely rounded. The eye tubercle is weakly developed.

The surface of the carapace is ornamented with dense fine to coarse pits. The ventral surface of each valve is ornamented with thin and weak ridgelets extending parallel to the ventral edge and fading posteriorly; rows of faint small pits run parallel to these ridgelets. Internal details could not be obsrved.

Dimension: (In mm).

	L.	H.	W.	L/H.
J.T. 37	0.450	0.282	0.260	1.595

Discussion:

This species is assigned to the genus *Eocytheropteron* because of its lateral outline; swollen ventre without development of a lateral wing; and its short posterior caudal process. This species bears some similarities to *Eocytheropteron retroversicardinatum* described from the Lower Cenomanian of Kuwait by Al-Abdul-Razzaq, 1980, in having a pitted surface, a weakly developed eye tubercle, but it differs in general outline, has shorter caudal process, lacks of a shallow depression behind the eye tubercle and less inflated ventre with a slightly less prominent edge. *Cytheropteron ? (Infracytheropteron) obscura* described by Kaye (1965) from Albian of Britain generally differs in shape and it has a smooth surface, although Kaye's figured specimen in Plate 7, fig. 10 has a similar outline to this species.

Genus Metacytheropteron Oertli, 1957

Type species:

Metacytheropteron elegans Oertli, 1957, Pl.4, figs 116-124.

Metacytheropteron berbericus (Bassoullet and Damotte, 1969) Pl. 8, figs. 4-6, Pl.9, figs. 1-10.

Synonymy:

1959 - Ostracode M_1, Glintzboectel and Magne, Pl.3, fig.22.

1968 - Cytheropteron M_1, Glintzboectel and Magne - Grekoff, p.232, Pl.1, figs. 3 a-b.

1969 - Cytheropteron berbicus Bassoullet and Damotte, p.137-138, Pl. 2, figs. 7 a-d.

1973 - Metacytheropteron parnesi (nonSohn) - Grosdidier, Pl.6, figs. 54 a-e.

1974 - Metacytheropteron berbericum (Bassoullet and Damotte).- Rosenfeld and Raab, P.12, Pl.2, figs 26-28; Pl.5, figs. 3-4.

1975 - Metacytheropteron berbericus (Bassoullet and Damotte).- Colin and El-Dakkak, p.58-59, Pl.2, figs. 8-11.

1977 - Metacytheropteron striata (M.S.) Al-Abdul-Razzaq, p.233-236, Pl. 64, figs. 1-4.

1978 - Metacytheropteron berbericus (Bassoullet and Damotte).- Babinot et al., p.21, Pl.4, fig. 10.

1981 - Metacytheropteron berbericus (Bassoullet and Damotte). - Bismuth et al., 225-226, Pl.8, figs. 7-8.

1983 - Metacytheropteron pleura Al-Furaih, p.2-3, Pl.1, figs. 1,2.

Diagnosis:

A species of Metacytheropteron with straight longitudinal ridges along the ventral part of the carapace and curved ridges along the dorsal part. The venter of the carapace rimmed by a sharp distinct ridge. The posterior margin varies in shape from pointed to having a short blunt caudal process. A smooth area in the antero-dorsal region is sometimes present, and the development of the longitudinal ridges of the carapace varies between specimens. In ventral view, longitudinal ridges are present.

Figured specimens:

J.T.45 - J.T. 54.

Material:

Total number of specimens found is 50. In South Rumaila Well-104, 47 specimens have been found in the Ahmadi Formation, at drilling depths of 2638-2780 m. In Ghalaisan Well-1 specimens have been found from the top of the Ahmadi Formation, at a depth of 4100 ft. In Kifl Well-2 one specimen from the Ahmadi Formation, at a depth of 5495 ft.

Type Locality:

Coupe de l'oued an Namous, sample Ost.2.

Stratigraphic range:

Upper Cenomanian.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 45	Female	0.520	0.282	0.305	1.843
J.T. 46	Female	0.490	0.282	0.260	1.737
J.T. 47	Female	0.480	0.260	0.282	1.846
J.T. 48	Female	0.490	0.282	0.282	1.7375
J.T. 49	Female	0.560	0.305	0.305	1.836
J.T. 50	Female	0.520	0.282	0.282	1.843
J.T. 51	Female	0.550	0.305	0.330	1.803
J.T. 52	Female	0.560	0.315	0.305	1.777
J.T. 53	Male	0.582	0.282	0.330	2.063
J.T. 54	Male	0.560	0.282	0.305	1.985

Discussion:

The specimens described from Iraq show continuous variation in the degree and development of the longitudinal ridges, in the shape of the posterior margin and in the appearance and development of a smooth area in the antero-dorsal region. Such variations are possibly genotypic or could be associated with some environmental factors. Similar variation is seen in material of this species from Algeria, Tunisia, Oman, Iran, Palestine and the Western Portuguese basin. Such differences are considered to be intraspecific and only one species is therefore recognised, i.e. Metacytheropteron berbericus. The Iraqi specimens tend to have a more prominent ventral "ridge" than the type specimens from Algeria. Metacytheropteron striata Al-Abdul-Razzaq (M.S. 1977) from the Ahmadi and Mishrif Formations of Kuwait is identical to the Iraqi material described here and her species is regarded as a junior synonym. Metacytheropteron striata differs from Bassoullet and Damotte's illustration in having a more pointed posterior end produced into a short caudal process and having a sharper ridge along the ventral edge. These differences are slight, lie within the range of variation seen in Metacytheropteron berbericus. Al-Abdul-Razzaq did not discuss the difference between M. striata and M. berbericus, but did remark that M. berbericus is similar to the females of M. striata with almost the same length and height (0.44 mm and 0.24 mm). Metacytheropteron pleura Al-Furaih (1983) from the Cenomanian of Saudi Arabia is identical to this species and is assigned to the synonymy of M. berbericus. Rosenfeld and Raab (1974), Bismuth et al (1981 a) and Colin and El-Dakkah (1975) considered the species illustrated by Grosdidier (1973, Pl.6, figs. 54 a-e) as Metacytheropteron parnesi Sohn to belong to M. berbericus (Basoullet and Damotte). Although Grosdidier's illustration has thicker longitudinal ridges and a blunter posterior end than normal, such differences lie within the variation shown by M. berbericus and it is considered here that Grosdidier's illustration is of M. berbericus. In their original description Bassoullet and Damotte (1969) did not mention sexual dimorphism but their specimens appear to be females (L. 0.445 mm; h: 0.235 mm) when compared with sexual dimorphism now known from Kuwait, Palestine, Egypt, Tunisia, Saudi Arabia and Iraq.

There is some variation in size, with female length ranging between 0.43-0.52 mm and male length between 0.51 and 0.58 mm. The specimens from Kuwait and Saudi Arabia lie in the lower part of the range, while these from Egypt, Palestine and Iraq tend to lie in the higher part of the range. The males from Kuwait are slightly more elongate than those from other areas. Sexual dimorphism is well seen in the Iraqi material with more elongate and larger males (average L/H female = 1.77 of average L/H male = 1.99) (Figs. 6.8, 6.9).

Al-Abdul-Razzaq (1977, M.S.) discussed the differences between her new species Metacytheropteron striata (i.e. Metacytheropteron berbericus (Bassoullet and Damotte) and Metacytheropteron parnesi Sohn (1967, P. 129, 130, Pl. 1, figs. 1-5) from the Lower Cretaceous of Palestine. She pointed out that Sohn's species differs in having a low umbo on the anterodorsal margin, and in having five to six teeth wider than the rest of the crenulated bar of the hinge instead of one knob-like tooth at the anterior end of the median bar of M. striata. In this study it is difficult to comment on the differences between M. parnesi and M. berbericus because the former species has not been studied, but Al-Abdul-Razzaq's conclusions have been followed for the synonymy, i.e. Sohn's species is regarded as a separate taxon.

Sayyab (1956, M.S.) described Eocytherura striata from the Cenomanian upper zone of the Middle Cretaceous strata of the wells along the Western side of the Arabian Gulf and south eastern Iraq which is identical to Metacytheropteron berbericus. Metacytheropteron pagena (Reyment, 1960) illustrated by Van Bold (1964) from the Santonian, shows some similarities in general outline; but can be easily distinguished by its different type of ornamentation and absence of well developed longitudinal ridges.

Occurrence:

Glintzboeckel and Magne (1959) found this species in the highest Vraconian and in the Cenomanian of East Algeria and

Tunisia; it is recorded from the Lower Cenomanian of Algeria by Grekoff (1968), Vraconian-Cenomanian of Tunisia (Bismuth et al., 1981 a), Lower-Upper Cenomanian of Palestine (Rosenfeld and Raab, 1974), Cenomanian of Egypt (Colin and El-Dakkak, 1975), Upper Cenomanian of Western Portuguese basin (Babinot et al., 1978), Cenomanian of Saudi Arabia (Al-Furaih, 1983), Cenomanian to ? Turonian of Kuwait (Al-Abdul-Razzaq, 1977, M.S.), middle-upper Cenomanian of Oman (Athersuch, personal communication) and Upper Cenomanian of Algeria (Bassoullet and Damotte, 1969). In Iraq it is found in the Lower Cenomanian of South Rumaila Well-104, Ghalaisan Well-1, and Kifl Well-2.

<u>Metacytheropteron</u> <u>hevyonensis</u> (Rosenfeld, 1974)
Pl.10, figs. 1-7.

1973 - <u>Metacytheropteron</u> IRC_{10} Grosdidier, Pl.6, figs. 50 a-c.

1974 - <u>Neocythere</u> ? <u>N</u>. <u>hevyonensis</u> Pl. 2, figs. 39-40; Pl.5, figs. 6-7.

<u>Diagnosis</u>:

A species of <u>Metacytheropteron</u> with five short longitudinal ridgelets in the median area which sometimes have pits between them, and four longitudinal ridgelets along the ventral surface; an anterodorsal sulcus is present; no eye tubercle.

<u>Figured specimens</u>:

J.T. 55 - J.T. 58.

<u>Material</u>:

Total number of specimens 10. In East Baghdad Well-3, 8 specimens: 7 specimens from the basal beds of the Rumaila, at depths of 2806-2842 m, one specimen from the uppermost bed of the Mauddud Formation, at a depth of 2865 m. South Rumaila Well-104, 2 specimens from the top bed of the Mauddud Formation, at a depth of 2791 m.

<u>Type Locality</u>:

Hamakhtesh Hagadol (Northern-Negev).

Type Stratum:

Hevyon Mbr. (Hazera Fm).

Stratigraphic range:

Lower Cenomanian.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 55	Female	0.560	0.340	0.350	1.647
J.T. 56	Male	0.610	0.350	6.350	1.742
J.T. 57	Female	0.540	0.350	0.330	1.542
J.T. 58	Female	0.560	0.350	0.305	1.6

Discussion:

This species was described originally by Rosenfeld as Neocythere ? N. hevyonensis in Rosenfeld and Raab (1974) from the Lower Cenomanian of Palestine. Athersuch (Personal communication) found similar forms in the basal strata of the lower Cenomanian age of Oman. Grosdidier (1973) illustrated forms which are identical to this species from the Albian of the Coastal Fars Province in Iran. He named them Metacytheropteron IRC_{10}.

Although the hinge elements could not be observed, the subtriangular almond-shape in lateral view, surface ornamented with longitudinal ridges and the small ventro-lateral swelling, suggests the assignment of this species tentatively to the genus Metacytheropteron. This species lacks the ventrolateral wing-like expansions of Cytheropteron and the prominent ventrolateral swelling of Eocytheropteron; it differs from Neocythere in shape and in details of surface ornamentation which consist of concentric reticulation or punctuation surrounded by coarse wrinkles and nodes.

Occurrence:

Known so far from the basal Cenomanian of South Rumaila Well-104 and East Baghdad Well-3; the Lower Cenomanian of

Palestine; the basal part of the lower Cenomanian of Oman; and the Albian of the Coastal Fars Province of Iran.

Genus Paracytheridea Mueller, 1894

Type species:

Paracytheridea depressa Mueller, 1894

Paracytheridea ibnaltayyibi sp. nov.
Pl.11, figs.1-8.

Name:

After Abdul-Faradj Ibn Al-Tayyib, a famous Arab Physician, Philosopher and Theologian, of the tenth and eleventh century.

Diagnosis:

A species of Paracytheridea in which the surface is reticulate; with three swollen areas; subcentral, postero-ventral and postero-dorsal, the latter having two small tubercles. The posterior caudal process is more prominent in the female.

Holotype:

Female carapace, J.T.59, pl.11,figs.1,2,8.

Paratype:

J.T. 60 - J.T. 62.

Material:

Total number of specimens 10: In Ghalaisan Well-1, 9 specimens, 3 from the Tanuma Formation, at drilling depths of 3720-3725 ft, 4, including one broken carapace, from the Khasib Formation at depths of 3735-3795 ft, one complete specimen and one broken specimen from the uppermost beds of the Rumaila Formation, at depths of 3850-3870 ft; in the Kifl Well-2, one specimen from the top bed of the Tanuma Formation, at depth of 4345 ft.

Type Locality:

Ghalaisan Well-1, south western Iraq.

Type Horizon:

Tanuma Formation of Upper Coniacian age, depth of 3720 ft.

Stratigraphic range:

Upper Turonian - Santonian, Upper Cenomanian ? - Lower Turonian ?.

Description:

Carapace elongate in lateral view with greatest length about mid-height; the dorsal margin is straight extending into a caudal projection, although projection of ornamentation gives a sinuous appearance; ventral margin turning strongly at postero-ventral angle, forming a distinct caudal process. Anterior margin broadly rounded; posterior margin drawn out into a sharply pointed caudal process which is more prominent in the female, the male appearing more tapered towards the posterior. Eye tubercle is large and well developed, situated below the antero-dorsal corner of the valve. Left valve slightly larger than the right valve. Ventral and posteroventral margins rimmed.

In lateral view there are three swollen areas: one in the position of the subcentral tubercle, a second in a postero-ventral position, and the third in the posterior half of the dorsal margin where two small tubercles are situated.

The whole surface is reticulate, mostly small-medium sized 3-4 sided, but with a row of large quadrate reticulation around the anterior margin and a smooth area on the posteroventral part of the caudal process.

In dorsal view the carapace is arrow shaped, compressed at posterior end; maximum width lies at the prominent spine-like postero-ventral swelling of the carapace. No internal features could be observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 59	Female (holotype)	0.520	0.270	0.330	1.925
J.T. 60	Female	0.520	0.260	0.282	2.00
J.T. 61	Male	0.540	0.240	0.305	2.25
J.T. 62	Male	0.540	0.240	0.330	2.25

Discussion:

Paracytheridea toleri Howe and Law (1936) as illustrated by Neufville (1973) from the Lower Eocene of the Sergipe basin (Brazil), differs from *Paracytheridea ibnaltayyibi* sp. nov. in outline, surface ornamentation, and in having a ventrolateral surface which is inflated into a sharp backwardly pointed ala.

Occurrence:

Known from the highest part of the Upper Cenomanian-Coniacian of Ghalaisan Well-1, Santonian (?) of the Kifl Well-2.

Family SCHIZOCYTHERIDAE Howe, 1961

Genus Amphicytherura Butler and Jones, 1957

Type species:

Cytherura ? dubia Israelsky, 1929

Amphicytherura mishrifensis Al-Abdul-Razzaq, M.S., 1977.

1977 - Amphicytherura mishrifensis (M.S.) Al-Abdul-Razzaq, p.222-225, Pl. 59, figs. 1-4.

Diagnosis:

A species of Amphicytherura distinguished by three longitudinal ridges: the dorsal ridge is weak, median ridge prominent, thick and undulate, curving to the posterior, the ventral ridge is well developed, ending posteriorly by a blunt tubercle. A short ridge connects dorsal and median ridge posteriorly. The lateral surface between the ridges is ornamented by irregular and weak reticulation with several tubercles. Eye tubercle prominent, large and rounded. 4 or 5 thin ribs extend almost vertical to posterior rim, and end into the compressed posterior area. Sexual dimorphism is distinct, with males longer than the females.

Figure specimens:

J.T. 63 - J.T.67.

Material:

19 specimens: in the Safawi Well-1, 11 specimens (including 2 broken valves) have been found, 10 specimens from the lower part of the Rumaila Formation, at drilling depths of 3490-3610 ft, one specimen from the Ahmadi Formation at depth of 3625 ft. In Ghalaisan Well-1, 6

specimens from the upper part of the Ahmadi Formation at depths of 4100-4190 ft. Finally in East Baghdad Well-3, one specimen and one broken carapace has been recorded from the upper strata of the Rumaila Formation, at depth of 2562-2590 m.

Type Locality:

Burgan Field, south eastern Kuwait, Burgan Well-342.

Type Stratum:

Mishrif Formation, depth 4390 ft.

Stratigraphic range:

? Turonian.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 63, 64	Female	0.550	0.315	0.282	1.746
J.T. 65	Female	0.560	0.330	0.305	1.696
J.T. 66	Male	0.595	0.330	0.305	1.803
J.T. 67	Male	0.582	0.305	0.282	1.908

Discussion:

Most of the specimens illustrated here from Iraq are badly preserved and deformed. Al-Abdul-Razzaq (1977, M.S.) described Amphicytherura mishrifensis, from the Turonian? Mishrif Formation of south eastern Kuwait. The Iraqi specimens are similar although slightly larger. One specimen has a prominent raised posterior end to the dorsal ridge of the left valve, but this may be due to deformation. Sayyab (1956) did not report any similar form to Amphicytherura mishrifensis from the Cretaceous of the Western Coast of Arabian Gulf. Closely similar species from the Middle East and North Africa are: A. sexta Bold (1964) from the Upper Cenomanian of Egypt and Cenomanian of Palestine, according to Rosenfeld and Raab (1974); Amphicytherura distincta Gerry and Rosenfeld (1973) from the Upper Cenomanian of Palestine (Rosenfeld and Raab, 1974) and

Cenomanian of Tunisia (Bismuth et al., 1981 a) which differs from this species by the presence of a prominent transversal ridge, the centrally depressed outline in dorsal view, and in having thinner median ridge; Amphicytherura aff. bergiguierensis Colin (1974) from the Cenomanian of Tunisia (Bismuth et al.,1981 a) differs from A. mishrifensis by having an obliquely rounded anterior margin, thinner median ridge, smooth lateral surface, and indistinct dorsal and ventral ridges.

Occurrence:

Known from the Cenomanian of Safawi Well-1, Lower Cenomanian of Ghalaisan Well-1, Cenomanian of East Baghdad Well-3; from the ? Turonian of south eastern Kuwait, and a few deformed specimens found in the Cenomanian of northern Kuwait.

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
Subfamily BRACHYCYTHERINAE Puri, 1954

Genus Brachycythere Alexan der, 1933

Type species:

Cythere sphenoides Reuss, 1854.

Brachycythere basrahaensis sp. nov.
Pl.12, figs. 6-8; Pl. 13, figs. 1-8; Pl.14, figs.1-8.

Name:

After Basrah City, southern Iraq.

Diagnosis:

A species of Brachycythere with well developed dense punctae on surface except for a smooth area towards the posterior margin. The punctation sometimes appears to form a network of reticulation.

Holotype:

Female carapace, J.T.84, pl.13,fig.1.

Paratype:

J.T.68-J.T.83, and J.T.85-J.T.93.

Material:

Total number of specimens 122. South Rumaila Well-104, 29 specimens: 15 (including 8 single valves) from the Tanuma Formation, at drilling depths of 2334-2372 m, 12 specimens (including 4 broken valves and six valves) from the Khasib Formation, at depths between 2384-2424 m, 1 single valve from the highest bed of the Mishrif Formation, at a depth of 2428 m, 1 single valve from the basal bed of the Sadi Formation, at a depth of 2328 m. In Ghalaisan

Well-1, 12 specimens: 3 specimens (including 2 broken valves) from the lower half of the Khasib Formation, at depths of 3760-3780 ft, 2 broken valves from the basal bed of the Sadi Formation at a depth of 3700 ft, one broken valve and 2 single valves from the highest bed of the Kifl Formation at a depth of 3805 ft, one compressed specimen from the highest bed of the Mauddud Formation, at a depth of 4330 ft, 2 (including 1 broken valve) from the Rumaila Formation, at depths 3850-3885 ft, one specimen from the Ahmadi Formation, at a depth of 4195 ft. In East Baghdad Well-3, 3 broken specimens have been found in the Tanuma Formation, at depths 2200 m, 2294-2300 m. In Safawi Well-1, 48 specimens: 40 specimens from the lower part of the Tanuma Formaiton, at depths 3205-3250 ft, 6 specimens (including one broken carapace and 2 single valves) from the highest beds of the Mishrif Formation at depths 3255-3260 ft, and one broken carapace and one specimen from the Rumaila Formation, at depths of 3285 ft, 3610 ft. In Kifl Well-2, 30 specimens: 3 specimens (including one single valve) from the basal bed of the Tanuma Formaiton, at a depth of 4405 ft, one broken valve from the basal bed of the Fahad Formation, at a depth of 5255 ft, and 26 specimens from upper part of the Khasib Formation, at depths between 4420-4485 ft.

Type Locality:

Kifl Well-2, middle western Iraq.

Type Horizon:

Khasib Formation, Lower Coniacian, depth of 4470 ft.

Stratigraphic range:

Turonian - Santonian, Cenomanian ?.

Description:

Medium-sized carapace, subtriangular in lateral view; greatest length below mid-height, maximum height in front of mid-length. The dorsal margin is slightly arched at the anterior, straight and flattened along the hinge-line, sloping posteriorly; ventral margin straight, strongly converging with the dorsal margin into the compressed posterior end. The anterior margin is broadly and obliquely rounded; posterior margin triangular with acute end. Left valve larger than right. Eye tubercle present, situated at the anterior cardinal corner of the carapace, with distinct oblique and short sulcus behind it. Sexual dimorphism is very pronounced, whereby the males are more elongated and more drawn out posteriorly than the females and the posterior end pointed more below mid-height in the females rather than in the males.

Surface of the valve ornamented with well-developed and dense puncta, deepest and largest puncta in the median region becoming smaller towards the marginal areas, the surface of the posterior marginal area is smooth, the anterior marginal area varies from partly and finely punctate in some specimens to coarser puntation in other specimens. In a few specimens the median puncta are larger than normal. In some specimens the puncta sometimes appears to form a network of reticulation. The surface ornamentation is weakly preserved in male specimens. Valves are inflated with a ventro-lateral swelling, more pronounced in the right valve.

In dorsal view, the carapace has ovate and swollen sides, with laterally compressed posterior and anterior ends; the maximum width lies centrally; the dorsal margin is smooth.

Internally, the hinge is Amphidont/heterodont, elements of hinge in the left valve consisting of a rounded smooth deep anterior socket closed ventrally by a curved ridge; a well-rounded smooth antero-median tooth, followed by a finely crenulate posterio-median bar, ending with an elongate crenulate posterior socket open ventrally. A broad accommodation groove overlies the bar. Right valve hinge elements consist of a high conical smooth anterior tooth with a lower part forming a ridge running below the deep smooth anterio-median postjacent socket, a finely and obviously crenulate posterio-median groove, ending with an elongate crenulate posterior tooth with 5-6 cusps. The anterior marginal zone is moderately narrow, inner margin and line of concrescence coincident, selvage sub-marginal and prominent, the list and other striation are distinct.

The muscle scars could not be observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T.68,69	Small Female	0.630	0.425	0.350	1.4823
J.T.71	Small Female	0.560	0.380	0.330	1.473
J.T.72	Small Female	0.630	0.425	0.400	1.4823
J.T.73	Small Female	0.630	0.400	0.380	1.575
J.T.74	Small Female	0.610	0.380	0	1.605
J.T.75,76	Small Female	0.640	0.450	0.380	1.422
J.T.77	Small Female	0.625	0.450	0	1.388
J.T.79	Small Female	0.630	0.400	0.350	1.575
J.T.81	Large Female	0.680	0.450	0	1.511
J.T.82	Large Female	0.700	0.450	0.380	1.555
J.T.83	Large Female	0.700	0.460	0.400	1.521
J.T.84	Large Female(holotype)	0.720	0.450	0.380	1.6
J.T.85	Large Female	0.790	0.470	0.450	1.680
J.T.86	Large Female	0.745	0.425	0.380	1.752
J.T.87	Large Female	0.700	0.460	0.400	1.5217
J.T.88	Large Female	0.770	0.450	0	1.711
J.T.89	Large Female	0.815	0.520	0	1.567
J.T.90	Male	0.720	0.350	0.400	2.05
J.T.91	Male	0.630	0.350	0.380	1.8
J.T.92	Male	0.745	0.380	0.380	1.9605
J.T.93	Male	0.720	0.400	0	1.8

Discussion:

Brachycythere basrahaensis sp. nov. differs from Brachycythere gudairensis Al-Abdul-Razzaq (1977, M.S.) from the base of the Santonian Gudair Formation of Kuwait and Brachycythere IRC$_{28}$ Grosdidier (1973) which is identical to Al-Abdul-Razzaq's species in outline of the carapace, in having a subtriangular shape in the females and distinctly tapering shape in the males, more densely developed and coarser punctation, and a more compressed anterior margin. Ostracode T_2 illustrated by Glintzboeckel and Magne (1959) from the lower part of the Campanian of East Algeria and Tunisia appears to be identical to the females of this species, although this cannot be certain without examination of their specimens. Brachycythere cf. sapucariensis Krommelbein (1964) described by Bismuth et al.(1981 a) from the upper half of the Lower Cenomanian to lower half of the Upper Cenomanian of Tunisia differs in the sharper outline of the posterior margin, more compressed anterior and posterior marginal areas, and in having a less densely punctate surface. Brachycythere basrahaensis differs from Brachycythere angulata Grekoff (1951) described by Apostolescu (1961) from the Senonian of Senegal and Ivory Coast, and by Grekoff (1968) from the Coniacian and Santonian of Algeria in having a dense and well-developed punctate surface, a less compressed anterior marginal area, and absence of the posterior and anterior marginal denticulations which are observed in Apostolescu's specimens.

Brachycythere basrahaensis sp. nov. shows size variation within the female specimens, with smaller and larger females. The smaller specimens are adult because they have a strong and well-developed ornamentation, the degree of calcification of the carapace are the same as the larger specimens and they have a well-developed Amphidont hinge identical with that of larger specimens. The smaller specimens have the same stratigraphic range and are found together with the larger specimens in many samples. Fig. 6.1 shows a continuous size range with no distinct breaks. Thus the only difference is size, and only one species is recognised.

Occurrence:

Known from the uppermost Lower Turonian , and Upper Turonian-Santonian of South Rumaila Well-104; Lower Turonian-Santonian and occurs as contaminants in the

Cenomanian of the Ghalaisan Well-1; Coniacian and as contaminants in the ? Lower Cenomanian of Kifl Well-2; uppermost Lower Turonian, Upper Turonian-Coniacian and as contaminants in the Cenomanian of Safawi Well-1; and Upper Coniacian Santonian (?) of East Baghdad Well-3.

Brachycythere ghalaisanaensis sp. nov.
Pl.16, figs.4-5; Pl.17, figs.1-6; Pl.18, figs.1-3.

1973 - "Mehesella" IRC_{23} Grosdidier, Pl.9, figs.76 a-e.

Name:

With reference to the type locality Ghalaisan Well-1, Iraq.

Diagnosis:

A species of Brachycythere with strong dense, fine to coarse punctation, a nearly smooth posterior marginal area; a prominent curved ridge at the base of the ventral swelling; a narrow depression boarding the wide anterior and posterior marginal areas; posterior margin subrounded with a slightly produced blunt end. The anterior and posterior marginal areas are compressed in dorsal view.

Holotype:

Female carapace, J.T. 102, Pl.17, figs. 1,6.

Paratype:

J.T. 101, and J.T.103 - J.T. 111.

Material:

A total of 38 specimens have been found. In Ghalaisan Well-1, 37 specimens: 5 specimens (including 1 single valve) from the basal beds of the Sadi Formation, at drilling depth of 3705-3710 ft, 9 specimens (including 2 single valves) were found in the Tanuma Formation, at drilling depth of 3715-3725 ft, 7 from upper part of the Khasib Formation, at drilling depth of 3730-3740 ft, 7 specimens from the Rumaila Formation, at depths of 3865-4085 ft, and 9 specimens from the Ahmadi Formation, at drilling depths of 4170-4320 ft. One specimen was found in the lowest bed of the Sadi Formation of Kifl Well-2, at a depth of 4340 ft.

Type Locality:

Ghalaisan Well-1, south western Iraq.

Type Horizon:

Khasib Formation, Lower Coniacian, depth of 3735 ft.

Stratigraphic range:

Coniacian - Santonian, Cenomanian ? - Turonian ?.

Description:

Carapace medium, subovate to subreniform in lateral view; greatest height lies in the anterior third, greatest length slightly below the mid-height. Dorsal margin is straight; ventral margin moderately arched, and is partly hidden in lateral view by the ventral swelling of the valves. Anterior margin is broadly rounded; posterior margin sub-rounded with a slightly produced blunt end. Left valve slightly larger than the right. The eye tubercle is large, elongate and visible lying obliquely at the tip of the antero-dorsal corner; a small narrow sulcus is present just behind each eye tubercle.

A very narrow and curved depression borders wide antero-marginal and postero marginal areas.

The surface ornamentation consists of strong dense fine to coarse punctation; a prominent curved ridge is present at the base of the ventral swelling running from the anterior sulcus. The surface of the anterior marginal area varies from finely punctate to being partly coarsely punctate in some specimens; the posterior marginal area has a nearly smooth to partly finely punctate surface although one specimen is distinct punctate. In a few specimens denticulation is present at the ventral part of the posterior margin.

In dorsal view the carapace is oval-shaped with pointed anterior and posterior extremities due to the lateral compression of the antero and postero-marginal areas; maximum width lies in the middle of the carapace. In ventral view the ventral marginal rim and the ventral ridge at the base of the ventral swelling are seen.

Internally, the hinge is Amphidont/heterodont; the elements of the hinge in the left valve are not well preserved because the anterior and the elongate posterior sockets are filled with matrix and the details could not be observed; the anteromedian tooth is smooth and well-rounded, connected above and behind with a smooth postero median bar, with a clear, broad accommodation groove overlying this bar and between it and the dorsal margin. The anterior hinge elements in the right valve are badly preserved, consisting of an anterior tooth which is broken or notched with a postjacent antero median socket closed ventrally. It is difficult to observe the anterior marginal area in the left valve because specimens are filled with sediment; in the right valve the anterior marginal area is indistinct; selvage submarginal and prominent; the coincidence of the line of concrescence and the inner margin is indistinct. The muscle scars could not be observed.

Dimensions:

	L.	H.	W.	L/H.
J.T. 101 Female	0.770	0.470	0.450	1.638
J.T. 102 Female (holotype)	0.840	0.520	0.470	1.615
J.T. 103 Female	0.770	0.470	0.380	1.638
J.T. 104 Female	0.720	0.470	0.470	1.5319
J.T. 105 Female	0.860	0.540	0.470	1.592
J.T. 106 Female	0.950	0.610	0.560	1.5573
J.T. 107 Female	0.910	0.560	0.560	1.625
J.T. 108 Male	0.840	0.490	0.470	1.712
J.T. 109 Male	0.815	0.490	0.470	1.663
J.T. 110 Male	0.815	0.470	0	1.734
J.T. 111 Male	0.980	0.582	0.582	1.683

Discussion:

This species is assigned to Brachycythere Alexander (1933) on the basis of ornamentation, presence of a ventrolateral swelling, type of hinge and presence of an accommodation groove. However this species has a more bluntly pointed posterior end instead of the more typical long drawn out pointed posterior.

Brachycythere ghalaisanaensis sp. nov. resembles Louza amygdaloidea Al-Abdul-Razzaq (1977, M.S.), type species of Louza Al-Abdul-Razzaq in having an Amphidont/heterodont hinge, but they differ in shape, in kind of ornamentation, the pattern of valve overlap, and in having strongly inflated carapace. Grosdidier (1973) illustrated a group of four species, "Mehesella", IRJ_1, "Mehesella" IRE_{31}, "Mehesella" IRC_{23} and "Mehessella" IRE_{30} from the Santonian-Maastrichtian of the coastal Fars Province of Iran. These closely resemble Brachycythere ghalaisanaensis sp. nov. in shape, general outline and in type of ornamentation and it is unlikely that Grosdidier's species belong to Mehessella.

Mehesella Reyment (1960) differs from this species, in having a posterior caudal process, in the type of surface and ornamentation, in shape and outline, and in having a

Merodont hinge. Al-Abdul-Razzaq (1977, M.S.) assigned Grosdidier's species ("Mehesella" IRC$_{23}$; "Mehesella" IRC$_{30}$ to her new genus Louza, although she indicated some differences between her genus and Grosdidier's species. Moreover she had some doubt about the generic assignment. Grosdidier's four species are here regarded as belonging to Brachycythere rather than to Louza or Mehesella.

Grosdidier (1973) illustrated forms as "Mehesella" IRC$_{23}$ from the Santonian of the Coastal Fars Province of Iran which are identical to Brachycythere ghalaisanaensis sp. nov. The species described by Sayyab (1956) as Brachycythere redmondi from the Upper Cretaceous of the Arabian Gulf Coast is conspecific with B. ghalaisanaensis sp. nov; but when studied Sayyab's material has identical forms to this species placed in Hemicythere Sars, 1922-28. Athersuch (personal communication) recorded specimens identical to B. ghalaisanaensis sp. nov. from the upper part of the Turonian - middle part of the Campanian ? of Oman. Brachycythere trahea Al-Furaih (1980) from the Upper Cretaceous of Saudi Arabia resembles Brachycythere ghalaisanaensis sp. nov. very closely in general outline and shape, in having laterally compressed anterior and posterior marginal areas, short oblique eye sulcus and in the type of surface ornamentation. However, Brachycythere trahea differs in having a well developed denticulation along the posterior and anterior margins, having a more elongate posterior margin, better developed ventral ridge, and in the larger size of the females (female Lv, L = 1.023 mm, H: 0.646 mm).

Al-Furaih suggested that Brachycythere redmondi Sayyab (1956, M.S.) from the Arabian Gulf was conspecific with Brachycythere trahea. However, the numerous differences listed above separate the two taxa. Brachycythere ovata Berry (1925) illustrated by Crane (1965) from the Upper Cretaceous of the Gulf Coast area, shows similarities in shape and general outline to B. ghalaisanaensis, but it can be easily distinguished by its ornament of very small and faint puncta covering the surface of the carapace, in the presence of a faint ridge on the ventral swelling of the right valve, and in its larger size.

Occurrence:

Known so far from the Cenomanian-Santonian of Ghalaisan Well-1, the Santonian of Kifl Well-2; Santonian of the Coastal Fars Province of Iran; Upper Cretaceous of the Arabian Gulf; and upper part of the Turonian - middle part of the Campanian ? of Oman.

Brachycythere hatraensis sp. nov.
Pl. 15, figs. 1-7; Pl.16, figs. 1-3.

1973 - Brachycythere IRE_{10}, Grosdidier, Pl. 11, figs. 85 a-f.

Name:

With reference to the old city of Hatra, northern Iraq, 250 B.C.-200 A.D.

Diagnosis:

An elongate to subrounded species of Brachycythere in which the surface of the valve is nearly smooth except for a weak punctation developed in some areas; eye tubercle is indistinct with a short sulcus lying antero-dorsally to it in the left valve; a conspicuous ventrolateral swelling is more prominent in the right; the median area is compressed laterally.

Holotype:

Female carapace, J.T.94, Pl.15, figs. 1,6.

Paratype:

J.T. 95-J.T. 100.

Material:

Total number of specimens 21: Ghalaisan Well-1, 5 specimens, one specimen in the Tanuma Formation from 3720 ft, 2 specimens recorded from upper and basal beds of the

Khasib Formation, at depths of 3740, 3800 ft, one specimen from the highest bed of the Rumaila Formation, at a depth of 3885 ft, and one specimen from the Ahmadi Formation, at depth of 4170 ft. In Kifl Well-2, 15 specimens (including 3 broken valves): 7 specimens (including 2 broken valves) from the basal beds of the Sadi Formation, at depths between 4335-4340 ft, 5 specimens and one broken valve from the Tanuma Formation, at drilling depths of 4345-4380 ft, and 2 specimens from the Khasib Formation, at depths of 4450-4510 ft. Finally, in South Rumaila Well-104, one specimen from the middle bed of the Khasib Formation, at a depth of 2402 m.

Type Locality:

Ghalaisan Well-1, south western Iraq.

Type Horizon:

Khasib Formation, Lower Coniacian, depth of 3740 ft.

Stratigraphic range:

Upper Turonian - Santonian, Cenomanian ? - Lower Turonian ?.

Description:

Medium sized carapace, subtriangular to subrounded in lateral view; greatest length slightly below mid-height; greatest height towards anterior. Dorsal margin strongly curved along the antero-dorsal area, being flatter along hinge line and slopes downwards to the posterior end; ventral margin strongly arched; dorsal margin converging strongly with ventral margin at the posterior; anterior margin broadly rounded; posterior margin subtriangular with subrounded end pointed slightly below mid-height. Sexual dimosphism pronounced with elongate males and subrounded females. Left valve larger than right, overlapping it strongly along the dorsal margin. The eye tubercle is indistinct, left valve with a subrounded oblique, short sulcus lying antero-dorsally to it.

The lateral surface of the valve is nearly smooth except for a weak fine punctation in the posteromedian and dorsomedian areas and a few weak puncta in the antero ventral area and ventro-lateral swelling. A conspicuous ventro-lateral swelling is present, more prominent in the right valve. The median area is compressed laterally.

In dorsal view the carapace is subovate, the two sides converging to the anterior, with laterally compressed anterior and posterior ends; the ventro lateral swelling of each valve is clearly observed, being almost wing-like; maximum width is central. Internal details unknown.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 94	Female (holotype)	0.652	0.460	0.350	1.417
J.T. 95	Female	0.680	0.460	0.380	1.478
J.T. 96	Female	0.670	0.460	0.380	1.4565
J.T. 97	Female	0.652	0.460	0.380	1.417
J.T. 98	Female	0.680	0.470	0.380	1.446
J.T. 99	Male	0.700	0.450	0.380	1.555
J.T.100	Male	0.700	0.450	0.360	1.555

Discussion:

Brachycythere hatraensis sp. nov. is similar to forms illustrated by Grosdidier (1973) as Brachycythere IRE_{10} from the Laffan Formation of Coniacian ? age of the Coastal Fars Province of Iran. Grosdidier regarded it as the characteristic species of that Formation. This species shows some similarity to Brachycythere gudairensis Al-Abdul-Razzaq (1977, unpublished Ph.D. dissertation) from the base of the Santonian Gudair Formation of Kuwait in general outline, but it can be easily distinguished by the presence of a prominent ventro-lateral swelling especially in the right valve, in the surface ornamentation consisting of a nearly smooth surface with fine punctation in some areas of the valve, in the absence of a short eye sulcus lying antero-dorsally in the right valve, female forms being larger than the females of B. gudairensis, and having distinctly compressed median area of the valves. _B. ibnalnafisi_ sp. nov. differs from _B. hatraensis_ sp. nov. in outline, having less laterally compressed posterior and anterior margins, in its larger size, absence of a distinct compressed median area of the carapace which is less associated with a prominent ventrolateral swelling, and the presence of a short antero-dorsal eye sulcus in the right valve as well as the left.

Occurrence:

Known from the Lower Cenomanina-Coniacian of Ghalaisan Well-1, Coniacian-Santonian of Kifl Well-2, Lower Coniacian of South Rumaila Well-104; Coniacian ? of the Coastal Fars Province of Iran.

Brachycythere ibnalnafisi sp. nov.

Pl.18, fig.4; Pl.19, figs. 1-6.

1973 - Brachycythere IRJ_{10} Grosdidier, Pl.11, figs. 86 a-e.

Name:

With reference to Ala Al-Din Ibn Al-Nafis, a distinguished Arab Physician and many-sided author of the 13th Century.

Diagnosis:

A medium to large species of _Brachycythere_ with weakly developed fine punctae on surface; subtriangular to subovate lateral shape; posterior end pointed below the midheight.

Holotype:

Female carapace, J.T.117, Pl.19, Fig.1.

Paratype:

J.T. 112-J.T.116, and J.T.118-J.120.

Material:

Total number of specimens 18. Safawi Well-1, 12 specimens, 9 specimens (including one single valve) from the basal strata of the Sadi Formation at a depth of 3170 ft, and 2 specimens and one single valve from Tanuma Formation at drilling depths of 3175-3180 ft and 3210-3230 ft; Kifl Well-2, 2 specimens from the highest part of the Khasib Formation at a depth of 4430 ft, and 2 specimens from the lower part of the Tanuma Formation at depths of 4390-4396 ft; South Rumaila Well-104, 2 specimens, one from the upper bed of the Tanuma Formation at a depth of 2344 m, the other specimen from the lower part of the Khasib Formation at a depth of 2410 m.

Type Locality:

Safawi Well-1, south western Iraq.

Type Horizon:

Tanuma Formation, Coniacian, depth of 3170 ft.

Stratigraphic range:

Upper Turonian - Coniacian.

Description:

Medium to large carapace, subtriangular to subovate in lateral view; maximum height situated at the anterior; maximum length below mid-height. Dorsl margin strongly arched around the anterior cardinal angle, then flattended and nearly straight along the hinge line, sloping posteriorly; ventral margin slightly arched in the left valve, sinuous in the right valve; both margins strongly converging towards the posterior; anterior margin obliquely rounded; posterior margin triangular with posterior end angulate below mid-height. Left valve larger than right. Sexual dimorphism pronounced with more elongate and larger male. A narrow and a slight compression lying along and parallel to the anterior margin. Valves inflated with a distinct ventrolateral swelling. Eye tubercle weakly developed with small subrounded sulcus situated behind it.

Surface of the valves ornamented by a very finely and weakly developed punctation.

In dorsal view, the carapace sides converge towards the anterior, maximum width lies at about mid valve.

Internally, the anterior marginal area is moderately broad; line of concrescence and inner margin coincide; selvage is sub-marginal and prominent; lists are distinct. The hinge is Amphidont/heterodont; the hinge-elements in the left valve consists of a rounded and smooth anterior socket open ventrally, a conical smooth antero-median tooth, connected behind by a prominently crenulate postero-median bar and ending with an elongate posterior socket open ventrally and crenulate with five well-developed pits; a narrow accommodation groove overlies the median bar. The other internal details could not be observed because the valve was filled with sediment.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 112	Male	0.975	0.610	0.582	1.598
J.T. 113	Male	0.930	0.582	0.582	1.597
J.T. 114	Female	0.815	0.560	0.520	1.455
J.T. 115	Female	0.815	0.582	0.540	1.400
J.T. 116	Female	0.760	0.560	0.490	1.357
J.T. 117	Female -(holotype)	0.770	0.530	0.470	1.452
J.T. 118	Female	0.815	0.540	0.520	1.50
J.T. 119	Female	0.770	0.530	0	1.452
J.T. 120	Female	0.745	0.540	0	1.3796

Discussion:

Grosdidier (1973) illustrated this under the name of Brachycythere IRJ_{10} from the Laffan Formation of Coniacian ? age of the Coastal Fars Province of Iran. He indicated that this species is known from other regions. Grosdidier's illustrations (Pl. 11, fig. 86 a-e) appear to be females when compared with the Iraqi specimens, although they are slightly shorter than the Iraqi females and may have a more pronounced overlap along the antero-cardinal angle. Brachycythere ibnalnafisi sp. nov. is identical to Brachycythere subrhomboidalis Sayyab (unpublished Ph.D. 1956) from the Upper Cretaceous strata of the Arabian Gulf Coast. Brachycythere angulata Grekoff (1951) illustrated by Van Bold (1964) from the Turonian and Santonian of Egypt differs in its much smaller size, in the general outline and having a less prominent ventro-lateral swelling. Brachycythere thlipsicarata Al-Abdul-Razzaq, (1977, unpublished Ph.D. dissertation) from the base of the Santonian Gudair Formation of Kuwait resembles Brachycythere ibnalnafisi sp. nov., but differs in the presence of a ventro-lateral swelling which is a sharp 'keel-like' bend in the right valve, in having well developed and coarser puncta covering the surface especially in the median area, more laterally compressed anterior and posterior marginal areas, in being smaller and the males have a slightly less pointed posterior end. The hinge of the right valve in Brachycythere thlipsicarata Al-Abdul-Razzaq shows a distinct variation in the posterior tooth which differs from being high, elongate and smooth to low, elongate and crenulated.

Dr. Athersuch (personal communication) also recorded Brachycythere thlipsicarata Al-Abdul-Razzaq from the upper half of the Turonian ? Campanian of Oman.

Occurrence:

Known from the Upper Turonian-Coniacian of Safawi Well-1 and South Rumaila Well-104; Upper Coniacian of Kifl Well-2; Coniacian ? of Iran; and Upper Cretaceous Strata of the Arabian Gulf.

Subfamily Buntoniinae Apostolescu, 1961

Genus Buntonia Howe, 1935

Type species:

Buntonia shubutaensis Howe, 1935

Buntonia ibnalbaitari sp. nov.
Pl.20, Figs. 1-7.

1973 - Buntonia IRC_{33}; Grosdidier, Pl.8, figs. 70 a-e.

Name:

With reference to Abd Allah Ibn Al-Baitar, the celebrated Arab botanist and herbal family of Malaga of the twelfth century, who wrote two books which have made his name famous.

Diagnosis:

A species of Buntonia with a smooth surface; three longitudinal ridges, the ventral ridge being thick; a fourth short ridge is present between the median and the ventral ridge; no eye tubercle; a very narrow depressed anterior area behind and parallel to the distinct anterior marginal area.

Holotype:

Female carapace, J.T. 122, Pl.20, fig. 3.

Paratype:

J.T. 121, and J.T.123-J.T. 124.

Material:

6 specimens: Kifl Well-2, middle western Iraq, 5 specimens from the Tanuma Formation, at depths of 4360-4405 ft; South Rumaila Well-104, south eastern Iraq, one specimen occurs in the base of the Sadi Formation at a depth of 2330 m.

Type Locality:

Kifl Well-2, middle western Iraq.

Type Horizon:

Tanuma Formation, Upper Coniacian, depth of 4370 ft.

Stratigraphic range:

Upper Coniacian - Santonian.

Description:

Carapace small, pear-shaped in lateral view. Greatest height at anterior cardinal angle; greatest length at about the middle. Anterior margin broadly and evenly rounded; posterior margin truncate in left valve, subrounded in the right valve. Dorsal margin nearly straight; ventral margin slightly concave typically turned upwards at posterior end. Left valve with pronounced posterior cardinal angle. No eye tubercle could be observed. Left valve larger than right.

A distinct and thickly developed marginal rim extends around the anterior margin, continuing along the ventral margin. A very narrow depressed anterior area is present behind and parallel to the anterior marginal rim.

Main surface ornamentation consists of three pronounced longitudinal ridges; the dorsal ridge commences from just behind a very small depression lying just below dorsal end of the antero-marginal rim, curves upwards and terminates just before the postero-cardinal angle; the median ridge is straight and shorter, starting near the centre of the carapace running approximately parallel to the dorsal and ventral ridges and ending before reaching the depressed posterior area; the ventral ridge is thick and slightly swollen, beginning in the antero-ventral area, and fading into the depressed posterior area at about three quarters of the length towards the posterior. A fourth short ridge is present between the median and ventral ridges and bears a prominent pore cone. The areas between the longitudinal ridges appear compressed.

The entire surface of the carapace is smooth; a few very small pore cones and papillae are present in the posterior area, at the ends of the median and ventral ridges, with faint ones in the anterior area.

In dorsal view, the carapace has sub-parallel sides and laterally compressed ends, maximum width in central area of the valve. In ventral view the ventro-marginal rims are clearly seen. No internal details were seen.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 121	Female	0.490	0.330	0.240	1.484
J.T. 122	Female	0.490	0.315	0.260	1.555
J.T. 123,124	Female	0.490	0.330	0.260	1.484

The specimens seem to be females rather than males when compared with other species belonging to Buntonia.

Discussion:

Grosdidier (1973) illustrated forms which he called Buntonia IRC$_{3,3}$ from the Santonian-Coniacian ? of the Coastal Fars Province in Iran which are identical to Buntonia ibnalbaitari sp. nov. Buntonia (Buntonia?) vanmorkhoveni Reyment (1960) from the Santonian? of Nigeria differs in outline, in having two broad irregular longitudinal ribs, lacks the depressed area behind the anterior marginal rim, has a distinct eye tubercle, the overlap of the left valve along the antero-dorsal margin is more prominent, but along the posterior margin is absent, and the posterior end is more extended.

Buntonia ibnrushdi sp. nov. shows some resemblance to Buntonia ibnalbaitari sp. nov. in shape, but differs in surface ornamentation, lacking the pronounced longitudinal ridges and anterior depressed area and having marginal rim; it is also larger. Buntonia attitogonensis Apostolescu (1961) from the Lower Eocene of Togo and recorded by Grekoff (1968) from the Lower Eocene of Algeria differs from this species in shape and general outline especially of the posterior margin, in the presence of two ridges in the central area of the valve, the lower of which curves upwards to join the upper ridge at its posterior end, and the area between median ridges is punctate.

Occurrence:

This species is known from the Upper Coniacian of Kifl Well-2, Santonian of South Rumaila Well-104; and from the Coniacian ? -Santonian of the Coastal Fars Province in Iran.

Buntonia ibnrushdi sp. nov.
Pl.21, figs. 1-6.

Name:

After Abul-Walid Ibn Rushid, a great Arab Philosopher of Spain and celebrated in mediaeval Europe as Averrose of the twelfth century.

Diagnosis:

A species of Buntonia with longitudinal rows of puncta in the central area; the rest of the valve is smooth. The eye tubercle is weakly developed. A slight ventro-lateral swelling is present. A thin marginal rim is present along the anterior and ventral margins. A distinct small node is situated on the posterior cardinal angle of the left valve.

Holotype:

Male Carapace, J.T. 125, Pl.21, figs. 1,2,5,6.

Paratype:

J.T. 126-J.T. 127.

Material:

3 specimens from South Rumaila Well-104, south eastern Iraq: one specimen from the upper part of the Tanuma Formation, at drilling depth of 2354 m; one specimen from

the basal part of the Khasib Formation at depth of 2416 m; and one specimen from the uppermost beds of the Mishrif Formation, at a depth of 2428 m.

Type Locality:

South Rumaila Well-104.

Type Horizon:

Khasib Formation, Upper Turonian, depth of 2416 m.

Stratigraphic range:

Upper Turonian - Coniacian.

Description:

Carapace pyriform, male more elongate; greatest height at anterior cardinal angle, greatest length passes through the central point. Anterior margin is broadly rounded; posterior margin is truncate; dorsal margin slightly sinuous; ventral margin almost straight to weakly concave, with a very faint convexity centrally in the male. Dorsal and ventral margins converging strongly towards the posterior. A distinct posterior cardinal angle of left valve is distinct and bears a small node. The left valve is larger than the right. The eye tubercle is weakly developed. Sexual dimorphism is pronounced. The central area appears swollen.

A thin marginal rim is present along the anterior margin continuing along the ventral margin to the posteroventral corner.

The lateral surface has 7-9 longitudintal rows of pits or puncta in the central area of the valve; faint ribbing is developed between the median and ventrally placed puncta. A slight ventro-lateral swelling is present; the rest of the surface is smooth.

In dorsal view the sides are convex, with maximum width in the centre; in ventral view the ventro-marginal rim is seen. Internal details could not be observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 125	Male (holotype)	0.630	0.330	0.260	1.909
J.T. 126	Male	0.630	0.315	0.260	2
J.T. 127	Female	0.540	0.305	0.282	1.770

Discussion:

The species described by Sayyab (1956) as Eobuntonia Seminuda from the upper Cretaceous strata of the Arabian Gulf Coast shows a close resemblance to Buntonia ibnrushdi sp. nov. in shape, outline and size, but differs in details of surface ornamentation. Sayyab assigned his new species to a new genus he named Eobuntonia. He regarded this genus as being closely related to Brachycythere. Alexander, 1933; Buntonia Howe, 1935, and Protobuntonia Grekoff, 1954, differing from these in the structure of the hinge. The hinge was described as Amphidont with smooth terminal elements and a faintly crenulate hinge bar which Sayyab regarded as being less advanced than Brachycythere, more advanced than Buntonia and almost in a Protobuntonia stage. A further characteristic of the hinge was that it occupies a position close to the posterior and so the posterior tooth is located close to the angle of curvature.

Eobuntonia could be differentiated from Protobuntonia by its oblongly Pyriform outline and blunt posterior. Buntonia ibnrushdi sp. nov. has been placed in Buntonia on the basis of its external characters; no internal characters could be observed in the Iraqi species studied so the possibility of a new genus is left for future investigation.

The species illustrated by Grosdidier (1973) as Buntonia IRE, from the Coniacian? of the Coastal Fars Province of Iran resembles Buntonia ibnrushdi sp. nov. in shape, general outline, in having compressed anterior area;

but differs in having a completely smooth lateral surface. <u>Buntonia</u> <u>Paucisulcata</u> Al-Furaih, 1980, from the Middle Palaeocene of Saudi Arabia closely resembles this species in ornamentation but differs in lateral outline especially the posterior margin which is pointed, the postero-cardinal angle is less distinct in the left valve, in having fewer longitudinal rows of puncta on the lateral surface, and is larger (male, L: 0.720 mm, female, L: 0.598 mm).

<u>Occurrence</u>:

Known so far from the Upper Turonian - Coniacian, and the uppermost Lower Turonian (♂) of South Rumaila Well-104.

Genus <u>Protobuntonia</u> Grekoff, 1954

<u>Type species</u>:

<u>Protobuntonia</u> numidia Grekoff, 1954

<u>Protobuntonia</u> <u>khasibaensis</u> sp. nov.
pl. 22, figs.1-6.

<u>Name</u>:

After the Khasib Formation from which this species is described.

<u>Diagnosis</u>:

A small species of <u>Protobuntonia</u> with punctate surface except for a smooth area at the posterior; a very feeble eye tubercle with shallow short sulcus behind it; a narrow, shallow sulcus borders and parallels the wide antero-marginal zone.

<u>Holotype</u>:

Female caraapce, J.T. 128, Pl. 21, fig. 1.

<u>Paratype</u>:

J.T. 129 - J.T. 130.

<u>Material</u>:

4 specimens from the middle beds of the Khasib Formation of South Rumaila Well-104, at depths of 2408-2414 m.

<u>Type Locality</u>:

South Rumaila Well-104, south eastern Iraq.

<u>Type Horizon</u>:

Khasib Formation, Upper Turonian, depth of 2408 m.

<u>Stratigraphic range</u>:

Upper Turonian.

Description:

Carapace small, elongate to subtriangular in lateral view, maximum length at about the middle, maximum height in front of the middle. The dorsal margin is nearly straight; ventral margin slightly concave; both margins converge towards the acutely pointed posterior end. The anterior margin is broadly and evenly rounded. The postero-cardinal angle is curved and distinct in the left valve, less distinct in the right. The eye tubercle is very feebly developed. Left valve larger than the right, with overlap strongest anterodorsally, posterodorsally at the upper part of the posterior margin and along the ventral margin.

The lateral surface is punctate except for a smooth area at the posterior. The anterior marginal zone is covered with small puncta, while the rest surface of the carapace is ornamented by a large and strongly developed punctation. A very narrow shallow sulcus borders the wide anteromarginal zone parallel to the margin; another narrow sulcus parallel to the posterior margin bounds the smooth posterior marginal area, especially in the ventral part. A shallow short sulcus lies just behind the feeble eye tubercle.

In dorsal view the carapace is oval with slightly compressed ends, maximum width lies in the middle of the valve; the dorsal surface along the hinge line in both valves is smooth or poorly punctate. Internal features could not be observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 128, 129	Female (holotype)	0.630	0.380	0.305	1.657
J.T. 130	Female	0.610	0.380	0.305	1.605

These species seem to be females rather than males when compared with other species belong to *Protobuntonia*.

Discussion:

Protobuntonia semmamaensis Bismuth & Le Fever (1981 b) recorded by Bismuth et al. (1981 a) from the upper part of the Lower Cenomanian to Middle Cenomanian of Tunisia is similar to this species, but the latter differs in having a more pointed posterior end, more distinct posterior cardinal angle, broader and evenly rounded anterior margin, wider anterior marginal zone with smaller punctation, and the overlap is stronger anterodorsally. Protobuntonia khasibaensis sp. nov. may be descended from the older Protobuntonia semmamaensis. A species reported by Glintzboeckel and Magne, 1959, as Ostracode T_1 from the upper part of Coniacian - lower part of Campanian of Tunisia and East Algeria shows some similarity but differs in possessing a less pointed posterior end, and in the presence of a distinct eye tubercle. Protobuntonia numidica Grekoff (1954) illustrated by Van Bold (1964) from the Santonian of Egypt and by Reyment and Elofson (1959) who designated it as Buntonia (Protobuntonia) numidica (Grekoff) from the Senonian of Tunisia, shows some resemblance to Protobuntonia khasibaensis sp. nov. in general outline, in possessing a pointed posterior end, and in the presence of a distinctly developed punctate lateral surface with smooth posterior marginal area; but Protobuntonia khasibaensis sp. nov. differs in having a very narrow curved sulcus bounding the wide anteromarginal zone, and a short sulcus lying just behind the eye tubercle.

Occurrence:

Known so far from the Upper Turonian - Lower Coniacian of South Rumaila Well-104.

Genus *Soudanella* Apostolescu, 1961

Type species: *Soudanella laciniosa laciniosa* Apostolescu, 1961.

Soudanella ? *alkhansai* sp. nov.
Pl. 23, figs. 1-4; pl. 24, figs. 1-6.

Name:

After Tumadir Al-Khansa, a famous Arab poetess of the sixth century.

Diagnosis:

A species of *Soudanella* in which the surface of the carapace has reticulation and thin ridgelets, apart from smooth areas around the anterior and posterior margins and the short antero-dorsal sulcus; posterior margin narrow sometimes with a pointed end; a faint vertical sulcus is present in the sub-central area.

Holotype:

Male carapace, J.T. 134, pl. 23, figs. 1; pl. 24, fig.6.

Paratype:

J.T. 131 - J.T. 133, and J.T. 135 - J.T. 140.

Material:

Total number of specimens 15 all from South Rumaila Well-104, and found through the upper half of the Ahmadi Formation at drilling depths between 2656 - 2704 m.

Type Locality:

South Rumaila Well-104.

Type Horizon:

Ahmadi Formation of Lower Cenomanian age, depth of 2710 m.

Stratigraphic range:

Lower Cenomanian.

Description:

Carapace small and subtriangular in lateral view; greatest height at the antero-cardinal angle; greatest length lies near to the ventral margin. The dorsal margin is straight; ventral margin straight to slightly convex at its anterior end where it joins the anterior margin; dorsal and ventral margins converging strongly towards posterior. Anterior margin obliquely rounded; posterior margin narrow sometimes with a pointed end. Left valve slightly larger than the right valve. No eye tubercle. The males are more elongate than the female.

Surface ornamentation consists of a network of reticulation and thin ridgelets, formed by the muri of the reticulation meshes. Rows of these ridgelets run more or less parallel to the margins, with less prominent longitudinal ridgelets present in the central area of the valve. The strength of the reticulation varies between specimens. Unornamented areas are present around the anterior and posterior margins and in the short antero-dorsal sulcus near the anterior cardinal angle. A faint vertical sulcus is present in the subcentral area, running from near the dorsl margin to near the ventral margin.

In dorsal view, the carapace is sub-ovate with subparallel sides and narrowly compressed anterior and posterior ends; a smooth dorsal area is seen along the hinge. In ventral view rows of punctation lying parallel and between the longitudinal ridgelets ornament the ventral surface. Internal features were not observed.

Dimensions: (In mm.)

			L.	H.	W.	L/H.
J.T. 131	Male		0.530	0.295	0.260	1.7966
J.T. 132	Male		0.540	0.305	0.260	1.770
J.T. 133	Male		0.550	0.315	0.260	1.746
J.T. 134	Male	(holotype)	0.560	0.305	0.282	1.836

J.T. 135	Male	0.540	0.295	0.260	1.8305
J.T. 136	Female	0.490	0.330	0.260	1.484
J.T. 137	Female	0.520	0.330	0.260	1.575
J.T. 138	Female	0.520	0.330	0.260	1.575
J.T. 139	Female	0.490	0.305	0.240	1.606
J.T. 140	Female	0.540	0.330	0.260	1.636

Discussion:

Sayyab (1956, unpublished doctoral dissertation) described forms identical to Soudanella? alkhansai sp. nov. in the upper zone of the Middle Cretaceous strata of the Western Coast of Arabian Gulf as Hutsonia? trigonia n. sp. While placing the species into the Jurassic genus Hutsonia Swain (1946) on the basis of external appearance, Sayyab admitted that "The affinities of this species are not clear, due to an absence of open valves" (p. 37).

There is some resemblance between this species and some species of the genus Soudanella in shape and general outline, but the lack of the diagnostic internal features make the generic assignment uncertain, and the absence of an eye tubercle also leads to doubts about this generic assignment.

Soudanella? alkhansai sp. nov. shows some affinities with the new genus described by Al-Abdul Razzaq (1977, doctoral dissertation) as Kuwaitella in having a subtriangular outline in lateral view, a reticulate surface, no eye tubercle and no marginal denticulation, and in the maximum height lying at the antero-candinal angle. However, the diagnostic internal features such as hinge-elements and muscle scars pattern were not observed in Soudanella ? alkhansai sp. nov., and greatest length lies near the ventral margin unlike Kuwaitella where it is more central.

Hutsonia ? ascalapha Van Bold (1964) from the Turonian of Egypt differs in shape and outline, in details of surface reticulation, in having a reticulate anterior margin, a clearly distinct vertical sulcus in the subcentral area, and in the absence of the punctation's rows along the ventral surface. *Soudanella alkansai* sp. nov. shows some resemblance to *Soudanella laciniosa reticulata* Apostolescu (1961) from the Palaeocene of the Ivory Coast; but it differs in details of ornamentation and reticulation, in shape and outline, in having an oblique short anterodorsally sulcus and faint vertical subcentral sulcus, thinner longitudinal ridgelets, unornamented anterior and posterior margins and antero-dorsal sulcus, in the absence of an eye tubercle, and in its smaller size.

Occurrence:

Known from the Lower Cenomanian of South Rumaila Well-104, and from the Cenomanian upper zone of the Middle Cretaceous of the Western Coast of Arabian Gulf.

CHAPTER 5

SYSTEMATIC DESCRIPTIONS - B

Classification and Terminology used in description of ostracodes:

The classification followed is that of Moore in the Treatise (1961), with modifications after Apostolescu (1961), Hazel (1967), and Deroo (1966).

Descriptive terms used are mainly those in Moore (1961) and Morkhoven (1962, 1963), with Morkhoven's terms used in hinge description. The terminology of Liebau (1969, 1971), Benson and Sylvester-Bradley (1971), Benson (1972), and Liebau (1977) is used in the description of pore cones and reticulation patterns (fig. 5.1).

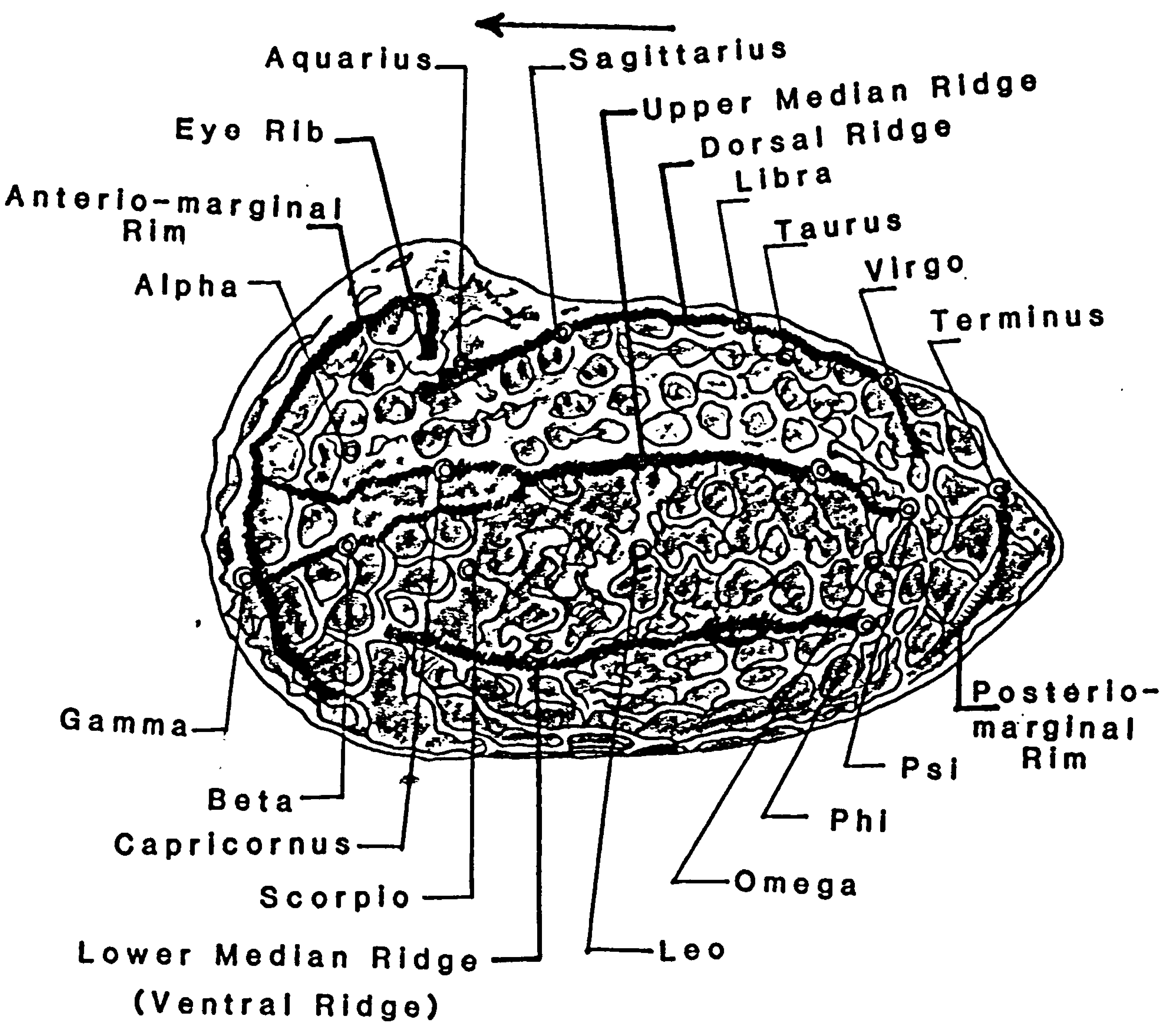


Fig.5.1 Morphology of the left valve of <u>Archeocosta alkazwinii</u> Al-Bashir and Keen(1984)showing the main ornamental features and principle pore cones,the latter labelled by Zodiacal and Greek names(After Benson,1972,Al-Sheikhly,M.S.,1980,Figs.6,10).

Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948.

Genus *Acanthocythereis* R.C. Howe, 1963

Type species:

Acanthocythereis araneosa R.C. Howe, 1963.

Diagnosis:

Trachyleberidinae in which the surface is reticulate with superimposed spines, indistinct or distinct subcentral tubercle.

Discussion:

Al-Sheikhly (1980, M.S.) recognised a quite distinct group of 4 species from north-eastern and western Iraq, Jordan and Syria as a new sub genus *Acanthocythereis* (*Canthylocythereis*) Al-Sheikhly (1980, M.S.). This is characterised by a distinct subcnetral tubercle, moderately broad marginal area and a non-crenulate posterior tooth. In this study subgenera are not recognised because of the lack of diagnostic internal features such as hinge structure and marginal area,, and the variation in degree of distinction of the subcnetral tubercle is seen to vary within species of the genus.

Acanthocythereis ibnbattutai sp. nov.
pl.26, figs. 1-5.

Name:

After Muhammad Ibn Battuta, a famous fourteenth century Arab traveller and author.

Diagnosis:

Subrectangular species of *Acanthocythereis* in which the entire surface has weakly developed reticulation with superimposed spines, small nodes, and a few normal pore canal openings. A distinct posterior cardinal process is present in the left valve.

Holotype:

Female carapace, J.T. 145, Pl.26, figs. 1, 2, 5.

Paratype:

J.T. 143-J.T.144, and J.T.146-J.T.147.

Material:

9 specimens from South Rumaila Well-104 Section, 3 specimens from the median and basal beds of the Tanuma Formation, at drilling depths of 2350-2354, 2372-2374 m; 4 specimens from the lower part of the Khasib Formation, at depths of 2398-2424 m; and 2 specimens from the highest bed of the Mishrif Formation, from samples at depths 2428-2430 m.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Type Horizon:

Mishrif Formation, Lower Turonian , depth of 2428 m.

Stratigraphic range:

Upper Turonian-Coniacian,Lower Turonian).

Description:

Carapace, small, subquadratic to subrectangular in lateral view; greatest height anteriorly on the antero-cardinal angle, greatest length lying just below the mid-height of the carapace; the ventral margin is straight; the dorsal margin is straight; both margins are subparallel. Anterior margin is broadly and evenly rounded; posterior margin subacutely angular and pointed just below the middle; prominent postero-dorsal marginal angle. The eye tubercle is small and distinct, lying at the antero-dorsal marginal angle. Subcentral tubercle present but not very prominent, lying slightly in front of the mid-length.

Distinct marginal rim extending along the anterior and posterior margins, being better developed at the anterior and ventral parts of the posterior margin than at the dorsal part of the posterior margin. Anteriorly there are two rows of spines or denticles; the outer row consisting of some 8-12 short spines or denticles; the inner row being much less heavily spinose, consisting of some 4-5 pustules or denticles on the antero-marginal rim. The posterior marginal rim has 6 small spines or pustules, strongest at the ventral part; a few small spines are present along the ventral margin in some specimens.

The entire surface is ornamented with weakly developed reticulation, relatively large reticules arranged in row A lying just behind the anterior marginal rim, followed by the second anterior row B of medium subquadratic reticules; smaller reticulation covers the remainder of the surface of carapace. The reticulation is very poorly preserved in some specimens.

Small spines or small nodes and a few normal pore canal openings are associated with the reticulation walls. 5 or 6 prominent but small nodes are present in the dorsal area, one of which is clearly a pore cone; three nodes are at the positions of the "Aquarius", "Sagittarius" and "Virgo" pore cones, "Virgo" present postero-dorsally; the pore cone "Sagittarius" may be more prominent; these nodes are variable in degree of prominence and development within the specimens. A small node lies below the eye tubercle; a small but prominent node or pore cone at "Leo" and a small poorly pronounced node is present at "Sigma" in the median region; at the posterior third two small nodes are present, one at the "Psi" and the other at the "Charon" pore cone; there are approximately 12 or 13 pustules or small spines along the ventro-lateral region, three of them at "Lambda", "Iota" and "Zeta". The subcentral tubercle bears some 5 pustules, two of them lying anteriorly, the ventralmost being the largest.

In dorsal view, the carapace has subparallel sides with laterally compressed ends. Internal features were not observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 143	Female	0.560	0.330	0.282	1.696
J.T. 144	Female	0.490	0.305	0.260	1.606
J.T. 145	Female (holotype)	0.560	0.330	0.260	1.696
J.T. 146	Male	0.595	0.330	0.282	1.803
J.T. 147	Male	0.610	0.330	0.282	1.848

Discussion:

Acanthocythereis (*Canthylocythereis*) *quinquespinosa* and *Acanthocythereis* (*Canthylocythereis*) *taqiyeansis* described by Al-Sheikhly (1980, unpublished Ph.D. thesis) from the Danian of Jordan and the Lower Palaeocene of Syria, show similarities to this species in shape and general outline, but differ in being much larger, in details of reticulation, in having better developed marginal spines and spines on the lateral surface, and in having a more distinct subcentral tubercle.

Acanthocythereis salahii Bassiouni (1969) from the Upper Eocene of Egypt and Oligocene of Libya, differs in general outline, details of ornamentation, and in the absence of a subcentral tubercle. *Acanthocythereis ibnbattutai* sp. nov. differs from *Acanthocythereis* sp. A in general shape and outline, in its smaller size, differs in details of reticulation, in degree of prominence of spines and pustules of the lateral surface and anterior and posterior margins, subcnetral tubercle is slightly more distinct, in having a less prominent eye tubercle and in the presence of a more pronounced postero-cardinal angle. *Acanthocythereis*? n. sp. 2 Salahi (1966) from the Palaeocene of Libya resembles this species, but can be easily distinguished by differences in ornamentation and reticulation, in its larger size, and in having more and better developed marginal spines and spines and pustules on the lateral surface of the valve.

Occurrence:

This species is recorded from the topmost Lower Turonian ? - Coniacian of South Rumaila Well-104, south eastern Iraq.

Acanthocythereis aff. ibnbattutai sp. nov.
pl.26, figs. 6-7.

Figures specimens:

Carapace, J.T. 148, Pl.26, figs. 6-7.

Dimensions: (In mm.)

	L.	H.	W.	L/H.
J.T. 148	0.630	0.330	-	1.909

Discussion:

One specimen only has been found, coming from the top bed of the Khasib Formation, at depth 2379 m, of Upper Turonian-Lower Coniacian of South Rumaila Well-104 section, south eastern Iraq. This specimen resembles Acanthocythereis ibnbattutai in shape and outline but differs in having better developed surface reticulation, which leads to less prominent pore cones, and the subcentral tubercle is also less distinct.

Acanthocythereis ibnkhalduni sp. nov.
pl. 27, figs. 1-3.

Name:

With reference to Abd Al-Rahman Ibn Khaldun, who devoted himself ardently to grammar, language, law and tradition and also to poetry in the fourteenth and fifteenth centuries.

Diagnosis:

A large species of Acanthocythereis with pore cones and some papillae associated with a smooth surface between them, apart from weak reticulation on the subcentral tubercle and the areas below the subcentral tubercle and along the ventral margin; subcentral tubercle has 6 or 7 pore cones and postules; posterior margin obtusely pointed and indistinctly rimmed; anterior margin with rim; both anterior margin and its rim are spinose and denticulate being strongest at the ventral half. Eye tubercle is small, but distinct.

Holotype:

Carapace, J.T. 149, pl. 27, figs. 1-3.

Paratype:

J.T. 150.

Materials:

Two specimens from the uppermost bed of the Mishrif Formation of the South Rumaila Well-104, section, at drilling depth of 2428 m.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Type Horizon:

Mishrif Formation, Lower Turonian , depth of 2428 m.

Stratigraphic range:

Lower Turonian .

Description:

Large carapace tapering towards posterior from greatest height at anterior cardinal angle; anterior margin broad and obliquely rounded; posterior margin rounded, its end obtusely pointed in the middle; maximum length at the mid-height; dorsal margin straight; ventral margin nearly straight. The eye tubercle is small, but distinct located just below the antero-dorsal corner of the valve; sub central tubercle is not very prominent, situated in the antero-central area.

Surface ornamentation consists mainly of pore cones and some papillae, with a smooth surface between them, except for some weak reticulation in the area along the ventral margin, the surface of the subcentral tubercle and the antero-ventral area below the sub central tubercle.

The surface of the dorsal region of carapace has some 15 small and prominent pore cones, some of them are lying in the position of "Aquarius", "Sagitarrius", "Libra", "Aries", "Taurus" and "Virgo" pore cones; the "Sagitarrius" pore cone is more prominent; some 5 or 6 small pore cones and pustules are located just above the middle of the posterior half; the area just below the centre of the valve has 4 small pore cones and postules, the strongest at "Leo"; in the postero-ventral and ventro-median areas there are some 9 postules, four of them lie at position of pore cones "Zeta", "Iota", "Phi", and "Omega"; the surface of the subcentral tubercle has 6 or 7 pore cones, three of them forming a row lying around the anterior part of the subcentral tubercle, in the position of "Alpha" and "Beta" and one lying below the "Beta" pore cone; the other three or four pore cones lie posteriorly.

The Anterior margin has a marginal rim which is strongest and most prominent along the antero-dorsal part; the posterior marginal rim is indistinct. The antero-marginal area is ornamented by 2 rows of short spines and pore cones, the inner row lying upon the antero-marginal rim and consisting of 9 postules or pore cones, stronger and larger in the ventral half, two being at the position of the "Gamma" and "Delta" pore cones; the outer row of antero-marginal spinal spines consists of 10-12 short spines, strongest in the antero-ventral part. The posterior margin has 9 distinct rounded denticulations or postules, usually along the ventral part, one of them present at the position of the "Terminus" pore cone.

In dorsal view the carapace has sub parallel sides, with a laterally compressed posterior end, weakly compressed anterior marginal area; the pore cones along the dorsal margin are parallel to each other in the two valves. No internal details were seen.

Dimension: (In mm.)

	L.	H.	W.	L/H.
J.T. 149 (holotype)	0.865	0.520	0.425	1.7019

Discussion:

This shows similarities to *Acanthocythereis* Howe (1963) and *Echinocythereis* Puri (1954) in general outline and ornamentation; presence of a subcentral tubercle suggests *Acanthocythereis* rather than the *Echinocythereis*, although it probably belongs to neither genus.

Acanthocythereis ibnkhalduni sp. nov. can be easily distinguished from *Acanthocythereis multibulbosa* Al-Furaih, 1980, from the Upper Cretaceous and Lower Palaeocene of Saudi Arabia, by its ornamentation, with a generally smooth surface associated with pore cones and some pustules instead of a reticulate surface with strong pustules in *Acanthocythereis multibulbosa*, smaller and weaker eye tubercle, lack of a small postero-dorsal process, in having pore cones and short marginal spines instead of strong anterior and posterior marginal postules in *A. multibulbosa*, and by its larger size.

Occurrence:

Known so far from topmost Lower Turonian (?) of South Rumaila Well-104.

Acanthocythereis musabnnusairi sp. nov.
pl. 27, figs. 4-9.

Name:

After Musa B. Nusair, Arab governor, conqueror of the Western Maghrib and of Spain. Musa and his troops thereupon entered on a career of successful conquest which ended in the consolidation of Arab power in Norther Africa and Spain in the sixth and seventh centuries.

Diagnosis:

A reticulate species of Acanthocythereis with a few weakly developed pustules; eye tubercle projected upwards with thin eye rib; subcentral tubercle distinct; well developed posterior cardinal process in the left valve.

Holotype:

Male carapace, J.T. 151, Pl.27, figs. 4, 7, 8.

Paratype:

J.T. 152-J.T.153.

Material:

3 specimens found; In Kifl Well-2, 2 specimens from the upper part of the Tanuma Formation, at depths of 4350-4370 ft. In Ghalaisan Well-1, one specimen from the middle part of the Khasib Formation, at a depth of 3760 ft.

Type Locality:

Kifl Well-2, middle western Iraq.

Type Horizon:

Tanuma Formation, Santonian ?, depth of 4350 ft.

Stratigraphic range:

Upper Turonian-Santonian.

Description:

Carapace medium sized, subrectangular in lateral view; greatest length at about middle, greatest height in the region of eye tubercle. Dorsal and ventral margins straight, both margins converging towards the posterior; anterior margin evenly rounded; posterior margin sub-triangular with acute end pointed at mid-height point. Dorsal margin ends posteriorly at well-marked posterior cardinal process in the left valve. Eye tubercle prominent rounded and slightly projecting upwards, with a thin eye rib running vertically from it to end at about mid-height. Subcentral tubercle distinct.

A well developed thin and narrow anterior marginal rim extends around and parallel to the anterior margin; posterior margin has well-developed marginal rim; anterior margin ornamented with row of fine denticulation; the posterior marginal rim has 5 denticles on its ventral half.

Surface ornamentation consists of reticulation with a few weakly developed pustules; the reticulation varies from large and weak quadratic reticules in the first anterior row (A) to smaller subrounded reticules covered the whole surface apart from the subcentral tubercle which is decorated with minute pits. The surface reticulation and the eye rib are very poorly developed in one specimen because of preservation. At the anterior there is a small pore cone at the position of the "Beta" pore cone; two pustules and one pore cone are present in the posterior region; ventrally there are a few small pustules. A small postero-dorsal process is present.

In dorsal view the carapace sides are almost parallel, with laterally compressed ends; subcentral tubercle can be seen clearly. Internal characters not observed.

<u>Dimensions</u>: (In mm.)

			<u>L</u>.	<u>H</u>.	<u>W</u>.	<u>L/H</u>.
J.T. 151	Male	(holotype)	0.650	0.330	0.260	1.969
J.T. 152	Male		0.582	0.282	0.260	2.063
J.T. 153	Female		0.560	0.305	0.240	1.836

<u>Discussion</u>:

This species shows some similarities to <u>Acanthocythereis</u> <u>mustansariya</u> sp. nov. but differs in its smaller size, in having a more pointed posterior end and evenly rounded anterior margin, weakly developed anterior and posterior marginal spines, a well-developed posterior cardinal process in the left valve, a distinct subcentral tubercle, in details of surface reticulation and spines or pustules on the lateral surface, and in the absence of the spines on the anterior marginal rim and along dorsal and ventral margins. Acanthocythereis oxyderca Al-Furaih (1980) from the Middle-Upper Palaeocene of Saudi Arabia, differs from this species in having a more prominent eye tubercle, in the carapace tapering more towards the posterior, in the absence of the small postero-dorsal process and the posterior cardinal process, in details of surface reticulation, thicker anterior rim, in the lacking of a few pustules on the lateral surface, in presence of a dorsal and ventral marginal spines and a more developed anteior and posterior marginal spines.

Occurrence:

Known from the Upper Coniacian-Santonian (?) of Kifl Well-2, and from the Lower Coniacian of Ghalaisan Well-1.

Acanthocythereis mustansariya sp. nov.
pl.28, figs. 1-11.

Name:

With reference to "Mustansariya", a college in Baghdad founded by the Caliph Al-Mustansir in 1232 A.D., it is an example of Abbasid architecture.

Diagnosis:

A species of Acanthocythereis with distinct small postero-dorsal process in the left valve; surface reticulate with a few superimposed small spines or pustules. The anterior marginal area is ornamented by two rows of spines; subcentral tubercle present but not prominent.

Holotype:

Female carapace, J.T. 154, pl.28, figs. 1-5.

Paratype:

J.T. 155-J.T.161.

Material:

Total number of specimens 13. In Ghalaisan Well-1, 12 specimens: 2 specimens from the Tanuma Formation from 3720 ft, one specimen from the highest part of the Khasib Formation from 3735 ft, 5 specimens from Rumaila Formation at depths of 3870-4085 ft, 3 specimens from the Ahmadi Formation at depths 4180-4185 ft, one specimen from the highest bed of the Mauddud Formation, at a depth of 4325 ft. In East Baghdad Well-3, only one broken valve has been found from the upper part of the Rumaila Formation, at a depth of 2608 m.

Type Locality:

Ghalaisan Well-1, south western Iraq.

Type Horizon:

Tanuma Formation of Upper Coniacian, depth of 3720 ft.

Stratigraphic range:

Coniacian, Cenomanian ?.

Description:

Carapace medium sized, subrectangular in lateral outline, greatest height at the position of the eye tubercle, greatest length passes through the middle of the carapace. Anterior margin obliquely rounded; posterior margin subacutely pointed at about mid-height; dorsal margin straight; ventral margin straight to slightly convex at the anterior; dorsal and ventral margins subparallel and converging towards the posterior. Posterior cardinal angle obtusely angled, being better developed in the left valve than in the right. Sexual dimorphism is pronouned with more elongate males than the females. Eye tubercle distinct and spherical, situated at the antero-dorsal corner. Sub-central tubercle is present but not prominent. The small postero-dorsal process is distinct in the left valve, but is weaker in the right valve.

Antero-marginal rim prominent, running from the eye tubercle around the anterior margin and finishing ventrally; a slight depressed antero-marginal area lying behind and below the anterior rim. The antero-marginal area is ornamented by two rows of spines; the inner row lies on the marginal rim and consists of some 5 rounded small spines or pustules, which are developed on the ventral part of the anterior rim; the outer row of spines consists of some 10-11 short spines. The postero-marginal rim has 6 pustules or small rounded spines on its ventral half and on the lower dorsal half. Many pustules present along the ventral margin and weak pustules along the dorsal margin.

The surface ornamentation consists mainly of a combination of reticulation with a few superimposed small rounded spines or pustules at the intersection of some of the muri. The reticulation varies from large and subquadrate fossae in the first row (A), smaller sub-quadrate fossae in the last posterior rows, to rounded-subrounded fossae covering the rest of the surface. The subcentral reticulation is variable with micro reticules (small pits) or with small reticules sometimes with superimposed pustules. Posteriorly there are approximately 8 small pustules or spines; many small pustules in the anterior, median and ventral areas; these small pustules are weakly developed, therefore it is difficult to see them clearly.

In dorsal view, the carapace has almost parallel sides, with laterally compressed ends. The internal details are unknown.

<u>Dimensions</u>: (In mm.)

		<u>L</u>.	<u>H</u>.	<u>W</u>.	<u>L/H</u>.
J.T. 154	Female (holotype)	0.582	0.330	0.260	1.7636
J.T. 155	Female	0.610	0.330	0.282	1.848
J.T. 156	Male	0.700	0.330	0.282	2.121
J.T. 157	Male	0.680	0.330	0.260	2.060
J.T. 158	Male	0.610	0.305	0.270	2

J.T. 159	Male	0.630	0.282	0.282	2.234
J.T. 160	Male	0.700	0.330	0.282	2.121
J.T. 161	Male	0.745	0.380	0.282	1.960

Discussion:

Acanthocythereis alacer Al-Furaih (1980) from the Lower and Middle Palaeocene of Saudi Arabia closely resembles *Acanthocythereis mustansariya* sp. nov. in shape, outline and in the presence of a few small cojunctive spines on the reticulate lateral surface, but differs in being smaller (i.e. female L: 0.561 mm, H: 0.310 mm; Male L: 0.620 mm, H: 0.313 mm), in having a more distinct postero-dorsal process, in details and arrangement of the lateral surface spines, in the thicker anterior marginal rim, in the slightly less pointed posterior end and pronounced sexual dimorphism. Al-Furaih has discussed the possible affinities of his species with *Acanthocythereis decoris* Siddiqui (1971) from the Middle-Upper Eocene of West Pakistan. Al-Sheikhly (1980, M.S.) recorded *Acanthocythereis alacer* from the (Maastrichtian?) Palaeocene-Lower Eocene of N E Iraq, and suggested that *A. alacer* Al-Furaih was ancestral to *A. decoris* Siddiqui (1971). The specimens described in this study also suggest some phylogenetic relationship, and these three species are probably related forming a lineage with this Coniacian species, the oldest, *A. alacer* Al-Furaih (1980) (Lower and Middle Palaeocene) next, and *A. decoris* (Middle-Upper Eocene) the youngest. *Acanthocythereis prora* Al-Furaih (1980) from the Lower Palaeocene of Saudi Arabia shows some resemblance to this species, but differs in having more developed and higher anterior and posterior marginal rims, lacks the small spines or pustules on the surface, has a distinct subcentral tubercle, differs in detail of reticulation, it has a small mid-dorsal tubercle, and its dorsal and ventral margins converge more strongly towards the posterior especially in the males. *Acanthocythereis stymatoura* Al-Furaih (1980) from the uppermost Maastrichtian and Lower Palaeocene of Saudi Arabia differs in having a well-developed posterior cardinal process in the left valve, having a rather strong mid-dorsal tubercle, prominent subcentral tubercle, more distinct postero-dorsal process, in its smaller size, in details of surface ornamentation, and its posterior anterior and ventral marginal spines are poorly developed.

Occurrence:

Known so far from Cenomanian and Coniacian of Ghalaisan Well-1, and the Upper Cenomanian of East Baghdad Well-3.

Acanthocythereis sp. A
pl.25, figs. 1-3.

Figures specimens:

Carapace, J.T. 141, pl. 25, figs. 1-3.

Material:

Total number of specimens 3. In South Rumaila Well-104, 2 broken specimens have been found in the basal beds of the Khasib Formation, at depth of 2421 m. In Ghalaisan Well-1, South Western Iraq, one broken carapace recorded from the highest stratum of the Tanuma Formation, at depth of 3715 ft.

Dimensions: (In mm.)

	L.	H.	W.	L/H.
J.T. 141	0.690	0.450	0.260	1.533

Discussion:

Only 3 specimens have been found and none of these are complete. It does appear to be quite distinctive and indicates a new species, but lack of material prevents its description. It is triangular in outline with a prominent eye tubercle; the surface is ornamented with large to small reticulation with pustules or small and short spines associated with the reticulation. Well developed anterior and posterior marginal spines are present; the sub central tubercle is indistinct and bears 4 small spines or pustules. The ventral margin appears to be ornamented with small spines. A distinct marginal rim extends along the anterior, ventral and posterior margins, being more prominent at the posterior and anterior margins.

Acanthocythereis (Acanthocytheries) cornioculus Al-Sheikhly (Ph.D., unpublished thesis, 1980) from the Upper Cretaceous-Lower Eocene of Iraq, Jordan, and Syria shows some resemblance in the presence of prominent eye tubercle, but differs in its larger size, in general shape, in stronger reticulation, in number, arrangement and degree of development of marginal spines and presence of spines on the lateral surface.

Acanthocythereis sp. Salahi (1966) from the Lower Eocene of Libya resembles this species in outline, prominent eye tubercle, but differs in details of ornamentation and reticulation, and in its extremely large size, (i.e. 1.50 cm.). It is possible that there is some phylogenetic relationship between Acanthocythereis sp. Salahi or Acanthocythereis (Acanthocythereis) Cornioculus Al-Sheikhly (1980, unpublished Ph.D.) and Acanthocythereis sp. A. Acanthocythereis (Canthylocythereis) quinquespinose Al-Sheikhly (1980), and A. (Canthylocythereis) taqiyeansis Al-Sheikhly from the Danian of Jordan and Lower Palaeocene of Syria differ in details of reticulation and spine arrangement, in having heavier and stronger developed marginal spines and spines on the lateral surface, having a less prominent eye tubercle, in the presence of a distinct subcentral tubercle, in shape and outline, and their larger size. See also Acanthocythereis ibnbattutai sp. nov.

Occurrence:

Known so far from the basal part of the Upper Turonian of South Rumaila Well-104, south eastern Iraq; and from the uppermost of Upper Coniacian of Ghalaisan Well-1, south western Iraq.

Acanthocythereis sp. B.
pl.25, figs. 4-6.

Figured specimens:

Carapace, J.T. 142, Pl. 25, figs. 4-6.

Material:

Two specimens only from the middle bed of the Tanuma Formation, at drilling depth of 2358 m, of the South Rumaila Well-104 section.

Description:

This species is characterised by its larger size compared with most species of Acanthocythereis found in this study, its distinctive elongate lateral outline, pointed posterior end, prominent protruding eye tubercle, prominent postero-dorsal node, spinose anterior and posterior margins with some spines developed along the ventral margin; the subcentral tubercle is indistinct and the lateral surface is covered with small reticulations which are almost absent in the anterior half; a marginal rim runs from the eye tubercle around the anterior, ventral and posterior margins.

Dimensions: (In mm.)

	L.	H.	W.	L/H.
J.T. 142	0.885	0.305	0.260	2.90

Discussion:

This species appears to be a new species, but as one specimen only has been found no new taxon has been created.

Acanthocythereis oxyderca Al-Furaih (1980) from the Middle and Upper Palaeocene of Saudi Arabia resembles this species in general shape, but differs in details of reticulation and spines, with a completely spinos ventral margin, in the degree of prominence, arrangement and size of the spines of the lateral surface and margins, and in having a more distinct cardinal angle.

This differs from Acanthocythereis sp. A in shape and outline, in details of reticulation, and in the details and prominence of spines and pustules of the lateral surface and anterior and posterior margins. Exophthalmocythere oertlii

Babinot (1971) from the Upper Cenomanian of South France shows some similarities to this species.

Occurrence:

Is known so far from Upper Coniacian of South Rumaila Well-104 section, south eastern Iraq.

Genus *Actinocythereis* Puri, 1953

Type species:

Cythere exanthemata Ulrich and Bassler, 1904.

Actinocythereis iraqensis Khalaf, 1982.
pl. 41, figs. 1-5.

1982 - *Actinocythereis iraqensis* Khalaf.

Figured specimens:

J.T. 235 - J.T. 236.

Discussion:

2 specimens of this have been found in the Lower Cenomanian of East Baghdad Well-3. This is undoubtedly due to contamination from overlying rocks because *Actinocythereis iraqensis* is a common Middle Miocene species (Khalaf, 1982).

Genus Archeocosta Al-Bashir and Keen, 1984.

Name:

Greek arche, beginning referring to first or earliest of the Costa group.

Diagnosis:

A genus of Trachyleberidinae, with 3 longitudinal ridges in the left valve, 4 ridges in the right valve; dorsal ridge bifurcates at posterior; prominent hinge ear, pointed posterior end, reticulate ornament, denticulate anterior and posterior margins, absence of sub-central tubercle; broad anterior duplicature, Amphidont/heterodont hinge.

Type species:

Archeocosta alkazwinii Al-Bashir and Keen, 1984.

Description:

As only one species is described, see specific description.

Discussion:

Archeocosta Al-Bashir and Keen, 1984 shows similarities in shape and ornament to Cythereis, but the latter differs in having a prominent sub-central tubercle and only three longitudinal ridges while internally the hinge is very different with denticulate anterior and posterior hinge elements. Several species from the Middle East showing similarities to Archeocosta Al-Bashir and Keen, 1984 have been tentatively placed in Dumontina Deroo, 1966 ; however the latter differs markedly in outline and ornamentation with less prominent longitudinal ridges, has a weak subcentral tubercle, no hinge-ear and internally has a hinge with denticulate or lobate anterior and posterior elements. Trachyleberidea Bowen 1953 (emend. Haskins 1963) differs in having a more sharply pointed posterior end, in having only three longitudinal ridges, a more weakly defined surface reticulation, ventral ridge continuous with anterior marginal rim, and internally in having lobate terminal teeth. Hazelina Moos, 1966 has a more bluntly produced posterior end, slightly thicker and more strongly developed longitudinal ridges, the median one of which curves upwards at its posterior to join the dorsal ridge, a prominent sub central tubercle and lobate hinge elements. None of these genera have two small ridges splitting from the posterior end of the dorsal ridge, seen in the left valve, and a short eye rib. The unpublished genus Ordoniya Al-Sheikhly (1980, unpublished Ph.D. thesis) differs in having only three longitudinal ridges, a weak subcentral tubercle, lacks a hinge ear, a ventral ridge continuous with anterior marginal rim, median ridge splits at posterior, strongest part turning downward. The hinge is very similar, but the duplicature is narrower than in new genus.

Archeocosta Al-Bashir and Keen, 1984 shows many similarities to Paracosta Siddiqui 1971, a genus characteristic of the Middle East, North Africa and West Africa from the Maastrichtian to the Oligocene. Two genera have been described, Paracosta Siddiqui, 1971 and Paleocosta Benson, 1977, which Al-Sheikhly (unpublished Ph.D. thesis, 1980) considered to be subgenera, and other closely related genera are Oblitacythereis Benson (1977) and unpublished genus Allocosta Al-Sheikhly (1980). The new genus would appear to be a member of this group of Trachyleberidid genera. Paracosta (Paracosta) and P. (Palecosta) differ from each other principally in the development of the ridges and intercostal reticulation; Paracosta (Paleocosta) has coarser reticulation and more prominent longitudinal ridges. ~~Archeocosta is at the smaller end of size range of Paracosta.~~ Paracosta (Paracosta) is very similar in most details, including the two small ridges bifurcating from the posterior end of the dorsal ridge, which is seen in the left valve, presence of a short eye rib, the crescent shaped anterior tooth of the right valve. Differences are in the asymmetry of Archeocosta Al-Bashir and Keen, 1984 where the ventral ridge is only really present on the right valve, the ridge running from the eye tubercle towards the subcentral area is shorter and less prominent, the two ridges joining the anterior end of the upper median ridge, the lack of the poorly developed fifth ridge of Paracosta (Paleocosta), the upper median ridge of Paracosta bifurcates at its posterior end, a feature not seen in Archeocosta, and the posterior end is always pointed, while in Paracosta it is variable from pointed to blunt. Internally the hinge differs in that Archeocosta has a smooth hinge bar, unlike the crenulate hinge bar of Paracosta (Paracosta). However, this character may be due to preservation; certainly many species of Paracosta (Paracosta) also appear to have smooth hinge bars, so too much reliance should not be placed on this observation. The internal marginal area is broader than that of Paracosta. It is possible there is a Phylogenetic relationship between Archeocosta Al-Bashir and Keen, 1984 and the genus Paracosta, and here is considered that Archeocosta is ancestral to Paracosta which is found and developed in the Maastrichtian to the Oligocene. The genus Oblitacythereis Benson (1977) from Miocene-Recent of the Mediterranean and South Atlantic, can be easily distinguished from the Archeocosta in the different antero-marginal area, lacks an eye tubercle and in its coarser reticulation. In addition Oblitacythereis has a much more distinct eye rib. The unpublished genus Allocosta (Al-Sheikhly, 1980) from the Palaeocene and Eocene of the South Shelf of the Tethys, bears some similarities to this new genus; but the latter differs by the presence of well-developed longitudinal ridges, a more prominent anterior marginal rim, in having a pointed posterior end, a less developed eye tubercle, and a very small eye rib, while the much more distinct and long eye rib of Allocosta runs diagonally across the carapace towards the ventral ridge.

<u>Archoecosta</u> <u>alkazwinii</u> Al-Bashir and Keen, 1984.
pl.29, figs. 1-4; pl.30, figs. 1-7; pl.31, figs. 1-8.

1984 - <u>Archeocosta</u> <u>alkazwinii</u> Al-Bashir and Keen, p.83-90, pl.11,84, figs. 1-4; pl.11, 86, figs. 1-4; pl. 11, 88, figs. 1-6; pl. 11, 90, figs. 1-4.

<u>Diagnosis</u>:

A species of genus <u>Archeocosta</u> with upper median ridge of variable length and prominence, with two slight ridges coming from its anterior end towards the anterior margin, strength of reticulation between the two median ridges and at the anterior and posterior is variable; ventral ridge of right valve variable in prominence.

<u>Holotype</u>:

Female carapace, British Museum (Nat. Hist.) no. OS12294.

<u>Paratype</u>:

British Museum (Nat. Hist.) no. OS12293, OS12295 - 12308.

<u>Other Figured Specimens</u>:

J.T. 162 - J.T. 178.

<u>Material</u>:

Total number of specimens: 114. South Rumaila Well-104, south eastern Iraq, 83 specimens have been recorded: 70 specimens (including 6 broken valves and 7 single valves) from the Khasib Formation, at drilling depths of 2379m-2424m below the surface; 7 specimens and 3 broken valves from the Tanuma Formation, at depths of 2340-2374 m; 2 specimens and one broken valve from the top beds of the Mishrif Formation, at depths of 2427-2428m. Kifl Well-2, middle western Iraq, 30 specimens have been reported: 18 specimens (including one single valve and 6 broken valves) from the Khasib Formation at depths of 4420-4585 ft. below the surface; 4 specimens and two broken valves found in the Kifl Formation, at drilling depths of 4605-4655 ft; 2 specimens and one single valve from the Fahad Formation, at depths of 5255-5260 ft; and two and one broken valve from the Maotsi and Maotsi/Fahad Formaitons, at depths of 4900-4905 ft. In Ghalaisan Well-1 section, south western Iraq, one specimen only has been found in the highest bed of the Rumaila Formation, at a depth between 3840-3845 ft.

Type Locality and Type Horizon:

South Rumaila Well-104, south eastern Iraq; Khasib Formation, Lower Coniacian, depth of 2386 m.

Stratigraphic range:

Lower Turonian-Coniacian, Cenomanian ?

Description:

Carapace subtriangular to subrectangular in lateral outline, small-median sized; maximum height at the hinge-ear, maximum length at mid-height. Sexual dimorphism is pronounced with males more elongate than the females, and females have subtriangular shape while the males have rectangular shape. Dorsal margin long and striahgt; ventral margin slightly concave; both margins subparallel and converging posteriorly towards the centrally pointed posterior end; anterior margin evenly rounded, posterior margin triangular and pointed at about the middle. Left valve slightly larger than right, conspicuous overlap only in the region of the postero-dorsal slope of the posterior margin and at the antero-cardinal angle. Eye tubercle is prominent and subspherical, situated at the antero-cardinal angle; a short rib extends downwards ending before reaching mid-height. An anterior hinge ear is present in left valve only, its prominence varying between specimens. No real subcentral tubercle is developed, but in some specimens a slight prominence may be detected.

In dorsal view, the carapace is subovate, maximum width in the centre; some females are more inflated than others, (cf. Pl.30, fig. 7 and Pl.31, figs. 7-8); the posterior end is compressed. There is a weak reticulation along the area between the dorsal ridge and its margin; traces of small reticules are present on the hinge ear. There are three or four longitudinal ridges. A dorsal ridge, an upper median ridge, a lower median ridge which would normally be considered to be the ventral ridge, and a marginal ventral ridge which is easily observed on most right valves although it is sometimes less distinct, usually absent or very indistinct on the left valve although occasionally it may be discerned. A well developed dorsal ridge commences just below and behind the eye tubercle, curving upwards and becoming parallel to the dorsal margin in lateral view; the presence of pore cones on the dorsal ridge gives some specimens a nodular and sinuous appearance; at the posterior a short curved ridge runs from the dorsal ridge to the "Terminus" pore cone; this short ridge varies in prominence between specimens, and in the left valve appears to be the dorsal ridge itself. It might be more correct to regard the dorsal ridge of the left valve as bifurcating at the posterior. The upper median ridge is usually shorter than the dorsal and lower median ridges, varies in thickness and length, starting from a subcentral position, is slightly curved, ending near a pore cone developed just above the "Charon" pore cone or at the "psi" pore cone in which case it appears to be longer.

In most specimens two thin ridges can be seen running from the anterior end of the upper median ridge towards the anterior margin; these are produced by thickening of the reticulation muri. The lower median ridge is usually prominent but is less conspicuous in some specimens, is curved, running from the antero-ventral corner of the carapace and terminating posteriorly just below the position of the "Omega"pore cone. The marginal ventral ridge is only clearly seen on the right valve of both male and female; it is continuous with the posterior marginal rim and at the anterior a branch of it is continuous with the anterior marginal rim, and it converges towards the lower median ridge towards the anterior.

Distinct marginal rims are present along the angerior and posterior margins with small spines or denticles. The anterior marginal rim is prominent with approximately 3-6 small denticles; a depression of varying prominence may be present behind the anterior marginal rim; the anterior margin bears 6-10 denticles. The posterior margin has 5-6 denticles, usually along its ventral part; the posterior marginal rim is not as prominent as the anterior, is continuous with the ventral marginal ridge, and also has a depression in front of it in some specimens.

The surface is reticulate between the longitudinal ridges, and many pore cones can be distinguished. The reticulation may be very weak in some specimens between the two median ridges and also behind the anterior and posterior marginal rims. In some specimens the muri are more strongly developed in certain areas, giving the appearance of small ridges; the two running from the anterior end of the upper median ridge have already been described; another can be seen running downwards from the "psi" pore cone at the end of the upper median ridge (Pl.30, figs. 2,5); others at the anterior give prominent ridge walls parallel to the anterior margin. The reticulation of row A and its ventral continuation is large and subrectangular; the reticulation of row B-E becomes smaller towards the subcentral area, and are rounded to quadratic; medium and rounded to subrounded reticulation covers the remainder of the surface. Normal pore canal openings can be seen, both intramural pores and pore cones. Small but prominent pore cones are present in the posterior, one of them is "Terminus", one lies just above the position of the "Charon" pore cone and another above the position of "psi"; "Omega" is present ventrally. The most prominent anterior pore cones are "Alpha", "Beta", "Capricornus", and "Scorpio" (see Pl. 29, fig. 1). The median surface has one prominent pore cone, i.e. "Leo". "Aquarius", "Sagittarius", "Libra", "Virgo" and "Taurus" pore cones are pronounced at the dorsal; apart from "Taurus" these are arranged along the dorsal ridge. (For definition of the pore conuli see fig. 5.1; Benson, 1972; Al-Sheikhly, 1980, M.S.).

Internally the marginal area is broad; inner margin and line of concrescence coincide, and run parallel to the outer margin; the selvage is distinct. The hinge is Amphidont/hetrodont; the right valve hinge has a smooth anterior tooth with a higher conical dorsal part and a lower ventral part which extends below the postjacent socket, giving a curved tooth in lateral view; the postjacent socket is deep, smooth, and rounded; the median groove appears to be smooth, and the posterior tooth is a large hemispherical boss; the left valve hinge has a deep smooth anterior socket, a postjacent small, smooth conical anteromedian tooth, followed by a smooth postero-median bar, ending with a smooth posterior socket. Muscle scare could not be seen.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 162	Male	0.790	0.400	0.260	1.975
OS 12300	Male	0.720	0.350	0.282	2.057
OS 12303, 12305	Male	0.680	0.350	0.330	1.942
J.T. 163	Male	0.742	0.350	0.282	2.12
J.T. 164	Male	0.720	0.380	0.305	1.894
OS 12301	Male	0.742	0.380	0.330	1.952
OS 12298	Male	0.742	0.400	0.330	1.855
OS 12299	Male	0.720	0.390	0.330	1.846
OS 12306	Male	0.700	0.380	0.282	1.842
J.T. 165	Female	0.582	0.350	0.282	1.662
J.T. 166	Female	0.620	0.380	0.240	1.631
OS 12308	Female	0.630	0.380	0	1.657
OS 12295	Female	0.620	0.350	0.305	1.771
OS 12297	Female	0.640	0.380	0.330	1.6842
J.T. 167	Female	0.610	0.360	0.330	1.694
OS 12294,12310	Female(holotype)	0.630	0.360	0.330	1.75
J.T. 168	Female	0.610	0.380	0.270	1.665
OS 12296	Female	0.582	0.350	0.305	1.662
OS 12309	Female	0.630	0.390	0.350	1.615
J.T. 169	Female	0.582	0.340	0	1.711

J.T. 170		Female	0.582	0.350	0.282	1.662
J.T. 171		Female	0.610	0.360	0.282	1.694
J.T. 172		Female	0.582	0.330	0	1.763
J.T. 173	Small	Female	0.652	0.330	0.282	1.975
J.T. 174	Small	Male	0.652	0.350	0.240	1.862
OS 12302	Small	Male	0.630	0.350	0.330	1.8
OS 12304	Small	Male	0.652	0.350	0.330	1.857
J.T. 175	Small	Female	0.540	0.305	0	1.770
OS 12293	Small	Female	0.540	0.330	0.305	1.636
J.T. 176	Small	Female	0.560	0.315	0.260	1.777
J.T. 177	Small	Female	0.560	0.330	0	1.696
J.T. 178	Small	Female	0.560	0.350	0.260	1.6

Discussion:

Sayyab (1956, unpublished Ph.D. thesis) described a new species Mesocythereis reticulata from the Upper Cretaceous of the Arabian Gulf Coast which is very similar to Archeocosta alkazwinii Al-Bashir and Keen (1984) externally, but internally is described as having a crenulate hinge bar and a reniform posterior tooth. It is not certain how important this difference is, as already mentioned the presence of a crenulate or smooth hinge bar may be dependent upon preservation and also on observation. It is felt that Sayyab's undescribed species is more probably conspecific with Archeocosta alkazwinii Al-Bashir and Keen (1984). "Dumontina" GAE20 illustrated by Grosdidier (1979) from the Lower Turonian of Gabon shows similarities in shape and hinge ear, but has only three longitudinal ridges which are longer than in Archeocosta alkazwinii Al-Bashir and Keen (1984), the median ridge is more inclined, almost meeting the dorsal ridge at the posterior, and there is a weak subcentral tubercle. Haughtonileberis ? GAF15 identified by Grosdidier (1979) from the Upper Cenomanian and Lower Turonian of Gabon has some resemblance to this species, but differs in details of reticulation, in having an elongate subcnetral tubercle, a thicker and longer median ridge. Two species of Paracosta (Paracosta) show some resemblance to A. alkazwinii Al-Bashir and Keen (1984); Paracosta (Paracosta) declivis Siddiqui, 1971 from the Upper Eocene of Pakistan however lacks the anterior hinge ear and has a much longer upper median ridge, and Paracosta (Paracosta) arabica (Bassiouni, 1969) from the Palaeocene-Middle Eocene of Syria, north western Iraq and Libya has a more bluntly rounded posterior margin, a very weak anterior hinge ear, less prominent longitudinal ridges with more prominent reticulation.

The species shows considerable range in size, female length ranging between 0.540 mm and 0.640 mm, male length 0.630-0.740 mm (fig. 6.7). The smaller individuals are heavily calcified, have the same ornamentaiton as the larger specimens, and have a fully developed Amphidont hinge; they therefore appear to be adults; smaller and larger individuals are found in the same sample (carapace Pl.29, fig. 1, a small form, L = 0.540 mm with the holotype Pl.29, fig. 4 L = 0.630 mm).

Occurrence:

This species is known so far from the Turonian and Santonian (?) of South Rumaila Well-104; Cenomanian, Turonian and Lower Coniacian of Kifl Well-2; and from the highest part of the Upper Cenomanian of Ghalaisan Well-1. It is found in the Upper Cretaceous of the Arabian Gulf Coast.

Genus Curfsina Deroo 1966

Type species:

Cythereis maior Van Veen, 1936.

Curfsina alkarkhii sp. nov.
pl.32, figs. 1-6.

Name:

After Abu Bakr Muhammad Al-Karkhi, a famous Arab mathematician of the tenth and beginning of the eleventh century.

Diagnosis:

A species of Curfsina with prominent dorsal and ventral ridges, both of which downturn at posterior; dorsal ridge with median pore cone; median ridge not really present; with elongate subcentral tubercle plus posterior and median pore cones; lateral surface has fine punctation which is stronger in the left valve.

Holotype:

Carapace, J.T. 194, plk. 32, figs. 1-6.

Paratype:

J.T. 195.

Material:

2 specimens from the Upper part of the Tanuma Formation of South Rumaila Well-104 section, south eastern Iraq, at drilling depth of 2348 m.

Type Locality:

South Rumaila Well-104.

Type Horizon:

Tanuma Formation, Upper Coniacian, depth of 2348 m.

Stratigraphic range:

Upper Coniacian.

Description:

Carapace medium-sized, subrectangular in lateral outline. Anterior margin broadly rounded, with gentler curvature in its dorsal part; posterior margin elongate, sharply angular and pointed below the middle nearer the venter. Dorsal and ventral margins straight and sub-parallel, converging towards the posterior. Eye tubercle small, rounded and pronounced at the antero-cardinal corner. Sub central tubercle is subovate situated just in front of the centre of the valve and slightly anterior to the centre. Anterior and posterior marginal areas are depressed laterally.

The lateral surface is ornamented by a fine punctation, stronger on the left valve, while the surface of the anterior and posterior depressed marginal areas are mainly smooth or may be very faintly punctate, apart from the presence of a row of "ghost" reticulation just behind the anterior marginal rim and just below the dorsal ridge; the region between the anterior margin and its rim is covered with subquadrate reticulation extending from behind the eye tubercle and finishing ventrally.

There are three prominent small pore cones present on the lateral surface, "Leo" in the median area, "Scorpio" anteriorly, "Terminus" at the posterior, a small pore cone is present on the indistinct median ridge which may lie at the position of the "Charon" pore cone or just above it and is best seen in the right valve.

The dorsal ridge is prominent, slightly undulating, commencing behind the eye tubercle, convex upwards, broken by a very small node present halfway along the dorsal margin in the position of the "Sagittarius" pore cone; at the posterior it is nodose and turns vertically downwards to terminate at mid-height. The median ridge is indistinct, but marked by a pronounced and small pore cone lying to the posterior of the prominent subcentral tubercle. The ventral ridge is straight, strongly developed, extending from just behind the antero-marginal rim, continuing along the ventral margin, and bending downwards at its nodose posterior end to end near the ventral margin.

A strongly developed marginal rim extends along the anterior and posterior margins, the anterior marginal rim running from each eye tubercle along the anterior margin and finishing ventrally. The anterior marginal rim has a few, weak, small and rounded denticles; several small denticles at the anterior margin which are indistinct because of the presence of reticulation along the margin; the posterior marginal rim has some 5 short spines or rounded denticles especially along the lower part.

In dorsal view, the carapace sides converge towards the anterior, both ends laterally compressed; maximum width lying in the posterior third of the carapace on the postero-ventral end of the ventral ridge; the reticulation between the anterior marginal rim and its margin is conspicuous.

Internal details are not known.

Dimensions: (In mm.)

	L.	H.	W.	L/H.
J.T. 194 (holotype)	0.652	0.350	0.282	1.862

Discussion:

This species is assigned to *Curfsina* Deroo (1966) on the basis of an elongate subcentral tubercle, three longitudinal ridges, the dorsal ridge turning ventrally at the posterior end, but not joining the median ridge, and surface ornamentation.

Curfsina nuda (Jones and Hinde, 1890) illustrated by Neale (1978) from the Middle Albian to Maastrichtian of Britain shows some similarities to this species, but differs in details of ornamentation, in having well-developed antero-ventral and postero-ventral spines, a rounded subcentral tubercle, a less pointed and elongate posterior end, larger eye tubercle, a prominent median ridge, and the ventral ridge turns upwards at its posterior end. Curfsina turonica Bate and Bayliss (1968) from the Turonian of Tanzania, resembles this species in shape, outline and in the ventral ridge turning downwards posteriorly; but differs in having a reticulate surface, a small node developed at the posterior cardinal angle in the left valve, a variable median ridge which may be either better or poorly developed, and in details of ornamentation. Cythereis dentonensis Alexander (1929) described by Howe and Laurencich (1958) from the Albian of Texas closely resembles Curfsina alkarkhii sp. nov. in outline and shape, but differs in details of ornamentations, in having strongly developed denticulate anterior and posterior margins, more rounded subcentral tubercle, a reticulate surface, and the dorsal and ventral ridges do not bend downwards posteriorly. Curfsina faujasi (Van Veen, 1936) described by Deroo (1966) from the Upper Maastrichtian of Limbourg, has some similarities to Curfsina alkarkhii sp. nov. but the latter differs in having a pointed and elongate posterior margin, more prominent and elongate subcentral tubercle, in details of ornamentation, and the dorsal ridge is slightly sinuous with a small node half way along it.

Occurrence:

Upper Coniacian-Santonian (?) of South Rumaila Well-104, south eastern Iraq.

Genus *Cythereis* Jones, 1849.

Type species:

Cytherina ciliata Reuss, 1846, p. 104 (=

Cythereis ornatissima Reuss, 1846, p.104), designated by Sutton and Williams, 1939, p.562.

Diagnosis:

Three longitudinal ridges, prominent subcentral tubercle, hinge ear present, ornamentaiton of reticulation and/or spines; strong anterior and posterior marginal rim.

Remarks:

Cythereis has been interpreted in many ways to include numerous species which subsequent authors have placed into new genera. Characters which have been used to diagnose *Cythereis* include the type of hinge, the presence of a subcentral tubercle and 3 longitudinal ridges. The ornamentation is highly variable.

Following Sylvester-Bradley (1948), Morkhoven (1962), Bate and Bayliss (1968), Sayyab (1956), and Damotte (1977), the hinge is usually accepted as being Amphidont with denticulate anterior and posterior elements in the right valve, with a smooth or crenulate hinge bar.

Some authors (Al-Abdul-Razzaq, 1977; Al-Abdul-Rassaq and Grosdidier, 1981, Bischoff, 1963; Bassoullet and Damotte, 1969; Grosdidier, 1973, and Al-Sheikhly, 1980, M.S.) have included species with Amphidont/heterodont hingement, i.e. non denticulate anterior element and non crenulate or weakly crenulate posterior element.

Reyment (1960, p.207) described the hinge in the right valve as follows: "The anterior tooth is strong and is usually, but not always notched. The posterior tooth may be more or less prominent and is usually notched".

Deroo (1966) included either crenulate or smooth anterior elements and mostly non-crenulate posterior elements. Neale (1975, p.56) stated that "Pokorny (1963) gave a very detailed description of Cythereis ornatissima (Reuss, 1846) the type species from the Coniacian of Luzice. Pokorny described the hinge as 'right valve at both ends with a terminal tooth. The median element is subdividied into an anterior socket and a posterior groove. The anterior tooth is well preserved only in two left female valves of the typical locality in our material. In dorsal view they have a roughly symmetrical, highly parabolic outline, or an outline of a parabola with truncated apex. They are divided by four incisions into five denticles. Two of the denticles are on the anterior slope and three form the apex. The posterior outline of the tooth is smooth in dorsal view, posterior tooth strong, in dorsal view asymmetrical, with its anterior slope inclined towards the contact of the valve under an angle of 45° and with a nearly perpendicular posterior slope. In one specimen its division into five denticles can be seen'. From this the hinge may be regarded as paramphidont, but to judge from the description and figures the division of the terminal elements is slight and difficult (sometimes impossible) to make out and the distinction from holamphidont is a fine one." In this study all species referred to Cythereis have been placed in the genus on the basis of external features. Morkhoven (1962, p.80) remarked that "Minor differences, which do not affect or change the basic type or subtype of hinge, include a stronger or weaker development of a hinge element, the presence or absence and degree of crenulation or lobation of one or more elements, and the presence or absence of an accommodation groove". It is possible, as suggested by Sayyab (1956) that postmortem attribution may have eradicated the crenulations of the teeth. Importance has been attached to the presence of a sub-central tubercle.

Cythereis alantakii sp. nov.
Pl. 32, figs. 7-9; pl.33, figs. 1-5.

Name:

After Dawud Al-Antaki, a famous Arabic writer on medicine in sixteenth century.

Diagnosis:

A species of *Cythereis* with weakly developed reticulate partly punctate ornamentation; with two parallel rows of micro-reticulation extending from below the eye tubercle and parallel to the anterior margin. The anterior and posterior marginal depressed areas are mainly smooth but may have fine faint puncta, with "ghost" reticulation just behind the anterior marginal rim. Dorsal ridge discontinuous with prominent median pore cone and posterior tubercle.

Holotype:

Carapace, J.T. 197, pl. 33, figs. 1, 2, 5.

Paratype:

J.T. 196, and J.T. 198 - J.T. 199.

Material:

Total number of specimens 6. South Rumaila Well-104 section, south eastern Iraq, 4 specimens; 2 specimens from the highest part and one specimen from the lowest part of the Ahmadi Formation, at drilling depths of 2652-2654 m, 2770-2772 m; one specimen from the basal bed of the Mishrif Formation, at drilling depth of 2546-2548 m. In Kifl Well-2, 2 specimens have been found from the lower part of the Maotsi Formation, at drilling depths of 4810-4815 ft, 4875-4880 ft.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Type Horizon:

Mishrif Formation, Upper Cenomanian, depth of 2548 m.

Stratigraphic range:

Upper Cenomanian, Lower Cenomanian ?.

Description:

Carapace small, subtrapezoidal in lateral view, greatest height at anterior hinge-ear; greatest length extends below the middle of carapace. Anterior margin broadly rounded with strongest curvature in the ventral part; posterior margin triangular, pointed posteriorly below mid-height point; dorsal margin straight but appearing sinuous because of tuberculated and depressed dorsal ridge; ventral margin nearly straight; dorsal and ventral margins are subparallel and converge towards the posterior. Hinge-ear is prominent in the left valve. Left valve slightly larger than the right. The sexual dimorphism is not pronounced. The eye tubercle is prominent situated on the antero-cardinal angle. Subcentral tubercle prominent and rounded, its surface marked with large puncta; in one specimen the subcentral tubercle surface appears smooth because of its poor preservation.

The surface of the valve is partly covered with weak reticulation and punctation. The surface of the area extending between the median ridge, subcentral tubercle and the ventral ridge is ornamented by weak reticulation which has a faint punctation developed on their floor; two parallel rows of microreticulation which give a punctate appearance start from below the eye tubercle extending parallel to the anterior rim and ending towards the antero-ventral corner; the depression lying behind the subcentral tubercle has some weakly developed punctation; a few large puncta cover the postero-dorsal tubercle of the dorsal ridge; a faint punctaiton is present on the antero-dorsal area; the postero-marginal depressed area and the area just behind the anterior marginal rim are generally smooth or perhaps have a few fine and faint puncta present with a "ghost" reticulation just behind the anterior marginal rim. The ornamentation is very poorly developed or preserved in some specimens.

The dorsal ridge appears discontinuous, beginning behind the eye tubercle, half way along the dorsal margin it has a prominent tubercle or pore cone lying in the position of the "Sagittarius" pore cone, the posterior end of the dorsal ridge forms a prominent elongate tubercle in front of the postero-dorsal angle. The median ridge is short and prominent, extending from behind the subcentral tubercle and separated from it by a shallow depression, and terminating level with the dorsal ridge and ventral ridge. The ventral ridge is well developed, start from the antero-ventral corner, and finishes with a blunt and prominent tubercle at about three quarters of the length. The posterior ends of the three ridges are aligned vertically.

Anterior and posterior margins are distinctly rimmed, both rims denticulate, the anterior one provided with several short rounded denticulations; the anterior margin has finely developed denticulation; there are 4 small rounded denticles along the ventral part of the posterior marginal rim.

Posteriorly there is a small distinct and rounded denticle or papilla present at the position of the "Terminus" pore cone and a small prominent tubercle or pore cone at the "Leo" pore cone in the median area.

In dorsal view, greatest width lies on the prominent subcentral tubercle; the carapace has subparallel sides with laterally compressed ends; the prominent postero-dorsal tubercle at the end of the dorsal ridge, the central tubercle or pore cone along the dorsal margin and the depression separating the median ridge from the subcentral tubercle are easily distinguished. Internal features are unknown.

Dimensions: (In mm.)

	L.	H.	W.	L/H.
J.T. 196	0.560	0.330	0.330	1.696
J.T. 197 (holotype)	0.550	0.340	0.305	1.617

J.T. 198	0.595	0.350	0.330	1.7
J.T. 199	0.652	0.400	0.305	1.63

Discussion:

Cythereis dilophata Al-Abdul-Razzaq (1977) from the Gudair Formaiton of Santonian age of south eastern Kuwait (1977, unpublished Ph.D. dissertation) can be easily distinguished from *Cythereis alantakii* sp. nov. by its outline, details of ornamentaiton, the lack of a median ridge, more developed reticulation completely covering the surface of the carapace, a narrowly rounded posterior margin, and posterior end slightly pointed above the mid-height. *Cythereis* sp. A. Al-Sheikhly (1980, unpublished Ph.D. thesis) from the Maastrichtian of northern Iraq bears some similarity to this species, but it differs in having an indistinct median ridge, less prominent hinge-ear, the posterior end is pointed slightly above the middle, in the absence of a prominent tubercle situated centrally on the margin, in details of ornamentation and reticulation, in having a more prominent subcentral tubercle, and in its larger size.

Rehacythereis senckenbergi (Triebel, 1940) described by Neale (1978) from the Lower Hauterivian of Britain and North Germany differs from *Cythereis alantakii* sp. nov., in details of ornamentation, in having a less pointed posterior end, less elongate posterior margin, in the presence of a continuous dorsal ridge not broken into tubercles turning downwards at its posterior end, and in having a less short median ridge. *Cythereis alfarazdaki* sp. nov. and *Cythereis alantakii* sp. nov. are close to each other in shape, outline, size, and in the presence of a discontinuous, sinuous and tuberculate dorsal ridge, but *Cythereis alantakii* has different details of surface ornamentation, a more prominent anterior hinge-ear, a weakly angulate posterior cardinal angle, a more prominent port cone mid-way along the dorsal margin, and having one more prominent tubercle at the end of the dorsal ridge.
Rehacythereis almutasimi sp. nov. and *Rehacythereis arabica* (Al-Furaih, 1983) are closely related to this species in

general, but they differ in details of ornamentation, in their larger size and in the existence of a better developed and clearly defined reticulation covering the whole surface of carapace.

Occurrence:

This species is report from the Cenomanian of South Rumaila Well-104 section and from the Upper Cenomanian of Kifl Well-2, middle west of Iraq.

Cythereis cf. alantakii sp. nov.
pl.33, figs. 6-8.

Figured specimens:

J.T. 200 - J.T. 201.

Material:

2 specimens from the lowest beds of the Ahmadi Formation, at depths of 2772-2774 m, of South Rumaila Well-104.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Dimension: (In mm.)

	L.	H.	W.	L/H.
J.T. 200	0.520	0.282	0.260	1.843

Discussion:

This differs from Cythereis alantakii sp. nov. in having a sharply angled posterior end with its point near to the ventral margin, in its slightly smaller size, in its totally smooth lateral surface, less rounded or subovate subcentral tubercle, and a less clearly defined ventral ridge. It is probably a new species, but as only two specimens have been found no new taxon has been created.

Occurrence:

Lower Cenomanian of South Rumaila Well-104 section.

Cythereis ? albahilii sp. nov.
pl.34, figs. 1-6.

Name:

After Abu Nasr Al-Bahili, a famous Arab philogist and author of the ninth century.

Diagnosis:

A species of Cythereis with smooth intercostal areas except for traces of reticulation below the dorsal ridge; posterior part of dorsal and ventral ridges formed by large tubercle; median ridge absent, but marked by a small pore cone. Two large tubercles present in the subcentral area running obliquely towards the antero-ventral corner.

Holotype:

J.T. 203, probably male, pl.34, figs. 1, 2,5.

Paratype:

J.T. 202.

Material:

3 specimens from the Upper part of the Ahmadi Formation of Ghalaisan Well-1 section, at drilling depths of 4195-4205 ft.

Type Locality:

Ghalaisan Well-1, south western Iraq.

Type Horizon:

Ahmadi Formation, Lower Cenomanian, depth of 4195 ft.

Stratigraphic range:

Lower Cenomanian.

Description:

Carapace small, subtriangular to subrectangular in lateral view; dorsal and ventral margins straight, subparallel and converging towards the posterior; anterior margin rounded, more gently in the dorsal half; posterior margin subtriangular, pointed slightly below the middle; greatest length runs more or less below the middle, greatest height at anterior cardinal angle. Consideration of L/H ratios suggests the presence of sexual dimorphism with a more elongate male; however the lateral outline (Pl.34, figs. 1-4) throws some doubt on this interpretation so the possibility of sexual dimorphism is left open. Eye tubercle more or less rounded. The subcentral area has two large tubercles aligned towards the antero-ventral corner of the carapace. Anterior and posterior marginal areas are depressed.

Dorsal ridge is weakly developed and appears slightly sinuous, ending with a prominent postero-dorsal tubercle, perpendicular to the dorsal ridge. A median ridge is not developed although a small pore cone situated posteriorly to the subcentral tubercle lies at the position of "Charon" pore cone. The ventral ridge is thick, starting from the antero-ventral area below the subcentral tubercle from which it is separated by a shallow depression, and terminating with a large rounded tubercle at its posterior end at about three-fourths of the carapace length.

The lateral surface is mainly smooth with traces of reticulation below the dorsal ridge. A very small pore cone or papilla is present at "Leo" in the median area of the carapace, and another two small pore cones are situated anteriorly in the position of "Alpha" and "Beta".

A marginal rim extends around the anterior, ventral and posterior margins, being more distinct along the anterior and the ventral part of the posterior margins than along the ventral margin. There are some 11 short spines or denticles around the anterior margin; the postero-ventral margin has several denticles which are indistinct in some specimens.

In dorsal view, the carapace has almost parallel sides slightly inflated towards the posterior with laterally compressed ends; maximum width at the postero-ventral tubercle of the ventral ridge about two-thirds of the way from the anterior; the postero-dorsal tubercle can be seen clearly. In ventral view, the denticles of the anterior margin and the compressed anterior marginal area are clearly observed. Internal characteristics are unknown.

<u>Dimensions</u>: (In mm.)

		L.	H.	W.	L/H.
J.T. 202	Male ?	0.560	0.305	0.190	1.836
J.T. 203	Female ? (holotype)	0.560	0.330	0.260	1.696

Discussion:

The lack of a median ridge raises doubts about its placing in Cythereis Jones (1849). Van Morkhoven (1963) considered the three longitudinal ridges as part of the basic ornamentation of the genus, although many species with only two longitudinal ridges have been designated to Cythereis by several authors, e.g. Damotte (1971), Butler and Jones (1957), Bischof (1963), Al-Abdul-Razzaq (1977, Ph.D., dissertation), Al-Abdul-Razzaq and Grosdidier (1981), Babinot (1980), and Damotte and Saint Marc (1972). This species also differs from Cythereis in possessing a smooth surface not reticulate as indicated by Morkhoven (1963), although a small group of species which a perfectly smooth surface have been attributed to Cythereis by authors such as Bate and Bayliss (1968), Pokorny (1965) and Triebel (1940). The internal details were not observed. The species is therefore assigned to Cythereis with some doubt.

Cythereis ? albahilii resembles Occultocythereis Howe (1951) in having a compressed carapace, rimmed and denticulate anterior and postero-ventral margins, and lacking a median ridge; it differs in having two pronounced tubercles in the subcentral area, better developed ventral ridge along the ventral margin ending with a prominent posterior tubercle, and lacks a postero-ventral wing-like projection present in the females of Occultocythereis. Spinoleberis Deroo (1966) differs in having a very prominent hemispherical subcentral tubercle, two strong groups of tubercles at the postero-dorsal and postero-ventral parts; in ornamentation, in having a more prominent eye tubercle, and strongly developed anterior and posterior marginal spines. Iraqicythereis gen. nov. shows some similarities to this species in the presence of a prominent tubercle at the posterior end of the dorsal and ventral ridges, but differs in details of ornamentation and presence of a weak ventral ridge associated with a weak ventral swelling.

Cythereis caudata described by Butler and Jones (1957) from the (Lower Maastrichtian ?) of Louisiana shows some resemblance to this species in shape and general outline and in having compressed anterior and posterior marginal areas; but it differs in its very strongly punctate carapace, in the more prominent and well rounded subcentral tubercle from which extend 6-8 weak bifurcated ridges, in having a more prominent anterior marginal rim and a straight and more developed dorsal ridge. *Cythereis praetexta arta* Damotte (1971) from the Cenomanian of the Dordogne (France) differs in its larger size, details of ornamentation, presence of weakly developed sub-central tubercle, in having a reticulate surface, and in the ventral ridge which runs continuously from the anterior marginal rim towards the postero-ventral tubercle. *Cythereis*? *albahilii* sp. nov. is easily distinguished from *Curfsina alkarkhii* sp. nov. by the presence of large tubercles at the posterior end of the dorsal and ventral ridges; in *Curfsina alkarkhii* both dorsal and ventral ridges bend downwards at their posterior ends; in the two rounded tubercles in the subcentral area, in a weaker dorsal ridge, less sharply pointed posterior end, and the smooth lateral surface.

Occurrence:

Known so far from the Lower Cenomanian of Ghalaisan Well-1 section, south western Iraq.

Cythereis alfarazdaki sp. nov.
pl.35, figs. 1-6.

Name:

After Hamman Al-Farazdak, the greatest Arab satirist of the seventh and eighth centuries.

Diagnosis:

A species of Cythereis in which areas between the longitudinal ridges are covered with faintly irregular reticulation or may be smooth, with large subquadrate reticulation between ventral ridge and ventral margin; an oblique eye rib extends towards the subcentral tubercle. The dorsal ridge is indistinct, consisting of a median prominent pore cone and ending with two less prominent tubercles at the posterior.

Holotype:

Carapace, probably male, J.T. 206, pl. 35, figs. 1, 2,5.

Paratype:

J.T. 204-J.T. 205.

Material:

Total number of specimens, 8. In South Rumaila Well-104, 6 specimens have been reported: 5 specimens from the middle beds of the Mishrif Formation at drilling depths of 2484-2490 m; and one specimen from the top bed of the Rumaila Formation, at drilling depth of 2552 m. In Kifl Well-2, middle western Iraq, 2 specimens have been found in the basal beds of the Maotsi Formaiton, at drilling depths of 4885-4905 ft.

Type Locality:

South Rumaila Well-104 section, south eastern Iraq.

Type Horizon:

Mishrif Formation, Upper Cenomanian, depth of 2484 m.

Stratigraphic range:

Upper Cenomanian.

Description:

Carapace small, subtriangular to subtrapezoid in lateral view; maximum height situated at the eye tubercle, maximum length slightly below mid-height. Dorsal margin straight, partly obscured by the dorsal ridge; ventral margin gently sinuous; dorsal and ventral margins subparallel and converging towards the pointed posterior end; anterior margin broad and evenly rounded; posterior margin triangular and elongate, pointed end slightly below mid-height; the posterior cardinal angle is conspicuous. Determination of L/H ratios indicates the presence of sexual dimorphism with more elongate males; but the lateral outline (Pl. 35, figs. 1-4) and the presence of only two specimens of presumed males gives doubt to this interpretation, and so the possibility of sexual dimorphism remains uncertain.

A hinge-ear present in the left valve; left valve slightly larger than right, conspicuously overlapping it at the antero-cardinal angle and in the region along the postero-dorsal slope of the posterior margin. The eye tubercle is rounded and prominent. A prominent rounded subcentral tubercle is situated slightly in front of the mid-point of the length of the carapace.

The lateral surface is reticulate, the reticulation varies with a large quadratic-shaped row (A) extending just behind and parallel to the anterior marginal rim; followed by medium, rounded to semi-rounded reticulations arranged in rows in the anterior area behind the first row (A) towards the subcentral tubercle, this reticulation decreasing in size towards the subcentral tubercle; a row of large subrounded to subquadrate reticules extends longitudinally between the ventral ridge and the ventral margin; the areas between the longitudinal ridges are covered with faintly developed and randomly arranged reticulation or may appear nearly smooth because of their state of preservation or the mechanical processes which may have eroded the reticulation; the surface of the posterior depressed area is generally smooth and may have "ghost" reticulation behind the posterior marginal rim; and the surface of the subcentral tubercle is smooth or may be slightly and finely reticulate.

A distinct marginal rim extends along the anterior and posterior margins. There are some 4-5 small denticles or papillae lying along the anterior marginal rim, the anterior margin is finely denticulate, and the posterior marginal rim is ornamented with approximately 7-8 small spines or denticles.

There are three distinct longitudinal ridges, the dorsal ridge is indistinct, commencing behind the eye tubercle, broken at the mid-way into a medium prominent pore cone or tubercle at the position of the "Sagittarius" pore cone with two further tubercles forming the posterior part of the ridge; the median ridge is short, and gently curved downwards, is sinuous with 3 or 4 small tubercles, is situated slightly above the mid-height starting from a depression behind the sub-central tubercle and fading into the depressed posterior area; the ventral ridge is the longest ridge beginning from the antero-ventral area behind the antero-ventral marginal rim and finishing with a blunt medium tubercle directed postero-ventrally at about three-fourths of the length. A short rib extending obliquely down from each eye tubercle terminates towards the subcentral tubercle or probably joins it.

Small tubercle or pore cones can be distinguished in the position of the "Terminus" and "Leo" pore cones, as well as "Sagittarius" already described on the dorsal ridge.

In dorsal view, the carapace has an irregular outline with latterally compressed ends; maximum width is at the prominent sub-central tubercle; the depression separating the sub-central tubercle from the median ridge, the posterior tubercles and central tubercle or pore cone of the dorsal ridge can be seen clearly. In ventral view the reticulation lying below the ventral ridge is clearly observed.

No internal characters were observed.

Dimensions: (In mm)

			L.	H.	W.	L/H.
J.T. 204	Female ?		0.610	0.350	0.260	1.742
J.T. 205	Female ?		0.540	0.315	0.260	1.714
J.T. 206	Male ?	(holotype)	0.560	0.310	0.240	1.806

Discussion:

Cythereis alfarazdaki shows similarities to *Cythereis algeriana* Bassoullet and Damotte (1969), but differs in the details of reticulation, in its much smaller size, in the general outline particularly of the posterior margin which is more elongate and angular, the posterior end pointed just below the middle, in the presence of an eye rib, and in the character of the posterior part of the dorsal ridge which is formed by two less prominent tubercles. It resembles *Rehacythereis almutasimi* sp. nov., but differs in being smaller; in the outline of the posterior margin, where the posterior end of *Rehacythereis almutasimi* sp. nov. is more ventrally situated; in details of reticulation; in having a longer more prominent eye rib; in the posterior half of the dorsal ridge which is more continuous with a single prominent posterior tubercle in *Rehacythereis almutasimi* sp. nov., and in having a sinuous median ridge with 3 or 4 small tubercles.
Rehacythereis arabica (Al Furaih, 1983) differs in having an arched postero-cardinal angle, a less pointed posterior end, a single prominent tubercle at the posterior end of the dorsal ridge, a straight median ridge, a shorter eye rib, and in details of reticulation.

Cythereis fahrioni Bischoff (1963) from the Albian of Lebanon differs from *Cythereis alfarazdaki* in the outline of the carapace being subrectangular rather than subtriangular; in its larger size; in details of ornamentation and reticulation; in having a much less pointed posterior end; in the absence of the distinct eye rib, and in the presence of a stronger more continuous dorsal ridge which does not show a tendency to break into tubercles.

Occurrence:

This species is recorded from the Upper Cenomanian of South Rumaila Well-104 section; and from the Upper Cenomanian of Kifl Well-2.

Cythereis aff. *alfarazdaki* sp. nov.
pl. 36, figs. 1-3.

Figured specimens:

J.T. 207-J.T. 208.

Material:

2 specimens: one from the basal bed of the Mishrif Formation, at drilling depths of 2550 m and one broken specimen from the upper part of the Ahmadi Formation, at drilling depth of 2662 m, of South Rumaila Well-104.

Type Locality:

South Rumaila Well-104 Section, south eastern Iraq.

Dimension: (In mm.)

		L.	H.	W.	L/H.
J.T. 207	Male ?	0.815	0.380	0.400	2.144

Discussion:

This is similar to *Cythereis alfarazdaki* in ornamentation but differs in its larger size and more elongate shape, in having a posterior most node on dorsal ridge which is more prominent and not divided into two parts as in *Cythereis alfarazdaki*, and the anterior row of reticulation (B) is weakly developed and may be unified with row (A) in the left valve. These may be the males of

Cythereis alfarazdaki, but the differences mentioned above suggest it is more likely to be a different species.

Occurrence:

Upper Cenomanian of South Rumaila Well-104, south eastern Iraq.

Cythereis ibnalnadimi sp. nov.
Pl. 36, figs. 4-6.

Name:

With reference to Abul-Faradj Muhammad Ibn Al-Nadim, author of the well-known Kitab al-fihrist, an "Index" of Arabic books, in the tenth century.

Diagnosis:

A species of Cythereis with three short indistinct nodose longitudinal ridges, situated dorsally, dorso-centrally, and ventro-centrally. The surface between the ridges is smooth with some microreticulation giving a pitted appearance. Posterior and anterior marginal rim weak.

Holotype:

Carapace, J.T. 209, pl. 36, figs. 4-5.

Paratype:

J.T. 210.

Material:

Two specimens from the median bed of the Tanuma Formation, at drilling depth of 2352 m, of South Rumaila Well-104.

Type Locality and Type Horizon:

South Rumaila Well-104, south eastern Iraq. Tanuma Formation, Upper Coniacian, depth of 2352 m.

Stratigjraphic range:

Upper Coniacian.

Description:

Carapace small, subtrapedzoidal to subtriangular in lateral view; greatest length near the ventral margin; greatest height at anterior at the eye tubercle. Dorsal margin straight, partly obscured in lateral view by the tuberculate or papillate dorsal ridge; ventral margin straight; both margins strongly converging posteriorly. Anterior margin is semicircular, broad and evenly rounded; posterior margin subtriangular, produced into pointed subacute end near the ventral margin; postero-cardinal angle is distinct. Left valve slightly larger than the right, overlap strongest at the postero-cardinal angle and postero-dorsally along the dorsal part of the posterior margin. A weak anterior hinge-ear is present. Eye tubercle rounded and prominent, situated at the antero-cardinal angle of each valve. Subcentral tubercle is distinct, sub-rounded, antero-central and towards the antero-ventral corner.

Three longitudinal ridges are present; a longer dorsal ridge and two short ridges in the posterior half of the valve; the dorsal ridge is tuberculate starting half way along the dorsal margin, extending posteriorly and ending before reaching the postero-cardinal angle; dorso-central and ventro-central ridges short, separated from the subcnetral tubercle and fading away posteriorly just at the laterally compressed posterior marginal area. Small tubercles or papillae are scattered on the lateral surface, mainly on the ridges.

The entire surface between the longitudinal ridges is nearly smooth with some microreticules, which give a pitted appearance, and are arranged into rows in antero-marginal area, extending from below the eye tubercle and fading out antero-ventrally, and traces of reticules are present in the antero-dorsal region of the valve.

Six of the small tubercles mentioned above form the dorsal ridge: a prominent "Aquarius", two posterior most small spines or small tubercles present at "Virgo", two between "Aquarius" and "Virgo" and one just in front of "Virgo"; "Virgo" is the biggest and most prominent; "Leo" is present in the median area.

A weak marginal rim is present along the anterior and posterior margins; the anterior margin is finely denticulate and the posterior margin is denticulate along ventral part.

In dorsal view, the carapace has almost parallel sides, the posterior end is laterally compressed, and produced into a sub-acute drawn-out point; the small tubercles forming a line along the dorsal margin, and there are two small spines lying on the subcentral tubercle in the right valve. Internal details are unknown.

Dimension: (In mm.)

	L.	H.	W.	L/H.
J.T. 209 (holotype)	0.582	0.330	0.270	1.763

Discussion:

This is tentatively placed in the Cythereis Jones (1849) because of the presence of the prominent subcentral tubercle, three longitudinal ridges, distinct eye tubercle, and shape.

It probably belongs to the new genus described by Al-Abdul-Razzaq (1977, unpublished Ph.D. dissertation) as Phymacythereis but not yet published, since it has its general main primary ornamentation consisting of three longitudinal ridges (dorsal, dorso central and ventro-central ridges), in possessing a similar type of secondary ornamentation consisting of tubercles and denticulation, and provided with a pronounced eye tubercle. However, Phymacythereis differs by having a well-compressed anterior marginal area, a prominent anterior margin rim, and distinctly elongate and more oblique sub-central tubercle.

Sayyab (1956) did not report this species in the Middle and Upper Cretaceous of the Western coast of Arabian Gulf. *Phymacythereis santoniensis* Al-Abdul-Razzaq, 1977, from the Santonian of South eastern Kuwait resembles *Cythereis ibnalnadimi* sp. nov. in shape and general outline and in most of the generic characteristics; but the latter species differs in having a partly reticulate surface consisting of some microreticulation at the antero-marginal area and weakly present along the antero-dorsal area, a rounded and smaller eye tubercle, lacks a compressed anterior marginal area, in details of ornamentation, in the absence of crater-like pits at the tops of the tubercles of the lateral surface of the longitudinal ridges; and has more prominent small tubercles or spines at the posterior end of the dorsal ridge.

Occurrence:

Known so far from the Upper Coniacian of South Rumaila Well-104 section, south eastern Iraq.

Cythereis ? *ibnyunusi* sp. nov.
Pl. 37, figs. 1-7; Pl. 38, figs. 1-6;
Pl. 39, figs. 1-6; Pl. 40, figs. 1-6.

Name:

After Abul-Hasan Ali Ibn Yunus, the greatest Arab astronomer. In spherical trigonometry he was the first to propound the prosthaspherical formula, in the eleventh century.

Diagnosis:

Medium-sized species of *Cythereis* in which the surface ornamentation varies from strongly reticulate to nearly smooth with pore cones. The three longitudinal ridges are not very prominent; dorsal ridge most prominent with pore cones and posterior most small node; median ridge is weak; ventral ridge marked by a ventro-lateral swelling ending posteriorly with a large tubercle comprised of pore cones and pustules. Subcentral tubercle distinct.

Holotype:

Female carapace, J.T. 227, Pl. 37, figs, 1, 4.

Paratype:

J.T. 211 - J.T. 226, and J.T. 228 - J.T. 234.

Material:

Total number of specimens 86 have been found in South Rumaila Well-104. Morphotype No.1 31 specimens: 30 specimens (including 4 single valves and 3 broken valves) have been found in the Khasib Formation, at drilling depths of 2379-2418 m; one specimen found in the oldest sediment of the Mishrif Formation, at drilling depth of 2427 m. Morphotype No.2 32 specimens (including 5 single valves and 5 broken valves) have been found in the Khasib Formation, at drilling depths of 2380-2424 m. Morphotype No.3 23 specimens: 16 specimens (including 2 broken valves) from the Khasib Formation, at drilling depth of 2379-2416 m; 4 specimens (including 2 broken valves) from the basal beds of the Tanuma Formation and from the contact bed between the Tanuma and Khasib Formation, at depths of 2376-2378 m.

Type Locality:

South Rumaila Well-104 section, south eastern Iraq.

Type Horizon:

Khasib Formation, Lower Coniacian, depth of 2390 m.

Stratigraphic range:

Upper Turonian-Coniacian.

Description:

Carapace medium in size, subrectangular to subquadrangular in outline. Dorsal margin straight, ventral margin generally straight; dorsal and ventral margins are almost parallel, converging posteriorly towards the extreme of the posterior end; anterior margin broadly and evenly rounded, with strongest curvature in its ventral part; posterior margin subtriangular with slightly produced posterior end, obtusely pointed at the middle or just above the middle, meeting with the dorsal margin in an obvious posterior cardinal angle. Left valve slightly larger than right, its overlap strongest antero-dorsally at the slightly elevated hinge-ear and postero-dorsally at the upper half of the posterior margin. Eye tubercle conspicuously present, rounded, situated on the antero-dorsal cardinal corner. Distinct subcentral tubercle placed slightly in front of centre of valve, gently descending to central anterior area. Maximum height at the antero-cardinal angle. Sexual dimorphism is well pronounced, the males are more elongate and larger than the females. Depressed marginal areas present at the anterior and posterior, being stronger at the posterior.

In dorsal view, the carapace has subparallel sides, both ends being laterally compressed; the small pore cones of the dorsal ridge of each valve and the depression lying behind the pronounced subcentral tubercle can be seen clearly; maximum width lies at the subcentral tubercle. In ventral view, the reticulation of the ventral surface and the depression behind the subcentral tubercle are clearly seen.

There are some pore cones on the lateral surface, "Aquarius", "Sagittarius", "Taurus", a small but distinct tubercle is recognised at the position of the "Virgo" pore cone, there are also three small and distinct pore cones lying between "Sagittarius" and "Virgo", these pore cones are situated in the dorsal region and form the dorsal ridge. "Terminus", "psi" and one other pore cone lying above the position of the "psi" pore cone are prominent at the posterior; a large tubercle consisting of small pore cones and pustules lies at the position of the "Omega" and "Lambda" pore cones present in the postero-ventral area; the most prominent median pore cones is "Leo"; 2-3 small pore cones situated just above the position of "Sigma" and a pore cone may lie at the position of "Charon", in the postero-median area (these pore cones are poorly developed in some specimens); "Alpha", "Beta", "Scorpio", "Capricornus", a pore cone lying below the eye tubercle, and a pore cone or small node at the "Gamma" are prominent in the anterior region.

Internally, the anterior marginal area is broad; selvage is sub-marginal and prominent; inner margin and line of concrescence coincide and run parallel to the outer margin anteriorly. The hinge is Amphidont; in the left valve the hinge is poorly developed, consists of a smooth deep anterior socket, postjacent small smooth conical antero-median tooth, a narrow smooth postero-median bar, and sub-ovate, deep and smooth posterior socket. The anterior tooth of the right valve is generally smooth, but one specimen (Pl. 38, fig. 4) has a crenulate tooth; it is not clear whether this represents differences in preservation or morphological variation; a lower ventral part of the tooth extends below the postjacent socket giving a curved tooth in lateral view; the postjacent socket is deep, smooth and rounded, closed all around except posteriorly and connecting to a narrow smooth groove.

Traces of an ocular boss can be seen in the left valve. Muscle scars lie just on the rim of a deep depression and consist of a vertical row of 4 elongated undivided adductor muscle scars; the details of the adductor muscle scars and frontal scar cannot be clearly observed.

This species shows considerable intra-specific variation in the degree of development of the reticulation and the pore cones which lie in the position of the median ridge, and these variations are thought to be genotypic, i.e. an example of polymorphism, in which 3 distinct morphotypes can be recognised.

Morphotype No. 1

This has three rather indistinct longitudinal ridges mostly formed by pore cones; the dorsal ridge is most distinct, starting from below and behind the eye tubercle, curves slightly upwards and has 5 small pore cones of which the pore cone at mid-way along the dorsal margin is most prominent, and ending with a distinct node at the posterior in front of the postero-cardinal angle. The median ridge is short and weak, extending from behind the sub-central tubercle and separated from it by a shallow depression, and is made up of 2-4 small pore cones, the posterior most pore cone being the largest, the others are variable in degree of prominence and development and may appear either as very low normal pore openings or may be so indistinct as to be difficult to observe. The ventral ridge is distinguished by a swelling lying along the ventro-lateral and ventro-median areas, and terminating with a blunt, large tubercle consisting of some small pore cones and pustules at its posterior end and towards the posterior marginal depressed area.

Surface ornamentation consists mainly of strongly developed and prominent reticulation covering the whole surface including the postero-dorsal and postero-ventral tubercles of the dorsal and ventral ridges and pore cones superimposed on the walls of the reticulation. The reticulation varies with moderately large rectangular shape in row A arranged parallel to anterior marginal rim; followed by rows B, C and D of smaller quadrate to subrounded reticules which become smaller towards the subcentral tubercle; the reticulation of the sub-central tubercle is the smallest and is rounded to subrounded; elongate and irregular shaped medium to large reticules covers the ventro-lateral and ventro-median swelling; the surface of the depressed posterior area has more or less rounded small reticulation, although this may have few reticules or may be nearly smooth; 3-4 sided reticules cover the rest of the surface. In some specimens weak reticulation is present on the area between the dorsal part of the anterior margin and its rim.

There are numerous normal pore canal openings interculated with the reticulation, some of which may have developed into pore cones of varying strength (these normal pore openings are defined as intramural pores by Sylvester-Bradley and Benson (1971) and run centrally through the muri).

The anterior margin has some 10-12 short rounded denticles along its ventral part. The anterior and posterior margins are strongly rimmed; the anterior marginal rim appears nodose with some 6-9 pore cones, and runs from the eye tubercle parallel to the anterior margin, fading away along the ventral margin; there are some 4-7 short rounded denticles around the ventral part of the posterior margin.

Morphotype No. 2

This has a morphology intermediate between Morphotype 1 and Morphotype 3. The lateral surface has a weakly developed reticulation, with more pronounced pore cones and normal pore canal openings, and denticulation around the margins and rims than in Morphotype 1.

Morphotype No. 3

The surface of the carapace is mainly smooth except for a row of poorly developed reticulation behind the anterior marginal rim and along the bottom of the ventro-lateral swelling. This morphotype differs from Morphotype 1 in having a smooth lateral surface with more distinct cones; one specimen has spinose denticulation at the anterior and along the ventral part of the posterior margin and rim; the specimens of this morphotype have more distinct pore cones forming the median ridge than Morphotypes 1 and 2.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 211	Male	0.815	0.425	0.380	1.9176
J.T. 212	Male	0.840	0.450	0.390	1.866
J.T. 213	Male	0.815	0.425	0.350	1.9176
J.T. 214	Male	0.910	0.470	0.425	1.936
J.T. 215	Male	0.840	0.435	0.400	1.9310

J.T. 216	Male	0.890	0.470	0.380	1.8936
J.T. 217	Male	0.860	0.455	0.380	1.890
J.T. 218	Female	0.745	0.450	0.400	1.655
J.T. 219	Female	0.745	0.450	0.380	1.655
J.T. 220	Female	0.720	0.425	0.400	1.694
J.T. 221	Female	0.790	0.450	0.350	1.755
J.T. 222	Female	0.720	0.400	0	1.8
J.T. 224	Female	0.745	0.425	0.350	1.752
J.T. 225	Female	0.825	0.470	0.425	1.755
J.T. 226	Female	0.745	0.450	0.350	1.655
J.T. 227	Female(holotype)	0.720	0.400	0.380	1.8
J.T. 228	Female	0.720	0.410	0.360	1.756
J.T. 229	Female	0.710	0.410	0.350	1.731
J.T. 230,231	Female	0.700	0.410	0.350	1.707
J.T. 233	Female	0.840	0.470	0.380	1.787

Discussion:

Single valves of this species were available for study but the evidence from the hinge is not clear because one right valve has a crenulate anterior hinge tooth while another specimen has a smooth tooth; the hinge of the left valve is poorly preserved. The muscle scare are not clearly observed, especially the anterior frontal muscle scar; the adductor muscle scars lie to the posterior of a deep depression or just on the rim of the depression. This does not allow a definite generic assignment. The presence of the subcentral tubercle, ornamentation, the presence of three longitudinal ridges suggest the genus Cythereis, although the median ridge is weakly developed. This species differs from Oertiella Pokorny (1964) in details of surface ornamentaiton, in having a median ridge and a more prominent subcentral tubercle.

Sayyab (1956 Ph.D. unpublished dissertation, p. 79-81) described a new species which he named Cythereis ? basrahensis, from the Upper Cretaceous strata of the Western Coast of the Arabian Gulf. This is identical to Morphotype 2 of this new species; he did not find Morphotypes 1 and 3. He indicated that this species is very rare and recorded in the Well Zubair No. 5 of the Zubair field in south eastern

Iraq. He doubtfully attributed his species to Cythereis because the hingement is not typical of Cythereis and the poor preservation of the hinge; he stated that the "hinge evidences are not enough to verify the identification", p.80.

Cythereis ? ibnyunusi sp. nov. is similar to Cythereis burlesonensis Alexander (1929), from the Lower Cenomanian of Texas and Cythereis eaglefordensis Alexander (1929) illustrated by Hazel and Washington (1969) from the latest Cenomanian of the Western Interior and Gulf Coast regions of the United States; however, Cythereis ? ibnyunusi sp. nov. differs by having less strongly developed spinose posterior and anterior margins; in details of ornamentation and reticulation; a less prominent hinge-ear; in the outline of the posterior margin with its more angular posterior end slightly above the middle and in having a thinner anterior marginal rim. The new species described by Reyment (1978) as Oertliella ? tarfayaensis from the Late Cenomanian to Early Turonian of Morocco, and described as Oertliella tarfayaensis by Reyment in 1979, and the species illustrated by Bismuch et al. (1981a) from the Lower and Middle Turonian of Tunisia as Oertliella ? aff. tarfayaensis, have some similarities to Cythereis ? ibnyunusi sp. nov. They differ in details of ornamentation and reticulation, in having a weak subcentral tubercle which is often very indistinct, differences in the dorsal ridge and ventro-lateral ridge or swelling which are more weakly developed, the median ridge is absent, in the absence or weak development of marginal denticulation, in the absence of pore cones, the posterior-most node forming the dorsal ridge, the posterior termination of the ventro-lateral ridge is less prominent or absent, and there are rarely pore cones associated with the lateral ornament.

Cythereis rawashensis kenaanensis Rosenfeld and Raab (1974) from the Lower Turonian of Palestine differs from this species in details of ornamentation and reticulation, in possessing a more distinct narrow and elongated median ridge, in the weaker sub-central tubercle, lack of pronounced, small posterior-most node and pore cones along the dorsal margin, less developed and thinner anterior rim, and in the presence of a ventral ridge which does not form a ventro-lateral swelling as in Cythereis ? ibnyunusi sp. nov. Cythereis vitiliginosa reticulata described by Apostolescu (1963) from the Senonian (Coniacian) of Gambia and Senegal, and from the Cenomanian of Gabon by Neufville (1973) closely resembles this species in shape and general outline, but it differs in details of surface ornamentation and reticulation, the node at the posterior termination of the ventral swelling is weaker or absent, in having a less distinct subcentral tubercle, and in the presence of a clear depression on the ventral and dorsal sides of the median ridge. Veenia ? n. sp described by Oertli (1966) from the Turonian-Santonian of Tarfaya shows some resemblance in shape and in having a variable surface ornamentation, but Cythereis ? ibnyunusi sp. nov. differs in having a distinct dorsal ridge and ventro-lateral swelling, in the presence of the median ridge, more distinct subcentral tubercle, slightly more pointed posterior end, in having a distinct tubercle at the posterior end of the ventro-lateral swelling, in details of surface reticulation and pore conation and in the presence of distinct pore cones and a posterior-most node along the dorsal margin.

Occurrence:

Known so far from the topmost Lower Turonian, basal Upper Coniacian of South Rumaila Well-104. It is also recorded from the Upper Cretaceous Strata of the Arabian Gulf Coast.

Genus *Dumontina* Deroo, 1966

Type species:

Cythere Puncturata Bosquet, 1854.

Dumontina ? alfarhidii sp. nov.
pl.42, figs. 1-7.

Name:

With reference to Al-Khalil, B. Ahmad Al-Farhidi, an important Arab Philologist of the eighth century.

Diagnosis:

A species of *Dumontina* distinguished by a network of reticulation with prominent longitudinal walls arranged as longitudinal striations, a distinct thin marginal rim extending continuously from the eye tubercle towards the ventral part of the posterior margin, distinct oblique and elongate subcentral tubercle. Eye tubercle is small. The ventral ridge is ill-defined and associated with a ventro-lateral swelling.

Holotype:

Female carapace, J.T. 243, Pl. 42, fig. 3.

Paratype:

J.T. 237 - J.T. 242, and J.T. 244 - J.T. 246.

Material:

Total number of specimens 11. In Kifl Well-2 middle western Iraq, 10 specimens have been recorded: 7 specimens found in the lower half of the Khasib Formation, at depths of 4530-4590 ft below the surface; 2 specimens from the Kifl Formation, at drilling depths of 4160-4655 ft; and one specimen from the highest bed of the Fahad Formation, at drilling depth of 4965 ft. In Safawi Well-1 Section, south western Iraq, one specimen found in the lowest stratum of the Tanuma Formation, at depth of 3250 ft.

Type Locality:

Kifl Well-2 section, middle western Iraq.

Type Horizon:

Khasib Formation, Upper Turonian, depth of 4585 ft.

Stratigraphic range:

Upper Turonian, Cenomanian ? - Lower Turonian ?.

Description:

Median sized carapace, elongate sub-rectangular in lateral view; greatest length at about mid-height, greatest height at the antero-cardinal angle; dorsal margin straight, partly hidden in lateral view by the dorsal ridge; ventral margin moderately concave; dorsal and ventral margins subparallel converging towards the posterior; anterior margin evenly rounded to slightly obliquely rounded. Left valve slightly larger than the right with small overlap at postero-dorsal. All the specimens examined are probably females (see discussion below).

Eye tubercles small but distinct. The marginal rim extends from the eye tubercle parallel to the anterior margin, ventral margin, and ventral part of posterior margin; it is distinct but thin at the anterior and posterior, the ventral portion being less distinct. Three small denticles may be present along the ventral part of the posterior margin, the top one on the pointed angle of the posterior end and the other two below it; their presence depends upon the state of preservation of the carapace.

The area behind the anterior marginal rim, and at the postero-dorsal and the psostero-ventral parts of the carapace appears correspondingly depressed. The central areas of the carapace are raised with more prominent protuberances in the postero-dorsal, postero-ventral central areas and also the sub-central tubercle. The latter runs diagonally towards the antero-ventral corner of the carapace.

The dorsal and ventral protuberances are associated with poorly defined dorsal and ventral ridges.

The entire surface is reticulate; the longitudinal walls are usually more strongly developed in the raised area, giving the appearance of longitudinal striations. The reticulation is weaker in the anterior and posterior depressed areas. The strength of the ornamentation varies from specimen to specimen. This development of the longitudinal walls gives 10 longitudinal ribs including the dorsal and ventral ridges. On some specimens the slight prominence of one of these longitudinal striations gives the impression of a median ridge.

The dorsal ridge commences just below the eye tubercle, is curved, finishing just before the posterior cardinal angle. The ventral ridge is ill defined and associated with the ventral part of the raised central area of the carapace, with a prominent swelling at the posterior.

In dorsal view, the sides of the carapace are more or less straight and subparallel, the ends laterally compressed; greatest width at the posterior portion of the raised area. In ventral view, the ventro-lateral swelling can be clearly discerned. Internal features are unknown.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 237	Female	0.628	0.330	0.260	1.903
J.T. 238	Female	0.630	0.330	0.240	1.909
J.T. 239	Female	0.595	0.305	0.240	1.950
J.T. 240	Female	0.595	0.305	0.260	1.950
J.T. 241	Female	0.610	0.350	0.240	1.742
J.T. 242	Female	0.540	0.315	0.210	1.714
J.T. 243	Female (holotype)	0.630	0.345	0.260	1.826
J.T. 244	Female	0.582	0.315	0.210	1.847
J.T. 245	Female	0.610	0.330	0.240	1.848
J.T. 246	Female	0.610	0.330	0.260	1.848

Discussion:

This species resembles Dumontina Deroo, 1966, in external appearance, in its general outline and absence of a hinge-ear, the elongate oblique subcentral tubercle, striate ornamentation and longitudinal ridges and its reticulate ornamentation. However, because no internal characters have been observed its assignment to Dumontina must remain questionable.

This species may belong to a new genus described by Al-Abdul-Razzaq (1977, Ph.D. dissertation, so far unpublished), which she named Retecytheretta. Externally Dumontina ? alfarhidii sp. nov. shows similarities to the type species Retecytheretta frontiradiata Al-Abdul-Razzaq, Ph.D. from the Santonian of Kuwait, but has a stronger subcentral tubercle, a more swollen ventral portion of the raised central area and Al-Abdul-Razzaq's species has a more uniform reticulation and the longitudinal striations are not as prominent as in Dumontina ? alfarhidii sp. nov. Once again, lack of information concerning internal characters prevents a definite generic designation. Retecytheretta frontiradiata is recorded from the Upper Cretaceous (Gudair Formation) in Kuwait, and has also been doubtfully synonymized with Dumontina ? IRE_{18} Grosdidier (1973) from the base of the Santonian-Coniacian ? in the coastal Fars Province of Iran, by Al-Abdul-Razzaq. Al Abdul-Razzaq described sexual dimorphism in her species where the males are noticeably more elongate than the females. The specimens studied here all fall within the L/H ratio of her females, and for this reason are all regarded as being females. Dumontina ? alfarhidii sp. nov. may be ancestral to Retecytheretta frontiradiata. Dumontina puncturata (Bosquet, 1854) the type species of the genus Dumontina and described by Deroo, 1966, from the Maastrichtian of Limburg, Belgium and Holland is similar to this species, but differs in having a weakly developed elongate subcentral tubercle, in the details of the ornamentation, and in its much larger size, (i.e. L: 0.90 mm; H: 0.44 m). Dumontina assyria described by Al-Sheikhly (unpublished Ph.D. thesis, 1980) from the Maastrichtian of Anah Well-2, western Iraq, is quite similar to Dumontina ? alfarhidii sp. nov. but differs in shape, with a bluntly pointed posterior end, and more concave ventral margin, has a slightly less developed subcentral tubercle, and the longitudinal striations are mostly less prominent except for one which by its prominence appears as a median ridge.

Occurrence:

This species has been recorded from the Lower Cenomanian (?), Lower Turonian-Lower Coniacian of Kifl Well-2; and from the Upper Turonian of Safawi Well-1.

Dumontina ? aff. alfarhidii sp. nov
pl.43, figs. 1-3.

Figure specimens:

J.T. 247

Material:

One specimen from the lowest bed of the Fahad Formation, from depth between 5250-5255 ft, of Kifl Well-2, central western Iraq.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 247	Female	0.610	0.330	0.240	1.848

Discussion:

This species differs from Dumontina ? alfarhidii sp. nov. in lacking the longitudinal striations and thus having a more regular reticulate ornamentation, and in having a less prominent subcentral tubercle.

Occurrence:

This has been reported from the Lower Cenomanian (?) of Kifl Well-2, central western Iraq.

Dumontina ? ibnmadjidi sp. nov.
pl. 43, figs. 4-7.

Name:

With reference to Shihab Ibn Madjid, a great Arab navigator of the 15th century.

Diagnosis:

A rectangular species of Dumontina with ten longitudinal ridges, the dorsal-most of which has a small postero-dorsal process; reticulation between the ridges; subcentral tubercle not distinct, raised area present behind subcentral area; prominent marginal rim; eye tubercle absent.

Holotype:

Male carapace, J.T. 248, Pl. 43, figs. 4-7.

Paratype:

J.T. 249.

Material:

Total specimens 3. East-Baghdad Well-3 section, middle-eastern Iraq, one specimen and one broken carapace from the lower half of the Tanuma Formation, at depths of 2282-2290 m below the surface. In Kifl Well-2 section, central western Iraq, one specimen found in the lowest bed of the Sadi Formation, at depth of 4375 ft below the surface.

Type Locality:

Kifl Well-2, central western Iraq.

Type Horizon:

Tanuma Formation, Upper Coniacian, depth of 4375 ft.

Stratigraphic range:

Upper Turonian-Coniacian.

Description:

Carapace elongate, sub-rectangular shaped in lateral view, medium size; maximum length centrally placed, maximum height at the antero-cardinal angle. Anterior margin evenly rounded, posterior margin slightly pointed; the dorsal margin is straight; ventral margin straight to slightly concave; dorsal and ventral margins are nearly parallel, slightly converging towards the posterior end; distinct postero-cardinal angle, better developed in the left valve; the postero-cardinal angle more defined than the antero-cardinal angle; left valve very slightly larger than the right valve, with slight overlap around the postero-dorsal angle about the top of the dorsal portion of the posterior margin; eye tubercle absent. The subcentral area has a slightly raised small tubercle situated slightly towards the antero-ventral area of the carapace.

A distinct and thin rim follows the anterior margin near the contact of the margin of the carapace (best seen in the right valve); just behind and parallel to the latter rim there is a thicker, better developed rim commencing from the antero-cardinal angle, running around the anterior margin and extending continuously and parallel to the ventral and posterior margins, being less developed along the dorsal part of the posterior margin. The posterior margin is ornamented by 5 small blunt denticles; 3 lying around the ventral portion, one on the slightly pointed posterior end, while the fifth is on the postero-marginal rim, in the dorsal part of the posterior margin. There are poorly developed small denticles along the antero-ventral margin.

The entire central, postero and ventro-median areas of the carapace are moderately raised. A moderately wide and smooth depressed antero-marginal area lies behind the anterior rim, and a narrow, nearly smooth depressed postero-marginal area lies behind and below the posterior rim.

The surface has several longitudinal ridges; a median line from dorsal margin to ventral margin passes through ten ridges. The dorsal-most ridge commences behind the antero-cardinal area ending at a small posterior process; below this a prominent ridge commences near the antero-marginal depression, splitting into 2 ridges about one third of the way towards the posterior; another prominent ridge runs from the top of the subcentral tubercle, ending level with the posterior process; behind the subcentral tubercle 3 short oblique ridges are present; a long ridge runs from the posterior towards the subcentral tubercle, splitting into two behind the subcentral tubercle, one branch inclined upwards and merging into reticulation developed behind the subcentral tubercle, the other branch forming the base of the sub-central tubercle; two further ridges are present along the venter. Reticulation is developed between these ridges.

The most prominent anterior pore cones are "Beta" and "Scorpio" and another pore cone is present on the area between the anterior rim and its margin just below the mid-anterior point and above the position of the "Gamma" pore cone.

In dorsal view the carapace has two subparallel sides, with laterally compressed ends; maximum width lies at centre and posterior region of the raised area of the carapace. In ventral view the ventro-marginal of both sides are parallel and prominent and the well developed posterior marginal rim with its ventral marginal denticles are clearly shown. No internal details were seen.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 248	Male	0.630	0.330	0.210	1.909
J.T. 249	Female (holotype)	0.610	0.330	0.2	1.848

Discussion:

This species is placed in Dumontina Deroo (1966) on the basis of lateral outline, lack of hinge-ear, the indistinct subcentral tubercle, the presence of the anterior marginal rim and similar type of surface ornamentation of reticulation and costae (longitudinal ribs). However the lack of information on internal characters leaves a great deal of uncertainty concerning its general designation.

It could also belong to Retecytheretta Al-Abdul-Razzaq (see discussion of Dumontina ? alfarhidii sp. nov.). The lack of an eye tubercle places doubt on both of these genera.

Retecytheretta frontiradiata Al-Abdul-Razzaq (1977, Ph.D. dissertation) from the Santonian of south eastern Kuwait differs in having stronger and more regular reticulation, less developed longitudinal ridges, more pointed posterior end, and has an eye tubercle. Dumontina ? alfarhidii sp. nov. is similar to this species in some features, but it is quite different in having an elongate and well developed subcentral tubercle, a small but distinct eye tubercle, lacks a distinct postero-dorsal process, in details of ornamentation of the lateral surface of carapace which is more strongly reticulate, less well developed marginal rims and in the presence of a more swollen ventro-median and postero-ventral parts of the carapace. The species identified by Grosdidier (1973) as "Leniocythere" IRR_{22} from the base of the Santonian to Coniacian ? in the Coastal Fars Provine of Iran, shows some resemblance to this species in general outline, but differs in details of the surface longitudinal ridges, it seems to have an eye tubercle, in the presence of less well-developed marginal rim, its dorsal ridge lacks a postero-dorsal process, the entire surface between the longitudinal ridges are smooth, and in the lack of a subcentral tubercle. Paracaudites (Dumontina) puncturatoides Babinot (Ph.D. thesis, 1980) from the Santonian of South France differs from this species Dumontina ? ibnmadjidi sp. nov. in details of ornamentation, in the presence of an eye tubercle, in the absence of a postero-dorsal process, a slightly elevated hinge-ear is developed in the left valve, and raised area behind subcentral area is lacking.

Occurrence:

Known so far from Upper Turonian-Coniacian of East-Baghdad Well-3, and the Upper Coniacian of Kifl Well-2.

Dumontina ? cf. *inbmadjidi* sp. nov.
Pl. 43, fig. 8.

Figured specimen and Material:

One specimen J.T. 250 only has been recorded from the middle part of the Tanuma Formation of the middle part of the Upper Coniacian, at drilling depth of 2280-2282 m, of East Baghdad Well-3, central eastern Iraq.

Dimension: (In mm.)

	L.	H.	W.	L/H.
J.T. 250	0.610	0.330	0.240	1.848

Discussion:

Part of the specimen is corroded, but it does seem to be the same as the species illustrated by Grosdidier (1973) as "*Leniocythere*" IRR_{22} from the base of the Santonian-Coniacian ? of the coastal Fars Province of Iran. It differs from *Dumontina* ? *ibnmadjidi* sp. nov. in lacking the small and slightly raised tubercle in the subcentral area and having more prominent ridges in the subcentral area; it lacks reticulation between the ridges; and it also appears to have an eye tubercle, a feature lacking in *Dumontina* ? *ibnmadjidi* sp. nov.

Occurrence:

This species known so far from Upper Coniacian of East Baghdad Well-3.

Dumontina ? *mdaouerensis* (Bassoullet and Damotte, 1969) Pl.44, figs. 1-8; Pl.45, figs. 1-3.

1969 - Cythereis mdaouerensis Bassoullet and Damotte, p. 136-137, Pl. 1, figs 5 a-d.
1981a - Cythereis mdaouerensis Bassoullet and Damotte - Bismuth et al., p. 231, Pl.11, fig. 10.
?1974 - Cythereis ? mdaouerensis Bassoullet and Damotte - Rosenfield and Raab, p. 18, Pl.3., figs. 12-15.

Diagnosis:

A species of Dumontina with three thin pronounced longitudinal ridges, median ridge continuous with subcentral tubercle; a thin but distinct antero-marginal rim; denticulate posterior and anterior margins; weakly developed subcentral tubercle; and with small, median, semi-rounded reticulation on the surface of carapace except for the anterior area behind the antero-marginal rim where large quadratic shaped reticulation is present.

Figured specimens:

J.T. 251 - J.T. 260

Material:

Total number of specimens 14. Safawi Well-1 section, south western Iraq, 6 specimens have been found, (4 specimens and two broken valves) in the Mishrif Formation, at depths of 3255-3270 ft. In Ghalaisan Well-1 section, south western Iraq, 6 specimens have been recorded; 4 specimens (including one broken valve) in the Kifl Formation, at depths between 3820 - 3836 ft; one specimen and one broken valve from the basal beds of the Ahmadi Formation at drilling depths of 4290 - 4310 ft.

Type Locality:

Coupe du Djebel em Mdaouer, Algeria.

Type Horizon:

Lower Turonian.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 251, 252	Male	0.700	0.350	0.260	2
J.T. 253	Male	0.745	0.350	0.260	2.12
J.T. 254	Male	0.732	0.350	0.260	2.091
J.T. 255	Female	0.560	0.330	0.190	1.696
J.T. 256	Female	0.610	0.350	0.190	1.742
J.T. 257	Female	0.582	0.330	0.210	1.763
J.T. 258	Female	0.582	0.330	0.260	1.763
J.T. 259	Female	0.582	0.330	0.240	1.763
J.T. 260	Female	0.610	0.330	0.210	1.848

Discussion:

This species is placed in Dumontina rather than Cythereis on the basis of the lateral outline, absence of an anterior hinge ear, absence or very poor development of a subcentral tubercle, and presence of longer and thinner longitudinal ridges. The internal characters have not been fully described and could not be observed in the study material.

he hinge elements could not be observed in any detail by Bassoullet and Damotte (1969), where not observed by Rosenfeld and Raab (1974), and were not described by Bismuth et al. (1981 a), and no other internal characters have been described. There is therefore a great deal of uncertainty as to its generic assignment. Rosenfeld and Raab (1974) suggested that the species might belong to Dumontina, and Bassoullet and Damotte as well as Rosenfeld and Raab compared the species with Isocythereis. Bismuth et al. did not include Rosenfeld and Raab material in their synonymy; their reason is not clear, although Rosenfeld and Raab's Fig. 12 does have a fairly prominent hinge-ear which is not characteristic of this species, and the median ridge seems to turn upwards to join the dorsal ridge at its posterior end. Because of this, Rosenfeld and Raab's material is included in the synonymy with some uncertainty. The material from Iraq however clearly belongs to this species.

Male and female dimorphs can be recognised in the study material although they have not been found together in the same sample. The females are rather smaller than those described by Rosenfeld and Raab (0.587 mm. cf. 0.64 mm) and appear to be much smaller than the measurements given in Bassoullet and Damotte. In the latter length is given as 0.72-0.74 mm with a height of 0.24-0.26 mm; this would give a L/H ratio of approximately 2.9, but the figured specimen when measured has a L/H ratio of only 1.92, compared with 1.762 in this study and 1.77-2.00 in Rosenfeld and Raab. Clearly there is an error in Bassoullet and Damotte's published dimensions. The males described here are slightly smaller than those of Bassoullet and Damotte (0.73 mm. cf. 0.76 mm) but identical to the male illustrated in Bismuth et al. (0.73 mm). There also appears to be an error in the male dimensions given in Bassoullet and Damotte where the published dimensions give a L/H ratio of 3·2 whereas the figured specimens have a L/H ratio of 2.10, i.e. the same as for the specimens described here from Iraq.

Rosenfeld and Raab mentioned that in the Elat region the species showed continuous variation from reticulate to non-reticulate. A similar variation can be observed in the Iraqi material (Pl. 44, figs. 1,2,3,4,5; Pl. 45, fig. 1.) In some specimens (Pl. 44, figs. 1, 2) there appears to be a weak subcentral tubercle formed by the reticulation. The strength of the dorsal and median ridges also varies, but they are always prominent.

Damotte and Saint Marc (1972) described a new sub-species, Cythereis mdaouerensis dlebtaensis from the Lower Cenomanian of the Lebanon; however the differences are so great as to suggest it is really a separate species; it has a bluntly pointed posterior end, a prominent subcentral tubercle, the median ridge is discontinuous behind the sub-central tubercle, and differs in outline in dorsal view. Neither Rosenfeld and Raab nor Bismuth et al. have used these subspecies in their synonymies. Neufville (1973) described Cythereis aff. mdaouerensis from the Cenomanian of Gabon, West Africa. However, the illustrations suggest that this form has little relaitonship to Cythereis mdaouerensis.

Occurrence:

This species so far has only been reported from the Lower Turonian of Algeria and Tunisia. In this study it has been found in the Lower Cenomanin - Lower Turonian. However, most of the material comes from the Mishrif (Upper Cenomanian-Lower Turonian) and Kifl Formation (Lower Turonian) Formation, and the earlier Cenomanian records are almost certainly due to contamination.

Dumontina ? sp. A.

Pl. 45, figs. 4-6.

Description:

A species of Dumontina with subrectangular outline; a well developed reticulate surface; small eye tubercle; a pointed posterior end; evenly rounded anterior margin; fairly distinct anterior and posterior marginal rims; an indistinct subcentral tubercle. Dorsl and ventral longitudinal ridges are thin and pronounced while the median ridge is weakly developed extending posteriorly towards the postero-dorsal area of the carapace; there is a prominent and short rib in the anterior area, spreading out from the subcentral area towards the antero-marginal rim.

Figures specimen and Material:

One specimen J.T. 261 only from the lower part of the Khasib Formation, at drilling depth of 2398 m, of South Rumaila Well-104, south eastern Iraq.

Dimensions: (In mm.)

	L.	H.	W.	L/H.
J.T. 261	0.652	0.360	0.260	1.811

Discussion:

This species is assigned to Dumontina on the external characters, but until internal characters are known its exact generic designation must remain uncertain.

It appears to be a new species, but as only one specimen has been found no new species haa been created. Dumontina ? mdaouerensis (Bassoullet and Damotte, 1969) from the Lower Turonian of Algeria and Lower Cenomanian-Lower Turonian of Iraq, shows a close resemblance to this species in shape and outline, but differs in details of reticulation and in having three more prominent developed longitudinal ridges.

Occurrence:

Known so far from Upper Turonian and Lower Coniacian of South Rumaila Well-104.

Genus Glenocythere Al-Abdul-Razzaq, 1979 b.

Type species:

Glenocythere bahreinensis Al-Abdul-Razzaq, 1979 b.

Diagnosis:

A genus of Trachyleberidinae, with three very broad ribs, two shorter (dorsal and median ribs) and one longer ventral rib; median-large carapace, sub-oval to sub-triangular in lateral view; anterior end broadly rounded with curved narrow sulcus, bordering wide marginal zone; posterior end narrowly rounded; prominent hinge-ear in the left valve; sub central tubercle large and very broad; eye tubercle present; surface ornamentation variable, consisting of nodes, ridglets and/or reticulations. Hinge Amphidont/heterodont, and central muscle scare with row of four adductor scars and V-shaped frontal scar.

Glenocythere bahreinensis Al-Abdul-Razzaq, 1979b.
Pl. 46, figs. 1-7.

1973 - Cythereis IRC_2 Grosdidier, Pl. 8, figs. 65 a-e.
1979b- Glenocythere bahreinensis Al-Abdul-Razzaq, Pl.1, figs.1-6; Pl. 3, fig. 1.
1983 - Glenocythere bahreinensis Al-Abdul-Razzaq - Al Furaih, p.3, Pl. 1, figs. 4, 5.

Diagnosis:

A species of Glenocythere with pitted surface of large rounded pits covering longitudinal ridges and subcentral tubercle with smooth to weakly pitted anterior and posterior areas.

Figured specimens:

J.T. 262 - J.T. 268.

Material:

Total number of specimens 21. In South Rumaila Well-104 13 specimens have been recorded: 7 (including one broken valve and one juvenile) from the basal part of the Ahmadi Formation, at depths of 2768 - 2788 m; and 6 specimens (including 3 broken valves and one juvenile) from the top bed and highest part of the Mauddud Formation, at drilling depths between 2791 - 2796 m. 4 specimens (including one broken valve) from the basal part of the Rumaila Formation, at drilling depths between 2794 - 2796 m (core samples). In Kifl Well-2 4 specimens from the uppermost beds of the Mauddud Formation, at depths between 2510 - 2520 ft.

Type Locality and Stratigraphic range:

Magwa field, Magwa Well-8, south eastern Kuwait, Lower Cenomanian.

Type Stratum:

Ahmadi Formation, depth 2,195.4 m (4,250 ft.)

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 262	Male	0.930	0.518	0.518	1.795
J.T. 263	Female	0.860	0.540	0.582	1.592
J.T. 264	Female	0.815	0.518	0.518	1.573
J.T. 265	Female	0.720	0.470	0.450	1.531
J.T. 266	Female	0.720	0.470	0.470	1.531
J.T. 267	Female	0.840	0.560	0.518	1.5
J.T. 268	Female	0.908	0.610	0.610	1.488

Discussion:

The species is very similar throughout its wide area of distribution, but slight differences can be seen in some specimens from Iraq and Oman. The dorsal ridge of the valve may differ in having a more pronounced tubercle at its anterior, it is probably less elongate; and the shape of the carapace in lateral view may be more triangular (Pl. 46, Figs. 4,5).

This species has been recognised for a long time in the Gulf area as an important marker species, informally identified as Cythereis bahreini. As quoted in Sayyab (1956) and Al-Abdul-Razzaq (1979 b) this dates back to 1933 when Mr. Allen Weymouth first used the name which then passed into common usage without ever being formally described. The species has also been quoted in the literature (Owen and Nasr, 1958); Dunnington, Wetzel and Morton, 1959). Sayyab erected a new genus Amphicythereis with 5 species, but never published his work. The species was figured by Grosdidier, but it was only in 1979 that Al-Abdul-Razzaq described this species as Gelenocythere bahreinensis n. sp., the type species of her new genus Glenocythere. Sayyab (1956) and Al-Abdul-Razzaq (1979 b) indicated the importance of this species as a horizon marker of the basal Ahmadi Formation and its equivalents throughout the Arabian Gulf. Owen and Nasr (1958, p. 1272) and Dunnington, Wetzel and Morton (1959, p. 32) stated that at the base of the Ahmadi Formation in the type section, the Burgan Well of Kuwait, a limestone characterized by an abundance of the ostracod Cythereis bahraini has been called the Cythereis bahraini Limestone. Dunnington, Wetzel and Morton (1959) showed that the Cythereis bahreini Limestone zone of the Ahmadi Formaiton in Kuwait has not been distinguished in the Basrah oil field of southern Iraq, although the microfauna occurs in thin limestone and in shales at the base of the Formation. Sayyab (1956) considered G. bahreinensis to represent the lower zone of the Middle Cretaceous of the Arabian Gulf area, suggesting an Albian age. G. bahreinensis is found in the Albian to lower part of the Cenomanian or Iran (Grosdidier, 1973); in the ? upper Aptian to middle part of the Cenomanian of Oman; it is recorded by Al-Furaih (1983) from the Cenomanian Wasia Formation of Saudi Arabia. He disagreed with Al-Abdul-Razzaq (1979 b) and Al-Abdul-Razzaq and Grosdidier (1981) in considering the Iranian Cythereis IRC_2 Grosdidier, 1973, to be synonymous with Glenocythere bahreinensis. They are regarded as synonymous in this study, Grosdidier's specimens are similar, but are compressed and less well preserved than the material from other localities.

In Iraq this species is present in the lower part of the Ahmadi Formation of Lower Cenomanian age and the highest part of the Mauddud Formation, but in the area east of Baghdad the Ahmadi Formation cannot be recognised and the species occurs in the basal part of the Rumaila Formation.

Juvenile moults differ from the adult in smaller size and less developed ornamentation, with less distinct median ridge and weaker secondary ornamentation; however the main features seen in the adult such as the curved ventral ridge and anterior sulcus are clearly developed.

<u>Occurrence</u>:

This species is know so far from Lower Cenomanian of Magwa Well-8, south eastern Kuwait; Cenomanian of the lower zone of the Middle Cretaceous of the Arabian Gulf; Albian-lower part of the Cenomanian of the Coastal Fars Province of Iran; ? Upper Aptian-middle part of Cenomanian of Oman; Cenomanian of Saudi Arabia; Lower Cenomanian of South Rumaila Well-104, East Baghdad Well-3, and Kifl Well-2

<u>Glenocythere</u> aff. <u>bahreinensis</u> Al-Abdul-Razzaq (1979 b)
Pl. 47, figs. 1-5.

<u>Figured specimens</u>:

J.T. 269 - J.T. 271.

<u>Material</u>:

3 specimens from the basal part of the lowermost part of the Ahmadi Formation of South Rumaila Well-104, at drilling depths of 2784-2788 m.

<u>Dimensions</u>: (In mm.)

		<u>L.</u>	<u>H.</u>	<u>W.</u>	<u>L/H.</u>
J.T. 269	Male	0.908	0.518	0.518	1.752
J.T. 270,271	Female	0.815	0.518	0.518	1.573

<u>Discussion</u>:

Glenocythere aff. bahreinensis differs from Glenocythere bahreinensis in outline of the anterior margin of the left valve which is distinctly pointed in its dorsal part (see Pl. 47, figs. 1-3), and in the presence of prominent pitting over the surface of the carapace.

Occurrence:

This species is recorded from the Lower Cenomanian of South Rumaila Well-104.

Glenocythere reticulata Al-Abdul-Razzaq (1979b)
Pl. 48, figs. 1-3.

1973 - Nigeria ? IRJ_{14} Grosdidier, Pl.7, figs. 63 a-f.
1979 b - Glenocythere reticulate Al-Abdul-Razzaq, Pl.2, figs. 1-4, Pl. 3, figs. 2, 3.

Diagnosis:

A large species of Glenocythere distinguished by three broad longitudinal ribs, and subcentral tubercle covered with prominent reticulation; the anterior and posterior marginal areas are smooth.

Figured specimen:

J.T. 272.

Material:

One specimen from the basal part of the Ahmadi Formation of South Rumaila Well-104, at a depth of 2786 m.

Type Locality and Stratigraphic range:

Magwa field, Magwa well-8, south eastern Kuwait, Lower Cenomanian age.

Type Stratum:

Ahmadi Formation, depth 1,292.35 m. (4,240 ft.)

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 272	Male	0.815	0.492	0.492	1.656

Discussion:

The specimen described here from south-eastern Iraq is not very well preserved, but from the general resemblance in outline, size, shape and primary and secondary ornamentation, is similar to Glenocythere reticulata Al Abdul-Razzaq (1979 b) from the Lower Cenomanian of Kuwait.

The median ridge is less prominent than in Al-Abdul-Razzaq's illustration, causing the subcentral tubercle to appear more prominent than in the Kuwaiti specimens. It is not clear whether this character is original or caused by factors such as compression of sediment.

The species identified by Sayyab (unpublished work, 1956) as Amphicythereis hasaensis from the lower zone of the Albian of the Middle Cretaceous of the Arabian Gulf coast, has the same shape and ornamentation, and is probably the same species. Al-Abdul Razzaq (1979 b) suggested that Glenocythere reticulata is descended from G. bahreinensis. The species is also present in the ?Aptian to the base of the Cenomanian of Oman and the Middle Cenomanian to Albian of the Coastal Fars Province in Iran. Typical specimens of this species are recorded from the upper zone of the Ahmadi Formation Limestone Member of Magwa Well-8 of Kuwait, although questionable specimens were recorded by Al-Abdul-Razzaq from the top of the basal zone of the Lower Ahmadi Limestone Member. The specimen described here comes from the basal part of the Ahmadi Formation, i.e. from older strata than in Kuwait, and its occurrence may be due to contamination from a higher horizon. The species described by Al-Abdul-Razzaq (1979) as Glenocythere triangularis, from the Lower Cenomanian of Kuwait, shows some affinity to this species but it is distinctly different by having a subtriangular shape in lateral view, the margins are angular, highly prominent hinge-ear in left valve, and in having three tuberculated longitudinal ridges. It is closely related to the type species <u>Glenocythere bahreinensis</u>, in all the characteristics except that three longitudinal ribs are covered with a network of reticulation.

<u>Glenocythere?</u> <u>rumailaensis</u> sp. nov.
Pl.48, figs. 4-6; Pl.49, figs.1-8.

<u>Name</u>:

With reference to the type locality South Rumaila Well-104, south eastern Iraq.

<u>Diagnosis</u>:

A large, subovate and swollen species of <u>Glenocythere</u> with ill-defined longitudinal ridges; short, swollen dorsal ridge consists of three minor longitudinal ribs; median ridge is broken and formed of three nodes; ventral ridge consists of 4-5 minor concentric ridges with reticulation between them; surface smooth; small circular pits present along the anterior, posterior and ventral margins; pore conuli present in the smooth area developed at the anterior and posterior as well as on longitudinal ridges.

<u>Holotype</u>:

Female carapace, J.T. 278, Pl.49, fig.1.

<u>Paratype</u>:

J.T. 273 - J.T. 277, and J.T. 279.

<u>Material</u>:

Total number of specimens 14. 13 specimens including one broken valve from the Ahmadi Formation of South Rumaila Well-104, at drilling depths between 2656 - 2788 m; and one specimen from the basal beds of the Ahmadi Formation of Ghalaisan Well-1, at a depth of 4320 ft.

<u>Type Locality and Type Horizon</u>:

South Rumaila Well-104, south eastern Iraq. Ahmadi, Lower Cenomanian, depth of 2788 m.

Stratigraphic range:

Lower Cenomanian.

Description:

Large carapace, subovate to subrectangular, in lateral view. Maximum length at about middle of carapace, maximum height anteriorly on antero-cardinal angle. Anterior margin more or less obliquely rounded; posterior margin obtusely rounded, truncate dorsally, a distinct postero-dorsal angle; dorsal margin sinuous; ventral margin gently convex, overhanging margin with a broad swelling of ventral ridge, converging with dorsal margin towards the posterior end. Eye tubercle more distinct on left valve. Large broad subcentral tubercle is well developed.

A broad area parallel to the ventral and posterior margins is unornamented, and a prominent sulcus runs from behind the eye tubercle parallel to the anterior margin and defines the edge of the unornamented area. Small circular pits are present along the anterior, ventral and posterior margins (see Pl.49, figs.7).

The three broad longitudinal ridges are not very well defined, in particular the median ridge is broken and formed of three nodes. The ventral ridge is more clearly defined, consisting of a swelling with 5 minor concentric ridges in the left valve and 4 in the right, with coarse reticulation between them, curving upwards at both ends, almost joining on to the nodes of the median area. The dorsal ridge is short, running from the anterior sulcus towards the posterior smooth area; its lower part curves downwards and joins part of the median ridge at its posterior; like the ventral ridge, the dorsal ridge is swollen and consists of three minor ribs with reticulation between them.

The median area of the valve consists of three nodes: a large and well defined sub-central tubercle, a smaller node behind this and ventrally placed, and a large swelling behind and dorsally situated; the latter joins the dorsal ridge at its posterior. These nodes are separated from each other and from the dorsal and ventral ridges by smooth and prominent sulci. The nodes are pitted. Pore conuli are present in the anterior and posterior smooth areas and on the longitudinal ridges (see Pl.48, figs. 5,6).

In dorsal view the carapace is suboval and swollen laterally; projection of pitted subcnetral tubercle, and the three minor longitudinal ribs of the dorsal ridges with reticulate furrows between them can all be seen clearly; maximum width antero-central at subcentral tubercle; in ventral view the 5 concentric ridges of left vale, the 4 ridges of right valve, with reticulation between them, and the small circular pits along the ventral and posterior margins can all be seen clearly. No internal features observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 273	Male	0.908	0.492	0.518	1.845
J.T. 274	Female	0.840	0.492	0.492	1.707
J.T. 275	Male	0.950	0.518	0.518	1.833
J.T. 276, 277	Female	0.815	0.492	0.492	1.656
J.T. 278	Female	0.815	0.492	0.492	1.656
J.T. 279	Female	0.792	0.492	0.492	1.609

Discussion:

Glenocythere ? rumailaensis sp. nov. is similar to G. bahreinensis Al-Abdul-Razzaq (1979 b) recorded from the Lower Cenomanian of Kuwait, differing in the following respects: the lack of a distinct median ridge, less prominent dorsal ridge, much less prominent eye tubercle, and the presence of reticulation or pitting of the ridges; the anterior hinge ear is better defined in Glenocythere bahreinensis, the ventral and dorsal ridges of the latter lack the small concentric and longitudinal ridges and ribs of Glenocythere?rumailaensis; G. bahreinensis lacks the pitted nodes behind the subcentral tubercle, in the median area, and the prominent sulci between these nodes are absent. This species seems to be identical to Amphicythereis ? zubairica described by Sayyab, 1956, from the upper zone of the Middle Cretaceous of the Arabian Gulf. Another species identified by Sayyab 1956 as Amphicythereis hedbergi from the lower zone of the Middle Cretaceous of the Arabian Gulf, is similar in shape, but differs in details of ornamentation and in its large size (length 1.04 mm). This species is placed in Glenocythere due to its general external appearance, but the lack of internal details leaves its generic assignment in doubt.

Occurrence:

Known so far from the Lower Cenomanian of South Rumaila Well-104, and of Ghalaisan Well-1; also recorded from the upper zone of the Middle Cretaceous of the Arabian Gulf.

<u>Iraqicythereis</u> gen. nov.

<u>Name</u>:

From the country of Iraq, from whence come the type specimens.

<u>Diagnosis</u>:

A genus of Trachyleberidinae with a dorsal ridge ending in a prominent posterior node, the latter may take the form of a short ridge running vertically downwards from the end of the dorsal ridge; a ventral ridge associated with a weak ventral swelling and also ending in a posterior node; elongate subcentral tubercle of varying strength; surface ornament consisting mainly of puncta, reticulation, or may be smooth; anterior and posterior margins denticulate, and rimmed, 4 adductor muscle scars and a single J shaped frontal scar; Amphidont hinge.

<u>Type species</u>:

<u>Iraqicythereis</u> <u>kadisiya</u> sp. nov.

<u>Description</u>:

Carapace small-medium size, rectangular to subrectangular in lateral view; greatest length passes through the mid-point, greatest height in region of eye tubercle and on the antero-cardinal angle, greatest width at the posterior third of the carapace, anterior margin evenly rounded; posterior margin subtriangular; dorsal and ventral margins are straight and subparallel, convering posteriorly.

Antero-cardinal angle rounded and fairly developed, particularly in the left valve; postero-cardinal angle obtuse and well pronounced in the left valve, but weakly distinct in the right valve. Left valve slightly larger and overlaps the right valve in region of the postero-cardinal angle and around the dorsal part of the posterior margin. Eye tubercle distinct, rounded, small to medium in size situated at the antero-cardinal angle. The valve is compressed laterally to the anterior and posterior end. Subcentral tubercle elongate, obliquely and broadly elevated, varying in degree of prominence.

There are two longitudinal ridges present: a distinct dorsal ridge which may appear undulating due to the reticulation covering the ridge or the area between the ridge and its margin, commencing just behind and below the eye tubercle and extending along the dorsal margin and ending posteriorly with a prominent node from which runs a short vertical ridge terminating above the mid-height; ventral ridge shorter and associated with a ventral swelling which may be less defined in some species which may belong to this genus (see discussion below); this starts from behind a shallow sulcus which lies in the antero-median area in front of the subcentral tubercle, extending towards the posterior, and terminating with a prominent node; the latter feature is not seen in the right valve of the male of the type species.

The distinct marginal rim is continuous from the eye tubercle around the venter to the postero-dorsal angle. The anterior margin is denticulate and the posterior margin is spinose along its ventral part. The antero and postero-marginal rim appear to have traces of small denticles. A depressed area lies behind and parallel to anterior and posterior rims.

Surface ornamentation is variable, with combination of macro-reticulation, and secondary ornamentation, or the surface may be almost smooth. Some pore cones are present in the ventral, posterior and anteior parts of the carapace, their prominence varying from specimen to specimen.

Internally, the line of concrescence and the inner margin coincide, and runs parallel to the outer margin; marginal area of average width; selvage prominent. The hinge is Amphidont, left valve hinge-elements consisting of anterior eye node formed as a small, rounded node situated at the antero-cardinal angle, moderately deep and smooth anterior socket, small spherical shaped antero-median postjacent tooth, followed by a smooth postero-median bar and ending with a posterior socket which is smooth and open ventrally, although it is difficult to observe with certainty, because of sediment fill. The muscle scars have not been observed internally, but their influence on the external ornamentation is so clear that their arrangement can be viewed externally (Pl. 54, figs. 2,4). They consist of a row of 4 oval and elongate adductor muscle scars, the second from dorsal being the longest, the third from dorsal being the smallest and less distinct, the fourth lowest one lying in an oblique direction, the lowermost two scars are joined together, whereas the uppermost two are distinctly separate from each other and from the lowermost two scars; the frontal J-shaped scar lies in front of the two dorsal-most adductor muscle scars; the inprint of two small and rounded mandibular scars are conspicuous below the adductor muscle scars.

Discussion:

This new genus belongs to the Cythereis group within the Trachyleberidinae. Cythereis Jones (1849) differs in having three longitudinal ridges, a more prominent and rounded subcentral tubercle, in arrangement of the four adductor muscle scars, and in having an Amphidont/lobodont hinge in which both the posterior and anterior hinge-elements are crenulate.

Iraqicythereis gen. nov. resembles Peloriops Al-Abdul-Razzaq (1979 a) more closely than any other genus described so far, having a compressed carapace with depressed antero-marginal area underlying the ridge, rimmed and denticulate margins and no median ridges; however, Peloriops differs in having a prominent hinge-ear, larger and more prominent hemispherical eye tubercle, lacks a sub-central tubercle, strongly tuberculate but much less defined dorsal and ventral ridges, usually has tuberculate ornamentation and has closely spaced adductor muscle scars with a V-shaped frontal scar. The hinge of Iraqicythereis gen. nov. is rather similar to that of Peloriops in having an ocular boss in the anterior of the left valve anterior hinge-element, a feature so far described only for these two genera. Curfsina Deroo, 1966, differs in the general outline of the carapace, in the presence in some species of a median ridge, in its ventral ridge joining the anterior ridge, in its split dorsal-most adductor scar and in details of the hinge especially the lobate anterior and posterior elements.

The new genus Iraqicythereis has similarities to Planileberis Deroo, 1966, in outline, and in the structure of the dorsal ridge; it differs in having a ventral ridge ending in a prominent posterior node and being associated with a ventral swelling; the ventral marginal rim of Planileberis is wide and may be confused with a ventral ridge, but strictly speaking, Planileberis has no ventral ridge; the sub-central tubercle of Planileberis is weak and similar to some individuals of Iraqicythereis gen. nov., although in general the subcentral tubercle is more pronounced than that of Planileberis; internally, the adductor muscle scars differ in that Planileberis has the three lowest scars in contact with each other whereas Iraqicythereis gen. nov. has only the lowest two in contact, the two higher muscle scars being well separated from the other scars; Planileberis has crenulate anterior and posterior hinge elements, and lacks the eye node of Iraqicythereis gen. nov.

Occultocythereis Howe (1951) differs from Iraqicythereis gen. nov. in lateral outline, in the presence of a stronger dorsal ridge, less surface ornamentation, lack of a subcentral tubercle and in the hinge which has a crenulate bar while the smooth bar of the new genus.

One species only is described for this genus, but several other figures or described species may belong here. These are discussed further under Iraqicythereis kadisiya.

Occurrence:

Iraqicythereis gen. nov. is recorded from the north western part of the Arabian Gulf; south-eastern, south western and northern parts of Iraq; south eastern Kuwait; Oman; and from the coastal Fars Province of Iran, and ranges from the Lower Turonian to the basal Santonian, and ? Campanian. Other species which may belong here would extend its range to the Albian - Lower Cenomanian, and Maastrichtian.

<u>Iraqicythereis</u> <u>kadisiya</u> sp. nov.
Pl. 50, figs. 1-4; Pl. 51, figs. 1-4; Pl. 52, figs. 1-7; Pl. 53, figs. 1-7; Pl. 53, figs. 1-7; Pl. 54, figs. 1-4; Pl. 55, figs. 1-6; Pl. 56, figs. 1-5; Pl. 57, figs. 1-4; Pl. 58, figs. 1-5.

1973 - <u>Planileberis</u> ? IRC_{27} Grosdidier, Pl. 14, figs. 110 a-d.

<u>Name</u>:

A town in the Iraq, south west from Kufa. The glorius day of al-kadisiya which made the Arabs masters of the Irak west of the Tigris is one of most celebrated events in the great period of the muslim conquests. The date of the battle (635-637) A.D.

<u>Diagnosis</u>:

A species of <u>Iraqicythereis</u> in which 5 morphotypes are recognised; ventral ridge associated with a ventral swelling and with a prominent node at its posterior end except for male right valve; posterior margin angular with 3-5 spines; ornamentation variable from smooth to macroreticulate.

<u>Holotype</u>:

Female carapace, J.T. 286, Pl.50, fig. 2; Pl.54, figs.2,4.

<u>Paratype</u>:

J.T. 280 - J.T. 285, and J.T. 287 - J.T. 309.

<u>Material</u>:

Total number of specimens 99. South Rumaila Well-104 section: 53 specimens have been recorded; 9 specimens from the Tanuma Formation, at drilling depths of 2342 - 2376 m; 33 specimens (including 6 single valves and 2 broken valves) from the Khasib Formation, at drilling depths of 2379-2427 m; 7 specimens and one single valve from the highest beds of the Mishrif Formation, at depths 2427 - 2430 m; and one specimen from the basal bed of the Sadi Formation which is in contact with the top bed of the Tanuma Formation, at drilling depth between 2328 - 2330 m.
Safawi Well-1 section, south western Iraq; 46 specimens have been found: 45 specimens (including 8 single valves and 2 broken valves) from the uppermost strate of the Tanuma Formation, at depths of 3175 - 3180 ft; one specimen, one single valve and three broken valves from the basal part of the Sadi Formation, at depths of 3160 - 3170 ft.

Type Locality and Horizon:

South Rumaila Well-104, south eastern Iraq. Khasib Formation, Upper Turonian-Lower Coniacian, depth of 2392 m.

Stratigraphic range:

Upper Turonian-Santonian.

Description:

The anterior margin has approximately 4 - 7 small spines or denticles, the posterior margin provided with some 3- 5 spines of varying size.

Sexual dimorphism is pronounced, the males being more elongate and with more nearly parallel dorsal and ventral margins and the males usually having larger posterior spines; there are also differences in the ventral ridge: the node at the posterior end of the ridge is absent in all male right valves and may be weakly developed in some male left valves; the ventral ridge of the right valve is thinner and less developed than that of the left in all males and also thinner and less developed than the ridge of the female right and left valves; and the ventral swelling is weaker in the male right valves than in the male left and female valves.

A few pore cones can be observed: at the posterior a distinct "Charon" pore cone is present at mid-height between the postero-dorsal and posteroventral nodes; anteriorly three small, distinct pore cones are present at the position of "Alpha", "Beta" and above and to the anterior of "pisces"; there is a prominent pore cone in the ventro-median area which may be the "Leo" pore cone. These pore cones are not always distinguishable due to the reticulation developed on the carapace.

In dorsal view the carapace has subparallel sides, with laterally compressed ends; postero-dorsal node of the dorsal ridge, the reticulation on the area between the dorsal ridge, anterior rim with their margins can all be seen clearly; maximum width lies at the posterior third of the carapace. In ventral view the ventro-marginal rim of both sides are clearly parallel and distinct, particularly in the males and sometimes the reticulation on the area along anterior, ventral and postero-ventral margins, can be clearly observed. Internal features already described under the generic description.

Morphotype No. 1.

This is characterised by the development of secondary reticulation and ornamentation within the macroreticulation meshes; characteristically this takes the form of minute tubercles or papillae (Pl. 51, fig. 4) covering the floor of the macroreticulation mesh, with small spines extending inwards from the mesh walls (Pl. 54, fig.2). In the central and subcentral areas minute pits or meshes (Pl. 53, fig. 4; Pl.54, figs. 2,4)are usually present (nannofossae of Liebau, 1977; or foveolation of Sylvester-Bradley and Benson, 1971) which seem to form when the papillae mentioned previously join up to form microreticulation walls (Pl. 52, fig.5; Pl.53, fig. 4; Pl.54, fig.4). The mesh walls of the macroreticulation is foveolate with two rows of small puncta (Pl. 51, fig. 4). The shape of the macroreticulation meshes varies over the surface of the carapace; in the central areas they are subrounded to subquadrate; in the depressed area at the posterior of the valve they are 3-4 sided and mural normal pore canals can be observed in some specimens (Pl. 53, fig. 4); row A (Liebau, 1971) which is parallel to the antero-marginal rim and row K which is parallel to the dorsal margin have subrounded, medium-sized meshes; row B, parallel to row A has small rounded meshes; subquadrate to subrectangular meshes are present along the ventral ridge its posterior node, postero-dorsal node, and postero-ventral area; subquadrate to subrectangular meshes are present between the margins of the valve and the anterior, venter, dorsal, and ventral part of the posterior marginal rim; the subcentral and antero-median areas are smooth to foveolate, this smooth area being smaller in size in the more heavily ornamented specimens.

Morphotype No. 2

This differs from Morphotype No. 1, in having weak ornamentaiton; in effect the macroreticulation is virtually absent apart from the anterior of the carapace and along the ventral ridge and postero-ventral angle; the secondary ornamentation of pitting is developed giving a pitted appearance to the central areas of the carapace and the dorsal node.

Morphotype No. 3

Only one specimen of this morphotype has been found, but as it differs from other morphotypes, it is felt justified to separate it as a distinct morphotype. It is similar to Morphotype No. 1, but differs in having a more pronounced subcentral tubercle and a thicker ventral ridge. The other noticeable difference is in the walls of the macroreticulation which are stellate in appearance (Pl. 56, fig. 1).

Morphotype No. 4

The whole surface is covered with subrounded to trapezoid prominent macroreticulation which gives the carapace a reticulate appearance. The mesh walls are foveolate (Pl. 57, fig.1). A secondary ornamentation of small spines project into the meshes. Small pits or meshes are developed on the floor of the macroreticulation in the subcentral area. The strong reticulation makes the longitudinal ridges, marginal rims, subcentral tubercle, and posterior spines less distinct than in Morphotypes Nos. 1-2.

Morphotype No. 5

This is similar to Morphotype 2, but differs in virtually lacking the anterior and ventral macroreticulation of the latter, in having a very ill-defined subcentral tubercle, and having less prominent posterior nodes on the dorsal and ventral ridges; the posterior margin is more pointed than in the other morphotypes. The surface is smooth or has faint pitting, probably the equivalent of the secondary ornamentation of Morphotypes Nos. 1-3; a remnant macroreticulation can be discerned along the dorsal and antero-dorsal areas.

Dimensions: (In mm)

		L.	H.	W.	L/H.
J.T. 280	Female	0.630	0.350	0.282	1.8

J.T.	281,282	Female	0.550	0.305	0.240	1.803
J.T.	283	Female	0.582	0.350	0.260	1.662
J.T.	284	Female	0.540	0.305	0.240	1.770
J.T.	285	Female	0.530	0.320	0.240	1.656
J.T.	286	Female (holotype)	0.582	0.330	0.260	1.763
J.T.	287,288 289	Female	0.582	0.330	0.260	1.763
J.T.	290	Female	0.582	0.330	0	1.763
J.T.	291	Female	0.540	0.330	0.260	1.636
J.T.	292	Female	0.560	0.320	0.282	1.75
J.T.	293	Female	0.570	0.330	0.260	1.727
J.T.	294	Female	0.519	0.305	0.240	1.701
J.T.	295,296	Female	0.560	0.305	0.238	1.836
J.T.	297	Female	0.610	0.350	0.242	1.742
J.T.	298,299	Female	0.560	0.330	0.210	1.696
J.T.	300	Female	0.582	0.350	0.260	1.662
J.T.	301	Male	0.610	0.305	0.238	2
J.T.	302	Male	0.630	0.330	0.190	1.909
J.T.	303,304	Male	0.630	0.330	0.210	1.909
J.T.	305,306	Male	0.630	0.330	0.238	1.909
J.T.	307	Male	0.630	0.330	0.260	1.909
J.T.	308	Male	0.630	0.330	0	1.909
J.T.	309	Male	0.610	0.305	0.238	2

Discussion:

Several species have been figured from around the Arabian Gulf which may belong to Iraqicythereis gen. nov., but without examining the material, and the lack of described internal details, it is not clear whether they should be assigned here or not.

Specimens from Oman have been studied and recorded by Dr. John Athersuch (personal communication) which are identical to Morphotype No. 5 from the upper part of the Turonian and ? Campanian of Oman. Grosdidier (1973, Pl.14, figs. 110 a-d) illustrated ostracodes which are similar to this species from the Santonian of the coastal Fars Province in Iran, naming them Planilebris? IRC_{27}. Occultocythereis asymmetra Al-Abdul-Razzaq (1977, unpublished Ph.D.

dissertation) from the Santonian of south eastern Kuwait is similar and could be identical to Morphotype No.1 of Iraqicythereis kadisiya sp. nov., in external appearance, but it differs in its smaller size (female L:0.48 mm - 0.51 mm; male L:0.53mm - 0.56 mm cf. female L:0.52 mm - 0.630 mm; male L:0.610 mm - 0.630 mm for Iraqicythereis kadisiya) and the ventral ridge in the male right valve is more weakly developed. However, there is some doubt about synonymising the two species because the hinge of Occultocythereis asymmetra is stated to be typical of the genus (i.e. Occultocythereis). If this is true, and Al-Abdul-Razzaq does not figure it or describe it, then the hinge is different from that of Iraqicythereis kadisiya sp. nov. Al-Abdul-Razzaq's species seems to belong to Iraqicythereis gen. nov. according to its external features, so its generic assignment is still uncertain. Al-Abdul-Razzaq considered the forms described by Grosdidier (1973) as Planilebris ? IRE_{23} from the Upper Santonian to Lower Campanian of Iran, to be synonymous with O. asymmetra, although this is open to doubt when comparing the illustrations of Al-Abdul-Razzaq and Grosdidier; nonetheless Grosdidier's specimens might belong to Iraqicythereis gen. nov. Planilebris ? IRD_{15} Grosdidier (1973) from the Albian to Lower Cenomanian of the coastal Fars Province of Iran differs in having a more elongate posterior margin giving a more tapered lateral outline; has less developed posterior and anterior marginal spines and denticles; ill-developed ventral ridge and ventro-lateral swelling; the nodes at the posterior end of the dorsal and ventral ridges are poorly developed; and the ornamentation differs in details.

Planilebris? IRD_{15} may belong to the new genus, but to make a proper assessment, details of the internal features are needed. Cythereis ? ashurbanipali Al-Sheikhly (1980, unpublished thesis) from the Upper Campanian ? - Maastrichtian of northern Iraq shows some resemblance to Morphotype No. 3 in general features, such as the two longitudinal ridges ending posteriorly in prominent nodes, and in having a less distinct subcentral tubercle; it differs in its larger size, in density and strength of the reticulation of the carapace, in having a slightly less developed posterior node at the end of the ventral ridge, and in the less pointed posterior end. Sexual dimorphism of Iraqicythereis kadisiya sp. nov. is more pronounced regarding shape, L/H ratio and the males have a prominent node at the end of the ventral ridge in the left valve only, unlike Cythereis ? ashurbanipali where a node is present on both male valves. No internal characters were observed by Al-Sheikhly, but the external characters suggest it belongs to the new genus.

As indicated in the description there is considerable variation within this species. This intraspecific variation may be of genetic origian or environmental origin. The fact that there is no obvious correlation with environmental changes, i.e. these 5 morphs are found in two formations representing more or less similar environmental conditions, and similar variants are also recorded in the Mishrif Formation which accumulated under different environmental conditions, leads support to a genetic origin. The variation is therefore regarded as a case of polymorphism.

Occurrence:

Known from the highest part of Lower Turonian to basal part of the Santonian of South Rumaila Well-104, south eastern Iraq; upper part of the Coniacian - base of Santonian of Safawi Well-I, south western Iraq. This species is also recorded from the Santonian of Iran and upper part of the Turonian and ? Campanian of Oman.

Genus Limburgina Deroo, 1966

Type Species:

Cypridina ornata Bosquet, 1847

Limburgina? aldjahizi sp. nov.
Pl. 59, figs. 1-9.

Name:

After Abu Othman Al-Djahiz, a famous Arab prose-writer and thologian, one of the chiefs of the Mutazilite school of Basrah.

Diagnosis:

A subquadratic species of Limburgina with well developed ventral and dorsal ridges, the former with a small posterior node, the latter with a postero-dorsal process; lateral surface reticulate, with large subrectangular reticules at the anterior, and muri appearing ridge-like at both the anterior and posterior.

Holotyps:

Female carapace, J.T. 311, Pl.59, figs. 2,3,7,9.

Paratype:

J.T. 310, and J.T. 312.

Material:

7 specimens have been found in Ghalaisan Well-1: 3 from the Tanuma Formation, at drilling depth 3715-3725 ft; one specimen from the highest bed of the Khasib Formaiton, at a depth of 3730 ft; one specimen from the highest part of the Rumaila Formation at a depth of 3850 ft; and 2 specimens from the Ahmadi Formaiton, at a depth of 4180 ft.

Type Locality:

Ghalaisan Well-1

Type Horizon:

Khasib Formation, Lower Coniacian, depth of 3730 ft.

Stratigraphic range:

Upper Turonian-Coniacian, Cenomanian ?.

Description:

Carapace subquadratic to subrectangular in lateral view; greatest length in the middle of the carapace; greatest height lies towards the anterior. Dorsal and ventral margins straight, sub-parallel and slightly converging towards the posterior; anterior margin evenly rounded; posterior margin subtriangular with slightly pointed end. Left valve slightly larger than the right. Eye tubercle well developed rounded, with short, distinct oblique rib. Subcentral tubercle distinct.

A distinct marginal rim extends along the anterior margin, continuing along the ventral and posterior margins. The anterior margin is ornamented with fine denticulation, the posterior margin has some 4 small denticles.

There are two longitudinal ridges. The dorsal ridge is well developed, starting from below the eye tubercle, curves upwards and ending posteriorly at a small postero-dorsal process; the latter joins with a nearly vertical short ridge which ends at about mid-height. The ventral ridge is strongly developed, straight, starting from the antero-dorsal corner and ends with a small node toward the posterior.

The entire surface is reticulate; large elongate subrectangular reticules lie parallel to the anterior margin; the reticules covering the rest of the valve are medium subrounded to square, except for the subcentral tubercle which is ornamented with small to very small reticules. The muri of the reticulation in the antero-marginal area area very prominent and appear as thin ridges extending from the anterior margin towards the subcentral tubercle; the muri in the posterior marginal area are very distinct and seem as ridges extending from the posterior margin.

In dorsal view, the anterior and posterior ends are compressed laterally, maximum width lies on the subcentral tubercle. No internal features could be seen.

Dimensions: (In mm.)

		L.	H.	L/H.
J.T. 310	Male	0.720	0.400	1.8
J.T. 311	Female (holotype)	0.720	0.425	1.694

Discussion:

This species shows similarities to *Limburgina* Deroo (1966) in external appearance, but lack of information on the internal features does not allow a definite generic assignment.

Limburgina binkhorsti (Van Veen, 1936) illustrated by Deroo (1966) from the Upper Maastrichtian of Limbourg shows some resemblance to *Limburgina* ? *aldjahizi* sp. nov. in outline and shape, in having two longitudinal ridges ending posteriorly with small nodes, a short rib, joining the posterior node of the dorsal ridge and in the presence of an eye rib; but it differs in details especially the arrangement of reticulation, in the anterior and posterior areas, and lacking the distinct mural ridges of *Limburgina* ? *aldjahizi*.

Occurrence:

Known from the Cenomanian-Coniacian of Ghalaisan Well-1.

Genus Louza Al-Abdul-Razzaq (M.S.) 1977

Type species:

Louza amygdaloidea Al-Abdul-Razzaq (M.S.), 1977

Louza amygdaloidea Al-Abdul-Razzaq (M.S.), 1977
Pl. 60, figs. 1-4.

1973 - Nigeria ? IRC_3 Grosdidier, Pl.7, figs. 62 a-c.

1977 - Louza amygdaloidea Al-Abdul-Razzaq (M.S.), p.169-173, Pl. 42, figs. 2-4; Pl. 43, figs. 1-5.

Diagnosis:

A species of Louza with a reticulate surface, longitudinal ridgelets along the ventral surface, and a finely pitted antero-marginal zone.

Figured specimen:

J.T. 313.

Type Locality:

Magwa field, south eastern Kuwait, Well-Magwa No.8.

Type Stratum:

Ahmadi Formation, depth 4270 ft.

Stratigraphic range:

Lower Cenomanian.

Material:

One specimen from the basal bed of the Ahmadi Formation, at drilling depth of 2775-2780 m in South-Rumaila Well-104.

Dimension: (In mm)

		L.	H.	W.	L/H.
J.T. 313	Male	0.610	0.315	0.350	1.936

Discussion:

Specimens illustrated here from south eastern Iraq are identical to the species described by Al-Abdul-Razzaq (1977, Ph.D.) from the Lower Cenomanian of Kuwait as Louza amygdaloidea. She assigned the species to a new genus she named Louza. In her recently published paper (1983) she referred to this species as Brachycythere n. sp. She (1977) regarded her new genus as being related to the Protocythere-Veenia group within the subfamily Trachyleberidinae, especially Veenia Butler and Jones (1957). The latter genus differs in having three longitudinal ridges, a prominent hinge ear and broad subcentral tubercle.

Louza is characterised by the presence of a wide finely pitted crescent-shaped antero-marginal zone which is laterally compressed; in having an almond-shape outline; absence of a subcentral tubercle, hinge-ear and marginal denticulation; and a surface ornamented with reticulation and longitudinal ridges. She also remarked in her dissertation that both Louza and Brachycythere belong to the same subfamily Trachyleberidinae and both have the same type of hinge but they differ in shape and in kind of ornamentation.

In this study the species recorded by Grosdidier (1973) as Nigeria ? IRC_3 from the Albian-Lower Cenomanian of the Coastal Fars Province in Iran is believed to belong to Louza amygdaloidea. Sayyab (1956, M.S.) found identical forms in the lower zone of the Middle Cretaceous of the Arabian Gulf Coast naming them Amphidentina nasri n. gen., n.sp. Athersuch (personal communication) recorded this species from the middle Cenomanian of Oman.

The specimen of Louza amygdaloidea illustrated here seems to be the male when compared with sexual dimorphism of the Kuwaiti specimens. The surface ornamentation of the Iraqi specimen is less developed, but this could be because of its state of preservation.

Al-Abdul-Razzaq pointed out that this species has been used in the paleontological collections of the Kuwait oil company under the name Brachycythere sp. and regarded as Cenomanian even though it has not been formally described. In addition this species has been used as an important stratigraphic marker throughout the upper zone of the lower Ahmadi Limestone Member (Jaber, 1965) which Jaber referred to as the Brachycythere limestone".

Protobuntonia semmamaensis Bismuth and Le Fevre (1981b) recorded by Bismuth et al. (1981a) from the upper part of the Lower Cenomanian and the Middle Cenomanian of Tunisa, shows some resemblance to this species; but differs in the outline of the posterior margin, in having an obliquely rounded anterior margin, a pitted lateral surface, and the anterior marginal zone is ornamented with larger and stronger pits.

Occurrence:

Known so far from the basal Cenomanian of South Rumaila Well-104; Lower Cenomanian of Kuwait; Albian-Lower Cenomanian of Coastal Fars Province in Iran; "Albian" lower zone of the Middle Cretaceous of the Arabian Gulf; and middle Cenomanian of Oman.

Genus Occultocythereis H.V. Howe, 1951

Type species:

Occultocythereis delumbata H.V. Howe, 1951.

Occultocythereis sp. A.

Pl. 60, figs. 5-7.

Diagnosis:

A species of Occultocythereis with punctate surface; prominent postero-dorsal process formed by confluence of dorsal ridge, a short vertical ridge and a short ridge running towards centre of valve.

Figured specimen:

Carapace, J.T. 314.

Material:

One specimen from the Tanuma Formation, at drilling depth of 3720 ft., of Ghalaisan Well-1.

Description:

Carapace small size, elongate, subrectangular in lateral view; anterior margin evenly rounded; posterior margin narrow, subangular pointed at mid-height; dorsal margin straight, partly hidden posteriorly by the dorsal ridge; ventral margin straight; ventral and dorsal margins subparallel and converge slightly towards the posterior end. Eye tubercle small; subcentral tubercle marked by a swelling on the surface inclined towards the antero-ventral corner of the carapace.

A distinct marginal rim extends around the anterior, ventral and posterior margins being better developed along the anterior and ventral part of the posterior margins than along the ventral margin. There are 5-6 short spines ornamenting the anterior margin and 4-5 small spines at the ventral part of the posterior margin.

Lateral surface is ornamented by small-medium puncta, with fewer puncta tending towards smoothness in the anterior and along the ventral swelling. A row of rounded reticulation is present above the ventro-marginal rim. Dorsal ridge is prominent, slightly convex upwards, commences from behind the eye tubercle and terminating posteriorly with a well developed and angular posterodorsal process; the latter is confluent with a short vertical ridge extending downwards to terminate before reaching mid-height, and with an oblique and faintly developed ridge running diagonally towards the ventro-lateral swelling. The left valve has a median ridge running obliquely through the antero-median swelling towards the antero-ventral corner. Ventral ridge indistinct, but a ventral swelling present running obliquely from mid-height towards posterior and parallel to antero-median swelling.

In dorsal view the carapace has two parallel sides with laterally compressed ends; the postero-dorsal process, the dorsal ridge and the anteromedian swelling are clearly seen. Internal details not seen.

Dimension: (In mm.)

	L.	H.	W.	L/H.
J.T. 314	0.470	0.260	0.210	1.807

Discussion:

Occultocythereis sp. A bears some resemblance to *Occultocythereis Hatraensis* Al-Sheikhly (M.S., 1980) from the Maastrichtian of western Iraq, but the latter species differs in having smaller sized punctation restricted to the median part of the lateral surface, lacks the median ridge lying obliquely upon the antero-median swelling of left valve, and has a straight dorsal ridge. *Occultocythereis namrudia* Al-Sheikhly (1980) from the Maastrichtian of western Iraq shows a close affinity to this species, but differs in having pitted dorsomedian surface with fine punctation on the ventral surface of the ventro-lateral swelling of the carapace, straight dorsal ridge, and lacks the ridge lying on the antero-median swelling of the left valve. Occultocythereis harthaensis Al-Sheikhly (op. cit.) from the Maastrichtian of western Iraq differs by its larger size, lacks the oblique ridge running from the postero-dorsal process towards the ventrolateral swelling, with larger spine at the ventral part of the posterior margin, and in having a more densely punctate lateral surface.

Occurrence:

Known so far from the Upper Coniacian of Ghalaisan Well-1.

Genus Peloriops Al-Abdul-Razzaq, 1979a.

Synonymy:

1982 - Aphrikanecythere Damotte and Oertli, p.287-288.

Diagnosis:

A genus of Trachyleberidinae with tuberculate dorsal ridge and ventral ridges, no subcentral tubercle or median ridge; prominent hinge ear and eye tubercle. The hinge is amphidont with ocular boss in left valve.

Type species:

Peloriops sphaerommata Al-Abdul-Razzaq, 1979a.

Description:

Carapace small to medium in size, subrectangular to subquadrate in lateral view with its greatest height at the prominent hinge-ear, greatest length at about mid-height; posterior margin usually varies from subacute to blunt; dorsal and ventral margins converge towards the posterior end.

Sexual dimorphism distinct with more elongate males. The eye tubercle is hemispherical and prominent. Hinge-ear prominent in the left valve. The left valve is slightly larger, strongly overlaps the right valve in the region of the antero-cardinal angle and slightly to strongly at the posterior-cardinal angle. No subcentral tubercle is present.

The dorsal and ventral ridges are tuberculate. There is no median ridge.

The anterior and posterior margins are rimmed and denticulate; the anterior marginal rim is smooth, denticulate, spinose, or tuberculate. The anterior and posterior marginal areas are typically depressed.

The ornamentation of the entire surface varies from reticulate (macro reticulate, microreticulate or combination), to smooth and tuberculate with spines.

Internally the marginal area is moderately wide, inner margin and line of concrescence coincide, selvage peripheral and prominent. The hinge is Amphidont; in the left valve consisting of an anterior ocular boss, anterior socket, knob-like antero-median tooth, postero-median bar which appears to be smooth, and ~~with a small ovate tooth at its posterior end,~~ followed by a deep, curved elongate posterior socket open ventrally. The central muscle scars consist of a row of four closely spaced adductor muscle scare, with a "V" shaped frontal scar, and small rounded mandibular scar.

Discussion:

The genus Peloriops is divided into two subgenera, Peloriops (Peloriops) and Peloriops (Hemipeloriops) sub gen. nov. which differ in the degree of development of the tubercles of the dorsal and ventral ridges and median, anterior and posterior areas, and usually in the shape of the posterior margin. The nominate sub genus Peloriops (Peloriops) has short tuberculate dorsal and ventral ridges; the surface ornament is variable with microreticulation, macroreticulation or a combination of them, together with smooth and prominent pore cones or tubercles and spines. The posterior end is generally subacute with the dorsal and ventral margins converging towards the posterior.

Peloriops (Hemipeloriops) sub gen. nov. has a tuberculate surface with prominent tuberculate dorsal and ventral ridges parallel to their margins; the surface of the median, antero-median and posterior areas also have prominent tubercles; the posterior end is subrounded giving a blunt appearance; the dorsal and ventral margins do not converge posteriorly as strongly as in the nominate subgenus.

In this study 9 species are regarded as belonging to subgenus Peloriops (Peloriops) from the Middle and Upper

Cretaceous and 3 new species are described and assigned to the new subgenus Peloriops (Hemipeloriops) sub gen. nov. from the Middle and Upper Cretaceous.

Peloriops is similar to both Planileberis Deroo, 1966 and Cythereis Jones, 1849; it differs from both of these in lacking a subcentral tubercle, having a more prominent eye tubercle, in having an ocular boss in the hinge of the left valve, and two short tuberculate ridges. The genus Cythereis also differs from Peloriops in having a median ridge. Peloriops also tends to have a more tuberculate surface in addition to the reticulation of the surface.

The new genus described by Damotte and Oertli (in Donze et al. 1982) as Aphrikanecythere is regarded as being identical to Peloriops (Peloriops) Al-Abdul-Razzaq, 1979a, on the basis of similarities in the external features mentioned above as well as internally in having an Amphidont hinge with an ocular boss in the left valve and also the type of muscle scars.

Damotte and Oertli even figure an external view (Pl. 6, fig. 9) in which the muscle scar pattern can be seen superimposed on the ornament similar to that described here (Pl.54, fig.2). Therefore the new species Aphrikanecythere phumatoides Damotte and Oertli from the Middle and Upper Maastrichtian of Tunisia is regarded here as Peloriops (Peloriops) phumatoides (Damotte and Oertli, 1982).

Occurrence:

Peloriops is distributed over the areas of the Middle East, and Western Coast of the Arabian Gulf, Oman, Kuwait, Iraq, the Coastal Fars Province of Iran; North Africa, Tunisia, Northern Central Tunisia and Algeria; and Palestine. It is common in the Vraconian and Albian-Cenomanian, and sometimes found in the ? Upper Aptian, Turonian, Coniacian, Santonian Campanian and Maastrichtian.

Sub Genus *Peloriops* (*Peloriops*) Al-Abdul-Razzaq, 1979a.

Synonymy:

1982 - *Aphrikanecythere* Damotte and Oertli, p.287-288.

Type species:

1979a - *Peloriops* *sphaerommata* Al-Abdul-Razzaq, p. 48-51, Pl.1, figs. 1-3, 6; Pl.2, figs. 1,2.

Diagnosis:

Peloriops (*Peloriops*) characterised by short and tuberculated dorsal and ventral ridges. Ornament of reticulation (macroreticulation, microreticulation, or a combination of them), with smooth areas and tubercles and spines; pore cones maybe prominent. Posterior end generally pointed.

Peloriops (*Peloriops*) *sphaerommata*
Al-Abdul-Razzaq, 1979a.
Pl.61, figs. 1-6; Pl.62, figs. 1-8.

Synonymy:

?1959 - *Ostracode* E_3, Glintzboeckel and Magne, Pl. 2, fig. 20.
1974 - *Planiberis* *ziregensis*, Rosenfield and Raab, p.19, Pl.3, fig. 1, non *Cythereis* *ziregensis*, Bassoullet and Damotte, 1969, Pl. 1, figs. 4 a-d.
1979a - *Peloriops* *sphaerommata*, Al-Abdul-Razzaq, Pl.1, figs. 1-3, 6; Pl.2, figs. 1,2.
1981a - *Peloriops* *ziregensis*, Bismuth et al., p.234, Pl.8, figs. 9-12, non *Cythereis* *ziregensis*, Bassoullet and Damotte, 1969, Pl.1, figs. 4 a-d.

Diagnosis:

A species of subgenus <u>Peloriops</u> (<u>Peloriops</u>) with microreticulate surface, macroreticulation sometime developed; dorsal and ventral ridges short and tuberculated, with smaller tubercles or pore cones developed in the posterior half of the median area.

<u>Figured specimens</u>:

J.T. 315 - J.T. 325.

<u>Material</u>:

36 specimens: 34 (including 6 broken carapaces and one open valve) from the Ahmadi Formation, at drilling depths between 2644-2744 m; and two specimens from the Mishrif Formation, at depths of 2552 m and 2488 m. All these specimens are found from the South Rumaila Well-104.

<u>Type Locality and Stratum</u>:

Magwa fields, Magwa Well-8, south eastern Kuwait. Ahmadi Formation, depth 4205 feet.

<u>Stratigraphic range</u>:

Cenomanian.

<u>Description</u>:

Carapace medium size; anterior margin evenly rounded; posterior end sub-triangular and pointed centrally, converging dorsal margin at distinct postero-cardinal angle, dorsal margin straight; ventral margin slightly concave, both margins sub-parallel and strongly converging posteriorly extending to tip of posterior end; posterior and anterior areas typically depressed laterally; prominent protruding spherical eye tubercle; prominent anterior hinge-ear; conspicuous overlap of right valve at antero-dorsal angle and dorsal part of posterior border. Greatest height at position of hinge-ear, greatest length lies in the middle of carapace and about mid-height. Sexual dimorphism is not prominent, although males are more elongate (L/H 2.00 cf.1.80).

In dorsal view the carapace has sub-parallel sides with laterally compressed ends; the prominent eye tubercle, "Sagittarius" pore cone and tuberculate posterior end of dorsal ridge can be seen clearly; maximum width lies at the posterior nodes of the ventral ridge. In ventral view the reticulation with projection of nodes of ventral surface and the denticles of anterior margin are moderately distinct.

The dorsal ridge is very short, consisting mainly of two closely spaced tubercles giving the appearance of a single large posterior node. The ventral ridge is variable, tuberculate with two prominent tubercles at posterior, and to the anterior of these may incorporate another 4 smaller tubercles or/and pore cones.

Prominent narrow anter-marginal ridge runs from eye tubercle around the anterior margin fading ventrally. The anterior margin has some 6-10 denticles or small-median spines varying in strength from specimen to specimen, the antero-marginal ridge may also bear 4-6 very small denticles or spines on each valve, but these are not always present. Depressed antero-marginal area lies just beyond and along antero-marginal ridge. The postero-marginal rim is thin and narrow and may be distinct or weakly developed, extending along the posterior margin. The posterior margin has some 5 denticles or spines along its ventral side. A small spine may be present near its dorsal end. The postero-marginal ridge has 2-4 small spiens or small nodes usually around its ventral portion.

The carapace has both macroreticulation and microreticulation and has conspicuous pore cones or/and tubercles. The micro-reticulation covers the entire surface including the tuberculate dorsal and ventral ridges and the area between the anterior and posterior margins and their respective marginal rims. The macro-reticulation varies in strength between specimens; in one specimen it is strongly developed, in others, it is more weakly developed or restricted to a few narrow weak meshes in the anteromarginal depression. It has not been possible to apply the terminology of Liebau to the macroreticulation. In the specimen showing well developed reticulation, the pattern is as follows: large, strong, quadratic reticulation is developed in the first two rows posterior to anterior marginal rim (A+B), with smaller triangular to rounded reticulation towards the centre of the valve, moderately large, subrectangular reticulation in the mid-ventral area, and small weak reticulation in the posterior marginal depression.

The tubercle or/and pore cones are developed on the surface and may be prominent parts of the ornamentation; the terminology adopted in the following description is based on Benson (1972), and Al-Sheikhly (1980, unpublished thesis, and see fig. 5.1). The anterior, posterior and central parts of the carapace have small and less prominent tubercles or pustules. The most prominent feature along the dorsal margin is the posterior node which is in the form of two tubercles, and forms the main and strongest postero-dorsal tubercles of the dorsal ridge, developed at the position of the "Virgo" pore cone; halfway between them and the eye tubercle is the smaller and prominent pore cone "Sagittarius" with a crater pore; and finally a small 'Aquarius" pore cone can be recognised behind the eye tubercle. Along the ventral area there are 2-6 tubercles or/and pore cones of varying size and strength; two of them lie in the position of "Iota" and "Zeta", although they are poorly developed in the single specimen showing strong macroreticulation and along the ventral margin; the two posterior most tubercles are elongate, prominent in a vertical direction occurring at the position of the "Lambda" or "phi" pore cones which form the postero-dorsal nodes of the ventral ridge. At the posterior there are 2-3 pore cones or/and small tubercles in the position of "Chi" and "Terminus". The postero-median area has 4-14 small tubercles or/and pore cones of different size and strength, one of them at the position of "Charon"; 7 small tubercles or spines are present in the antero-median area of some right valves.

Internally the marginal area is moderately wide, inner margin and line of concrescence coincide, selvage peripheral and prominent. The hinge is Amphidont; in the left valve it consists of anterior ocular boss, anterior socket, knob-like antero-median tooth, postero-median bar which appears to be smooth, with a small ovate tooth at its posterior end, and deep, curved elongate posterior socket open ventrally. The muscle scare have not been observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 315	Male	0.630	0.305	0.305	2.065
J.T. 316	Female	0.610	0.330	0.260	1.848
J.T. 317	Male	0.652	0.330	0.282	1.975
J.T. 318,319	Female	0.630	0.350	0.305	1.8
J.T. 320	Male	0.680	0.350	0.330	1.942
J.T. 321	Female	0.652	0.350	0.305	1.862
J.T. 322	Female	0.680	0.380	0.282	1.789
J.T. 323	Female	0.582	0.330	0.260	1.763
J.T. 324	Female	0.610	0.380	0	1.605
J.T. 325	Female	0.580	0.352	0.260	1.662

Discussion:

Some difference in the degree of development of the tubercles, spines and reticulation can be recognised within this species as mentioned above. These differences might be genetic or perhaps due to some environmental factors such as salinity and food supply.

Peloriops (*Hemipeloriops*) *levisculcata* M.S., Al-Sheikhly (1980) from the Maastrichtian of northern Iraq, and *Peloriops* (*Hemipeloriops*) cf. *djabirbnhaiyani* sp. nov. show some resemblance to *Peloriops* (*Peloriops*) *sphaerommata* in having a tuberculate surface, but differs in the outline of the carapace which has a bluntly pointed posterior end, more developed nodes on the dorsal and ventral ridges, and in the median, posterior and anterior areas, and in having a non-reticulate surface.

Planileberis pustulata Rosenfeld and Raab (1974) from the Cenomanian of Palestine resembles this species in outline, shape, lack of subcentral tubercle, lack of median ridge, in having a prominent hinge-ear and prominent eye tubercle; but differs in its large size (i.e. L = 0.72 mm - 0.94 mm), in degree of development, size, number and arrangement of tubercles of the carapace and in the details of reticulation. This species has the characters of Peloriops rather than Planileberis. Planileberis ziregensis (Bassoullet and Damotte, 1969, p. 135, Pl. 1, figs. 4 a-d) described by Rosenfeld and Raab, 1974, Pl. 3, fig. 1 from the Cenomanian of Palestine closely resembles this species in external features, but the details of the reticulation cannot be seen clearly (see Rosenfield and Raab, 1974, Pl.3, fig. 1). Nevertheless it seems to be identical and is placed under the synonymy of Peloriops (Peloriops) sphaerommata. Cythereis ziregensis Bassoullet and Damotte, 1969 from the Cenomanian of Algeria is similar to Peloriops (Peloriops) sphaerommata and there is some controversy concerning the synonymy of these two species.

In a recent paper (Bismuth et al. 1981a) the type species of Peloriops, (Peloriops) sphaerommata has been questionably regarded as a junior synonym of Peloriops (Peloriops) ziregensis Bassoullet and Damotte, 1969). Al-Abdul-Razzaq, (Summer, 1978) examined material of Cythereis ziregensis Bassoullet and Damotte, 1969, and noted its similarity to Peloriops (Peloriops) sphaerommata, but obviously did not regard them as being the same. She did regard it as a species of Peloriops however. In a more recent paper (1983) however, Al-Abdul-Razzaq seems to consider Peloriops (P.) sphaerommata to be a junior synonym of Peloriops (P.) ziregensis in her list of species.

The specimens illustrated by Bismuth et al. are almost certainly of the same species described as Peloriops (P.) sphaerommata as interpreted here and by Al-Abdul-Razzaq, but seen to be rather different from the illustrations of Cythereis ziregensis given by Bassoullet and Damotte. Until this problem is cleared up, it seems sensible to retain Peloriops (P.) sphaerommata as a distinct and separate species from Peloriops (P.) ziregensis, reported by Al-Abdul-Razzaq, 1979a (Kuwait), Sayyab, 1956 (Western Coast of Arabian Gulf), Bismuth et al. 1981a (Tunisia), Rosenfeld and Raab, 1974 (Palestine), Athersuch (personal commun. (Oman), possibly Glintzboeckel and Magne, 1959 (East Algeria and Tunisia) and from this study south eastern Iraq. Peloriops (Peloriops) ziregensis is recorded by Bassoullet and Damotte, 1969 (Algeria), Glintzboeckel and Magne (1959, Pl.3 fig. 32), (East Algeria and Tunisia).

Occurrence:

Known so far from the Cenomanain of Magwa Well-8 of Kuwait, from the upper zone of the Middle Cretaceous of Western Coast of the Arabian Gulf, from the lower Cenomanian of Oman, Cenomanian of South Rumaila Well-104, Lower-Upper Cenomanian of Palestine, Vraconian-Cenomanian of East Algeria and Tunisia and from Lower Cenomanian-lower part of the Upper Cenomanian of Tunisia.

<u>Peloriops</u> (<u>Periop</u>) <u>almasudii</u> sp. nov.
Pl.63, figs. 1-5.

<u>Name</u>:

After Abul-Hasan Al-Masudi, a famous Arab historian and geographer and one of the most versatile authors of the eleventh century.

<u>Diagnosis</u>:

A species of <u>Peloriops</u> (<u>Peloriops</u>) with a smooth surface which is covered by small-medium tubercles or/and pore cones, and some spines, a well-developed narrow anterior marginal rim with conspicuous medium tubercles along it.

<u>Holotype</u>:

Male carapace, J.T. 329, Pl.63, figs.1,5.

<u>Paratype</u>:

J.T. 326 - J.T. 328, and J.T. 330.

<u>Material</u>:

Total number of specimens 14. 12 specimens (including 2 broken valves) from the Ahmadi Formation, at depths between 2644 - 2730 m; one specimen from the Mishrif Formation, at a depth of 2482 m. In Kifl Well-2 one specimen from the basal part of the Fahad Formation, at a depth of 5255 ft.

<u>Type Locality and Horizon</u>:

South Rumaila Well-104, south east Iraq. Ahmadi Formation, Lower Cenomanian, depth of 2660 m.

<u>Stratigraphic Range</u>:

Lower Cenomanian, Upper Cenomanian ?.

<u>Description</u>:

Small to medium sized carapace, subtrapezoid, in lateral view, greatest height at prominent hinge-ear, greatest length at about mid-height, anterior and evenly rounded, posterior and subacutely pointed at about mid-height; dorsal and ventral margins subparallel, strongly converging towards posteior, dorsal margin straight, ventral margin slightly to strongly concave at antero-ventral area. The eye tubercle prominent; the left valve slightly larger, overlaps the right valve at well-defined anterodorsal and postero-dorsal cardinal angles, and at the upper portion of the posterior end.

The valves are compressed along the periphery of the anterior and posterior margins. In lateral view the dorsal ridge is short and more or less restricted to a large posterior tubercle, the ventral ridge is marked by a row of tubercles, or/and pore cones, and the anterior marginal rim also bears prominent tubercles.

The entire surface is usually non-reticulate with small tubercles or/and few pore cones, although one specimen (Pl.63, fig.3) has indistinct macroreticulation at the anterior.

The dorsal ridge is short, and bearing 3-5 tubercles or/and pore cones, the postero-dorsal tubercle is large, prominent, present at the position of the "Virgo" pore cone, consisting of a cluster of 3-7 smaller tubercles, and sometimes it seems to be as bilobate tubercles; smaller pore cone or tubercle lies in the position of the "Sagittarius" pore cone is prominent mid-way between the "Virgo" and the eye tubercle, 1-2 small tubercles or pore cones lie at the position of the "Aquarius" pore cone, and there are traces of small nodes between "Virgo" and "Sagittarius". The ventral ridge is distinct, short and broken into 5 tubercles or/and pore cones, varying in strength and size; it is formed mainly from two postero-ventral tubercles sometimes joined and which are prominent, elongate vertically and lie in the position of the "Lambda" or "phi" pore conuli, and may have several smaller nodes upon them. The other two ventral tubercles or/and pore cones lie in the position of "Iota" and "Zeta". Numerous c.25 tubercles or/and pore conuli are developed between the dorsal and ventral ridges and the antero-marginal rim; some of these can be placed in to the Benson (1972) and Al-Sheikhly (1980) system of nomenclature; at anterior "pisces" and "Capricornus"; "Sigma" and "Charon" vary in development and size; at the posterior "Terminus" and "Chi". In general, these small tubercles are more prominently developed in the posterior half of the valve.

A narrow, prominent marginal rim extends along the anterior margin, commencing at the eye tubercle and fading away ventrally; a depressed anterior area lies behind the rim; posterior marginal rim distinct especially along its ventral half. The antero-marginal rim has 7-8 very prominent tubercles and sometimes has a few small nodes developed just below and on the eye tubercle (see Pl.63, fig.2). The posteromarginal rim has 2-3 small nodes or spines especially around its lower portion. The anterior margin has small spines or denticles developed and the posterior margin has about 8 small spines between the postero-cardinal angle and the ventral margin, 2-3 of these spines (one at the top and the others at the bottom) present on the upper portion of the posterior margin.

In dorsal view the carapace has sub-parallel sides with laterally compressed ends, small nodes, small spines, denticles and eye tubercle can be clearly observed; maximum width lies at posterior of carapace. No internal features were observed.

Dimensions: (In mm.)

			L.	H.	W.	L/H.
J.T. 326	Male		0.610	0.305	0.282	2
J.T. 327	Female		0.630	0.330	0.282	1.8
J.T. 328	Male		0.582	0.305	0.240	1.908
J.T. 329	Male	(holotype)	0.582	0.305	0.240	1.908
J.T. 330	Female		0.540	0.305	0.210	1.770

Discussion:

Peloriops (*P.*) *almasudii* is very similar to *P.* (*P.*) *sphaerommata* Al- Abdul-Razzaq (1979a) from the Cenomanian of Kuwait, Iraq and Oman, in outline, in having tuberculate ridges and in the position of some tubercles or/and pore cones (which are more prominent). It differs in having the entire surface smooth, in the number and prominence of tubercles, spines, or pore cones on the lateral surface, in having a cluster of small nodes on the posterodorsal tubercle, and the antero-marginal rim having prominent tubercles along it. This species also differs from *Peloriops* (*Peloriops*) *ulosa* Al-Abdul-Razzaq (1979a), from the Cenomanian of Kuwait, Iraq and from (Upper ? Aptian-Cenomanian) of Oman, in having a tuberculated antero-marginal rim, in the greater prominence of the nodes or tubercles along the surface of the carapace, and the crater-like pits on the tips of tubercles or pore cones being poorly distinguished. It differs from *P.* (*Hemipeloriops*) *levisulcata* Al-Sheikhly (unpublished Ph.D. thesis, 1980) from the Maastrichtian of Iraq and *P.* (*Hemipeloriops*) cf. *djabirbnhaiyani*, in having smaller and less developed tubercles or nodes on the dorsal and ventral ridges, posterior, anterior and median areas, in its pointed and heavily spinose posterior end, and its tuberculate anterior marginal rim which is also narrower.

Cythereis IRE$_{21}$ Grosdidier (1973) from the Campanian of Iran shows some resemblance; but differs in having a less prominent hinge-ear, a distinct subcentral tubercle, less developed tubercles on the dorsal, ventral, anterior and central positions, and the eye tubercle is not very prominent. The presence of sub-central tubercle and absence of hinge-ear suggests that Grosdidier's species does not belong to *Peloriops*.

Occurrence:

This species is recorded so far from the Cenomanian of South Rumaila Well-104 and the Lower Cenomanian (?) of Kifl Well-2.

Peloriops (Peloriops) alrazii sp.nov.
Pl. 64, figs. 1-3.

Name:

After Abu Bakr Muhammad Al-Razi, a celebrated physician, alchemist and philosopher of the ninth and tenth century.

Diagnosis:

A subquadrate species of the subgenus *peloriops* (*peloriops*) with a broad continuous well developed ridge extending around the dorsal, ventral and anterior margins; and with strong microreticulation.

Holotype:

Female carapace, J.T. 331, Pl.64, figs. 1-3.

Paratype:

J.T. 332.

Material:

3 specimens. In South Rumaila Well-104 one specimen from the top of the Tanuma Formation at a drilling depth of 2332 m; one specimen has been found in the uppermost Tanuma Formation of East Baghdad Well-3, at a drilling depth of 2238 m; in Kifl Well-2, one specimen has been recorded from the lowermost Sadi Formation, at a depth of 4335 ft.

Type Locality and Horizon:

South Rumaila Well-104 Section, south eastern Iraq.
Tanuma Formation, Santonian, depth of 2332 m.

Stratigraphic range:

Santonian.

Description:

Medium sized carapace, subquadrate in lateral view, greatest height at prominent anterior hinge-ear, greatest length along central line of the carapace, anterior margin broadly rounded, posterior margin narrow, obtusely angled produced into a blunt end pointed at about middle, with a distinct postero-cardinal angle; dorsal and ventral margins subparallel, dorsal margin long and straight along hinge line, ventral margin slightly concave, anterior and posterior areas typically compressed. Sexual dimorphism cannot be recognised, but comparison of L/H ratio with the other species of the subgenus suggests that the specimens of this species are females rather than males. The eye tubercle is ovate, elongate and prominent at antero-cardinal angle. Conspicuous overlap of the right valve by left at the antero-cardinal angle, at postero-cardinal angle, and at dorsal part of the posterior margin.

The surface of the carapace is marked with two longitudinal ridges, a marginal rim and a pattern of strongly developed rounded microreticulation covering the entire surface. The high, broad, and long dorsal ridge is very well developed, starting from the eye tubercle running parallel to the dorsal margin, and ending with a slightly convex downward turn just before the postero-cardinal angle. The ventral ridge is also thick and prominent, commencing at the postero-ventral corner of the carapace, extending parallel to the ventral margin and joining the antero-marginal rim. The latter is thick, denticulate and prominent, extending from eye tubercle, running parallel to the anterior margin and joining the ventral ridge ventrally; there is a narrow depressed marginal area underlying rim and emphasising its elevation.

The postero-marginal rim is less developed than the antero-marginal rim but still distinct, running along the depressed posterior margin. Faint weak microreticulation is present in the antero and postero-marginal depressed areas. Small denticles are developed around the anterior margin, and some four spines are seen along the ventral half of the posterior margin.

In the dorsal view, the carapace has almost parallel sides with laterally compressed ends; the prominent eye tubercle and thick, prominent dorsal ridge can be seen clearly; maximum width lies at posterior end of ventral ridge in both valves. No internal details were observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 331	Female	0.680	0.380	0.330	1.789
J.T. 332	Female (holotype)	0.630	0.350	0.305	1.8

Discussion:

Peloriop (*Peloriops*) *alrazii* sp. nov. differs from other species of the subgenus, but is assigned to *Peloriops* on the basis of the following characters. It has a compressed carapace with a similar outline, rimmed denticulate margins, absence of median ridge and subcentral tubercle, prominent hemispherical eye spots, strong secondary ornamentation, depressed antero and postero-marginal areas behind the margins, a prominent hinge-ear, and in the presence of dorsal and ventral ridges. This species is distinguished from *P.* (*P.*) *tetrancota* Al-Abdul-Razzaq (1979a) from the Upper Cretaceous of Kuwait and lower Santonian-Coniacion? of the Coastal Fars Province of Iran, in its prominent and thick ridges and antero-marginal rim which is continuous with the ventral ridge, it lacks the tubercles of *P.* (*P.*) *tetrancota*, and is also slightly more elongate. The type of microreticulation in these 2 species is similar. *P.* (*P.*) *elassodictyota* from the Cenomanian of Iraq, Cenomanian and? Turonian of Kuwait, differs in having two tuberculate ridges, lacks the prominent ridges and anteromarginal rim of *P.* (*P.*) *alrazii* sp. nov. and has one or two nodes along the ventral margin from the postero-ventral tubercle of the ventral ridge towards the anterior. For further discussion, see also *P.* (*P.*) aff. *tetrancota*.

Occurrence:

Known from the Santonian ? of South Rumaila Well-104 and East Baghdad Well-3; Santonian of Kifl Well-2.

Peloriops (Peloriops) elassodictyota Al-Abdul-Razzaq, 1979a Pl.64, figs. 4-6.

1979a Peloriops elassodictyota Al-Abdul-Razzaq, p.51, Pl.2, figs. 7, 8, 12, 13; Pl.2, figs. 4, 5.

Dimension: (In mm.)

	L.	H.	W.	L/H.
J.T. 333	0.610	0.330	0.282	1.848

Discussion:

A single specimen J.T. 333 of this species has been found in the Ahmadi Formation of South Rumaila Well-104, south east of Iraq, depth 2714-2716 m.

P. (P.) elassodictyota, originally described from Kuwait, is characterised by an ornament of strong microreticulation, covering its entire surface, giving the carapace a punctate appearance. The dorsal ridge has a strong posterior tubercle and continues to the eye tubercle, with a small and less prominent node or tubercle at the central part of the dorsal ridge, better seen in dorsal view; the ventral ridge also has a strong posterior tubercle vertically below that of the dorsal ridge, with one or two less prominent tubercles towards the anterior. These tubercles are weaker on the specimen recorded here than in the illustrations of Al-Abdul-Razzaq. In ventral view the carapace has subparallel sides, slightly converging towards the anterior, with compressed ends; microreticulation of ventral side, and posterior nodes of the ventral ridge can be observed clearly. Maximum width lies at posterior nodes of ventral ridge.

Peloriops (Peloriops) tetrancota Al-Abdul-Razzaq, closely resembles this species, but has a bluntly pointed posterior end, the dorsal ridge has a blunt tubercle at its posterior with a strongly depressed central area ending with two tubercles slightly behind the eye tubercle; the ventral ridge also has a blunt tubercle at its posterior end. *P.* (*P.*) *malzi* (Bischoff, 1963) from the Albian of Lebanon is another related species (see Damotte and Saint-Marc, 1972, p.278, Pl.1, fig. 7). These three species are closely related and perhaps form part of a phylogenetic sequence: *P.* (*P.*) *malzi* (Albian), *P.*(*P.*) *elassodictyota* (Cenomanian and Turonian (?) and *P.* (*P.*) *tetrancota* (Santonian). Al-Abdul-Razzaq assigned *Cythereis malzi* Bischoff, 1963 in Damotte and Saint-Marc (1972) to *Peloriops*; in this study it is regarded as belonging to the subgenus *Peloriops* (*Peloriops*).

Occurrence:

Known from the Lower Cenomanian of South Rumaila Well-104.

Peloriops (*Peloriops*) *ibnalkasimi* sp. nov.
Pl. 65, figs. 1-5.

Name:

With reference to Muhammad Ibn Al-Kasim, governor of Basrah, and conqueror of Sind in the eighth century.

Diagnosis:

Elongate species of *Peloriops* (*Peloriops*) with coarse, sub-quadrate macroreticulation on median and posterior parts of valve. Oblique ridge present across the carapace from the posterior node to ventral margin, bifurcating near the ventral margin. Ventral ridge of 5 tubercles and tuberculate muri; antero-marginal depression with weaker macroreticulation and two vertical, oblique ridges in central anterior area which bear a few small mamillate spines with foveolate muri.

Holotype:

Male carapace, J.T. 334, Pl.65, figs. 1,2,5.

Paratype:

J.T. 335-J.T.336.

Material:

3 specimens from the Ahmadi Formation of South Rumaila Well-104, at drilling depths between 2692 - 2700 m.

Type Locality and Horizon:

South Rumaila Well-104, south eastern Iraq. Ahmadi Formation, Lower Cenomanian, depth of 2692 m.

Stratigraphic range:

Lower Cenomanain.

Description:

Carapace medium size, subtrapezoid, elongate in lateral view, relatively flattended ventrally, greatest length in middle of carapace, greatest height at the prominent anterior hinge-ear, anterior margin evenly rounded, posterior margin sub-triangular, joining dorsal margin at distinct postero-cardinal angle, dorsal margin straight, ventral margin strongly concave at anterior.

In dorsal view the carapace has subparallel sides, maximum width towards the posterior end of ventral ridge.

The lateral surface of the carapace is strongly ornamented by coarse, subquadrate macroreticulation especially developed in the median and posterior areas. The posterior node of the dorsal ridge is incorporated into mesh system; below this are two large, subquadrate meshes, the anterior mesh of which may be subdividied in the right valve; the posterior mesh has a pore cone in its centre; the ventral muri of these two meshes form short median ridge; the anterior muri of the anterior of these two meshes form the dorsal part of a prominent ridge running obliquely across the carapace from the posterior node to the ventral margin; this ridge bifurcates near the ventral margin. There are five prominent tuberculate muri along the ventral margin including two formed from the bifurcating oblique ridge and forming the ventral ridge; the third and fourth of these muri which have a few mamillate spines, join a small macro mesh which may be present below the ventral muri of these median and posterior meshes. The anterior part of the carapace has weaker macro-reticulation, the most prominent part of which appears as two near-vertical ridges in the central anterior area bearing few small mamillate spines. The muri appear to be finely foveolate.

The dorsal ridge shows a tendency to bear or break into 3-5 tubercles or pore cones, one appearing as a bilobate tubercle lying in the position of the "Virgo" pore cone and forming a prominent posterior node with a large macroreticulation mesh; the "Sagittarius" pore cone is prominent and connected to the macroreticulation; "Aquarius" lies just below or behind the eye tubercle; "Lambda" or "phi", "Iota", "Zeta" and "Chi" pore cones can be recognised.

The anterior marginal rim is prominent, running from the eye tubercle to the ventral ridge; narrow macroreticulation is present between the rim and the anterior margin, and depressed antero-marginal area behind the anterior rim. The anterior margin bears 5-6 very small denticles which are sometimes indistinct because of the thickening of the anteromarginal rim. The posterior marginal rim is not well developed, the posterior margin bears 2-3 small spiens or denticles.

No internal details are known.

<u>Dimension</u>: (In mm.)

			<u>L.</u>	<u>H.</u>	<u>W.</u>	<u>L/H.</u>
J.T. 334	Male	(holotype)	0.680	0.330	0.282	2.060
J.T. 335	Female		0.610	0.350	0.330	1.742
J.T. 336	Female		0.582	0.350	0.330	1.662

<u>Discussion</u>:

<u>Peloriops</u> (<u>Peloriops</u>) <u>ibnalkasimi</u> sp. nov. is easily distinguished from other species of <u>Peloriops</u> (<u>Peloriops</u>) by

the presence of the coarse macroreticulation and oblique ridges. Several species of Cythereis from the Middle East resemble Peloriops (Peloriops) ibnalkasimi sp. nov. but they are all distinguished by having the prominent subcentral tubercle, the three well developed longitudinal ridges of the genus, and in the presence of other ornamental differences such as cross ribs, cross reticulation or subcentric reticulation. These species are:
Veeniacythereis jezzineensis (Bischoff, 1963)
Veeniacythereis maghrebensis (Bassoullet and Damotte, 1969)
and Veeniacythereis streblolophata (Al-Abdul-Razzaq, unpublished Ph. D., 1977), (Al-Abdul-Razzaq and Grosdidier, 1981).

Occurrence:

Known so far from the Lower Cenomanian of South Rumaila Well-104.

Peloriops (Peloriops) ibniraki sp.nov.
Pl.66, figs. 1-7; Pl.67, figs. 1-8.

Name:

After Abu Nasr Mansur Ibn Irak, a famous Arab astronomer and mathematician who flourished about 1000 A.D.

Diagnosis:

A species of subgenus Peloriops (Peloriops) with short tuberculate dorsal and ventral ridges, and with microreticulation covering the postero-dorsal and ventral tubercle; small pore cones and tubercles present, with 3-4 of them along the dorsal margin between the postero-dorsal tubercle and eye tubercle; most of the small tubercles have pores at their summit.

Holotype:

Female carapace, J.T. 342, Pl.66, figs. 1,6; Pl.67, 3,4,8.

Paratype:

J.T. 337-J.T.341.

Material:

10 specimens (including 2 broken valves) from the Ahmadi Formation of South Rumaila Well-104, at drilling depths between 2704-2750 m.

Type Locality and Horizon:

South Rumaila Well-104, south eastern Iraq.

Ahmadi Formation, Lower Cenomanian, depth of 2716 m.

Stratigraphic range:

Lower Cenomanian.

Description:

Carapace of average size, sub-rectangular in lateral view; anterior margin evenly rounded, posterior margin slightly pointed; dorsal and ventral margins subparallel, strongly converging towards posterior; dorsal margin straight; ventral margin slightly concave; distinct posterior cardinal angle, maximum height lies at the prominent hinge-ear anteriorly. Maximum length runs through the mid-height point. Left valve slightly larger overlaps the right valve in the region of the antero-cardinal angle, postero-cardinal angle, and at the dorsal part of posterior end. The carapace is compressed anteriorly and posteriorly. Eye tubercle hemispherical and prominent, lies at the anterocardinal angle which is fairly well developed. Sexual dimorphism is pronounced with more elongate male, the males usually have small pore cones along the dorsal margin between the postero-dorsal tubercle and the eye tubercle; the mid-dorsal pore cone is equally developed in both sexes.

In dorsal view the carapace has almost parallel sides, both ends laterally compressed; the three-four smaller pore cones along the dorsal margin, the posstero-dorsal tubercle, and the eye tubercle can be clearly seen; maximum width at posterior third of the carapace. In ventral view the microreticulate postero-ventral and denticulate ends are well pronounced.

The dorsal ridge is formed by 3-4 small pore cones and tubercles, with a large postero-dorsal tubercle in the position of the "Virgo" pore cone; the "Sagittarius" pore cone lies mid-way between the eye tubercle and the postero-dorsal tubercle. The ventral ridge has a large hemispherical tubercle at its posterior, at the position of the "Lambda" or "Phi" pore cones, and aligned with the postero-dorsal tubercle.

The antero-marginal rim is thin, extending from the eye tubercle to the ventral margin; it may be denticulate, but the state of preservation does not allow any certainty. The anterior margin has some 4-7 denticles, or small spiens. The postero-marginal rim is thin, running around the posterior margin, and is less prominent in the right valve; the posterior margin has some 3-6 spines or small pore cones of variable size.

Depressed anterior and posterior marginal areas are present.

In ventral half some 6-7 pore cones and tubercles are present with a large tubercle at the postero-ventral end, and median sized tubercles at "Iota" or "Zeta"; the other ventral pore cones are small. 7-10 pore cones are present in the posterior and median areas, including a small "Chi" pore cone; two small pore cones can be seen in the anterior at the position of "Capricornus" and "Scorpio".

The entire surface is ornamented with a microreticulation of distinct meshes, including postero-dorsal and ventral large tubercles and pore cones, although the reticulation is weaker in the areas between the marginal rims and the margins of the carapace and in the depression of the antero and postero-marginal areas.

The micro reticulation varies in strength between specimens and is seen as strongly elevated reticulation in some specimens. Usually the small tubercles covering the surface have pores at their summit.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T.337	Male	0.582	0.295	0.165	1.972
J.T. 338	Male	0.582	0.305	0.210	1.908
J.T. 339	Male	0.540	0.282	0.190	1.914
J.T. 340	Female	0.610	0.330	0.238	1.848
J.T. 341	Female	0.560	0.330	0.238	1.696
J.T. 342	Female (holotype)	0.560	0.305	0.210	1.836

Discussion:

Peloriops (Peloriops) ibniraki sp. nov. differs from the other species of the subgenus in its small size, less elongate and less pointed posterior end. Its microreticulate surface is similar to Peloriops (Peloriops) sphaerommata, Peloriops (Peloriops) elassodictyota, Peloriops (Peloriops) tetrancota, Peloriops (Peloriops) alrazii, sp. nov. but lacks the macroreticulation of the P. (P.) sphaerommata. It differs from Peloriops (Peloriops) almasudi sp. nov. in lacking a prominent tuberculate anterior rim, in having microreticulate surface, and most of the tubercles, having pores at their tips. Peloriops (Hemipeloriops) levisulcata is further differentiated in the development of tubercles on the lateral surface and along the dorsal margin, which are only present as smaller cones with pores on the tips in Peloriops (P.) ibniraki sp. nov., in outline, and in being larger.

Planileberis Pusulata Rosenfeld and Raab (1974) which probably belongs to Peloriops (Al-Abdul-Razzaq, 1979a), differs in having bilobate postero-dorsal and ventral tubercles and also a sexual difference where the female carapace have a single pustule or small tubercle in the centre of the dorsal ridge, while the male has 3 pustules along the dorsal ridge, compared with the 3-4 in both sexes of Peloriops (Peloriops) ibniraki, sp. nov. and in having less clearly defined pores on the tops of tubercles or pustules covering the surface.

This species resembles Peloriops (Peloriops) malzi (Bischoff) described by Damotte and Saint-Marc (1972) from the Albian of the Lebanon, but it differs in having smaller tubercles at the posterior end of the dorsal and ventral ridges and in the centre of the ventral ridge, by having numerous pore cones with some very small tubercles covering the lateral surface, and by well developed marginal spines or denticles.

Occurrence:

This species is known so far from the Lower Cenomanian of South Rumaila Well-104.

Peloriops (Peloriops) kiflàensis sp. nov.
Pl.68, figs. 1-2A.

Name:

With reference to the type locality, Kifl Well-2, Iraq.

Diagnosis:

Elongate species of Peloriops (Peloriops) with smooth surface, postero-dorsal and postero-ventral tubercles, and a few small indistinct nodes or pore cones scattered on the surface.

Holotype:

Carapace, J.T. 334, Pl.68, figs. 1, 2A.

Paratype:

J.T. 343.

Material:

2 specimens, one from the top bed of the Mauddud Formation at a drilling depth of 5510 ft, and the other specimen from the basal part of the Fahad Formation, at a depth of 5270 ft. Both specimens from Kifl Well-2.

Type Locality and Horizon:

Kifl Well-2, central western Iraq. Fahad Formation, Lower Cenomanian ?, depth of 5270 m.

Stratigraphic range:

Lower Cenomanian ?

Description:

Carapace medium size, elongate, subtriangular, maximum height lies at anterior hinge ear, maximum length running just in middle of the valve, carapace relatively flattened; anterior margin evenly rounded, posterior margin pointed, dorsal and ventral margins straight and subparallel, strongly converging towards the posterior end, peripherally compressed anteriorly and posteriorly. Eye tubercle well developed, left valve larger, overlapping right valve at antero-cardinal angle. The hinge-ear is present but not very distinct.

Entire surface of carapace is smooth with a few poorly developed pore cones or small nodes.

The dorsal ridge and ventral ridge each have one large elongate and prominent tubercle, situated posteriorly, parallel to each other, lying in the position of the "Virgo" and "Lambda" or "phi" porconuli. The "Sagittarius" pore cone lies in the centre of the dorsal margin, and there is a weak, indistinct pore cone or node at the position of "Aquarius". Posteriorly there are two small and less prominent pore cones or nodes at the "Chi" and "Terminus" positions, which are weakly pronounced in the right valve. The "Iota" pore cone or node can be recognised in its ventral position near the large posterior tubercle of the ventral ridge, but is poorly developed in the right valve.

The antero-marginal rim is narrow and distinct, starting from the eye tubercle, and ending ventrally, and bearing a few denticles; a shallow furrow lies to the posterior of the anterior rim. The posterior rim is less developed but is distinct especially in the ventral half, and also bears small spines or denticles. There are traces of marginal spines along the anterior margin; the spines of the posterior margin are more pronounced in the left valve.

In dorsal view the carapace has subparallel sides, with laterally compressed ends, the prominent eye tubercle and the posterior tubercles of the dorsal ridge on each valve can be seen clearly, maximum width lies at posterior tubercles of the ventral ridge.

No internal details observed.

Dimensions: (In mm.)

		L	H.	W.	L/H.
J.T. 343	Male	0.610	0.282	0.282	2.163
J.T. 344	Male (holotype)	0.680	0.330	0.282	2.06

Discussion:

Peloriops (*Peloriops*) *kiflaensis* sp. nov. is distinguished from *Peloriops* (*Peloriops*) *sphaerommata* and *Peloriops* (*Peloriops*) *ulos* Al-Abdul-Razzaq (1979a) from the Cenomanian of Kuwait and *Peloriops* (*Peloriops*) *almasudi*, sp. nov. in having fewer and weaker, pore cones or nodes and spines on the lateral surface, marginal rims and margins, less prominent hinge-ear, and in lacking the reticulate surface of *P.* (*P.*) *sphaerommata.* *Peloriops* (*Peloriops*) *ziregensis* (Bassoullet and Damotte, 1969) from the Upper Cenomanian of Algeria differs from this species in the surface ornamentation and in being less elongate (L/H:1.86). *P.* (*P.*) *kiflaensis* possesses a hinge-ear, but this is not very prominent; nevertheless, it is placed in *Peloriops* (*Peloriops*) because it lacks a subcentral tubercle, has a prominent eye tubercle, no median ridge, tuberculated dorsal and ventral ridges, a few small tubercles in the intercostal area, and has the same type of valve overlap. It is not possible to determine whether the specimens are male or female, but in comparison with other species of the subgenus, the L/H ratio suggests males rather than females.

Occurrence:

This species is known so far from the Lower Cenomanian of Kifl Well-2.

Peloriops (Peloriops) aff. tetrancota Al-Abdul-Razzaq (1979a) Pl. 68, figs. 3-4.

Dimension: (In mm.)

	L.	H.	W.	L/H.
J.T. 345	0.630	0.380	-	1.657

Discussion:

A single left valve J.T. 345 has been found from basal part of the Kifl Formation of Kifl Well-2 at depth of 4645-4650 ft.

The specimen is clearly related to Peloriops (Peloriops) tetrancota, but differs in lacking the tubercles behind the eye tubercle at the end of the dorsal ridges; in having a more swollen and elevated ventral ridge; in having a more rounded and narrower posterior margin and a more obliquely rounded anterior margin. This is similar to Peloriops (Peloriops) tetrancota, in shape, general outline of the carapace, surface with microreticulation and at posterior end of dorsal and ventral ridges.
Al-Abdul-Razzaq described this species from the Santonian of Kuwait and Lower Santonian-Coniacian ? of the coastal Fars Province of Iran (Grosdidier, 1973), which is younger than the Kifl Formation, so this single specimen from Iraq may be contamination from higher in the well. The hinge, although poorly preserved can be observed in this specimen and appears to lack the eye node or ocular boss in the left valve which characterises the genus.

Peloriops (Peloriops) ulosa Al-Abdul-Razzaq, 1979a Pl. 68, figs. 5-9; Pl.69, figs.1-8.

1973 Cythereis gr. malzi, Bischoff, Grosdidier, Pl.14, figs. 105 a-e.

1979a Peloriops ulosa Al-Abdul-Razzaq, Pl.1, figs. 4,5,11,15. Pl.2, fig.3.

Diagnosis:

A species of Peloriops (Peloriops) with subtriangular posterior end, smooth surface except for faint markings in the antero and postero-marginal depressed areas; dorsal and ventral ridges consisting of two prominent tubercles; small tubercles or pore cones with crater-like pores at their tops occur on the posterior half of the valve, and a few small tubercles lie in the median area.

Figured specimens:

J.T. 346 - J.T. 363.

Material:

29 specimens (including 5 broken valves and 1 broken single valve) from the Ahmadi Formation of South Rumaila Well-104, at drilling depths between 2654-2736 m.

Type Locality and Stratum:

Magwa Field, south eastern Kuwait, Well-8. Ahmadi Formation, depth 4250 feet.

Stratigraphic range:

Cenomanian.

Dimensions: (In mm.)

		L.	H.	L/H.
J.T. 346	Male	0.815	0.400	2.037
J.T. 347	Male	0.770	0.400	1.925
J.T. 348	Male	0.720	0.380	1.894
J.T. 349	Male	0.735	0.380	1.934
J.T. 350	Small Male	0.610	0.305	2

J.T. 351	Female	0.720	0.390	1.846
J.T. 352	Female	0.745	0.425	1.752
J.T. 353	Female	0.700	0.400	1.75
J.T. 354	Female	0.680	0.380	1.789
J.T. 355	Female	0.630	0.380	1.657
J.T. 356	Female	0.630	0.350	1.8
J.T. 357	Small Female	0.610	0.350	1.742
J.T. 358	Small Female	0.581	0.330	1.760
J.T. 359	Small Female	0.560	0.305	1.836
J.T. 360	Small Female	0.560	0.330	1.696
J.T. 361	Small Female	0.540	0.305	1.770
J.T. 362	Small Female	0.540	0.315	1.714

Discussion:

This species shows a close resemblance to the type species *Peloriops (Peloriops) sphaeromatta* Al-Abdul-Razzaq (1977, Ph.D., and 1979a) in most features, differing in having a smooth surface between the tubercles and pore cones which makes the latter more prominent. For further discussion see Al-Abdul-Razzaq (1979a), *Peloriops (Peloriops) almasudii* sp. nov., *Peloriops (P.) kiflaensis* sp. nov., *Peloriops (P.) ibnirakii* sp. nov.

The Iraqi specimens have been measured and plotted (fig. 6.2) and can be seen to show considerable variation in size with smaller and larger male and female specimens. The smaller specimens have a similar ornamentation and have all the characters of the larger specimens, so there is no question of them being a separate species, and the size range seems to be continuous with no clear break. The small forms have a thick and fully developed carapace. The smaller and larger forms are often found together in the same sample. This could be an example of early sexual dimorphism discussed previously by Whatley and Stephens (1977). However, as stated above the smaller specimens seem to be adults. For further discussion see chapter 6.

Occurrence:

This species is recorded from the Cenomanian of Magwa Well-8 in Kuwait; Lower Cenomanian of South Rumaila Well-104; ? Upper Aptian-Cenomanian of Oman, and from the Albian of the Coastal Fars Province of Iran.

Peloriops (Hemipeloriops) sub gen. nov.

Type species:

Peloriops (Hemipeloriops) djabirbnhaiyani sp. nov.

Name:

Greek Hemi = half

Diagnosis:

Ornament of strong tubercles forming dorsal and ventral ridge and also present in median areas of carapace; posterior end blunt.

Occurrence:

This subgenus is known from the Cenomanian-Coniacian.

Peloriops (Hemipeloriops) djabirbnhaiyani sp. nov.
Pl. 70, figs. 1-4; Pl.71, figs. 1-5.

Name:

After Abu Musa djabir B. Haiyan, a famous Arab alchemist, known as Geber. He most probably flourished in the eighth century.

Diagnosis:

A species of Peloriops (Hemipeloriops) in which the surface of the carapace varies from completely smooth to faintly reticulate in places.

Holotype:

Male carapace, J.T. 364, Pl.70, fig.1; Pl.71, fig.3.

Paratype:

J.T. 365 - J.T. 367.

Material:

Total number of specimens 4, recorded from Ghalaisan Well-1; one specimen and one single valve in the basal bed of the Tanuma Formation at 3725 ft, one specimen from the base of the Rumaila Formation, at 4095 ft, and one specimen from the base bed of the Ahmadi Formation, at a depth of 4315 ft.

Type Locality:

Ghalaisan Well-1, south western Iraq.

Type Horizon:

Tanuma Formation, Upper Coniacian, depth of 3725 ft.

Stratigraphic range:

Upper Coniacian, Cenomanian ?.

Description:

Carapace medium sized, subrectangular in later view; greatest length lies in the middle of the carapace; greatest height at the prominent hinge ear. Anterior margin broad, rounded; posterior margin bluntly pointed and truncated dorsally. Dorsal and ventral margins are straight, sub-parallel or slightly converging to the posterior. Hinge-ear is prominent in the left valve. Eye tubercle is subovate and well developed and protruding at antero-cardinal angles; well developed postero-cardinal angle and antero-cardinal angle in the left valve, less so in the right valve. Left valve slightly larger than the right, conspicuously overlapping it around the antero-cardinal corner, postero-cardinal corner and along the upper portion of posterior margin.

Dorsal ridge distinctly broken into 6 nodes; one distinct node lies mid-way along the dorsal margin and sometimes bears a pore opening at its top. The ventral ridge is clearly divided into 6 vertical nodes, three of these nodes are small while the posterior-most is the largest and probably consists of several nodes joined together; the anterior-most is formed by mammillate small spines; the second from anterior sometimes appears to be two nodes. The median inter-costal area between the dorsal and ventral ridges and the area in front of the ridges have some 7 nodes, some of which seem to bear pore openings in some specimens. The antero-median area is ornamented with 8 nodes, the largest node lies just in front of a distinct furrow, and seems to be formed of several nodes joined together, most of them anteromedian nodes appear to have pore openings in most specimens.

A well-developed marginal rim extends along the anteior; the anterior margin is ornamented with some 4-6 denticles, a distinct depressed antero-marginal area lies behind the anterior rim, 6 weak pustules present on the anterior rim; posterior marginal rim is distinct with distinct depressed posterior marginal area lying behind and parallel to it, the posterior margin is decorated with 5-6 small spines.

The entire surface between the tubercles varies between specimens from completely smooth to partly faintly reticulate; in two specimens a microreticulation covers the posterior depressed marginal area, the area between the postero-dorsal nodes (sometimes faintly covering the nodes), the furrow behind the antero-median nodes, the antero-dorsal area, and the antero-marginal depressed area; the microreticulation covers the floor of several quadrate weak macroreticules lying at the anterior and posterior depressed areas and the subcentral furrow; the rest of the surface is smooth.

In dorsal view the carapace has almost parallel sides with projecting nodes, and with laterally compressed posteior and anterior ends; the prominent eye tubercle and the nodes along the dorsal margin on both sides can be seen clearly. In ventral view, the ventral surface is ornamented with microreticulation

Internally, the anterior marginal area is indistinct; the coincidence of the inner margin and line of concrescence is indistinct; selvage prominent. Hinge is Amphidont/heterodont, the left valve hinge elements consisting of an anterior socket, antero-median postjacent small conical tooth, connected to a smooth postero-median bar, ending with slightly elongate, deep and ventrally open posterior socket. The muscle scars were not observed, because the valve was filled with sediment.

Dimensions: (In mm.)

		L.	H.	W..	L/H.
J.T. 364	Male (holotype)	0.650	0.340	0	1.917
J.T. 365, 366	Male	0.630	0.330	0.330	1.909
J.T. 367	Male	0.652	0.350	0.330	1.862

Discussion:

Peloriops (*Hemipeloriops*) *levisulcata* (Al-Sheikhly, 1980, unpublished Ph.d.) from the Maastrichtian of Northern Iraq bears some resemblance to this species in outline and shape, and in having a tuberculate surface; but it differs in having 9 nodes forming the dorsal ridge, in the number of nodes on the ventral ridge, i.e. 4, in the number and size of the nodes at the median and antero-median area, in lacking the large node situated in the antero-median area in front of the subcentral furrow of *Peloriops* (*Hemipeloriops*) *djabirbnhaiyani* sp. nov. *Peloriops* (*Hemipeloriops*) *levisulcata* (Al-Sheikhly) has a complete smooth surface between the tubercles of the carapace and in the marginal areas, unlike *Peloriops* (*Hemipeloriops*) *djabirbnhaiyani* sp. nov. Al-Sheikhly (1980, M.S.) considred *Peloriops levisculcata* to belong to *Peloriops* Al-Abdul-Razzaq (1979a), but in this study it is assigned to the new subgenus *Peloriops* (*Hemipeloriops*) because it has all the diagnostic features of the new sub genus. Sexual dimorphism has not been observed in *P*. (*Hemipeloriops*) *djabirbnhaiyani* sp. nov., but they appear to be males when compared with the sexual dimorphism of P. (Hemipeloriops) levisculcata (Al-Sheikhly) (L/H: 1.862 - 1.917, cf. L/H: 1.839-1.937).

Occurrence:

Known from the Cenomanian and Upper Coniacian of Ghalaisan Well-1.

Peloriops (Hemipeloriops) cf. djabirbnhaiyani sp. nov.
Pl. 71, figs. 6-8.

Discussion:

A single J.T. 368 presumed male specimen has been found in the Ahmadi Formation of the Ghalaisan Well-1, at a depth of 4310 ft. This specimen resembles Peloriops (Hemipeloriops) djabirbnhaiyani sp. nov. in outline and shape, but differs in having more prominent nodes at the posterior end of the dorsal ridge which are joined together to form a larger node; the ventral ridge consists of 3 nodes; in the lack of a large node in the antero-median area; in the number and size of the nodes in the median and anteromedian areas; and in the lack of the subcentral sulcus.

The specimen resembles P. (Hemipeloriops) levisculcata (Al-Sheikhly, 1980, M.S.) but differs in having 4 nodes instead of 2 along the dorsal margin between the eye tubercle and the posterior most nodes, and the ventral ridge is divided into 3 nodes instead of 4 nodes in the Al-Sheikhly species. By comparison with Al-Sheikhly's species it is taken to be a male although it is more elongate (L/H: 2.00 cf. 1.839-1.937). Although this specimen is closer to Peloriops (Hemipeloriops) levisulcata Al-Sheikhly than to P. (Hemipeloriops) djabirbnhaiyani sp. nov. it is referred to as Peloriops (Hemipeloriops) cf. djabirbnhaiyani sp. nov. because the Al-Sheikhly species is unpublished. Similar specimens have been reported from the Upper Member of the ? Campanian Fiqa Formation of Oman by Dr. John Athersuch (personal commun.), but differ in having some weakly developed nodes in the central and anteromedian areas and in the presence of reticulation in the median and posterior marginal areas. Athersuch assigned his specimen to Peloriops Al-Abdul-Razzaq (1979a) but they belong to the new sub genus Peloriops (Hemipeloriops) sub gen. nov. Dr. Athersuch also regarded them as being synonymous with Anchycythereis quatrata Sayyab (1956, M.S.) from the Upper Cretaceous of the western coast of the Arabian Gulf.

In this study Anchycythereis quadrata Sayyab is regarded as being identical to Peloriops (P.) tetrancota Al-Abdul-Razzaq (1979a) and not to Peloriops (Hemipeloriops) cf. djirbnhaiyani sp. nov. Peloriops (P.) sphaerommata Al-Abdul-Razzaq from the Cenomanian of Kuwait differs in the general outline of the carapace where it tapers to the posterior end, the node of the dorsal and ventral ridges of the latter species are more developed and arranged longitudinally along the dorsal margin and the nodes of the median area are more developed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 368	Male	0.700	0.350	0.380	2

Occurrence:

Known from the basal Cenomanian of the Ghalaisan Well-1.

Peloriops (Hemipeloriops) Kufaensis sp. nov.
Pl. 72, figs. 1-4.

Name:

With reference to the Iraqi city built in 638 by Sadbn-Abi Wakkas (after the battle of al-kadisya) on the western arm of the Euphrates (Al-Furat).

Diagnosis:

A subquadrate species of Peloriops (Hemipeloriops) in which the surface between the tuberculated dorsal and ventral ridges is ornamented by various sized tubercles and papillae.

Holotype:

Female carapace, J.T. 370, Pl.72, figs. 3,4.

Paratype:

J.T. 369, and J.T. 371 - J.T. 372.

Material:

Total number of specimens is 4, all from Ghalaisan Well-1: one specimen from the highest bed of the Tanuma Formation, at 3715 ft, one specimen and 1 single valve from the upper half of the Khasib Formation, at 3750 - 3755 ft, and one specimen from the uppermost Rumaila Formation at 3850 ft.

Type Locality:

Ghalaisan Well-1, south western Iraq.

Type Horizon:

Khasib Formation, Upper Turonian-Lower Coniacian, depth of 3750 ft.

Stratigraphic range:

Upper Turonian-Lower Coniacian, Upper Cenomanian?

Description:

Carapace medium sized, subquadrate in lateral view; greatest length runs through the middle of the carapace; greatest height at the anteior cardinal angle. Dorsal margin straight; ventral margin slightly convex; dorsal and ventral margins are subparallel, converging slightly towards the posterior; anterior margin obliquely rounded, with strongest curvature on its ventral half; posterior margin bluntly angled in the left valve, obtusely angled in the right valve. Hinge ear of the left valve is distinct. Left valve slightly larger than right. Eye tubercle prominent.

The surface is marked with two longitudinal and tuberculate ridges. Dorsal ridge consists of 4 tubercles along the dorsal margin; the tubercle lying in the middle of the dorsal margin is the largest and seems to be a pore cone in one specimen. Ventral ridge consists of 4 prominent tubercles lying parallel to the ventral margin, the posterior most tubercle appears to consist of two tubercles joined together, and is the largest and aligned level with that of the dorsal ridge. The central and postero-central areas between the two ridges are ornamented mainly by large tubercles (including tubercles of "rounded" cone shaped and "Castellated turret" of Sylvester-Bradley and Benson, 1971), with small tubercles and papillation; there is a larger pore cone in front of and below the posterior-most tubercle of the dorsal ridge. The anterior region is covered by papillation and small tubercles. The surface ornamentation is poorly preserved in two specimens.

A distinct margin rim extends around the anterior and posterior margin; the posteiror margin has 8 spines, one of them is a distinct pore cone (these posterior marginal spines are weakly developed in two specimens perhaps because of preservation); antero-marginal area ornamented by two rows of spines, the inner lying on the antero-marginal rim and consisting of 7 strongly developed mamillate spines and pustules, the outer row consists of some 7 spines.

Internally, the marginal area is indistinct; the coincidence of the inner margin and line of concrescence is indistinct; selvage prominent. The hinge is Amphidont/heterodont, elements of the left valve consisting of a prominent anterior ocular boss, other elements of the anterior socket, antero-median tooth and part of the postero-median bar are broken, the remaining part of the postero-median bar is smooth, ending with a slightly elongate and ventrally open posterior socket. The muscle scars were not observed.

<u>Dimensions</u>: (In mm.)

		L.	H.	W.	L/H.
J.T. 369	Male	0.860	0.450	0.520	2.023
J.T. 370	Female (holotype)	0.720	0.410	0	1.756
J.T. 371	Female	0.720	0.450	0.400	1.6
J.T. 372	Female	0.720	0.450	0.380	1.6

Discussion:

There is no difficulty in distinguishing this species from Peloriops (Hemipeloriops) djabirbnhaiyani sp. nov. and Peloriops (Hemipeloriops) levisulcata Al-Sheikhly (1980, M.S.) as it is larger and differs in shape and outline, in details of surface tuberculations, in size and number of nodes on the dorsal and ventral ridges, in having stronger anterior and posterior marginal spines, in the presence well-developed anterior rims spines, in having a papillation covering the entire surface between tubercles of the surface unlike the smooth surface of P. (Hemipeloriops) levisulcata and smooth to mostly reticulate surface of P. (Hemipeloriops) djabirbnhaiyani sp. nov.

Occurrence:

Known so far from Coniacian and Upper Cenomanian of Ghalaisan Well-1.

Genus *Phymacythereis* Al-Abdul-Razzaq, M.S.,1977.

Type species:

Phymacythereis santoniensis Al-Abdul-Razzaq, M.S.,1977.

Diagnosis:

A genus of Trachyleberidinae with dorsal ridge and two short dorsocentral and ventrocentral ridges, distinct and elongate subcentral tubercle, a strong antero-marginal rim, and the surface ornamented with tubercles.

Phymacythereis santoniensis M.S., Al-Abdul-Razzaq, 1977.

Pl. 73, figs. 1-3.

1977 - *Phymacythereis santoniensis* (M.S.) Al-Abdul-Razzaq, p.139-142, Pl.30, figs. 3,4; Pl.31, figs. 1-5.

Diagnosis:

A species of *Phymacythereis* characterised by tuberculate dorsal ridge and short, tuberculate dorsocentral and ventrocentral ridges; large and elongate eye tubercle; elongate and oblique subcentral tubercle; a distinct anterior marginal rim; laterally compressed anterior and posterior marginal areas; a few scattered tubercles with pores at their top are found on the ridges.

Figured specimen:

J.T. 373.

Material:

One specimen only from the uppermost bed of the Tanuma Formation of Kifl Well-2, at a drilling depth of 4355 ft.

Type Locality:

Burgan Field, south eastern Kuwait, Burgan Well-342.

Type stratum:

Gudair Formation, depth 3465 ft.

Stratigraphic range:

Santonian age.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 373	Male	0.680	0.315	0.260	2.158

Discussion:

Al-Abdul-Razzaq (1977, unpublished Ph.D. dissertation) found this in the Upper Cretaceous of south eastern Kuwait from the Gudair Formation of Santonian age. She assigned her specimens to one species of a new genus she called *Phymacythereis*. I considered that this species belongs to her new genus *Phymacythereis*. This new genus is characterised by three longitudinal ridges, dorsal, dorsocentral and ventro central ridges, the latter two are short and situated at the middle of the posterior half of the valve; the subcentral tubercle is distincly developed, elongate and oblique; distinct anterior marginal rim; secondary ornamentation of tubercles and denticulations, and the anteior and posterior marginal areas are compressed laterally. She considered *Phymacythereis santoniensis* to closely resemble "*Mauritsina*" IRE_7 Grosdidier (1973) from the Campanian of the coastal Fars Province of Iran. Sayyab (1956) did not record this species in his work.

The specimen found in this study is probably a male although it is larger than the Kuwait specimens.

Occurrence:

This species known so far from basal part of the Lower Santonian of Kifl Well-2 section, middle western Iraq, and the Santonian of south eastern Kuwait.

Genus Rehacythereis Gruendel, 1973

Type species:

Cythereis luermannae Triebel, 1940

Rehacythereis alkindii sp. nov.
Pl. 73, figs.4-5; Pl.74, figs.1-7.

Name:

After Abu Yusuf Al-Kindi, a famous ninth century A.D. Arab Philosopher, called the failasuf al-Arab.

Diagnosis:

A small species of Rehacythereis with acute posterior end, angulated below the mid-height, weakly developed postero-cardinal angle; with discontinuous dorsal ridge, papillate median and ventral ridges. Lateral surface variably reticulate, with faint reticulation or smooth median area, and smooth postero-marginal depressed area. A few small papillae occur in the anterior area and between the three ridges.

Holotype:

Male carapace, J.T. 376, Pl.74, figs.1,3.

Paratype:

J.T.374-J.T.375, and J.T.377-J.T.380.

Material:

10 specimens from the South Rumaila Well-104; 8 specimens and one broken valve found in the upper half of the Ahmadi Formation, and one specimen from the lower half of the latter Formation, at drilling depths of 2644-2702 m; 1736-2738 m.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Type Horizon:

Ahmadi Formation, Lower Cenomanian, depth of 2684 m.

Stratigraphic range:

Lower Cenomanian.

Description:

Carapace small, subtriangular to subquadrate in outline; anterior margin broadly rounded; posterior margin pointed just below the mid-height or at about the middle; dorsal margin straight, ventral margin slightly sinuous; both margins are subparallel and converge towards the posterior end. Eye tubercle hemispherical and prominent. Subcentral tubercle is pronounced.

Lateral surface is usually reticulate; the reticulation of the anterior area arranged in rows of square reticules, the surface of the posterior depressed marginal area is smooth, and 3-4 sided reticules cover the rest of the surface of the carapace. The median region of the valve is very feebly reticulate to smooth in some specimens. In some specimens whole lateral surface is nearly smooth which could be the result of their bad state of preservation.

Marginal rim extends along the anterior and posterior margins and is distinct. The anterior marginal rim is denticulate or papillose and consists of a row of some 8-12 small denticles or papillae; anterior margin finely denticulate. The posterior marginal rim has some 3-4 rounded denticles or papillae, especially along the ventral part.

The dorsal ridge is discontinuous; an anterior part commences behind the eye tubercle, about half way along the dorsal margin is a prominent pore cone at the position of "Sagittarius", the posterior part of the dorsal ridge is formed by a distinct tubercle. The median ridge is short and curved posteriorly; starting from behind the subcentral tubercle without joining it, it is dividied into 4 small nodes or papillae, one of which lies just above the position of the "Sigma" pore cone and the second is located slightly above the position of the "Psi" pore cone. The ventral ridge consists of some 7-8 papillae or small nodes, three of which lie at the position of the "Lambda", "Iota", and "Zeta" pore cones. The papilla at "Leo" pore cone is prominent in the median area. A few small papillae are scattered in the anterior area in front of the subcentral tubercle, and between the three longitudinal ridges.

In dorsal view the two sides converge towards the anterior, with both ends laterally compressed; maximum width lies on antero-median subcentral tubercle; the pore cone and posterior node of the dorsal ridge lying along the dorsal margin; the "Leo" pore cone and subcentral tubercle are clearly observed. In ventral view, the reticulation of the ventral surface and the papillae of the ventral ridge can be seen.

Internal characteristics could not be observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 374	Male	0.630	0.330	0.350	1.909
J.T. 375	Male	0.650	0.330	0.350	1.975
J.T. 376	Male (holotype)	0.610	0.330	0.305	1.848
J.T. 377	Female	0.560	0.330	0.330	1.696
J.T. 378	Female	0.540	0.330	0.330	1.636
J.T. 379	Female	0.540	0.330	0.305	1.636
J.T. 380	Female	0.570	0.330	0.305	1.727

Discussion:

Rehacythereis alkindii is assigned to *Rehacythereis* Gruendel (1973) because of similarities in shape, outline, presence of three longitudinal ridges, distinct subcentral tubercle, ornamentation, and the presence of a hinge ear.

This species is similar to *Cythereis arabica* (Al-Furaih, 1983) but differs in the Papillose development of the median and ventral ridges; in the presence of a few papillae in the anterior area and between the longitudinal ridges, as well as in details of the weakly developed reticulation. Rehacythereis alkindi sp. nov. also resembles Rehacythereis almutasimi sp. nov. but differs in having papillose median and ventral ridges, in its much smaller size, weaker reticulation and in having a few papillae between the three ridges and on the anterior area.

Occurrence:

This species is known so far from the Lower Cenomanian of the South Rumaila Well-104, south eastern Iraq.

Rehacythereis almutasimi sp. nov.
Pl.75, figs.1-5; Pl.76, figs.1-6.

Name:

With reference to an Abbasid Caliph Al-Mutasim, in (795-796) or (796-797) A.D.

Diagnosis:

A medium sized species of Rehacythereis with three longitudinal ridges; the dorsal ridge discontuous with a prominent pore cone half way along the dorsal margin and a prominent elongate tubercle at its posterior; median ridge short and curving downwards; ventral ridge strongest and finishing with a large tubercle at posterior end. Lateral surface reticulate; subcentral tubercle prominent and usually finely reticulate.

Holotype:

Female carapace, J.T. 391, Pl.75, figs. 1,2,4.

Paratype:

J.T. 381-J.T.390, and J.T.392 - J.T. 394.

Material:

Total number of specimens 52. In South Rumaila Well-104, 31 specimens have been recorded: 28 specimens including (one single valve and 3 broken single valves) from the Ahmadi Formation, at drilling depths of 2658-2762 m; one specimen from the top bed of the Rumaila Formation, comes from sample at depth of 2552 m; and one specimen and one single valve from the uppermost of the Mauddud Formation, at depths of 2792-2796 m. 17 specimens have been found in the Ghalaisan Well-1; 16 specimens (including 9 specimens and 7 broken valves) from the Ahmadi Formation, at drilling depths of 4280-4320 ft, and one specimen from the top bed of the Mauddud Formation, at depth of 4325 ft. In East Baghdad Well-3, 3 broken specimens from the lower-most of the Rumaila Formation, at depths of 2814-2858 m. In Safawi Well-1, one specimen from just below the middle part of Rumaila Formation, at drilling depth of 3495 ft.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Type Horizon:

Ahmadi Formation, Lower Cenomanian, depth of 2694 m.

Stratigraphic range:

Lower Cenomanian, Upper Cenomanian ?

Description:

Carapace medium sized, subtrapezoid to subrectangular in lateral view; maximum length towards venter; maximum height at the pronounced eye tubercle. Dorsal and ventral margins subparallel; dorsal margin straight and long, mostly hidden by dorsal ridge, giving it a sinuous appearance; ventral margin long and straight, converging with dorsal margin towards the posterior. Posterior margin triangular with pointed posterior end near the ventral margin; anterior margin broadly and evenly rounded; both ends compressed laterally seen in dorsal view, especially the posterior margin. Males larger and more elongate than the females. Hinge-ear is distinct in the left valve; left valve slightly larger than the right, conspicuously overlapping it along the dorsal half of the posterior end and along the hinge-ear. A high rounded and prominent sub-central tubercle situated slightly anterior of centre; eye tubercle medium-sized, well rounded and distinct, situated at the antero-cardinal corner of the valve; each eye with a short rib running perpenidularly downwards and finishing above the mid-height.

Three distinct longitudinal ridges are present. The dorsal ridge appears discontinuous; anterior part commences below and behind the eye tubercle; between one third to half way along the dorsal margin is a prominent tubercle which is really the "Sagittarius" pore cone; the posterior part of the dorsal ridge is formed by a prominent elongate tubercle. The median ridge is short, it does not join the subcentral tubercle, but commences in a shallow depression just behind it, the ridge curves downwards, ending level with the dorsal and ventral ridges. The ventral ridge is the strongest developed ridge, commences against the 'A' row of reticulation, is straight and parallel to the ventral margin, finishing at the posterior with a large blunt tubercle.

The marginal rim is best developed around the posterior and anterior margins, and is not clearly seen along the ventral margin. There are some 6-11 denticles along the anterior margin and 4-7 posterior marginal denticles, those at the posterior being mostly along the ventral part of the margin.

The surface of the valves is reticulate, including the posterior tubercles of the dorsal and ventral ridges. The reticulation is mostly semi-rounded and medium-large in size; row 'A', parallel to the anterior margin and has large quadratic reticulation; the depressed posterior area may also have large quadratic reticulation or may appear smooth or may have "ghost" reticulation; the subcentral tubercle usually has very fine reticulation or pitting, although one specimen has larger reticulation. The reticulation between the median and ventral ridges and at the anterior marginal depressed area behind the anteior marginal rim in a few specimens (Pl. 75, fig.4; Pl.76, fig.1) appear to be coarser, with a reduction in the number of reticules present caused by amalgamation of neighbouring meshes.

The "Terminus" and "Leo" pore cones can be recognised, as well as "Sagittarius" already described on the dorsal ridge.

In dorsal view, the female carapace appears swollen and has subparallel sides which slightly converge towards the anterior and has laterally compressed ends; the shallow depression which separates the subcentral tubercle from the median ridge, the median ridge, and large tubercles of the dorsal ridge are clearly seen; maximum width lies at the subcentral tubercle. In ventral view, the ventral ridge appears wing-like with its posterior node clearly visible; the median ridge can also be seen.

Internal details are not clearly visible, although the anterior marginal area appears broad; inner margin and line of concrescence probably coincide; and the selvage is prominent. Hinge Amphidont/heterodont, elements of hinge in the left valve consisting of an anterior socket opened ventrally, median element subdividied into a small conical and smooth antero-median tooth, followed by a smooth postero-median bar, ending with an elongate posterior socket opened ventrally. There also appears to be an eye boss (Pl. 76, fig.4). The other internal details are not clearly observed.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 381	Male	0.890	0.450	0.450	1.977
J.T. 382	Male	0.890	0.470	0.450	1.8936
J.T. 383	Male	0.815	0.435	0.400	1.873
J.T. 384	Male	0.840	0.450	0.450	1.8666
J.T. 385	Female	0.720	0.425	0.350	1.694
J.T. 386	Female	0.745	0.425	0.380	1.752
J.T. 387	Female	0.700	0.400	0.330	1.75
J.T. 388	Female	0.745	0.400	0.350	1.75
J.T. 389	Female	0.745	0.425	0.400	1.752
J.T. 390	Female	0.790	0.470	0.450	1.680

J.T. 391	Female (holotype)	0.720	0.425	0.380	1.694
J.T. 392	Female	0.745	0.425	0	1.752
J.T. 393	Female	0.790	0.450	0.380	1.755
J.T. 394	Female	0.680	0.380	0.380	1.789

Discussion:

Although the hinge structure is poorly developed, this species is placed in *Rehacythereis* Gruendel (1973) because of the external appearance, presence of three longitudinal ridges, distinct subcentral tubercle, and ornamentation.

Two previously described species from the Cretaceous of North Africa and the Middle East show resemblances to *Rehacythereis almutasimi* sp. nov. These are *Cythereis namousensis* Bassoullet and Damotte and *Cythereis algeriana* Bassoullet and Damotte (1969). *Cythereis namousensis* is a small species, averaging 0.60 mm in length, compared to *Cythereis algeriana* which is 0.90. They also differ in lateral outline, where *Cythereis algeriana* has a very triangular posterior margin especially in the right valve, and *Cythereis namousensis* has a more prominent hinge-ear; the three longitudinal ridges of *Cythereis algeriana* are not strongly developed, the ventral ridge has a posterior protuberance sometimes almost like a spine; *C. namousensis* has more prominent tubercles at the posterior of the dorsal ridge. Published illustration and descriptions of these 2 species (Bassoullet and Damotte, 1969; Rosenfield and Raab, 1974; Bismuth et al., 1981a; Grosdidier, 1973; Al-Abdul-Razzaq and Grosdidier, 1981; and Damotte and Saint-Marc, 1972) show considerable variation and it is not always clear whether the species being described are truly conspecific. *Rehacythereis almutasimi* sp. nov. is mid-way between these two species regarding size (0.77 mm cf. 0.60 mm and 0.90 mm). This difference in size between *Cythereis namousensis* and *Cythereis algeriana* is considered to be an important character and is seen in the work of Bassoullet and Damotte (1969), Rosenfeld and Raab (1974), Bismuth et al. (1981a). Damotte and Saint-Marc (1972), Grosdidier (1973), Al-Abdul-Razzaq and Grosdidier (1981) described a smaller *Cythereis algeriana* but it is not certain whether these truly belong to the species. Rosenfeld and Raab and Bismuth et al. did not include Damotte and Saint Marc's record in their synonymy. Grosdidier's (1973) original designation was Cythereis cf. algeriana, presumably indicating some doubt in the authors mind, although subsequent references (Rosenfeld and Raab, 1974, Al-Abdul-Razzaq and Grosdidier 1981) have omitted the cf. Al-Abdul-Razzaq and Grosdidier described the species published (1981) as Cythereis algeriana (1981, Pl.1, fig.4) in her unpublished dissertation (1977) as a new species, Cythereis pericompsa (Pl.23, fig.3 of the dissertation is the same specimen as Pl.1, fig.4). Thus there is considerable confusion over the identification of these smaller forms. Cythereis namousensis differs from Rehacythereis almutasimi sp. nov. in its smaller size, lateral outline, in having smooth and elongate subcentral tubercle, and the posterior group of tubercles on the dorsal ridge which tend to divide into 2 groups. It is similar in having a prominent spine on the dorsal ridge half way along the valve. Cythereis algeriana is much larger, up to 1.04 mm. in length (Rosenfeld and Raab, 1974) and also differs in having a less pointed triangular posterior margin, less distinct dorsal ridge with less prominent posterior tubercle and a less distinct spine or pore cone half way along the dorsal margin. The reticulation developed on Cythereis algeriana appears to be variable; in the original description of Bassoullet and Damotte, the subcentral tubercle is described as reduced to a smooth button; this type of subcentral tubercle is also seen in the illustration of Rosenfeld and Raab (Pl.3, fig.19); however in Bismuth et al. the subcentral tubercle is clearly reticulate. Rosenfeld and Raab mention that the reticulation is variable, with 2 forms of the species differing in strength of reticulation at the anterior and on the subcentral tubercle and median ridge.

Cythereis almutasimi sp. nov. shows variation in development of reticulation in the posterior depressed area and to a less degree at the anterior (see description above). The species described by Al-Abdul-Razzaq and Grosdidier

(1981) as Cythereis algeriana is rather similar to Rehacythereis almutasimi sp. nov. but differs in several respects; it is smaller, the tubercles at the posterior end of the dorsal ridge are less prominent, the depression between the subcentral tubercle and median ridge is less developed, and the postero-median bar of the hinge is described in Al-Abdul-Razzaq's dissertation as being crenulate and not smooth as in Rehacythereis almutasimi sp. nov. As already mentioned it is not clear whether this Kuwaiti species is really Cythereis algeriana.

Cythereis algeriana and Rehacythereis almutasimi sp. nov. belong to a wide-spread group of species with a similar morphology to Cythereis reticulata Jones and Hinde (1890). These form a distinct group belonging to Rehacythereis Gruendel 1973. Species such as Cythereis fournetensis Damotte (1971) from the Cenomanian of the Dordogne of France are very similar to Cythereis algeriana. Cythereis fournetensis differs from Rehacythereis almutasimi sp. nov. in details of reticulation, less prominent tubercle at posterior end of the dorsal ridge, and weaker pore cone half-way along the dorsal margin.

Occurrence:

Known so far from the Lower Cenomanian of South Rumaila Well-104, south eastern Iraq and Ghalaisan Well-1, south western Iraq; from the ? Lower Cenomanian of Safawi Well-1; and Lower Cenomanian of East Baghdad Well-3, middle eastern Iraq.

Rehacythereis arabica (Al-Furaih, 1983)
Pl. 77, figs. 1-4; Pl.78, figs.1-6.

1983 Limburgina arabica Al-Furaih, p.3-4, Pl.1, figs,6,7.

Diagnosis:

A small reticulate species of Rehacythereis, with subobtuse postero-cardinal angle, pointed posterior end slightly below mid-height; the dorsal ridge is discontinuous with prominent "Sagittarius" pore cone and posterior tubercle; the median and ventral ridges are straight and well developed; subcentral tubercle reticulate.

Figured specimens:

J.T. 395 - J.T. 411.

Material:

Total specimens 65.

In South Rumaila Well-104 section, 56 specimens (including one single valve, 6 broken single valves, and 11 broken valves) have been found in the Ahmadi Formation, at drilling depths of 2644-2738 m. In Kifl Well-2, 6 specimens (including 2 broken valves) are recorded from the basal beds of the Fahad Formation, at depths between 5230-5260 ft. In Ghalaisan Well-1, one specimen and one broken valve from the flower part of the Ahmadi Formation, at depths of 4200-4275 ft.

Type Locality:

ST-23, Saudi Arabia.

Type Horizon:

Wasia Formation, Cenomanian, sample 4,655 -4,660 ft below surface.

Stratigraphic range:

Cenomanian.

Description:

Carapace small, subrectangular to subovate; anterior margin broadly and evenly rounded, posterior margin pointed slightly below the middle; dorsal and ventral margin straight and subparallel converging to the posterior. Hinge ear is present in the left valve. Left valve slightly larger than the right valve, overlapping it slightly at the postero-dorsal and antero-dorsal margins; posterior cardinal angle curved and forming sub obtuse angle; males more elongate than females. Eye tubercle median sized, hemispherical and pronounced with very short rib extending downwards; subcentral tubercle prominent.

The entire surface is reticulate; relatively large quadratic shape in the first row (A); medium sized rounded to subrounded reticulation arranged in rows in the anterior area, the areas between the longitudinal ridges, the posterior-most tubercle of the dorsal ridge and the postero-marginal depressed area. The reticules upon the subcentral tubercle are smaller.

The prominent "Sagittarius" pore cone is present midway along the dorsal ridge giving the impression of a spine; small tubercles can be recognised in the position of the "Terminus" and "Leo" pore cones.

A marginal rim is distinctly developed at the anterior and posterior margins; the anterior margin has small denticles and several small denticles lie along the anterior marginal rim; there are a few weakly developed denticles on the ventral part of the posterior margin.

Three distinct longitudinal ridges are present. The dorsal ridge appears sinuous and discontinuous, beginning from below and behind the eye tubercle, has the "Sagittarius" pore cone mid-way along it, after which it slopes strongly downwards in a saddle-shaped section, rises to terminate with a large elongate and pronounced tubercle situated at about three-quarters along the dorsal margin. The median ridge is short and straight, starting from a depression behind the subcentral tubercle, and ending in the depressed posterior area. The ventral ridge is the longest commencing in the anterior area and finishing with a blunt median tubercle at about two-thirds of the length. The 3 ridges all finish at about the same distance from the posterior.

In dorsal view, the two sides of the carapace converge towards the anterior, with laterally compressed ends; the subcentral tubercle appears in a shallow depression, the pore cone at the centre of the dorsal margin in both sides of the valve, and the tubercle at the posterior end of the dorsal ridge are distinctly observed; maximum width lies in the anterior third of the carapace on the subcentral tubercle. In ventral view the reticulation of the ventral surface is clear.

Internally, the anterior marginal area is of medium-width, inner margin and line of concrescence coincide, the selvage is prominent. The hinge is Amphidont/heterodont, the hinge elements of the right valve consist of a conical and smooth anterior tooth, a postjacent smooth antero-median socket, followed by a postero-median groove which is probably smooth although it could not be clearly observed because it is not well preserved; the posterior tooth was not observed because it is broken on the specimen, the anterior hinge elements of the left valve consist of a deep smooth anterior socket opened to the venter, a postjacent conical smooth antero-median tooth, followed by a postero-median bar which is probably smooth. The muscle scars are unknown.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T.395	Male	0.680	0.350	0.400	1.942
J.T. 396	Male	0.700	0.380	0.400	1.842
J.T. 398	Male	0.630	0.330	0.330	1.909
J.T. 399	Female	0.630	0.390	0.380	1.615
J.T. 400	Female	0.582	0.365	0.380	1.594
J.T. 402	Female	0.630	0.400	0.400	1.575
J.T. 403	Female	0.630	0.400	0.380	1.575
J.T. 405	Female	0.610	0.380	0.350	1.605
J.T. 406	Small Female	0.540	0.330	0.282	1.636
J.T. 407	Small Female	0.560	0.350	0.330	1.6
J.T. 408	Small Female	0.540	0.330	0.330	1.63
J.T. 409	Small Female	0.540	0.330	0.350	1.63
J.T. 410	Small Male	0.582	0.350	0.330	1.662
J.T. 411	Small Male	0.560	0.330	0.330	1.696

Discussion:

Al-Furaih (1983) described this species from the Cenomanian of Saudi Arabia, assigning it to Limburgina Deroo (1966). He indicated that this species is identical to the species described by Sayyab (1956) as Cythereis hindei and recorded from the upper zone of the Middle Cretaceous strata of the Western Coast of the Arabian Gulf. Sayyab (1956) pointed out that the hinge structure in the right valve consists of crenulate anterior and posterior teeth separated by a smooth groove. The specimens studied here appear to have a smooth anterior tooth in the right valve, but this may be due to preservation, especially as the posterior tooth is broken. The species is assigned to Rehacythereis Gruendel (1973) on the basis of the external appearance, the presence of a strong hinge ear in the left valve, well-developed subcentral tubercle, ornamentation, and three longitudinal ridges; internally it almost certainly has the same type of hinge structure, but as mentioned above the crenulation is poorly preserved.

Rehacythereis arabica (Al-Furaih) resembles Cythereis namousensis Bassoullet and Damotte (1969) from Upper Cenomanian of Algeria in size (average length 0.60 mm), and in the presence of the "spine" mid-way along the dorsal ridge; it differs in the lateral outline especially the posterior margin, in the posterior group of tubercles on the dorsal ridge which tends to divide into two groups in Cythereis namousensis, and in the subcentral tubercle which is smooth and elongate in Cythereis namousensis.

Rehacythereis arabica (Al-Furaih) shows some similarities to Cythereis algeriana Bassoullet and Damotte (1969) from the Upper Cenomanian of Algeria, differing slightly in the outline of the posteior margin, where the point of the posterior end is more ventrally situated in Cythereis algeriana; in having a reticulate subcentral tubercle unlike the smooth button of C. algeriana; in being much smaller (0.6 mm cf. 0.90 mm); the "spine" mid-way along the dorsal margin is more prominent in Rehacythereis arabica as is the posterior tubercle of the dorsal ridge. Grosdidier (1973) described a species which he called Cythereis IRK9 from Middle Cenomanian-Upper Albian of the Coastal Fars Province in Iran which shows some resemblance to Rehacythereis arabica but differs in details of reticulation, in outline of the posterior margin which has a less elongate and pointed posterior end, in having tuberculate ventral and median ridges, and the dorsal ridge terminates with two tubercles at its posterior part.

Rehacythereis almutasimi sp. nov. is similar to Rehacythereis arabica in most aspects, but differs in having a slightly more prominent and elongate postero-dorsal tubercle at the end of the dorsal ridge, a more distinct posterior cardinal angle (see Pl.75, figs. 1-4; Pl.76, figs. 1-3), in the posterior end pointing subventrally, in details of the reticulation, in the median ridge which curves downwards towards the posterior while in Rehacythereis arabica it is straight, in its larger size (0.77 mm cf. 0.60 mm), and the surface of the posterior marginal depressed arera which has variable ornamentation varying from smooth to distinctly reticulate. These two species are found together for an interval of about 80 m. in the Ahmadi Formation of the South Rumaila Well-104, but Rehacythereis almutasimi sp. nov. is found alone in the lower part of the Ahmadi Formation and uppermost part of the Mauddud Formation of South Rumaila Well-104 for an interval of about 58 m.

This species shows considerable variation in size, with smaller and larger males and females (Fig. 6.3). The smaller specimens appear to be adults in that they have a thick shell and fully developed ornamentation. The ornamentation is similar in all sizes so there is no question of them being separate species, and the size range seems to be continuous rather than discontinuous. Small and large specimens can be found in the same sample. This could be a case of precocious sexual dimorphism, but as stated above, the smaller specimens do appear to be adults.

Occurrence:

This species is known so far from the Lower Cenomanian of South Rumaila Well-104 and Ghalaisan Well-1; and from the Lower Cenomanian (?) of Kifl Well-2.

Genus Spinoleberis Deroo, 1966

Type species:

Cythere eximia Bosquet, 1854

Spinoleberis ibnalfakihi sp. nov.
Pl. 79, figs. 1-5.

Name:

After Abu Bakr Ibn Al-Fakih, a famous Arab geographer, who wrote a comprehensive "Kitab al-Buldan" about the year 903-A.D.

Diagnosis:

A species of Spinoleberis with short, undulate dorsal ridge, dividied into 2 or 3 nodes, the posterior most is larger, more prominent and angulate and joins a short, vertical ridge, extending downwards, a faintly developed median ridge is marked by a small node; ventral ridge is continuous with anterior marginal rim, ending with a distinct node at its posterior end. Subcentral tubercle is rounded and prominent; a curved and short eye rib extends towards the subcentral tubercle. Lateral surface is mainly smooth with several nodes and pore cones.

Holotype:

Carapace, Probably Female, J.T. 412, Pl.79, figs. 1,3,4.

Paratype:

J.T. 413.

Material:

4 specimens only: 2 specimens from the basal strata of the Mishrif Formation, at drilling depths of 2546-2548 m, and another 2 specimens from the uppermost beds of the Rumaila Formation, at drilling depths of 2556-2558 m, of the South Rumaila Well-104 section.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Type Horizon:

Rumaila Formation, Upper Cenomanian, depth of 2556 m.

Stratigraphic range:

Upper Cenomanian.

Description:

Medium sized carapace with quadratic shape in lateral view; slightly obliquely rounded anterior margin, and pointed posterior margin; dorsal and ventral margins straight, sub parallel, converging towards the posterior end, the ventral margin obscured by the ventral ridge. The L/H measurements could indicate sexual dimorphism, but as only 2 specimens have been found and the lateral view of them does not indicate any pronounced differences, the question of sexual dimorphism must be left open. The eye tubercle is rounded and pronounced with short curved rib running diagonally downwards to the subcentral tubercle, this rib is indistinct in one specimen because it is not well preserved; subcentral tubercle is large, rounded and prominent.

The lateral surface of the carapace is mainly smooth except for a row of some weak reticulation along the area between the anterior margin and its rim, and a few poor reticules covering the ventral ridge. These latter reticules are indistinct in one specimen, it is probably because of their state of preservation.

The dorsal ridge is short undulating and distinct, beginning from the mid-dorsal margin, with one or two small nodes and ending with a more prominent large and angulate node or process before reaching postero-dorsal angle at about three-fourths of the length, the latter process joining a short ridge which runs vertically downwards and terminates before reaching the mid-height; the median ridge is feebly developed and distinguished by a small node situated posteriorly to the prominent subcentral tubercle; the ventral ridge is the longest and best developed continuing from the anterior marginal rim, running parallel to ventral margin and finishing with a blunt and pronounced node directed postero-ventrally at about two-thirds of the carapace length. The ventral ridge is less developed because of some reticules covering it in one specimen.

Anterior and postero-ventral slope of the posterior margin are distinctly rimmed, strongest along the anterior margin; both margins have denticles, ornamented with approximately 6-7 short rounded denticles along the anterior margin and with some 4-5 small denticles along the posterior margin, particularly the ventral part.

There are several nodes and pore cones, two in the median area of the carapace, "Leo" and "Sigma", are prominent; "Terminus" and another prominent pore cone probably lying in the position of "Theta" are present at the posterior; and two prominent nodes at the position of "Virgo" and "Sagittarius" dorsally which form the dorsal ridge, "Virgo" being the larger.

In dorsal view, the carapace has subparallel sides, with laterally compressed ends; maximum width lies just in front of mid-length at the position of the subcentral tubercle; the prominent subcentral tubercle and the nodes lying along the dorsal margin are clearly obsrved; the posterior node of the dorsal ridge is seen to bear two short tibs lying perpendicular to the margin.

No internal features were seen.

<u>Dimensions</u>: (In mm.)

		L.	H.	W.	L/H.
J.T. 412	Female? (holotype)	0.640	0.400	0.350	1.6
J.T. 413	Male?	0.650	0.380	0.282	1.71

Discussion:

This is assigned to the genus *Spinoleberis* Deroo (1966) because of the presence of a prominent hemispherical subcentral tubercle, strong tubercles at the posterior angles, the median ridge which may be present as a node, in the surface ornamentation, with small nodes in the posterior part.

Cythereis (Jones, 1849) differs in having three clearly defined and distinct longitudinal ridges, in the surface ornamentation, and lacks prominent tubercles in the postero-dorsal and postero-ventral parts.

Spinoleberis pseudoeximia Deroo (1966) from the Lower-Upper Maastrichtian of Belgium shows some resemblance in shape and general outline, but differs in details of ornamentation, in the presence of a thicker and more prominent eye rib, in having distinctly developed spinose anterior and posterior margins, and reticulate surface.

The dorsal ridge of *Spinoleberis ibnalfakihi* sp. nov. has an angulate posteriormost node joining a short rib unlike *Spinoleberis pseudoeximia*. This species differs from *Spinoleberis kasserinensis truncata* Bismuth et al. (1981a) from the upper part of the Middle Cenomanian to Upper Cenomanian of Tunisia, in details of ornamentation, i.e. in having a mainly smooth surface unlike the spinose-reticulate ornamentation of *Spinoleberis kasserinensis truncata*, in having a short eye rib, a more distinct dorsal ridge, and the presence of an angulate node at the posterior end of the dorsal ridge.

Spinoleberis ectypus Babinot (1973), described by Babinot (1980) from the Turonian of France, shows some similarity to this species in shape and general outline, but differs in the ornamentation of the carapace, lacks the short eye rib, and in the number and arrangement of the scattered papillae and pore cones on the lateral surface.

Occurrence:

This species is recorded from the Upper Cenomanian of South Rumaila Well-104 Section, south eastern Iraq.

Genus *Veenia* Butler and Jones, 1957

Type Species:

Cythereis ozanana Israelsky, 1929.

Subgenus *Veenia* (*Veenia*) Butler and Jones, 1957

Type species:

Cythereis ozanana Israelsky, 1929.

Veenia (*Veenia*) *ibnhazmi* sp. nov.

Pl.80, figs. 1-8.

Name:

After Abu Muhammad Ali Abn Hazm, a versatile Spanish Arab scholar, a notable theologian, historian and distinguished poet in the tenth and eleventh centuries.

Diagnosis:

A species of *Veenia* with three longitudinal ridges (dorsal, median and ventral ridges), and smooth surface amongst the longitudinal ridges and rims with several pore cones. The median ridge joins the ventral ridge anteriorly; the area between the median and ventral ridge is raised. The anterior and antero-ventral areas of the carapace are laterally depressed. Eye tubercle is pronounced. The posterior margin is triangular and elongate.

Holotype:

Female carapace, J.T. 420, Pl.80, fig.1.

Paratype:

J.T. 414 - J.T. 419.

Material:

Total specimens 7.

South Rumaila Well-104 section, south eastern Iraq, 5 specimens have been reported from the Tanuma Formation, at drilling depths of 2340-2347 m. below the surface, and 2 specimens from the lower part of the Khasib Formation, at depths of 2404-2422 m.

Type Locality:

South Rumaila Well-104 section.

Type Horizon:

Tanuma Formation, Upper Coniacian, depth of 2342 m.

Stratigraphic range:

Upper Turonian - Coniacian.

Description:

Medium sized, subtriangular carapace, with pronounced sexual dimorphism, males being fmore elongate than the females, greatest height at prominent anterior hinge-ear, greatest length through the cnetral point of the carapace; anterior margin evenly and broadly rounded, posterior margin elongate and triangular; dorsal and ventral margins sub-parallel in male, strongly converging towards posterior in the female; dorsal margin partly hidden by the dorsal ridge in lateral view; ventral margin concave in male, almost straight in female. A distinct eye tubercle is present; hinge ear only present in left valve, more prominent in female; left valve sligthly larger than right valve.

There are three distinct longitudinal ridges; the dorsal ridge is curved, starting from behind the eye tubercle and ending in front of the posterodorsal angle and at about three-fourths along the length of the carapace; the median ridge is straight, longer than the dorsal ridge, commencing at the subcentral area and ending posteiorly at the "Charon" pore cone; the ventral ridge is curved, seeming to join the median ridge at the anterior and ending just behind the "Omega" pore cone or at the position of "Omega" at the posterior.

The area between the median and ventral ridges is raised. The anterior and antero-ventral depression emphasises this ventro-median raised area.

There is no subcentral tubercle in the female, a slight subcentral tubercle is present in the male.

An anterior marginal rim is present and bears 4-7 small pore cones. There are some 12 denticles along the anterior margin and some 4-6 denticles along the posterior margin.

The surface between these ridges and rims is smooth. Several pore cones can be observed. On the posterior area three prominent small pore cones are present at "Terminus", "Psi" and "Charon"; a small distinct node or pore cone lies in the position of "Leo" in the median area of the valve; 2 prominent small spines lie near each other probably at the position of "Omega" or just behind the position of "Omega" at the posterior end of the ventral ridge; dorsally there are six small pore cones. "Taurus", "Aquarius", "Sagittarius", "Libra" and "Virgo"; the "Sagittarius" is prominent, the latter four lie along the dorsal ridge; "Alpha", "Beta" and "Scorpio" are small distinct pore cones at the anterior.

In dorsal view the male carapace has subparallel sides, in the female they converge towards the anterior, with greatest width towards posterior; anterior and posterior ends are compressed. In ventral view, the junction of the ventral ridge with the median ridge, the distinct anterior marginal rim relative to the weak ventromarginal rim and the anteromarginal depressed area are clearly seen. Internal features could not be observed.

Dimensions:

		L.	H.	W.	L/H.
J.T. 414	Male	0.630	0.305	0.240	2.065
J.T. 415	Male	0.640	0.325	0.250	1.969

J.T. 416, 417	Male	0.630	0.305	0.260	2.065
J.T. 418	Male	0.635	0.330	0.240	1.924
J.T. 419	Female	0.540	0.320	0.240	1.6875
J.T. 420	Female(holotype)	0.540	0.320	0.240	1.6875

Discussion:

This species is tentatively placed in Veenia (Veenia) Butler and Jones (1957) because of its general external features. However no internal details are known.

The species described by Grosdidier (1979) as Veenia GAE_8 from the Lower Turonian of Gabon (Western Africa) shows some similarities to this species Veenia (Veenia) ibnhazmi sp. nov. but differs in having a micro-reticulate or punctate surface, an elongate oblique indistinct subcentral tubercle, and the ventral ridge does not join the median ridge at the anterior.

Occurrence:

This species is recorded from the Upper Turonian and Coniacian of South Rumaila Well-104.

Subgenus Veenia (Nigeria) Reyment, 1963

Type species:

Veenia nigeriensis Reyment, 1960

Veenia (Nigeria) shatalarabia sp. nov.
Pl.81, figs. 1-7; Pl.82, figs. 1-6.

Name:

With reference to Shat Al-Arab, the name given to the tidal estuary formed by the united streams of the Euphrates and the Tigris.

Diagnosis:

A species of Veenia (Nigeria) with distinct dorsal ridge, reticulate subcentral area, vertical sulcus behind the subcentral area, short irregular ridgelets in poster-median area, and parallel longitudinal ridgelets in ventral half of carapace; anterior and posterior marginal areas smooth apart from a few pore cones.

Holotype:

Female carapace, J.T. 423, Pl. 81, fig.1; Pl.82, fig.3.

Paratype:

J.T. 421 - J.T. 422, and J.T. 424 - J.T. 432.

Materials:

58 specimens have been found. In South Rumaila Well-104 57 specimens: 56 (including 3 broken valves) from the Ahmadi Formation, at depths of 2638-2780 m, one specimen from the middle part of the Mishrif Formation, at a drilling depth of 2486 m. In Safawi Well-1 one specimen only was found in the Ahmadi Formation, at a depth of 3620-3625 ft.

Type Locality:

South Rumaila Well-104.

Type Horizon:

Ahmadi Formation, Lower Cenomanian, depth of 2736 m.

Stratigraphic range:

Lower Cenomanian, Upper Cenomanian ?.

Description:

Pyriform shaped to almond-shaped in lateral view; greatest height located at the antero-cardinal angle; greatest length runs through the central part of the carapace.

The dorsal margin is straight, mostly obscured by the dorsal longitudinal ridge; the ventral margin is slightly arched, strongly converging with the dorsal margin posteriorly. The posterior margin is narrowly rounded; the anterior margin broad and evenly round. A small but distinct eye tubercle has two short ribs; one being straight, distinct and extending towards the subcentral area; but without reaching it; the other is short and curved lying behind and parallel to the anterodorsal margin; in some specimens these ribs and the eye tubercle are weakly developed due to the state of preservation. A wide and short eye sulcus lies obliquely behind the eye tubercle. Left valve slightly larger than the right valve.

A thin antero-marginal rim is present in the left valve, it is strongest along ventral half of the anterior margin. A smooth wide crescent-shaped anterior marginal zone runs parallel to the anterior margin, with a narrow sulcus behind it. The posterior marginal area is smooth, compressed, particularly in the ventral part.

The dorsal ridge is well-developed starting from behind the eye sulcus, curving upwards and ending to the posterior at about three-fourths of the length. 4 thick longitudinal ridges lie parallel to the ventral margin with rows of subrounded to ovate reticulation between them. The subcentral area is ornamented with small rounded to subrounded reticules, with very thick and prominent muri giving the appearance of short ribs. A small smooth depression lies between the subcentral area and the ribs of the postero-median area. The postero-median area of the valve has 6-7 short, thick and irregularly arranged ribs with small reticules between them.

A few small pore cones and traces of reticulation can be seen in the smooth anterior and posterior marginal areas.

In dorsal view the carapace is subovate with slightly compressed anterior and posterior extremities; maximum width lies in front of mid-point; the dorsal ridge, the eye sulcus, the depression behind the subcentral area, and the few small reticules lying above and along the dorsal ridge can be observed. In ventral view, the four longitudinal ridges with rows of reticulations between them can be seen clearly. The internal features are unknown.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 421	Female	0.520	0.330	0.260	1.575
J.T. 422	Female	0.540	0.350	0.282	1.542
J.T. 423	Female (holotype)	0.560	0.350	0.260	1.6
J.T. 424	Female	0.520	0.315	0.260	1.650
J.T. 425	Female	0.540	0.330	0.260	1.636
J.T. 426	Female	0.490	0.305	0.240	1.606
J.T. 427	Female	0.520	0.315	0.260	1.6507
J.T. 428	Female	0.490	0.295	0.240	1.661
J.T. 429	Female	0.582	0.350	0.282	1.66
J.T. 430	Male ?	0.520	0.305	0.260	1.7049
J.T. 431	Male ?	0.490	0.282	0.240	1.737
J.T. 432	Male ?	0.540	0.305	0.282	1.770

Discussion:

The external appearance, ornamentation of irregular reticulation, and presence of a sulcus posterior to the eye tubercle suggest the assignment of this species to the subgenus *Veenia* (*Nigeria*) Reyment (1963), although the generic affinity remains uncertain because of the lack of observation of the hinge.

Buntonia (Howe 1935) differs in surface ornamentation and in the outline of the posterior end; an eye tubercle may be present (Reyment and Elofson, 1959) or absent (Morkhoven, 1963). Veenia (Veenia) Butler and Jones (1957) differs in having a prominent hinge ear and three longitudinal ridges. Veenia (Nigeria) shatalarabia sp. nov. has some resemblance to the new but unpublished genus described by Al-Abdul-Razzaq (1977, M.S.) as Louza in general outline, in having a wide smooth crescent-shaped antero-marginal zone bordered by a very narrow sulcus, in the absence of a hinge-ear and marginal denticulation, in the surface ornamentation and in the absence of subcentral tubercle. However, Louza differs in having an inflated and more arched ventral margin. Internal details such as the hinge elements could not be observed.

Veenia? ughelli (Reyment 1960) from the Maastrichtian of Nigeria shows some resemblance to this species in having a smooth wide crescent shaped antero-marginal zone bordered by a narrow sulcus, an eye sulcus, and a smooth posterior marginal area; but differs in ornamentation, in the presence of a hinge ear, a marginal denticulation, in the absence of the two short ribs extending from the eye tubercle, and in its extremely large size.

Occurence:

Known so far from the Cenomanian of South Rumaila Well-104, and from the Lower Cenomanian (?) of Safawi Well-1.

Genus Veeniacythereis Gruendel, 1973

Type species:

Cythereis ? imparia Gruendel, 1968

Veeniacythereis ibnalhaithami sp. nov.

Pl.83, figs. 1-8; Plk.84, figs. 1-6.

Name:

After Ali Al-Hasan Ibn Al-Haitham, who was one of the most important mathematicians and physicists of the Arabs, he studied also in medicine and other sciences of the ancients notably in the philosophy of Aristotle, in the tenth to the beginning of the eleventh century.

Diagnosis:

A species of Veeniacythereis characterised by three longitudinal ridges which show a tendency to divide into nodes. Surface of carapace varies from mainly smooth to partly reticulate; a prominent rounded tubercle lies in front of the subcentral tubercle at the antero-ventral corner. Anterior margin is thickly rimmed.

Holotype:

Female carapace, J.T.441, Pl.83, fig.1; Pl.84, fig.5.

Paratype:

J.T. 433 - J.T. 440, and J.T. 442 - J.T. 450.

Material:

Total number of specimens found is 50.

In South Rumaila Well-104, section, 22 specimens: 9 specimens (including 4 broken single valves and 3 single valves) from the Tanuma Formation, at drilling depths of 2334-2372 m; one broken valve from the basal stratum of the Sadi Formation, at depth of 2326 m; 2 single valves from the highest beds of the Mishrif Formation, come from samples at depths 2428-2429 m; and 12 specimens (including 5 broken single valves and 4 single valves) from the Khasib

Formation, at drilling depths of 2379-2416 m. In Ghalaisan Well-1 section, south western Iraq, 7 specimens have been found: 6 specimens found in the Khasib Formation, at depths of 3730-3795 ft; and one specimen from the basal bed of Tanuma Formation, at drilling depth of 3725 ft.

In Safawi Well-1, south western Iraq, one specimen only from the upper part of the Tanuma Formation, at depth of 3205 ft. In Kifl Well-2, middle western Iraq, 12 speciments found: 4 specimens (including 2 broken valves and one broken single valve) from the Tanuma Formation, at drilling depths of 4380-4405 ft; 6 specimens and one broken valve and one broken single valve from the basal beds of the Sadi Formation, at depths of 4335-4370 ft. In East Baghdad Well-3, central eastern Iraq, 8 specimens have been recorded through the lower half of the Tanuma Formation, at depths of 2288-2320 m.

Type Locality:

South Rumaila Well-104, south eastern Iraq.

Type Horizon:

Khasib Formation, Upper Turonian-Lower Coniacian, depth of 2416 m.

Stratigraphic range:

Upper Turonian-Santonian.

Description:

Carapace small, subquadrate to subrectangular in lateral view; greatest height at hinge-ear; greatest length at about the mid-height. Dorsal and ventral margins converging posteriorly into central pointed posterior end; dorsal margin straight, mostly obscured by the dorsal ridge along the hinge line; ventral margin weakly convex to slightly concave into selvage area. Anterior margin broadly and evenly rounded; posterior margin subtriangular with pointed end towards the middle; the dorsal part of the posteior margin is straight to concave. Well-developed postero-cardinal angle in the left valve. Left valve with a pronounced hinge-ear on the antero-dorsal angle; left valve larger than the right, with strongly and conspicuously defined overlap at the antero-dorsal margin along the area of the hinge-ear, and the postero-dorsal area along the posterior cardinal angle and dorsal part of the posterior margin; along the antero-ventral margin the overlap is sometimes distinct. Eye tubercle, rounded, large and prominent at the antero-cardinal angle. Subcentral tubercle prominent, rounded and smooth situated in front of the mid-length of the valve; another prominent and smooth rounded tubercle lies at the antero-ventral corner of the carapace in front of the subcentral tubercle and clearly consists of some small tubercles with pores at their tops in some specimens.

There are three longitudinal ridges which show a tendency to break into nodes. The dorsal ridge commences from a small pore cone or node lying behind each eye tubercle, curved upwards, bearing or breaking into 3 or 4 nodes lying along the dorsal margin, these nodes usually coalesce giving the ridge a thickened and slightly sinuous appearance in lateral view; the ridge ends posteriorly in front of the posterior cardinal angle. The median ridge is shorter, distinctly defined and tuberculate, starting from behind the sub-central tubercle and separated from it by a shallow depression; it consists of 4 almost equal sized nodes which coalesce to form the ridge; the nodes are variably developed between specimens; when they are poorly developed the ridge appears thick and almost straight with a slight undulation and nodosity; in one specimen the nodes are unequal in size, smaller at the posterior, larger towards the depression. The ventral ridge is broken into a series of 5 or 6 nodes parallel to the ventral margin and ends before reaching the posterior margin. In some specimens the nodes of the dorsal and median ridge usually have pores at their tops.

The surface of the carapace is variable from mainly smooth in most specimens to partly reticulate; in a few specimens of the latter, reticulation covers the area between the dorsal and median ridge and behind and along the anterior marginal rim, these reticules becoming weaker at the antero-dorsal area below the eye tubercle and in the depressed area lying behind the subcentral tubercle.

A thickly developed rim extends around the anterior margin, but the posteior and ventral marginal rims are not clearly observed and seem to be poorly developed. The anterior margin has some 10-14 small spines or rounded denticulations; some 3-5 small pore cones or pustules are arranged on the anterior rim; at the posterior margin there are 4-5 pustules or rounded denticles and one pore cone or pustule lying at the dorsal part of the posterior margin. These anterior and posterior marginal spines or denticulations are usually prominent, but in some specimens they appear to be weakly developed.

Two of the dorsal ridge nodes or pore cones lie in the position of "Sagittarius" and "Aquarius"; "Terminus" is prominent posteiorly; in the median area there is a prominent node in the position of "Sigma" and another prominent pore cone at "Leo"; ventrally the three prominent nodes of the ventral ridge are at the positions of "Iota", "Zeta" and "Lambda"; two small pore cones or papillae are probably in the position of "Beta" and "Alpha". There are a few additional secondary nodes or very small pore cones between the major ones.

In dorsal view the carapace has almost parallel sides, and laterally compressed ends; the nodes along the dorsal margin, the subcentral tubercle, antero-ventral tubercle, and the depression lying behind the subcentral tubercle can be observed clearly.

Internally, the anterior marginal area appears to be broad, line of concrescence subparallel to the outer margin, far removed from the inner margin; selvage prominent; hinge is Amphidont/heterodont, the anterior terminal hinge element of the right valve consisting of an anterior tooth with higher conical, smooth dorsal part and a lower ventral part which extends below the post-jacent socket, giving a curved tooth in lateral view; the antero-median postjacent socket is deep, smooth and subrounded opened posteriorly and connected to a smooth postero-median groove. The elements in the left valve consist of deep and rounded anterior socket closed ventrally, a postjacent high conical and smooth antero-median tooth, followed by a smooth postero-median bar, ending with an elongate posterior socket, open ventrally. Trace of an eye ocular node present in the hinge of the left valve. Muscle scars are not seen.

Dimensions: (In mm.)

		L.	H.	W.	L/H.
J.T. 433	Male	0.720	0.350	0.350	2.057
J.T. 434	Male	0.680	0.350	0.315	1.942
J.T. 435	Male	0.680	0.350	0.282	1.942
J.T. 436	Male	0.680	0.330	0	2.060
J.T. 437	Female	0.610	0.350	0	1.742
J.T. 438	Female	0.620	0.380	0.305	1.6315
J.T. 439	Female	0.630	0.380	0.330	1.657
J.T. 440	Female	0.652	0.400	0.330	1.63
J.T. 441	Female (holotype)	0.630	0.360	0.350	1.75
J.T. 442	Female	0.610	0.350	0.305	1.742
J.T. 443	Female	0.640	0.380	0	1.6842
J.T. 444	Small Female	0.560	0.335	0.282	1.6716
J.T. 445	Small Female	0.560	0.330	0.282	1.696
J.T. 446	Small Female	0.560	0.350	0.252	1.6
J.T. 447	Small Female	0.540	0.330	0.295	1.636
J.T. 448	Small Female	0.550	0.330	0.282	1.666

Discussion:

The species is assigned to Veeniacythereis Gruendel (1973) on the basis of the external appearance, the presence of a distinct hinge ear in the left valve, well developed three longitudinal ridges; internally it has the same type of hinge structure.

Cythereis cf. OUM 1658-2 Grekoff (1968) illustrated by Grosdidier (1973, Pl.12, figs. 89 a-d) from the Laffan Formation of the Coniacian? of the coastal Fars Province of Iran, was considered by Grosdidier to be characteristic of that Formation and was reported from other areas. It seems to be similar to Veeniacythereis ibnalhaithami sp. nov. and Grosdidier's figures indicate a somewhat similar variation to that seen in some specimens of Veeniacythereis ibnalhaithami sp. nov., i.e. the median ridge may be more or less nodose; figs. 89 a and b have an almost straight and non-nodose ridge, so if these forms are conspecific they extend the ragne of variation seen in the species. Sayyab (1956, unpublished Ph.D. dissertation) found specimens almost identical to this species in the Upper Cretaceous of the Arabian Gulf Coast; which he named Cythereis ? dukhanensis sp. nov., describing its common occurrence in many wells along the Arabian Gulf. He placed his species in Cythereis stating that "the presence of a median tubercle, ventral and dorsal flanges and median ridge associated this species with Cythereis"; however, he also remarks that "some doubt remains because of the poor preservation of the hinge". He noted that "The pattern of ornamentation of this form resembles that of the genus Actinocythereis? puri 1953" (p.81-82). The ornamentation of the ventral surface in the ventral view is more clearly developed in Sayyab's species than in Veeniacythereis ibnalhaithami sp. nov. A more important difference was in the hinge which Sayyab described as having faintly crenulate anterior tooth and median groove; it is not clear how much importance should be attended to this observation. The figured specimens of Cythereis OUM 1658-2 illustrated by Grekoff (1968) from passage beds between the Coniacian and Santonian of Algeria, in Pl.2, figs. 24 a-d, are not clearly illustrated, so gives a doubt as to whether they are identical to Veeniacythereis ibnalheithami sp. nov. or not.

The species illustrated by Grosdidier (1973) as IRE_{12} from the Coniacian ? of the coastal Fars Province of Iran, can be easily distinguished from Veeniacythereis ibnalhaithami sp. nov. in its smaller size; in the number, arrangement and degree of development of the tubercles of the lateral surface, in particular those of the three longitudinal ridges, and in having a smooth surface between the tubercles instead of the variable surface ornamentation of Veeniacythereis ibnalhaithami sp. nov. Cythereis ? gambiensis Apostolescu (1963) and Cythereis sarakundaensis Apostolescu (1963) from the Senonian (Maastrichtian) of Gambia, show some similarities in shape and general outline, but they differ from this species in the size, thickness, number and arrangement of the tubercles of the three longitudinal ridges; and in the presence of deep and broad grooves between the longitudinal ridges and above and under the subcentral tubercle. Cythereis ? gambiensis is distinguished by its larger size; Cythereis sarakhudaensis differs in having a small narrow longitudinal groove underlying the tubercles of the ventral ridge in its posterior half.

This species shows considerable variation in size, with smaller and larger females (Fig. 6.4). The smaller specimens appear to be adults in having thick shelled carapaces and fully developed ornamentation. The ornamentation is similar in all sizes so there is question of them being separate species, and the size range seems to be continuous rather than discontinuous. The small and large specimens have the same stratigraphic range. This could be a case of precocious sexual dimorphism, but as mentioned above the smaller specimens appear to be adults.

Occurrence:

This species is known from the Upper Turonian-basal part of the Santonian and from the highest Lower Turonian of South Rumaila Well-104, south eastern Iraq; Upper Turonian-Coniacian of Ghalaisan Well-1 and Safawi Well-1; Upper Coniacian-basal Santonian of Kifl Well-2; and Upper Turonian-Coniacian of East Baghdad Well-3. After Sayyab it also recorded from the Upper Cretaceous strata of the Western Coast of the Arabian Gulf.

Veeniacythereis maghrebensis (Bassoullet and Damotte, 1969) Pl. 85, figs. 1-5; Pl.86, figs. 1-5.

1959 - *Ostracode* C_1 - Glintzboeckel and Magne, Pl.3, fig. 33.

1969 - *Cythereis maghrebensis* Bassoullet and Damotte, p.133-134, pl.1 figs. 2 a-e, non Ostracode C_2 Glintzboeckel and Magne 1959 and non Ostracode C_3 Glintzboeckel and Magne 1959.

1974 - *Veeniacythereis jezzineensis* (Bischoff).- Rosenfeld and Raab (Pars), p.21, Pl.3, fig.30, non figs. 28-29 and figs. 31-33.

?1975- *Cythereis jezzineensis* Bischoff - Colin and El-Dakkak, p.56 - 57, Pl.1, figs. 11-12.

1977 - *Veeniecythereis maghrebensis* (Bassoullet and Damotte). - Damotte, Pl.1, fig.9.

1981 - *Veeniacythereis maghrebensis* (Bassoullet and Damotte). - Al-Abdul-Razzaq and Grosdidier, 182-183, pl.1, fig.3.

?1981- *Veeniacythereis maghrebensis* (Bassoullet and Damotte). - Bismuth et al., p.232-233, Pl.10, Figs. 1-2.

Diagnosis:

A species of *Veeniacythereis* with prominent longitudinal ridges, strong cross-ribs between ridges and between ventral ridge and ventral margin; dorsal ridge "humped"' five to six radial ridges run from the anteromarginal rim towards the subcentral tubercle but do not reach the latter; the anteromarginal area smooth; distinct punctate subcentral tubercle.

Figured specimens:

J.T. 451 - J.T. 469.

Material:

Total number of specimens 112 have been recorded.

In South Rumaila Well-104, south eastern Iraq, 37 specimens have been found. 22 specimens (including 1 broken carapace and 2 single valves) from the Ahmadi Formation, at drilling depths of 2636-2722 m; 8 specimens and 1 broken valve from the middle and basal beds of the Mishrif Formation, at drilling depths of 2484 - 2550 mm below the surface; 3 specimens and 2 broken valves from the top bed and the upper part of the Rumaila Formation, at drilling depths of 2552 - 2584 m; and one single valve from the Mauddud Formation, at depth of 2794-2796 m. In Ghalaisan Well-1 Section, south western Iraq, 54 specimens:48 specimens (including 4 single valves, and 5 broken valves) found in the Ahmadi Formation, at drilling depths between 4100 - 4320 ft; 5 specimens present at the base of the Rumaila Formation, at a drilling depth of 4095 ft; and one specimen from the top bed of the Mauddud Formation, at depth of 4325 ft. In Safawi Well-1, south western Iraq, 10 specimens have been found: 9 specimens (including 2 broken valves and one single valves) found in the beds below the middle part of the Rumaila Formation, at drilling depths of 3490 - 3545 ft; and one specimen from the lower beds of the Ahmadi Formation, at depth of 3630 - 3635 ft. In Kifl Well-2 Section, middle western Iraq, 11 specimens have been reported: 8 specimens from the basal beds of the Maotsi Formation, at depths of 4880-4890 ft below the surface; 2 broken valves from the top and basal beds of the Fahad Formation, at depths between 5225-5230 ft and 4900 - 4905 ft; and one specimen from the lower bed of the Mahilban Formation, at depth of 5445 ft.

Type Locality:

Coup de l'Oued an Namous, Algeria.

Type Horizon:

Upper Cenomanian.

Dimensions: (In mm.)

	L.	H.
J.T.451-454 Male	0.890-0.950	0.490-0.550
J.T.455-464 Female	0.815-0.910	0.490-0.582
J.T.465-467 Small Male	0.860-0.790	0.470
J.T.468-469 Small Female	0.700-0.720	0.470
	W.	L/H.
J.T.451-454 Male	0.490-0.582	1.7009-1.816
J.T.455-464 Female	0.470-0.582	1.455-1.663
J.T.465-467 Small Male	0.470-0.490	1.829-1.6808
J.T.468-469 Small Female	0.470	1.489-1.53

Discussion:

There has been a great deal of confusion over this species and the related species *Veeniacythereis jezzineensis* (Bischoff, 1963) and *Veeniacythereis streblolophata* (Al-Abdul-Razzaq and Grosdidier, 1981). A recent paper by Rosenfeld and Raab (1983) placed all three into a single highly variable species, *Veeniacythereis jezzineensis*. However the material from Tunisia, Iraq, Kuwait and around the Arabian Gulf does not support this hypothesis because there is no intergradation between the species and three distinct groups can be recognised. These may be morphs of a single species, but they can equally well be regarded as distinct species, and the majority of workers have regarded them as such.

In their original description of *Veeniacythereis maghrebensis*, (Bassoullet and Damotte, 1969) included in their synonymy Ostracodes C_2 and C_3 of Glintzboeckel and Magne (1959) and Cythereis C_2 of Grekoff(1968); C_1 is here regarded as *Veeniacythereis maghrebensis*, and C_2 and C_3 as *Veeniacythereis streblolophata* (Al-Abdul-Razzaq and Grosdidier, 1981). Bassoullet and Damotte (1969) regarded C_2 and C_3 as female and male dimorphs; Al-Abdul-Razzaq and Grosdidier (1981) indicated in their remarks that Bassoullet and Damotte's illustrations show a completely smooth antero-marginal area lacking the ribs radiating inwards from the anteromarginal rims towards the subcentral tubercle but not reaching the latter, one of the important differences between *Veeniacythereis maghrebensis* and *Veeniacythereis* streblolophata; C_2 and C_3 are also small specimens, similar in size to Veeniacythereis streblolophata rather than Veeniacythereis maghrebensis. Rosenfeld and Raab (1974) placed V. maghrebensis within the synonymy of V. jezzineensis together with forms they regarded as juveniles and subsequently described as a new species, Cythereis streblolophata by Al-Abdul-Razzaq and Grosdidier (1981). They also included C_1 of Glintzboeckel and Magne in their synonymy, which Bassoullet and Damotte (1969) had not done. Their reasons for doing so were fully documented in a later paper (1983). In this later paper they stated that the ornamentation between these species is transitionally variable, although they do not illustrate such forms. They plotted the length and height of some 170 specimens and believed they could recognise pre-adult sexual dimorphism in Stages A-2 and A-1. They placed V. streblolophata schista as A-2, V. streblolophata streblolophata as A-1 and V. jezzineensis and V. maghrebensis as adults. Their graphs shows virtually continuous size variation with no clear breaks between moult stages. They also included in their synonymy the forms of V. maghrebensis described by Al-Abdul-Razzaq and Grosdidier (1981), and by Bismuth et al. (1981a), and the forms of V.jezzineensis illustrated by Al-Abdul-Razzaq and Grosdidier (1981), as female adults; however the dimensions of these specimens would place them in the field of Moult A-1 female in Rosenfeld and Raab's graph. Colin and El-Dakkak (1975) also placed V. maghrebensis into the synonymy of V. jezzineensis, regarding the differences between them as insufficient for specific separation; they suggested the differences might be due to ecological or sedimentological conditions. They also noted small specimens which they thought might be juveniles, but would now be placed in V. streblolophata. Their Pl.1, figs. 11-12 would appear to be doubtfully synonymized with V. maghrebensis as interpreted in this study, because the radial ribs in the anteromarginal area are not clearly pronounced; like Rosenfeld and Raab (1974, 1983) they also considered C_1 of Glintzboeckel and Magne (1959) as synonymous with their species. Al-Abdul-Razzaq recognised and described Veeniacythereis jezzineensis, Veeniacythereis maghrebensis and Veeniacythereis streblolophata in her Ph.D. dissertation of 1977 on Kuwaiti Cretaceous ostracods. The last named species was divided into 2 subspecies which were formally described in 1981 by Al-Abdul-Razzaq and Grosdidier as C. streblolophata streblolophata and C. streblolophata schista. The two "subspecies" are present in Iraq, but for reasons given in the discussion of the species they are not separated into "subspecies" but regarded as morphs of a single species. Al-Abdul-Razzaq and Grosdidier thought that a phylogenetic relationship existed between the older V. jezzineensis (Lower Cenomanian) and the younger V. maghrebensis (Upper Cenomanian). This opinion seems to be in conflict with the observation of other authors such as Rosenfeld and Raab (1974, 1983) and Colin and El-Dakkak (1975) who found these species occurring together in many of the samples through the same stratigraphic range. Al-Abdul-Razzaq and Grosdidier assigned C_1 of Glintzboeckel and Magne to the Synonymy of V. maghrebensis Bismuth et al. (1981a) recognised V. maghrebensis and the two "subspecies" of V. streblolophata in the Cenomanian of Tunisia; as in this study they synonymized C_1 of Glintzboeckel and Magne with V. maghrebensis and C_2 and C_3 with V. streblolophata.

They also believed V.jezzineensis to be an Albian species, V. streblolophata Lower Cenomanian-basal Upper Cenomanian, and V. maghrebensis to be an Upper Cenomanian species. However, the specimen they illustrated V. maghrebensis (Pl. 10, figs.1-2) has the feature of V. jezzineensis rather than V. maghrebensis, therefore it is questionably assigned to V. maghrebensis in this study. Sayyab in his unpublished work of 1956 described identical forms to V. maghrebensis from the upper zone of the Middle Cretaceous strata of the Arabian Gulf area. He pointed out that this species is an important stratigraphic marker. Dr. John Athersuch (pers. commun.) has found V. maghrebensis in the upper part of the Cenomanian of Oman.

The diagnostic features of the three species are as follows:

Size:

See Fig. 6.5 Adult females of V. maghrebensis and V. jezzineensis range between 0.80 mm and 0.95 mm; adult females of V. streblolophata range between 0.63 - 0.72 mm (see Fig. 6.6).

Ornamentation:

The three longitudinal ridges tend to be more sharply defined in V. maghrebensis and V. streblolophata than in V. jezzineensis. The anterior area shows important differences: V. jezzineensis has irregular small reticulation covering the whole area between the subcentral tubercle and the anteromarginal rim; V. maghrebensis has 5-6 ribs radiating from the anteromarginal rim towards the sub-central tubercle, but not extending as far as the latter; V. streblolophata has a completely smooth anterior area. V. jezzineensis and V. maghrebensis have well defined subcentral tubercles, Veeniacythereis streblolophata has a 'J' shaped ridge in the position of the subcentral tubercle in the left valve; the dorsal ridges of V. jezzineensis and V. maghrebensis are similar, with two prominent humps whereas V. streblolophata has an arched ridge with strong cross ridges coming from it towards the median ridge; the cross ridges running between the median and ventral longitudinal ridges form more of a reticulate pattern in V. jezzineensis than in the other two species where they seldom run the whole distance between the longitudinal ridges.

The idea of Rosenfeld and Raab regarding precocious sexual dimorphism is interesting because there is a large size range in V. maghrebensis. However, V. streblolophata cannot be regarded as a juvenile because specimens studied have a thick shell with strong calcification and ornamentation and have a fully developed Amphidont hinge. The latter character is considered to be important in this study, as already argued by Al-Abdul-Razzaq and Grosdidier (1981, p.184-185) who noted the importance of the Amphidont hinge structure from the statements of Van Morkhoven (1962, p.89).

The Iraqi specimens have been measured and plotted (Fig. 6.5) and Rosenfeld and Raab's adult and juvenile fields superimposed on the diagram. As can be seen some small male and female specimens fall into Rosenfeld and Raab's A-1 female and A-1 male ranges. These specimens appear to be adult and have all the characters of the larger female specimens differing only in size. They are definitely not V. streblolophata. This problem has been encountered with other Iraqi species and is discussed in Chapter 6. All the large female specimens and some large male specimens fall within the field of the adult female stage while the other large male specimens fall into field of the adult male stage, but very near to the boundary of this field. V. maghrebensis as mentioned above and as seen in Fig. 6.5 shows a wide size range within the Iraqi material and also between different areas; the smallest specimens come from Tunisia (Bismuth et al., 1981a) and Kuwait (Al-Abdul-Razzaq, 1977; Al-Abdul-Razzaq and Grosdidier, 1981) followed by Palestine (Rosenfeld & Raab, 1974), Algeria(Bassoullet and Damotte, 1969) with the largest from Iraq. These differences could be attributed to geographical or stratigraphic distribution or to some environmental factor.

The Maastrichtian species Cythereis sennacheribi, and Cythereis esarhaddoni Al-Sheikhly, (1980, unpublished Ph.D. thesis) from northern Iraq, differ from the Cenomanian-Turonian species described in this study in having different outlines, three weakly developed longitudinal ridges, less developed eye tubercle and hinge-ear in the left valve, and in the lack of other ornamental features such as cross ribs and subconcentric reticulations.

Occurrence:

This species occurs in the Cenomanian of South Rumaila Well-104, Kifl Well-2, and Safawi Well-1; and the Lower Cenomanian and basal part of the Upper Cenomanian of

Ghalaisan Well-1. This species has also been recorded from the Upper Cenomanian of Algeria (Bassoullet and Damotte, 1969); Upper Cenomanian of East Algeria and Tunisia (Glintzboeckel and Magne, 1959); questionably recorded from the Cenomanian of Sinai, Egypt (Colin and El-Dakkak, 1975); Upper Cenomanian of Kuwait (Al-Abdul-Razzaq and Grosdidier, 1981; Al-Abdul-Razzaq, 1977); Lower-Upper Cenomanian of Palestine (Rosenfeld and Raab, 1974); Upper zone of the Middle Cretaceous of the Arabian Gulf Coast (Sayyab, 1956); questionably from the upper half of the Upper Cenomanian of Tunisia (Bismuth et al., 1981a) and the upper part of the Cenomanian of Oman (Athersuch, pers. commun.).

V. maghrebensis and V. streblolophata have a wide geographic distribution in most regions of North Africa, the Arabian Gulf Coast, Kuwait, Oman and Palestine. V. jezzineensis has not been found in the material studied from Iraq, nor in Oman, the Western Coast of the Arabian Gulf, East Algeria and Tunisia. In this study V. maghrebensis and V. streblolophata are found together in most of the samples studied. They have the same stratigraphic range, i.e. Cenomanian, but only V. streblolophata is present in the Lower Cenomanian of East Baghdad; they are also recorded together in Palestine, the Arabian Gulf Coast, upper part of Cenomanian of East Algeria and Tunisia; however, they appear to have different stratigraphic ranges in Kuwait and Oman.

Veeniacythereis streblolophata (Al-Abdul-Razzaq and Grosdidier, 1981. Pl.87, figs.1-4; Pl.88, figs.1-4, Pl.89, figs.1-8.

1959 - Ostracode C_2, Glintzboeckel and Magne, Pl.3, fig.27.
1959 - Ostracode C_3, Glintzboeckel and Magne, Pl.3, fig.28.
1968 - Cythereis C_2, Glintzboeckel and Magne.-Grekoff, p.10, Pl.1, fig. 5.
1973 - Cythereis IRE_3, Grosdidier, Pl.8, figs. 67 a-c.
1973 - Cythereis IRC_4, Grosdidier, Pl.8, figs. 66 a-d.

1974 - Veeniacythereis jezzineensis (Bischoff).- Rosenfeld and Raab, p.21, Pl.3, figs. 31-33, non figs. 28-30.

1975 - Cythereis jezzineensis, Bischoff, form jeune? - Colin and El-Dakkak, p. 56-57, Pl.2, figs. 1-2.

1980 - Cythereis jezzineensis Bischoff.- Ben Yousseff, p.79-80, Pl.6, figs.1-4.

1981 - Cythereis streblolophata streblolophata, Al-Abdul-Razzaq and Grosdidier, p.183-185, Pl.1, figs. 7-10, Pl.2, figs. 6-8.

1981 - Cythereis streblolophata schista, Al-Abdul-Razzaq and Grosdidier, p.185-186, Pl.2, figs. 1-5.

1981a- Veeniacythereis streblolophata streblolophata (Al-Abdul-Razzaq and Grosdidier).- Bismuth et al., p.233, Pl.10, figs. 3-4.

1981a- Veeniacythereis streblolophata schista (Al-Abdul-Razzaq and Grosdidier).- Bismuth et al., p.233, Pl.10, figs. 5-7.

1983 - Veeniacythereis jezzineensis (Bischoff), juvenile A-1 male. - Rosenfeld and Raab, Pl.1, figs.3-4; Pl.2, figs.3-4, 10-11.

1983 - Veeniacythereis jezzineensis (Bischoff), juvenile A-1 female. - Rosenfeld and Raab, Pl.2, figs. 5, 12).

1983 - Veeniacythereis jezzineensis (Bischoff) juvenile A-2 male. - Rosenfeld and Raab, Pl.1, figs. 5,7,8,10; Pl.2, fig. 6.

1983 - Veeniacythereis jezzineensis (Bischoff) juvenile A-2 female. - Rosenfeld and Raab, Pl.1, figs. 6,9,11-13; Pl.2, figs. 7,13.

1983 - Veeniacythereis jezzineensis (Bischoff), juvenile A-3. - Rosenfeld and Raab, Pl.1, figs. 14-15.

1983 - Phyrocythere streblolophata (Al-Abdul-Razzaq and Grosdidier) - Al-Furaih, p.4, Pl.1, figs.8-10.

Diagnosis:

A species of Veeniacythereis characterized by three prominent longitudinal ridjges, dorsal ridge is arched; strong cross ridges developed between them and also between ventral ridge and ventral margin; prominent eye ridge may connect with rounded ridge in the position of the subcentral tubercle, the latter forming "J" shape in the left valve;

anteromarginal area totally smooth; anterior and posterior margins rimmed and denticulate.

Figured specimens:

J.T. 470 - J.T. 493.

Material:

Total number of specimens 630. In South Rumaila Well-104 section, south eastern Iraq, 519 specimens have been found: 486 specimens (including 10 broken single valves) from the Ahmadi Formation, at drilling depths of 2636-2790 m; 23 specimens (including 6 broken valves) from the lower half of the Mishrif Formation, from samples at depths of 2482-2490 m, 2548-2550 m; 8 specimens from the top bed and upper part of the Rumaila Formaiton, come from samples of depths 2552-2584 m; and one specimen and one broken valve from the Mauddud Formation, at depths between 2791-2796 m. In Ghalaisan Well-1, south western Iraq, 44 specimens have been found: 40 specimens (comprising of 5 broken valves) from the Ahmadi Formation, at depths of 4182 - 4320 ft; and one specimen and 3 broken valves from the top and uppermost beds of the Mauddud Formation, come from samples at depths of 4325-4335 ft. In Safawi Well-1, south western Iraq, 56 specimens have been recorded: 5 specimens and 4 broken valves present through the lower half of the Rumaila Formation, at drilling depths of 3480-3615 ft; 34 specimens and 13 broken valves from the Ahmadi Formation, at depths of 3625 - 3635 ft; and 2 specimens from the top and uppermost bed of the Mauddud Formation, at depths of 3645 - 3650 ft.

In East Baghdad Well-3, middle eastern Iraq, 3 specimens present in the basal part of the Rumaila Formation, at depths of 2810 - 2842 m. Finally in Kifl Well-2, middle western Iraq, 7 specimens and one broken valve have been found; 3 specimens from the lowest part of the Maotsi Formation, at drilling depths between 4885 - 4890 ft; one specimen and one broken valve from the lowest beds of the Fahad Formation, come from samples of 5230 - 5270 ft; one specimen from the top bed of the Mailban Formation, at depths of 5280 - 5285 ft; and two specimens from the highest bed of the Mauddud Formation, at depths between 5510 - 5515 ft.

Type Locality:

Ahmadi Field, south eastern Kuwait, Ahmadi Well-3; Ahmadi Well-4.

Type stratum:

Ahmadi Formation, depths 1331 m, 1163 m.

Stratigraphic range:

Lower and Upper Cenomanian age.

Dimensions: (In mm.)

		L.	H.
J.T.470-481	Male	(0.700-0.790)	(0.380-0.435)
J.T.482-493	Female	(0.630-0.720)	(0.380-0.470)
		W.	L/H.
J.T.470-481	Male	(0.350-0.425)	(1.75-1.8626)
J.T.482-493	Female	(0.305-0.400)	(1.5319-1.71)

Discussion:

This has been regarded by several authors as the juvenile of V. jezzineensis or V. maghrebensis. For reasons already stated (see discussion of V. maghrebensis) this idea is rejected. Al-Abdul-Razzaq (Ph.D. 1977) and Al-Abdul-Razzaq and Grosdidier (1981) dividied it into two subspecies, Cythereis streblolophata streblolophata and Cythereis streblolophata schista. The differences they gave are: V. streblolophata schista is slightly inflated in the central area when seen in dorsal view; and the eye ridge runs from the eye tubercle and connects with the "sub central tubercle" in V. streblolophata schista, whereas it does not join the "subcentral tubercle" in Veeniacythereis streblolophata streblolophata.

There is in fact no true "subcentral tubercle" in this species. These two differences can be seen in the Iraqi material. Al-Abdul-Razzaq and Grosdidier (1981) also mentioned a third difference, that in the left valve a cross rib joins the ventral ridge to the lower part of the "J" shaped ridge of the "subcentral tubercle". This has not been observed in the Iraqi specimens. Al-Abdul-Razzaq and Grosdidier believed these two "sub species" had different stratigraphic ranges: V . streblolophata streblolophata, Upper Cenomanian and V. streblolophata schista, Lower Cenomanian. However this can no longer be considered correct as both "sub species" occur together in Iraq from the Cenomanian. ~~Albian to the Lower Turonian.~~ Rosenfeld and Raab (1983) found both "subspecies" occurring together through the Upper Albian to Upper Cenomanian; Bismuth et al. (1981a) also records both "sub-species", V. streblolophata streblolophata from the Middle to the base of the Upper Cenomanian, and V. streblolophata schista from the Lower Cenomanian of Tunisia, i.e. a similar range to that given by Al-Abdul-Razzaq and Grosdidier. In fact there is a discrepancy in Al-Abdul-Razzaq and Grosdidier (1981) as pointed out by Rosenfeld and Raab (1983) where they placed the Albian-Lower Cenomanian Cythereis IRE_3 of Grosdidier (1973) into the Upper Cenomanian V. streblolophata streblolophata and the Cenomanian (including upper Cenomanian) Cythereis IRC_4 into the Lower Cenomanian V. streblolophata schista. The fact that morphological differences are very small and the two "subspecies" occur together suggest that these are morphs of a single species rather than 2 subspecies.

Al-Furaih (1983) found this species in the Cenomanian of Saudi Arabia, placing it in Phyrocythere Al-Furaih (1980). In this study the species is assigned to Veeniacythereis thus following several authors mentioned above. This species differs from Phyrocythere in shape and outline, in type of surface ornamentation, and in having three longitudinal ridges.

Further occurrences are known from Oman (Dr. John Athersuch, personal commun.) where forms similar to V. streblolophata have been found from the Aptian ? to just above the middle part of the Cenomanian. Both morphs have the same stratigraphic range in the studied wells of south eastern, south western, middle western and middle eastern Iraq. The morph "V. streblolophata schista" is frequently the commoner in samples of these wells. The two morphs are abundant and very well pronounced in South Rumaila Well-104; rare and badly preserved in the East Baghdad Well-3, middle eastern Iraq; and rare in the Kifl Well-2, middle western Iraq. They are recorded in the Mishrif Formation of Upper Cenomanian-Lower Turonian age; found abundantly in the Ahmadi Formation and the Rumaila Formation and its equivalents and are rare in the basal Cenomanian of the Mauddud Formation. The sexual dimorphisms of these two morphs is distinct, the males are more elongate than the females. There is a slight difference between the males of the two morphs where V. streblolophata streblolophata is more tapered towards the posterior than V. streblolophata schista. The Iraqi specimens of these two are generally larger in size than the Kuwaiti specimens.

Occurrence:

Known so far from the Cenomanian of South Rumaila Well-104, Kifl Well-2, and Safawi Well-1; and the Lower Cenomanian of Ghalaisan Well-1 and East Baghdad Well-3.

Sayyab (1956) found identical forms to V. streblolophata in the upper zone of the Middle Cretaceous strata of the western coast of the Arabian Gulf, and regarded them as instars of the species later described as V. maghrebensis. Grekoff (1968) recognised forms similar to V. streblolophata streblolophata from the upper part of the Cenomanian of Algeria. Glintzboeckel and Magne recorded the two "subspecies" (morphs) from the Cenomanian of East Algeria and Tunisia. Similar forms to V. streblolophata streblolophata have been reported by Colin and El-Dakkak (1975) from the Cenomanian of Jebel Nezzarat (Sinai, Egypt) as juveniles of V. jezzineensis. Rosenfeld and Raab (1974) illustrated three specimens identified as juveniles of V. jezzineensis (Pl.3, figs. 31, 32, 33) from the Lower-Upper Cenomanian of Palestine, which Al-Abdul-Razzaq and Grosdidier (1981a) identified as V.

streblolophata _streblolophata_. They are considered here to be more like the morph "_V_. _streblolophata_ _schista_". _Veeniacythereis_ _streblolophata_ was recorded by Al-Furaih (1983) from the Cenomanian Wasia Formation of Suadi Arabia.

CHAPTER - 6

VARIATIONS OF THE SIZE AND ORNAMENTATIONS OF THE OSTRACODS STUDIED

VARIATIONS OF THE SIZE AND ORNAMENTATIONS OF THE OSTRACODS STUDIED

Variations of the size of the Ostracods studied

During this study several species were found to show a considerable range in size.

These species are Peloriops (Peloriops) ulosa, Veeniacythereis ibnalhaithami sp. nov., Rehacythereis arabica, Brachycythere basrahaensis sp. nov., Archeocosta alkazwinii and Veeniacythereis maghrebensis (see systematic Chapters 4, 5).

The smaller individuals are heavily calcified and have the same ornamentation as the larger specimens. In the case of Archeocosta alkazwinii Al-Bashir and Keen (1984) where internal details could be observed the smaller specimens have a fully developed Amphidont hinge and therefore appear to be adults. This would appear to exclude the phenomenon of precocious sexual dimorphism as discussed by Spjendnaes (1951) and Whatley and Stephens (1977). The possibility of larger and smaller forms belonging to two closely related species is not acceptable because the smaller forms have similar characteristics to the larger forms in all details, apart from size. The graphs of size distribution in Figs. 6.1, 2,3,4,5,7, show the size range to be continuous rather than discontinuous with a slight clustering about a few points. The smaller and larger individuals have the same stratigraphic range and frequently occur together in the same sample. Many authors have considered the variation in the size of some species of ostracods might be due to post-muturation moulting, i.e. the occurrence of moulting in adult ostracods, such as Benson (1964), Kesling (1961) and R.C.W. in Whatley and Stephens (1977). On the other hand, Kornicker (1975) and Muller (1976) suggested there was no evidence for post-adult moulting occurring in ostracods. This is not considered to be the explanation in the cases studied here. Several possibilities can be considered to explain the size variation in the species studied:

1. The large and smaller individuals were derived from two populations living under different environmental conditions and were mixed together after death.

2. The size variation resulted from the accumulation of several generations in the same bed of sediment. This could have been related to the season in which they reached sexual maturity, factors such as temperature and feeding conditions might have led to different adult sizes.

3. The larger and smaller forms could have lived under different ecological conditions which could have affected their size.

4. Changes in temperature and food supply could have led to variation in size.

5. The variation within adults of a species may be a specific character, i.e. the species has a large size range which is the result of the genetic composition of the populations.

<u>Hypotheses given by other authors</u>. Reyment (1978) observed size differences within samples in his study of Cretaceous ostracods from Morocco and suggested that the cause is a mixture of specimens coming from different environments and mixed together after death. McKenzie (personal communication in Bless and Pollard, 1975, p.112) states that "the size range in recent dimorphic fresh water ostracods which he studied, do not or only slightly overlap, if the specimens are collected alive. But when dealing with fossils size overlaps are common because several generations may be preserved in the same layer of sediment". Whatley in Bless and Pollard (1975, p.123-124) stated: "Dr. Wall and I have observed a number of marine and fresh water species which exhibit in the adult stage noticeable changes in size and or shape depending upon at which time of the year the adults reach maturity. For example if within the same species certain individuals winter as adults, others as

instars and yet others as eggs, when spring temperatures become sufficiently elevated for development to begin again, the three, which are essentially distinct, races of the population, will each go its appropriate life cycle without being caught up or cathcing up with each other. We believe this to be responsible for observable seasonal differences in shape and size in Cythere lutea perhaps Heterocythereis albomaculata".

Several authors ascribe differences in valve size to differences in water temperature (Elofson, 1941, 1969; Pokorny, 1966; Ishizaki, 1975). Morkhoven (1962) pointed out that only the size of the ostracod is affected by differences in temperature; the rate of growth in ostracods is related to the temperature, so increased temperature accelerates the growth rate, and the length of time taken in ontogenetic development from egg to maturity may be decreased by 50% at relatively warm temperature. Moore (1958) pointed out that large size indicated long continuous growth because while the growth rate is accelerated at high temperature, it is reduced at low temperature and the latter may result in a decrease in available food in winter.

Kesling (1953), Howe (in Szczechura, 1971) and Morkhoven (1962) indicated that the quantity and quality of food supply is related to seasonal differences and this may be the major controlling factor affecting the size of ostracods. Rome (1947 in Kesling, 1953) indicated that some parasites of ostracods cause inflation in the adult ostracod, and others may change the dimensions of the ostracod host when the infestation happens before the last molt. Elofson (1941, 1969) in his studies on the Skagerrak ostracods indicated the relationship between length of body and type of substrate. Krutak (1972) studied the relationship between the grain size of the substrate and the carapace size in brackish water ostracods and observed that certain important structural features of the valves such as size (length, height, width) are influenced by the grain size of the sediments. Benson (1972, 1975), Morkhoven

(1972) and Peypouquet (1977) noted increasing depth of water as a factor in increasing size of ostracods.

Ishizaki (1975) explained that differences in valve size may be due to zoogeographical variation between the Japan sea and Pacific sides of Japan, rather than the type of explanations referred to above.

Reyment (1978) suggested that salinity variation can often cause changes in the size and shape of the ostracod carapace and suggested that continuous size variation is more likely to be influenced by regional environmental fluctuations.

Peypouquet (1977) believed that the increase in dissolved organic matter caused an increase in dissolved nutrients, which resulted in a larger sized ostracod.

No firm conclusions have been reached because the size variation of these fossil specimens is probably caused by one or more of the factors mentioned, so it is difficult to determine whether the size variation is due to environmental or genetic causes.

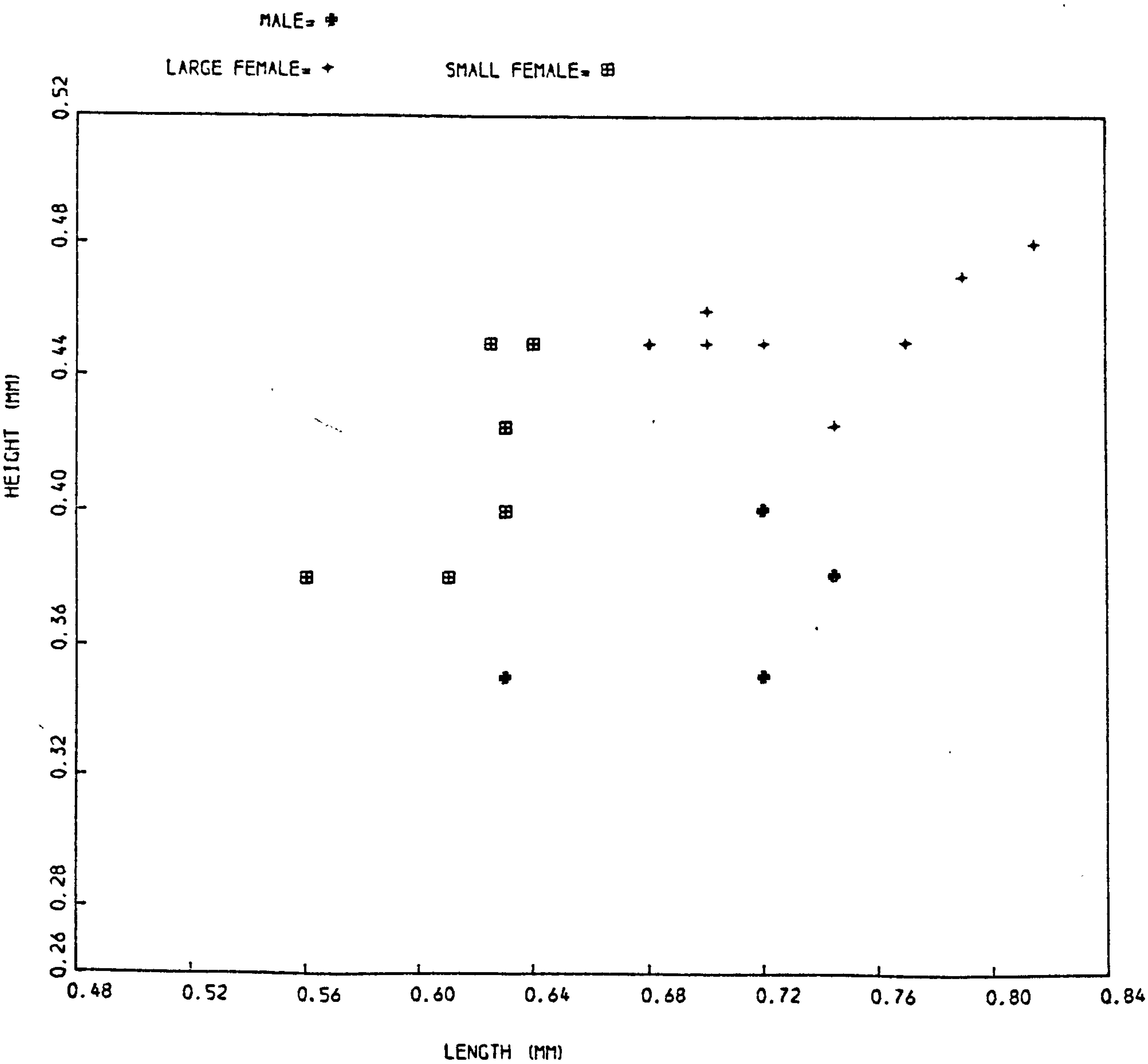


FIG. 6.1 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF BRACHYCYTHERE BASRAHAENSIS SP.NOV.

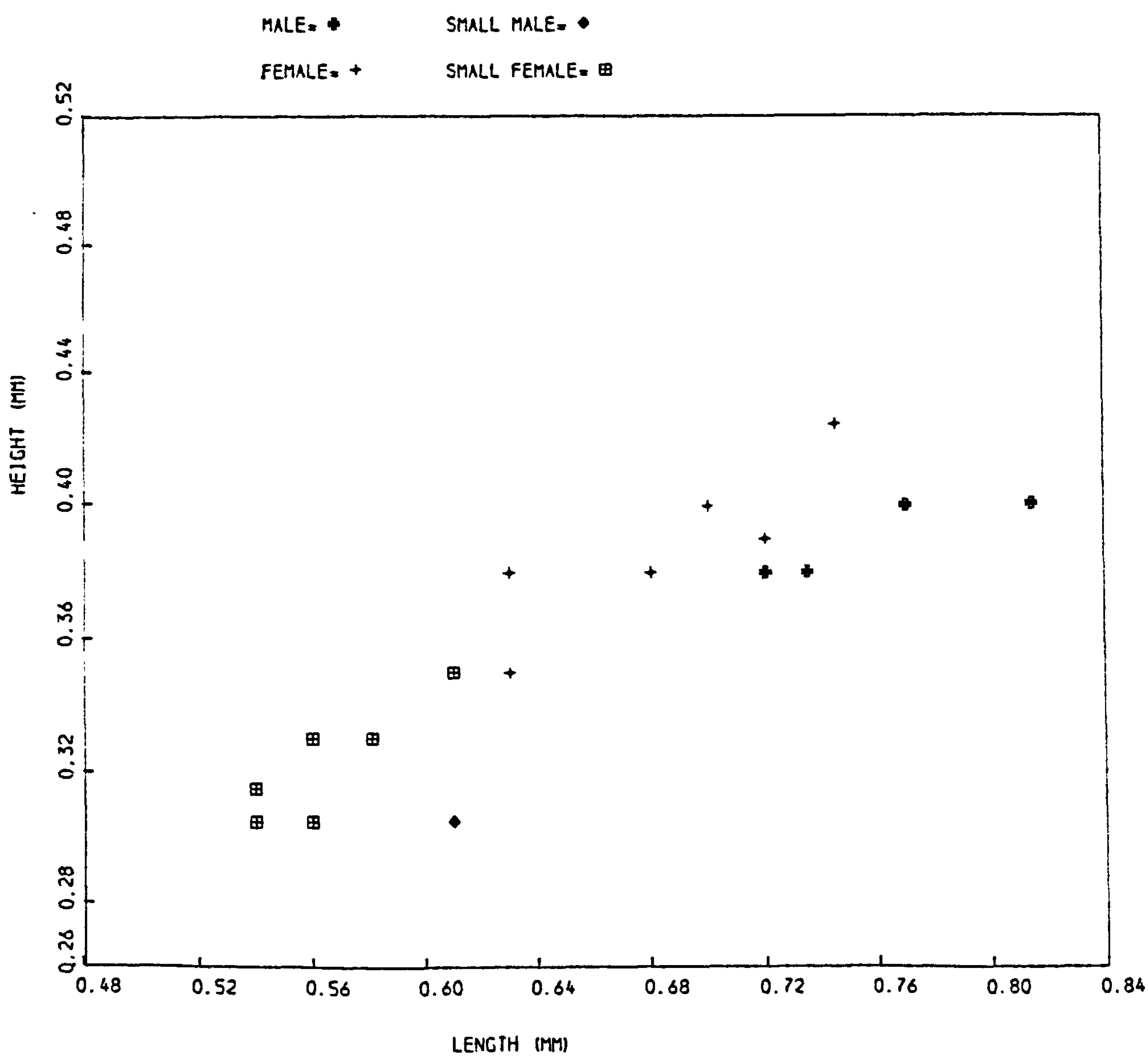


FIG. 6.2 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF PELORIOPS (PELORIOPS) ULOSA AL-ABDUL-RAZZAQ (1979).

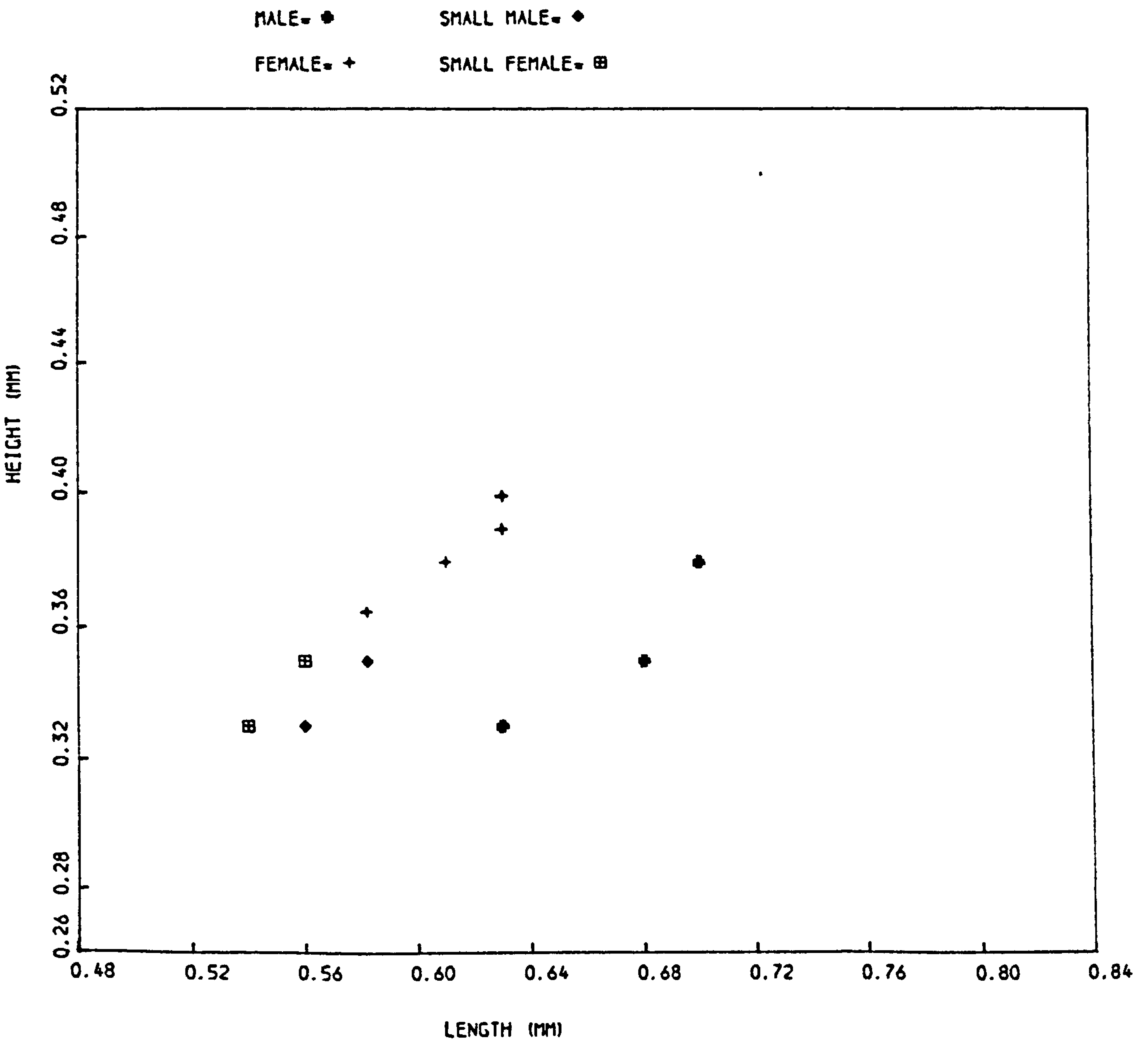


FIG. 6.3 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF *REHACYTHEREIS ARABICA* AL-FURAIH(1983).

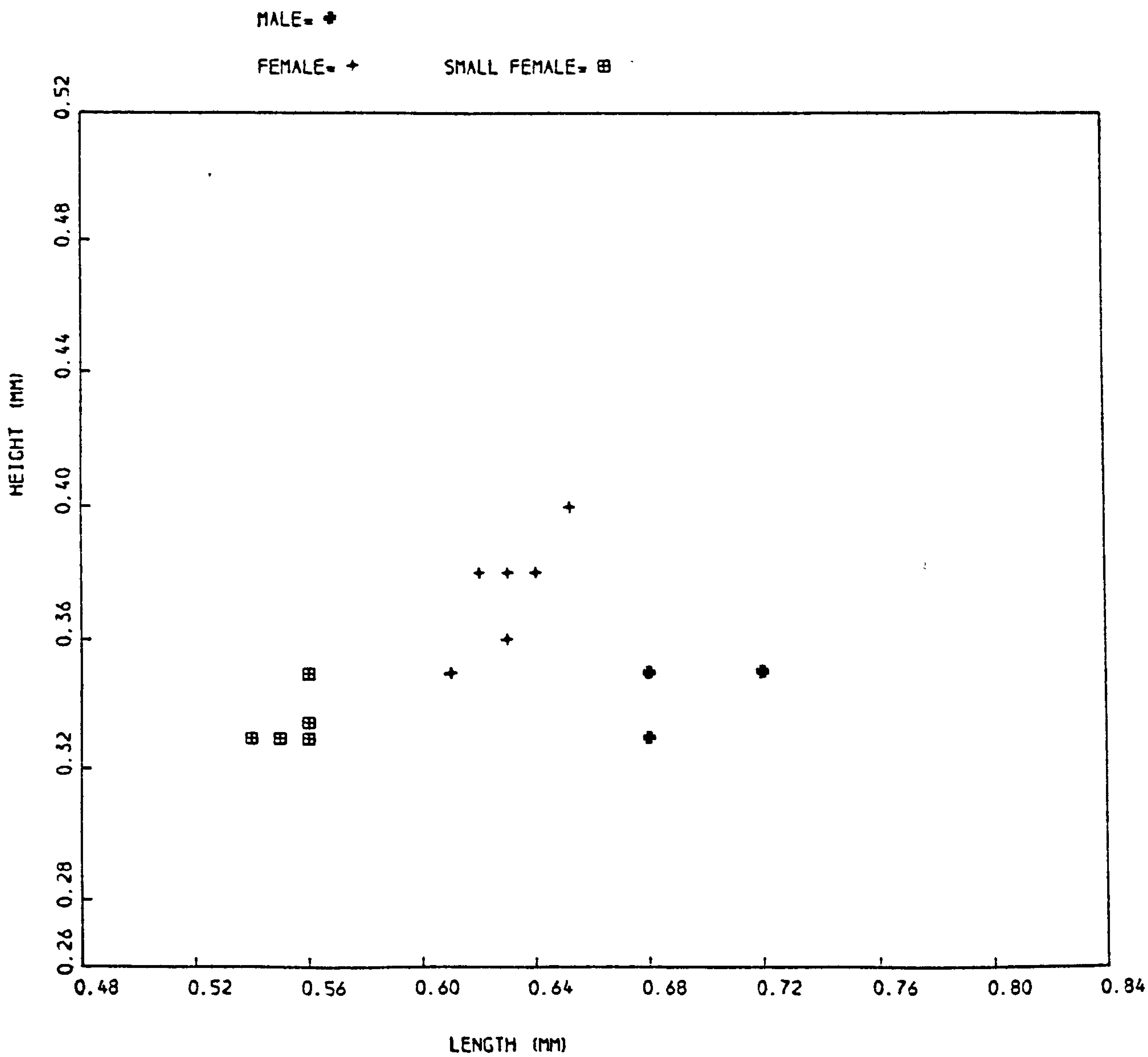


FIG. 6.4 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF VEENIACYTHEREIS IBNALHAITHAMI SP.NOV.

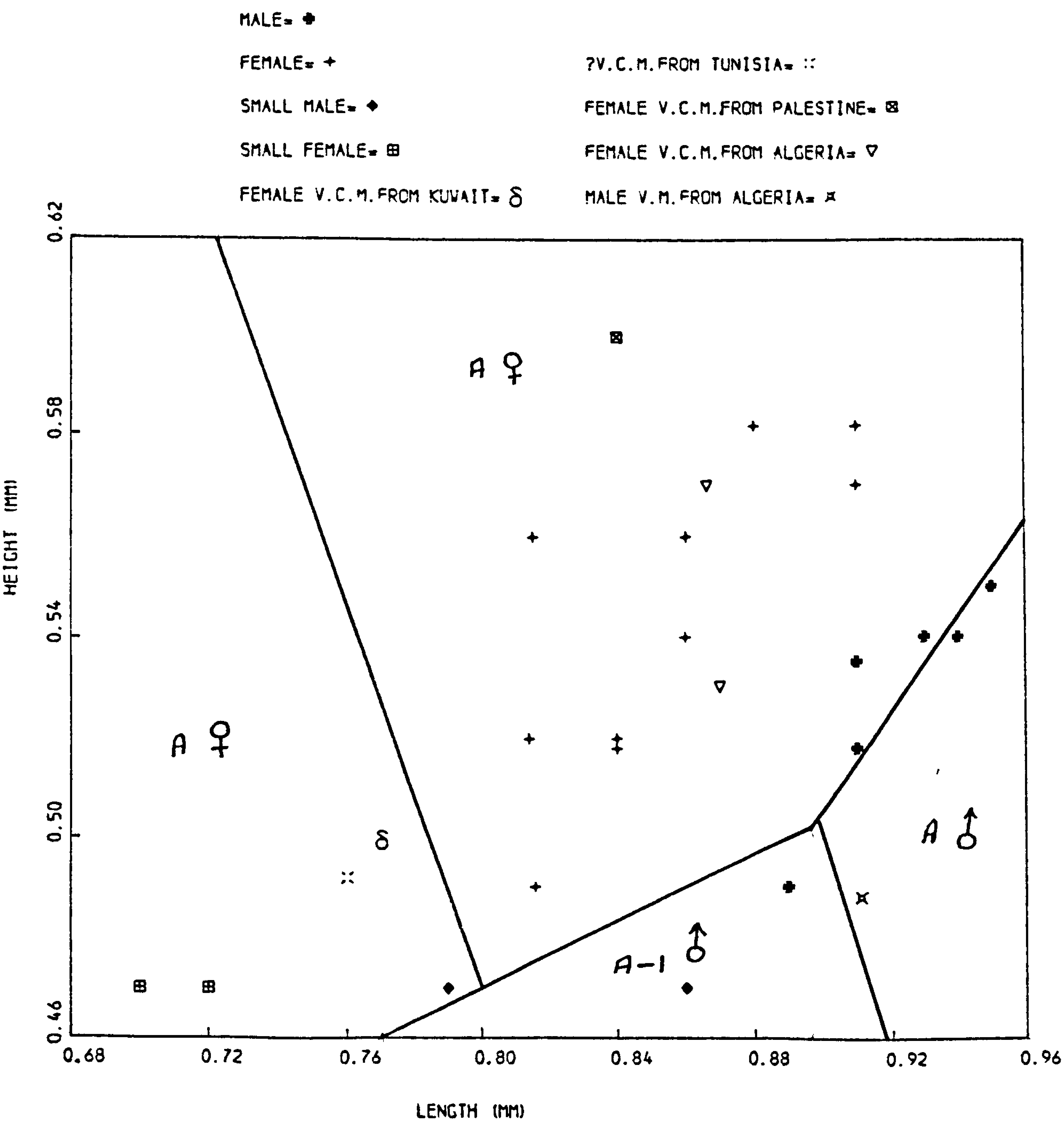


FIG. 6.5 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF VEENIACYTHEREIS MAGHREBENSIS (BASSOULLET AND DAMOTTE, 1969) FROM IRAQ AND MIDDLE EAST AREAS WITHIN ROSENFELD AND RAABS ADULT AND JUVENILE FIELDS OF VEENIACYTHEREIS JEZZINEENSIS (BISCHOFF).

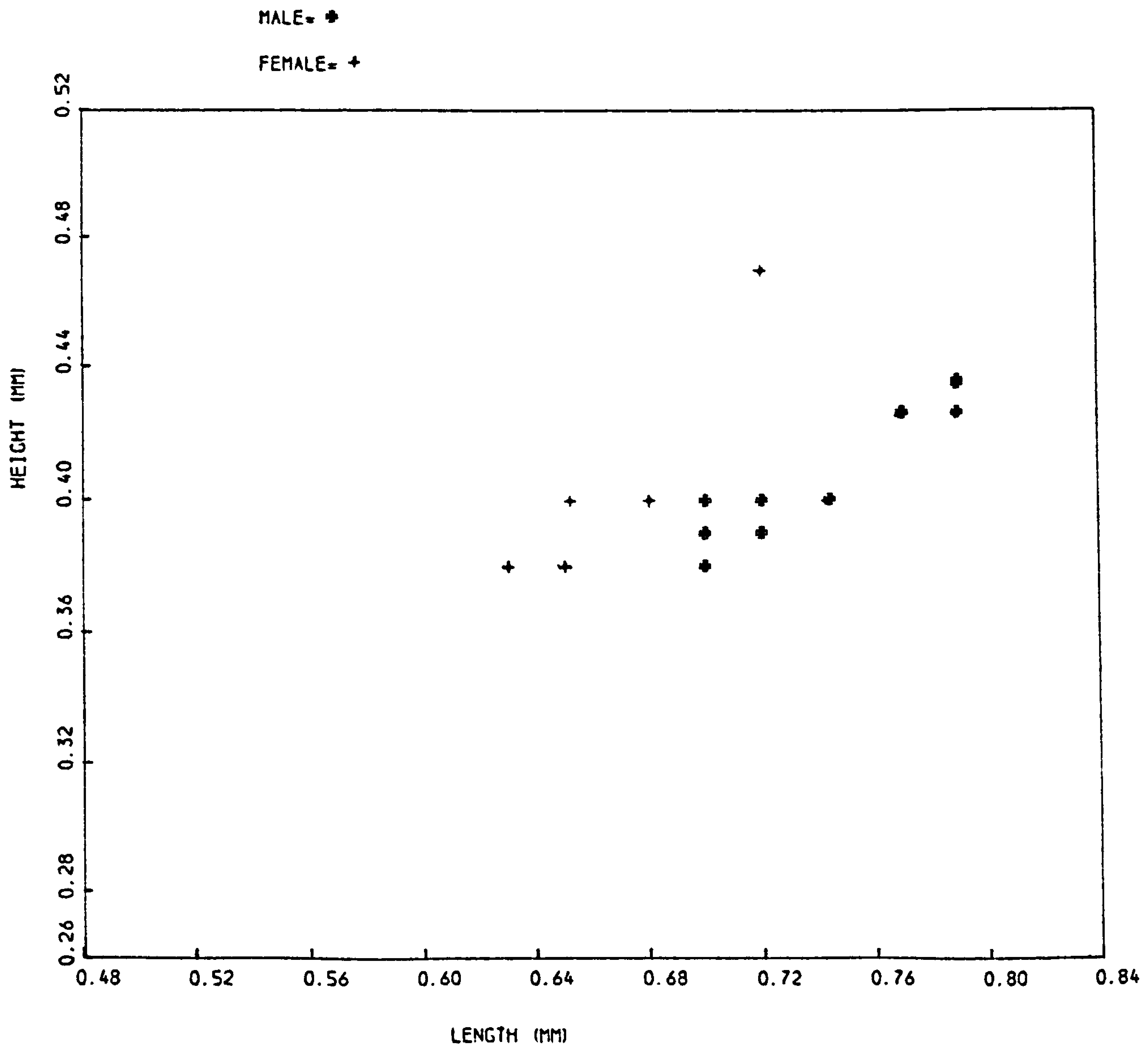


FIG. 6.6 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF VEENIACYTHEREIS STREBLOLOPHATA (AL-ABDUL-RAZZAQ AND GROSDIDIER, 1981).

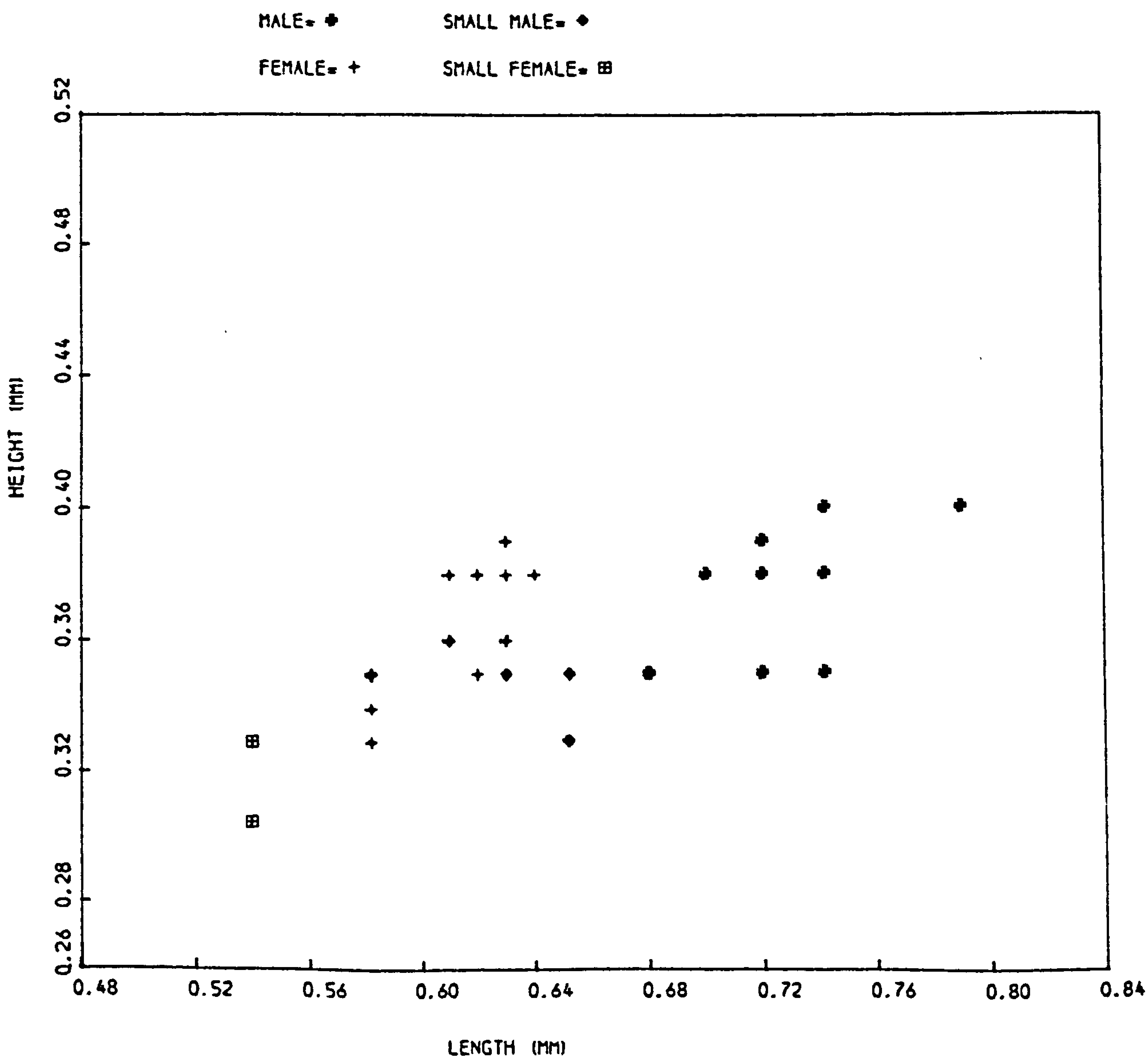


FIG. 6.7 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF ARCHEOCOSTA ALKAZVINII AL-BASHIR AND KEEN (1984).

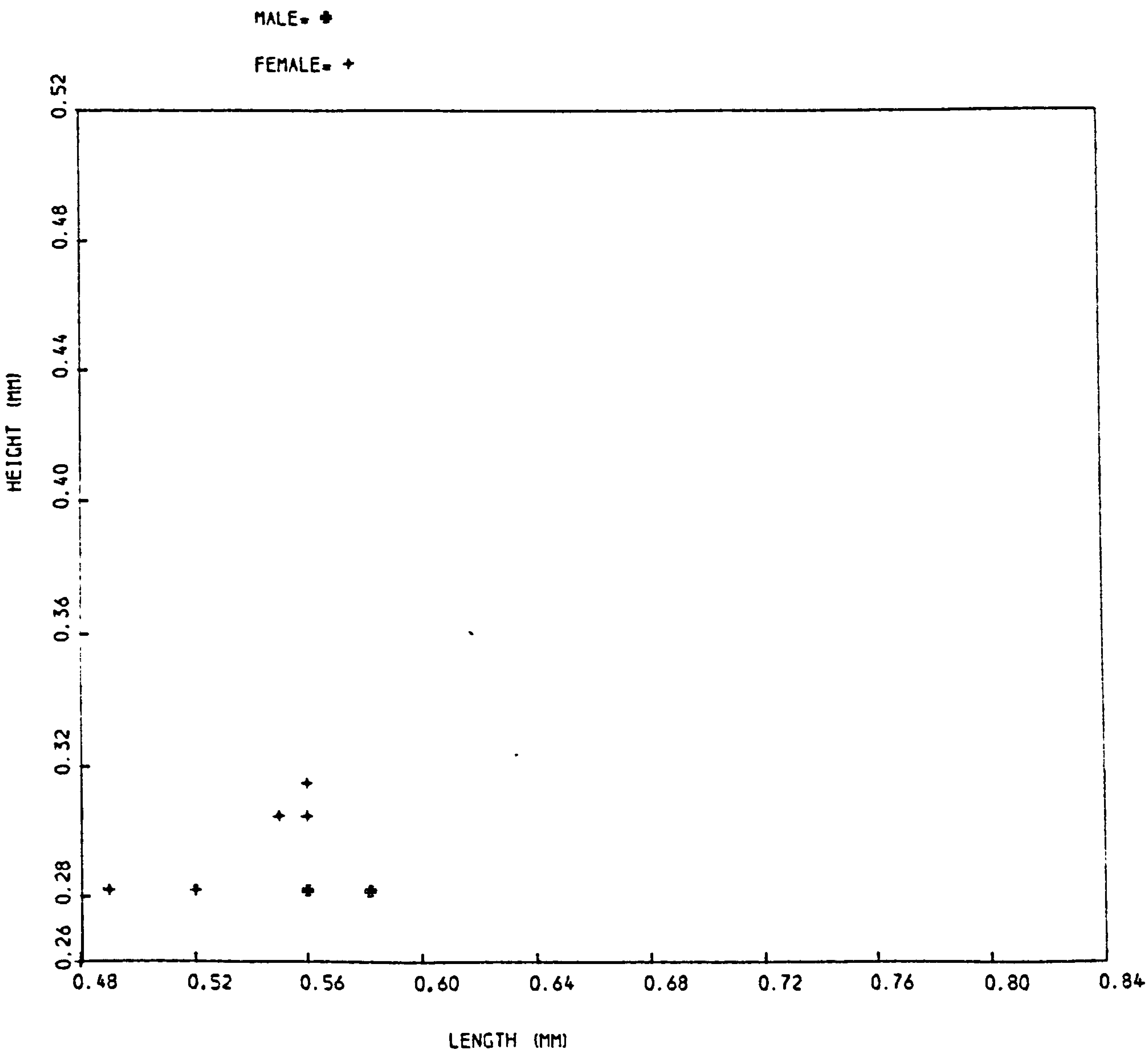


FIG. 6.8 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF METACYTHEROPTERON BERBERICUS (BASSOULLET AND DAMOTTE, 1969).

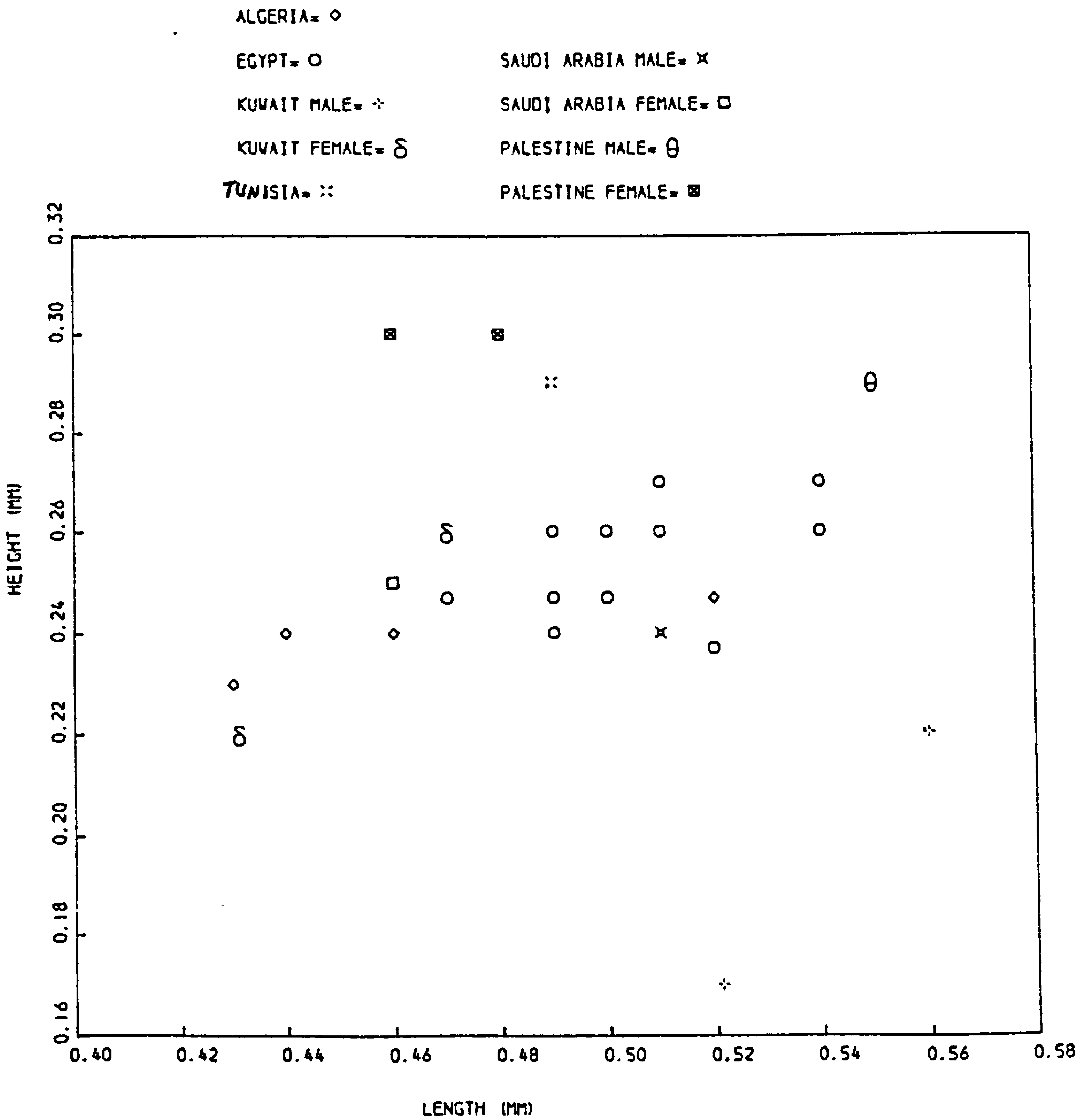


FIG. 6.9 - SCATTERGRAM FOR LENGTH AND HEIGHT IN THE SPECIES OF METACYTHEROPTERON BERBERICUS (BASSOULLET AND DAMOTTE, 1969) IN THE MIDDLE EAST AREAS.

Variations of the ornamentation of the Ostracods studied

Several species in this study show considerable intra-specific variation in ornamentation: Iraqicythereis kadisiya gen. et sp. nov., Veeniacythereis ibnalhaithami sp. nov., Cythereis ? ibnyunusi sp. nov., Peloriops (P.) sphaerommata, Peloriops (Hemipeloriops) djabirbnhaiyani sp. nov. and Metacytheropteron berbericus.

1. Iraqicythereis kadisiya. gen. et sp. nov.

This species shows considerable intraspecific ornamental variation, which can be interpreted as being due to the presence of morphotypes. Five morphotypes can be identified: Morphotype No. 1 characterized by a strongly developed macroreticulation with secondary ornamentation and reticulation within the macroreticulation; Morphotype No. 2 with a weak ornamentation where the macroreticulation is virtually absent in places; Morphotype No. 3 with a more pronounced subcentral, thicker ventral ridge and stellate macroreticulation; Morphotype No. 4 with very strong reticulation making the longitudinal ridges, marginal rim and subcentral tubercle less distinct, and with a different shape of macroreticulation: Morphotype No. 5 has a smooth surface and ill-defined subcentral tubercle and less pronounced nodes on the dorsal and ventral ridges (for further details see the systematic chapter). These morphotypes seem to represent a stage of stable polymorphism. Polymorphism is defined as "the occurrence together in the same habitat at the same time of two or more distinct forms of a species in such proportions that the rarest of them cannot be maintained merely by recurrent mutation" (E.B. Ford in Sheppard, 1967). The morphotypes are believed to be genetically controlled. Stable polymorphism results when there are opposing selective forces operating which ensure that two or more allomorphs of one gene are maintained in a population. The polymorphism is not likely to result from environmental variation. It would be necessary for there to be two distinct types of environment present at the same place and at the same time for a polymorphism to result and this is an unlikely situation. The relationship between environmental factors and ornamental variation are not obviously correlated in the case of this species. It can be observed that the strongly ornamented and smooth morphotypes are found together in the same sample at the same time and presumably under the same environmental conditions, suggesting that these variants are genetically controlled.

The problem of intraspecific variation has been discussed by several other authors. Keen (1982) suggested that the intraspecific variation observed within the species of the Tertiary genus Cytheretta, are genetic and Keen (1976, 1982) indicated that species of Hammatocythere show a great variation considered as a case of polymorphism, and he suggested that the morphotypes are genotypic.

Peypouquet (1977) considered that many ornamental variations are principally associated with changes in the ionic concentration of Ca and Mg, when it increased the activity of the epidermal cells responsible for the construction of the carapace causing an increase in ornamentation. He proposed that the appearance of spines in Agrenocythere is related to the increasing concentration of Mg^{++}, and the lack of spines is correlated with increasing Ca^{++}.

Ohmert (1971) and Omatsola in Ohmert (1971) believed decreasing strength of reticulation is dependent upon several ecological factors related to depth, such as energy level and type of sub strate. Keen (1982) pointed out that some species of Echinocythereis are more reticulate, but that others are more papillose and he suggested that these characters are related to the chemistry of the water in which the animal lives.

2. Cythereis ? ibnyunusi sp. nov.

This species shows distinct variation with three variants regarded as morphs:strongly reticulate forms, mainly smooth forms, and intermediate forms. These morphs may occur together, suggesting a genotypic cause with no clear correlation with environment.

Reyment (1978) observed a similar type of variation which grades from macroreticulation to a smooth surface in the species of Oertliella from the Upper Cretaceous of Morocco and he regarded this variation as an example of polymorphism considered to be genetic, but unlikely to be due to environmental conditions. The variation from reticulate to smooth surface seen in this species has been observed in other ostracode species by several authors who gave different explanations for the variation. Gerald (1983) concluded that the ornamentation on the surface of the carapace of Cytheracean ostracods developed by a process of "excavation" of the valve surface and the intraspecific variation was a result of different degrees of excavation of cuticle before calcification. The type of surface ornamentation was accounted for by the time of calcification relative to the beginning of ecdysis. He observed an ornamental variation with individuals of the instars stage A-1 of Hermanites hadropleura Hazel, the variation ranging from smooth to totally reticulate. The smooth forms bears "Proto fossae" areas, these areas contain surface microreticulation which is modified by "excavation" processes (probably by enzymatic activity) to create large and coalescing pits and finally fossae; these areas may reflect areas of division in the underlying epidermal cells. This "excavation" process starts after ecdysis and continues with development of reticulation and eventually stops when calcification begins.

The "excavation" process of Gerald is opposite to that of Liebau (1977) who suggested that reticulate species may lose the reticulation when the macroreticulation is reduced or replaced by a microreticulation; the latter is related to a thinning in degree of calcification, finally leading to fine pitting or even a smooth surface. He pointed out that there are two types of smoothing, one of them resulting from extreme microreticulation and the other by direct replacement from macroreticulation. Liebau's explanation is less likely because so many ostracode species have a thick calcified carapace with a smooth or microreticulate surface, and as Liebau mentioned, the microreticulation and smoothing are not always related to a thinning of the shell layer, and it is probable that a single layer of the shell is responsible for its development and other layers supply the shell thickness (Liebau, 1977).

3. *Veeniacythereis ibnalhaithami* sp. nov.

This species shows intraspecific variations from mainly smooth to partly reticulated and the anterior and posterior marginal spines vary from prominent to weak. The nodes of the median ridge vary; in some specimens these are poorly developed, so the ridge appears as thick and slightly sinuous, but in others the nodes are well developed (see systematic chapter). These variations seem to be continuous because it is difficult to separate them into morphotypes. The variation is probably due to genetic causes rather than environmental because specimens with variable development of nodes of the median ridge, the smooth forms and the partly reticulate forms are found in the same environmental conditions, i.e. open marine neritic conditions of the Tanuma and Khasib Formation.

4. *Peloriops* (*Peloriops*) *sphaerommata* Al-Abdul-Razzaq, 1979a.

This species has both macroreticulation and microreticulation. The macroreticulation varies in strength between specimens, and the strength of development and number of the tubercles on the lateral surface are also variable. These variations are considered to be continuous because it is difficult to recognise distinct morphotypes. The variation is probably of genetic origin because it can be observed in samples from the same formation where individuals probably lived under similar conditions and the same variation is also observed in collections coming from different formations (i.e. Mishrif and Rumaila Formations) and probably representing different environments.

5. <u>Peloriops</u> (<u>Hemipeloriops</u>) <u>djabirbnhaiyani</u> sp. nov.

The degree of development of the macro and micro-reticulation in this species differs from specimen to specimen, especially in the antero-marginal, postero-marginal and antero-median areas. This difference is probably genetic because it is observed in specimens found in the same sample and presumably living under the same environmental conditions as well as in the samples representing different conditions.

6. <u>Metacytheropteron</u> <u>berbericus</u>
(Bassoullet and Damotte, 1969)

This species shows considerable variation in the degree and development of longitudinal ridges, in shape of the posterior margin and in the appearance and development of a smooth area in the antero-dorsal region. These variations are continuous and could be genetic or associated with some environmental factors.

CHAPTER - 7

BIOSTRATIGRAPHY

BIOSTRATIGRAPHY

Ostracod Biozones:

The samples studied came from well cuttings, so difficulties arise in determining the stratigraphical range of species, especially when only a few specimens are found. In general only the highest occurrence of a species in a well can be considered with any confidence as all lower records may be due to contamination. These problems can be minimised by considering the general state of preservation of a particular faunal assemblage, when contaminants often have a different appearance, and by considering the general distribution of a species in each well and by comparison of its stratigraphic range in the surrounding area if it has a wide spread distribution.

In the summary diagram (fig. 7.1) where definite contamination is considered likely species ranges are indicated by dotted lines, where the species is rare the range is indicated by dashed lines, where the species is rare but whether or not due to contamination, the range is indicated by lines of small pluses, and the definite range is indicated by a solid line.

Individual samples are marked by a large single dot. The distribution of species when zones or subzones are undifferentiated is marked by a cross.

Four biozones have been recognised in Iraq in this study, one of which is divided into three subzones. The age of these zones and subzones is determined by the ranges of ostracode species, the ranges of contemporaneous fossils (foraminifers, molluscs ... etc.).

1. Veeniacythereis streblolophata - Veeniacythereis maghrebensis - Total Range Zone (A-1)

Rosenfeld and Raab (1974) defined this zone in Palestine as Veeniacythereis jezzineensis Acme Zone.

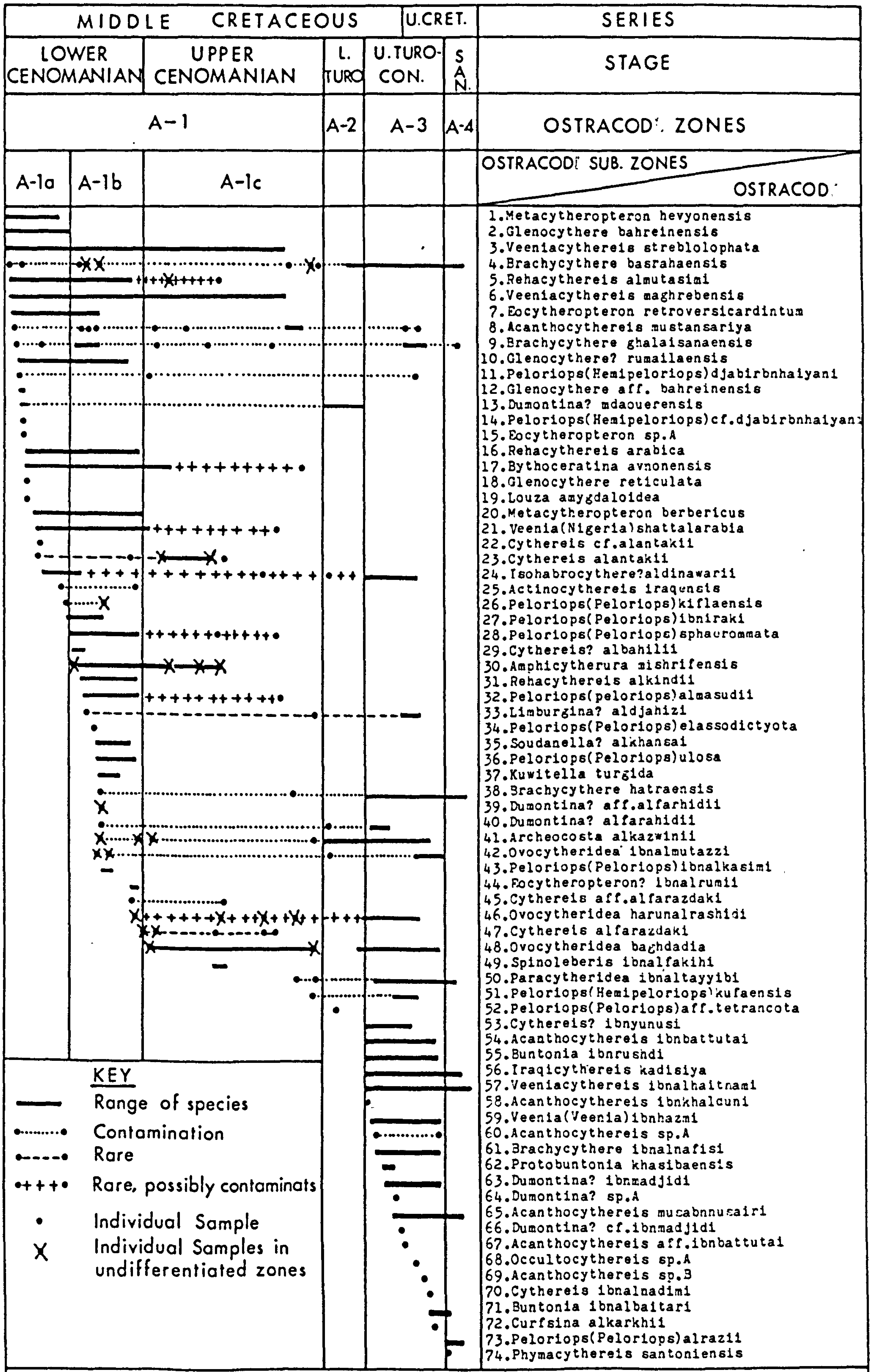


Figure 7·1 The Biozones, subzones and stratigraphic range of Cenomanian — Santonian Ostracode species in Iraq.

In this present work, this zone is recognised by the total range of _Veeniacythereis streblolophata_ and _Veeniacythereis maghrebensis_ which are distinct and abundant in this zone. A Cenomanian age is proposed for this zone on the basis of the ranges of those two species which are also recorded from the Cenomanian of Palestine, Arabian Gulf and Egypt, and the stratigraphic position. Rosenfeld and Raab (1974) also suggested a Cenomanian age for this zone.

This zone is subdivided into three subzones: _Glenocythere bahreinensis_, _Soudanella? alkhansai_, and _Cythereis alfarazdaki_. Sayyab (1956, unpublished work) found this zone in the Middle Cretaceous strata of the Arabian Gulf Coast, referring to it as the _Cythereis arabica_ zone, and suggested a Cenomanian age.

A - _Glenocythere bahreinensis - Total Range Subzone_ (A-1a)

This subzone was established as the _Glenocythere bahreinensis_ Assemblage Zone by Al-Abdul-Razzaq (M.S., 1977; 1983). It is defined and characterised in Iraq and Kuwait by the total range of _Glenocythere bahreinensis_; _Louza amygdaloidea_ is restricted to this subzone in Iraq and Kuwait. _Metacytheropteron hevyonensis_ is restricted to this subzone in Iraq, but is not recorded from Kuwait. The single specimen of _Glenocythere reticulata_ found in this study has been found in this subzone in Iraq, but is mainly found in the succeeding zone in Kuwait where it is regarded as a characteristic species by Al-Abdul-Razzaq.

Several new species from Iraq are also restricted to this subzone, but not recorded elsewhere _Glenocythere_ aff. _bahreinensis_, _Eocytheropteron_ sp. A, _Peloriops_ (_Hemipeloriops_) cf. _djabirbnhaiyani_, _Cythereis_ cf. _alantakii_. Other species are found in this subzone but not restricted to it, ranging into higher zones and subzones: _Veeniacythereis streblolophata_ _Veeniacythereis maghrebensis_, _Metacytheropteron bergericus_, _Eocytheropteron retroversicardinatum_, _Bythoceratina avnonensis_, _Rehacythereis arabica_, _Rehacythereis almutasimi_, _Glenocythere? rumailaensis_, _Veenia_ (_Nigeria_) _shattalarabia_, and Peloriops (Peloriops) ibniraki. The following 6 species are almost certainly contaminants: Brachycythere basrahaensis, Acanthocythereis mustansariya, Dumontina? mdaouerensis, Brachycythere ghalaisanaensis, Peloriops (Peloriops) kiflaensis, Peloriops (Hemipeloriops) djabirbnhaiyani. Cythereis alantakii is also very rare. Actinocythereis iraqensis is certainly a contaminant because it was described from the Middle Miocene of Iraq (Khalaf, 1982). The presence of Isohabrocythere ? aldinawarii in this subzone is probably due to contamination.

Age:

Owen and Nasr (1958) (as reported by Dunnington et al., 1959) and Sayyab (1956, M.S.) referred to Glenocythere bahreinensis as "Cythereis bahreini" and considered it to be the characteristic species of the marly limestone unit at the base of the Ahmadi Formation often called the "Cythereis bahreini limestone" in its type section of South eastern Kuwait. Al-Abdul-Razzaq (M.S.,1977; 1979b) described the new species as belonging to a new genus, Glenocythere bahreinensis. Al-Abdul-Razzaq (1977, M.S.; 1983) considered this sub zone to be of basal Cenomanian age, i.e. she recognised 2 zones in the Early Cenomanian of which Glenocythere bahreinensis is the older. She indicated that the palaontologists in the Kuwait Oil Company regarded Glenocythere bahreinensis as being of Cenomanian age. There is some conflict concerning the Cenomanian age of the Ahmadi Formation. Sayyab (1956, M.S.) regarded this subzone from the Cretaceous of the Western Coast of the Arabian Gulf as Albian in age; however more recent palaontological evidence (see Al-Abdul-Razzaq, 1983) suggests a Lower Cenomanian age as more likely. In Iraq 5 species (Glenocythere bahreinensis, Veeniacythereis streblolophata, Veeniacythereis maghrebensis, Rehacythereis almutasimi, Eocytheropteron retroversicardinatum) normally regarded as characteristic Cenomanian species are found in the highest part of the Mauddud Formation. This Formation has been regarded as Upper Albian by Loutfi and Jaber (1970) and as Albian by Al-Naqib (1967), Dunnington et al. (1959), Buday (1980), and Sugden (1958, M.S. as reported by

Dunnington et al., 1959) on the evidence of the fossil content. On the other hand it was considered to be Cenomanian by Owen and Nasr (1958) and Al-Siddiki (1978), based on the ranges of micro fossils, correlation, and stratigraphic position. Smouth (1956) concurred with the idea of a Cenomanian age for the Mauddud Formation although he accepted the possibility of an Albian age. On the basis of the ostracods at least the upper part of the Mauddud Formation seems more likely to be basal Cenomanian. However, Albian ostracods have not been described from Iraq so there is obviously some uncertainty here. Also the occurrence of the five species mentioned above may be due to well contamination, and so the age of the upper part of the Mauddud Formation would be still uncertain. Grosdidier (1973) also recorded Clenocythere bahreinensis from the Albian Kazhdumi-Nahr umr Formation and lower part of the Cenomanian Sarvak Formation (Mauddud member) of Iran. Athersuch (personal commun.) found this species in rocks regarded as ? Aptian to middle Cenomanian of Oman; Al-Furaih (1983) recorded this species from the Cenomanian Wasia Formation of Saudi Arabia. Al-Abdul-Razzaq (1977, M.S.) described Louza amygdaloidea as a new species, belonging to a new genus Louza M.S., which she considered to be a characteristic species of this subzone in Kuwait. She pointed out that, after Jaber (1965) this species is important in the Lower Ahmadi Limestone Member where it has been recorded as Brachycythere sp. by palaentologists of the Kuwait Oil Company; it is so characteristic that the upper part of the Lower Ahmadi Limestone Member is referred to as the "Brachycythere Lst". In her most recent published paper (1983) Al-Abdul-Razzaq refers to Louza amygdaloidea as Brachycythere n. sp. This species is recorded from the lower zone of the "Middle Cretaceous Albian" of Sayyab of the Arabian Gulf by Sayyab (op.cit.), it occurs in the middle part of the Cenomanian of Oman according to Athersuch (personal commun.) and Albian-Lower Cenomanian of the Coastal Fars Province in Iran by Grosdidier (1973). Metacytheropteron hevyonensis was originally described from Palestine as Neocythere? N. hevyonensis by Rosenfeld (reported in Rosenfeld and Raab, 1974). Rosenfeld and Raab recorded it as being restricted to Lower Cenomanian; Athersuch (personal commun.) found this species in the basal part of the lower Cenomanian of Oman and it is recorded by Grosdidier (1973) from the Albian of Iran.

Al-Abdul-Razzaq (op.cit.) described Glenocythere reticulata as being a characteristic species restricted to the upper zone of the Lower Ahmadi Limestone Member in Kuwait; it was described from the lower zone of the Middle Cretaceous of the Arabian Gulf Coast by Sayyab (op. cit.) who assigned an Albian age to it; it is found in the Albian-Middle Cenomanian of the Coastal Fars Province of Iran (Grosdidier, 1973) as well as in the ? Aptian to lower part of the Cenomanian of Oman (Athersuch, personal commun.). Eocytheropteron retroversicardinatum was described from the Lower Ahmadi Limestone Member of Kuwait where Al-Abdul-Razzaq described the specimen in the basal zone as having a larger left valve (i.e. normal valve overlap) while specimens from the upper zone show reversed valve overlap. Specimens from Iraq, however, show both types of valve overlap having the same stratigraphic range. Sayyab recorded this species from the "Albian" and Cenomanian of the Arabian Gulf. Al-Furaih (1983) described Rehacythereis arabica from the Cenomanian of Saudi Arabia which had been earlier recorded from the upper zone of the Middle Cretaceous of the Arabian Gulf by Sayyab (1956, M.S.) who also suggested a Cenomanian age.

On the evidence of the ranges of the characteristic and important ostracod species restricted to this subzone, the stratigraphic position and other palaeontological evidence, Al-Abdul-Razzaq (1983) considered this subzone to be of basal Cenomanian age, a conclusion supported by this study.

Occurrence:

This subzone is found in the uppermost Mauddud Formaiton and the lower part of the Ahmadi Formation in Safawi Well-1, South Rumaila Well-104, and Ghalaisan Well-1; in the uppermost Mauddud and lower part of the Rumaila

Formation in East Baghdad Well-3; and in the uppermost Mauddud Formation of Kifl Well-2.

B - Soudanella? alkhansai - Assemblage Subzone (A-1b)

This subzone is named after Soudanella? alkhansai which is rather unsatisfactory because it is only found in the single well South Rumaila Well-104, but no species restricted to this subzone in Iraq are recorded from more than one well. The only other species which could have been used as the nominate species is Kuwaitella turgida which is found in strata of equivalent age in Kuwait, it is also only recorded in one well in Iraq, but this species described by Al-Abdul-Razzaq in her thesis (1977) has not been published yet, so it is undesirable to use this at the present time. This subzone has a rich and characteristic fauna in South Rumaila Well-104 which is taken as the reference section. Elsewhere the subzone is more difficult to define. In South Rumaila Well-104, the lower boundary of the subzone corresponds to the first appearance of Peloriops (Peloriops) sphaerommata. This species ranges into the younger subzone A-1c in this well only.

Species which are restricted to this subzone and first appear close to the base of the subzone in South Rumaila Well-104 are:
Peloriops (Peloriops) ulosa, Peloriops (Peloriops) elassodictyota; Rehacythereis alkindii, Soudanella? alkhansai, Kuwaitella turgida, Peloriops (Peloriops) ibnalkasimi. These species are not found in the other studied wells in Iraq and most of them are newly described and not recorded in nearby areas. In Ghalaisan Well-1 three species make their first appearance at the base of the subzone and are restricted to it:
Cythereis? albahilii, Amphicytherura mishrifensis. Eocytheropteron? ibnalrumii appears at the top of this subzone and also restricted to it in South Rumaila Well-104. Other ostracode species which occur in this subzone but are also recorded from the underlying or/and overlying zones and subzones are: Peloriops (Peloriops) almasudii, Veeniacythereis streblolophata, Veeniacythereis

maghrebensis, Rehacythereis almutasimi, Eocytheropteron, retroversicardinatum, Glenocythere? rumailensis. Veenia (Nigeria) shattalarabia, Bythoceratina avnonensis, Rehacythereis arabica, Peloriops (Peloriops) ibniraki, Metacytheropteron berbericus and Amphicytherura mishrifensis. Peloriops (Peloriops) almasudii first appears close to the base of this subzone. The occurence of the Miocene species Actinocythereis iraqensis in this subzone is due to contamination. The following species are found in this subzone but their occurrence is certainly due to contamination and caving of the well samples from higher strata: Brachycythere basrahaensis, Acanthocythereis mustansariya, Cythereis aff. alfarazdaki, Brachycythere hatraensis. The presence of Isohabrocythere? aldinawarii is probably due to contamination. Cythereis alantakii, Limburgina? aldjahizi and Brachycythere ghalaisanaensis are found as rare specimens in this subzone; the latter is certainly a contaminant because it is restricted to the Santonian in Iran where Grosdidier considered it to be a characteristic species for the Santonian.

Age:

Peloriops (Peloriops) sphaerommata was reported by Sayyab (1956, M.S.) from the upper zone of the Middle Cretaceous of the Arabian Gulf Coast which he suggested to be Cenomanian; it is present in the Cenomanian rocks of Palestine (Rosenfeld and Raab, 1974) and of Kuwait (Al-Abdul-Razzaq, 1979a); the Lower Cenomanian - lowest part of the Upper Cenomanian of Tunisia (Bismuth et al., 1981a); the lower Cenomanian of Oman (Athersuch, personal commun.); and Glintzboeckel and Magne (1959) found forms questionably synonymous with this species in the Vraconian-Cenomanian of Tunisia and East Algeria. Peloriops (P.)ulosa occurs in the Cenomanian of Kuwait (Al-Abdul-Razzaq, 1977, M.S; 1979a), Albian of Iran (Grosdidier, 1973), and uppermost Aptian ? - Cenomanian (Athersuch, personal commun.).

Peloriops (Peloriops) elassodictyota is known from the Cenomanian and ? Turonian of Kuwait (Al-Abdul-Razzaq, 1979a; 1977, M.S.). Soudanella? alkhansai was reported from the

Cenomanian upper zone of the Middle Cretaceous strata of the Arabian Gulf by Sayyab (1956, M.S.).
Kuwaitella turgida was originally described by Al-Abdul-Razzaq (1977, M.S.) from the upper zone of the Lower Ahmadi Limestone Member, indicating that it is restricted to the Lower Cenomanian; Sayyab (1956, M.S.) reported it from the "Albian" lower zone of the Middle Cretaceous of the Arabian Gulf Coast. Eocytheropteron? ibnalrumii is recorded from the middle part of the Cenomanian of Oman (Athersuch, personal commun.). Al-Abdul-Razzaq (1977, M.S.) described Amphicytherura mishrifensis from the Mishrif Formation of Kuwait which she questionably dated as Turonian, she also found deformed specimens of this species in the Ahmadi Formation of Cenomanian age in northern Kuwait; it first appears in A-1b subzone and probably has a long stratigraphic range.

Bythoceratina avnonensis Rosenfeld was described from the Upper Cenomanian of Palestine (Rosenfeld and Raab, 1974) although it had been recorded earlier by Sayyab (1956) from the Cenomanian upper zone of the Middle Cretaceous of the Arabian Gulf under the name Monoceratina compressa. Eocytheropteron retroversicardinatum was described by Al-Abdul-Razzaq (1980) who observed that it showed normal valve overlap in the basal zone of the Lower Ahmadi Limestone Member, and reversed valve overlap in the upper zone of the Lower Ahmadi Limestone Member and suggested a Lower Cenomanian age for these two zones.

Metacytheropteron berbericus is widely distributed in the Cenomanian of North Africa and from the Middle East; it was described by Bassoullet and Damotte (1969) from the Upper Cenomanian of Algeria; recorded from the Cenomanian of the Middle Cretaceous of Arabian Gulf (Sayyab, 1956, M.S.); in the Cenomanian of Egypt (Colin and El-Dakkak, 1975), Saudi Arabia (Al-Furaih, 1983) and Palestine (Rosenfeld and Raab, 1974); Upper Cenomanian of Western Portuguese basin (Babinot et al., 1978); uppermost Vraconian-Cenomanian of Tunisia and East Algeria (Glintzboeckel and Magne (1959); Vraconian-Cenomanian of Northern Central Tunisia (Bismuth et al., 1981a); Lower Cenomanian of Algeria (Grekoff, 1968); Cenomanian and ? Turonian of Kuwait (Al-Abdul-Razzaq, 1977, M.S.); middle part-upper part of the Cenomanian of Oman (Athersuch, personal commun.), and from the Albian-middle part of the Cenomanian in Iran (Grosdidier, 1973).

On the basis of the Ostracod species restricted to this subzone and others occurring in the subzone it is regarded as Cenomanian. Its stratigraphic position in the lower part of the Cenomanian sequence, the age determination for Kuwaitella turgida in Kuwait, and the age determinations for the Ahmadi Formation in which the subzone is mostly found lead to the conclusion that the subzone is of a Lower Cenomanian age. This agrees with the conclusions of several other authors, although the exact age of the Ahmadi Formation is open to dispute.

Dunnington et al. (1959), Loutfi and Jaber (1970) and Buday (1980) assigned a Lower Cenomanian age to the whole of the Ahmadi Formation based mainly on its stratigraphic position and microfauna contents. Other authors (e.g. Al-Siddiki, 1978) suggested a Lower Cenomanian age for the Ahmadi Formation on the evidence of the stratigraphic ranges of microfossils and the stratigraphic position of the rock units. Al-Abdul-Razzaq (1977, M.S.; 1983) found an assemblage zone in the upper part of the Ahmadi Formation (Upper Ahmadi Shale Member) which she named the Cythereis streblolophata schista zone and considered to be characterised by the appearance of Veeniacythereis streblolophata schista and Veeniacythereis maghrebensis. These two taxa are restricted to it and diagnostic of it and she proposed an Upper Cenomanian age for the zone. However in this study the first subspecies is regarded as a morphotype of Veeniacythereis streblolophata (Al-Abdul-Razzaq and Grosdidier, 1981) and this species and Veeniacythereis maghrebensis are found throughout the Cenomanian of Iraq as well as Palestine, the Arabian Gulf and Egypt. Al-Abdul-Razzaq also proposed a Late Cenomanian age for the Upper Ahmadi Formation, principally on the occurrence of Praealveolina cretacea (reported by Loutfi and

Jaber, 1970). However both Loutfi and Jaber also recorded this species from the Lower Ahmadi as well as the Lower Rumaila Limestone Members, and did not place any emphasis on this species.

Praealveolina cretacea is recorded by many authors from the Arabian Gulf region: Mishrif Formation of Iraq, Owen and Nasr (1958), Dunnington et al. (1959), Al-Siddiki (1978); Sarvak Formation of Iran, James and Wynd (1965); Ahmadi-Rumaila Formations of Kuwait, Loutfi and Jaber (1970), and none seem to place special importance to it. On the basis of the whole fauna, these authors suggest Cenomanian-Turonian ages for the strata containing P. cretacea. The problem with placing the upper part of the Ahmadi Formation into the Upper Cenomanian is that the Upper Cenomanian would then include the whole of the Rumaila and part of the Mishrif as well. There seems little reason for changing the conventional interpretation of the Ahmadi as Lower Cenomanian, Rumaila-Lower Mishrif Formation as Upper Cenomanian.

Occurrence:

This subzone is recognised in the upper part of the Ahmadi Formation of South Rumaila Well-104 and Ghalaisan Well-1. It cannot be separated from the overlying subzone A-1c in Safawi Well-1 or from A-1c and zone A-2 of East Baghdad Well-3. In Safawi Well-1 subzones A-1b and A-1c are present in the upper part of the Ahmadi Formation, the Rumaila Formation and lower part of the Mishrif Formation. In Kifl Well-2 subzone A-1c is recognised in the Maotsi Formation but it is not clear where its lower boundary lies so the Mahilban and Fahad Formations may belong to subzone A-1b.

C - Cythereis alfarazdaki - Assemblage Subzone (A-1c)

This subzone is distinguished from the preceding subzones by its low diversity. In effect there are two main species, Veeniacythereis streblolophata and Veeniacythereis maghrebensis. Because of this there is obviously a strong facies control, but this low diversity fauna can be recognised in 2 wells, South Rumaila Well-104 and Ghalaisan Well-1 and so is given the status of a subzone. This is named after Cythereis alfarazdaki which is a rare species and would not normally be chosen as a nominate species. However few taxa are available and the 2 commonest species, Veeniacythereis streblolophata and Veeniacythereis maghrebensis have a longer range and have been chosen to define the whole Cenomanian (V. streblolophata - V. maghrebensis zone). Cythereis alfarazdaki is found in two wells, South Rumaila Well-104 where it is restricted to the subzone although only present in its upper part, and Kifl Well-2 where it occurs at the base of the Maotsi Formation and from its stratigraphical position is probably time equivalent to the subzone at the South Rumaila Well-104. The probelm at Kifl Well-2 is that the Glenocythere bahreinensis subzone can be recognised, but ostracods are only found at 2 horizons between this and the Dumontina? mdaouerensis zone. Thus it is not possible to position the boundaries between the Glenocythere bahreinensis, Soudanella? alkansai, and Cythereis alfarazdaki subzones.

The other species found in this subzone are recorded from only one, two, or three samples: Rehacythereis almutasimi, Veenia, (Nigeria) shattalarabia, Bythoceratina avnonensis, Peloriops (Peloriops) almasudii, Peloriops (Peloriops) sphaerommata, Cythereis aff. alfarazdaki, Spinoleberis ibnalfakihi, Cythereis alfarazdaki, Cythereis alantakii; the first five of these species have an extensive range into the lower two subzones. ~~it is not clear whether their occurrence in the subzone A-1c is due to contamination although they are regarded as such; if they are not contaminants the ranges of these species would be considerably extended from their generally accepted ranges.~~ Peloriops (P.) sphaerommata has been recorded by Al-Abdul-Razzaq from the Cenomanian Ahmadi Formation, but in this study it is recorded from the Ahmadi and lower part of the Mishrif Formations, so is possible to interpret the lower part of the Mishrif Formation as being of Cenomanian age which is suggested in this study. Bythoceratina avnonensis is recorded from the Upper Cenomanian of Pelestine while it is found earlier in this study indicating that this species probably has a more extensive stratigraphic range. Species occurring in this subzone as contaminants from higher strate are: Brachycythere basrahaensis, Acanthocythereis mustansariya, Brachycythere ghalaisanaensis, Brachycythere hatraensis, Paracytheridea ibnaltayyibi, Peloriops (Hempipeloriops) djabirbnhaiyani, and Peloriops (Hemipeloriops) kufaensis. Limburgina? aldjahizii occurs in this sub zone as rare specimens.

As has already been mentioned it is not always possible to separate the two subzones A-1b, A-1c and the zone A-2, and the following species are present in this undifferentiated interval: Peloriops (Peloriops) kiflaensis, ~~Rehacythereis arabica,~~ Dumontina aff. alfarahidii, Amphicytherura mishrifensis, Ovocytheridea baghdadia.

Archeocosta alkazwinii, Dumontina? alfarahidii, and Ovocytheridea ibnalmutazzi are present almost certainly as contaminants; Ovocytheridea harunalrashidi is rare and may be a contaminant.

The following species are found in A-1c as mentioned above as well as in the undifferentiated interval when A-1b and A-1c subzones and A-2 zone cannot be recognized, or the boundary between A-1b and A-1c is difficult to place as in Kifl Well-2: Brachycythere basrahaensis, Archeocosta alkazwinii, Peloriops (Peloriops) almasudii, Cythereis alantakii, Cythereis alfarazdaki, and Acanthocythereis mustansariya.

Age:

Al-Abdul-Razzaq and Grosdidier (1981), and the present study recognise 3 species, Veeniacythereis jezzineensis, Veeniacythereis maghrebensis and Veeniacythereis streblolophata but other authors have placed these into a single species, V. jezzineensis (Rosenfeld and Raab, 1983;

Colin and El-Dakkak, 1975 and Sayyab, 1956); for a more detailed discussion of this problem see V. maghrebensis and V. streblolophata. Veeniacythereis maghrebensis was reported from the Upper Cenomanian of Algeria (Bassoullet and Damotte, 1969), Tunisia and East Algeria (Glintzboeckel and Magne, 1959), Kuwait (Al-Abdul-Razzaq and Grosdidier, 1981), and Oman (Athersuch, personal commun.); Bismuth et al. (1981a) identified forms which are probably identical to V. maghrebensis from the upper half of the Upper Cenomanian of Northern Central Tunisia. This species is also found in rocks regarded as Cenomanian in the Arabian Gulf Coast (Sayyab, 1956, M.S.) and Palestine (Rosenfeld and Raab, 1974), while forms which are probably conspecific are recorded from the Cenomanian of Egypt (Sinai) by Colin and El-Dakkak (1975). Veeniacythereis streblolophata is known from the Lower and Upper Cenomanian of Kuwait (Al-Abdul-Razzaq and Grosdidier, 1981); the Cenomanian of Tunisia and East Algeria (Glintzboeckel and Magne, 1959), Palestine (Rosenfeld and Raab, 1974), Western Coast of Arabian Gulf (Sayyab, 1956) and Egypt (Colin and El-Dakkak, 1975); Upper Cenomanian of Algeria (Grekoff, 1968); Lower to basal Upper Cenomanian of Northern Central Tunisia (Bismuth et al., 1981a); Albian-Cenomanian of Iran (Grosdidier, 1973); Upper Albian-Cenomanian of Palestine (Rosenfeld and Raab, 1983); from Aptian ? to middle part of Cenomanian of Oman (Athersuch, personal commun.); and Cenomanian of Saudi Arabia (Al-Furaih, 1983). The species present in this subzone indicates a Cenomanian age and its stratigraphic position in the upper part of the Cenomanian sequence underlying the Turonian indicate an Upper Cenomanian age. Several authors have argued similarly for this age of the Rumaila Formation. The Rumaila Formation was regarded as Upper Cenomanian by Loutfi and Jaber (1970) and Al-Siddiki (1978) on the basis of fossil assemblages; a Middle to Early Upper Cenomanian age was given to the Rumaila Formation by El-Naggar and Al-Rifaiy (1972, as reported by Al-Abdul-Razzaq, 1977, M.S.), on the basis of stratigraphic position and fossil assemblages. Al-Abdul-Razzaq (op. cit.) regarded the Rumaila Formation as being Upper Cenomanian due to its stratigraphic position, but she did not find any ostracod species in this Formation in Kuwait. Dunnington et al. (1959) regarded the Rumaila Formation as Cenomanian but they regarded the Ahmadi and Mishrif Formations as Cenomanian also. They remarked that the presence of Orbitolina concava var. qatarica in the Rumaila Formation gave a pre-Turonian age for the Rumaila Formation.

Occurrence:

This subzone is known in the Rumaila Formation of Ghalaisan Well-1; it is also found in the Rumaila and lower part of the Mishrif Formations of South Rumaila Well-104. This subzone is recognised in Kifl Well-2 although its boundaries cannot be determined. It cannot be recognised in Safawi Well-1 and East Baghdad Well-3.

2. Dumontina? mdaouerensis - Partial Range Zone (A-2)

This zone was defined as the Cythereis mdaouerensis zone by Bismuth et al. (1981a) and is distinguished by the first appearance of Dumontina? mdaouerensis, a characteristic and restricted species in Northern Central Tunisia and in Iraq. Archeocosta alkazwinii occurs in this zone although is not restricted to it, but its first appearance has been used to recognise the base of this zone in Kifl Well-2. Dumontina? alfarhidii and Ovocytheridea ibnalmutazzi are rare and their presence is due to contamination; Isohabrocythere ? aldinawarii is also rare and possibly a contaminant; the ranges of these species extend into and lower higher zones. Peloriops (Peloriops) aff. tetrancota is found in a single sample and is a contaminant.

Age:

Bassoullet and Damotte (1969) first described and reported Dumontina? mdaouerensis as Cythereis mdaouerensis from Algeria and regarded it as Lower Turonian; it also is known from the Lower Turonian of Northern Central Tunisia according to Bismuth et al. (1981), was described as Cythereis? mdaouerensis from the Lower Turonian of Palestine by Rosenfeld and Raab (1974) (although the latter is doubtfully considered as synonymous with Dumontina?

mdaouerensis in this study because of the difference in their diagnostic characters).

Archeocosta alkazwinii was identified by Sayyab (1956) from the Upper Cretaceous strata of the Arabian Gulf Coast. Bismuth et al. (1981a) suggested this zone was of Lower Turonian age in Northern Central Tunisa. In the present work the range of Dumontina? mdaouerensis also supports a Lower Turonian age. The age of the Mishrif Formation, and the Kifl Formation where this zone occurs has been determined by other workers.

The Mishrif Formation was regarded as Late Cenomanian to Early Turonian by El-Naggar and Al-Rifaiy (op. cit.); Jaber (1972) considered the Mishrif Formation to be Late Cenomanian age, although he remarked that Late Cenomanian to Early Turonian "seems more appropriate as in more complete sections, the upper part of the Mishrif could represent the Turonian" (quoted from Al-Abdul-Razzaq, 1977, M.S.); Buday (1980) favours an Upper Cenomanian-Early Turonian age for the Mishrif Formation according to its stratigraphic position in the upper part of the Cenomanian sequence; Upper Cenomanian-Lower Turonian age was argued by Al-Siddiki (1978); Smout (1956) considered the genus Nezzazata which is found in the Mishrif Formation to indicate a Turonian age, but the presence of Aleveolinidae indicate a Cenomanian age, suggesting that the Mishrif Formation is of Cenomanian-Turonian age. The Kifl Formation was dated as Cenomanian-Early Turonian by Buday (1980) on its stratigraphic position in the sequence and with respect to its gradational development from the underlying Cenomanian Formations.

Occurrence:

This zone is found in the Kifl Formation of Ghalaisan Well-1 and the upper part of the Mishrif Formation of Safawi Well-1. In Kifl Well-2 the zone occurs in the Kifl Formation. In East Baghdad Well-3, this zone is difficult to separate from the two underlying subzones. In South Rumaila Well-104, this zone cannot be recognised with any certainty although there is a suggestion of its presence near the top of the Mishrif Formation and its upper boundary may coincide with the top of the Mishrif Formation.

3. Veeniacythereis ibnalhaithami - Partial Range Zone (A-3)

The base of this zone is defined by the first appearance of Veeniacythereis ibnalhaithami, although this species extends into younger zones. A large number of species first appear within this zone and are restricted to it: Acanthocythereis ibnbattutai, Buntonia ibnrushdi, Cythereis? ibnyunusi, Curfsina alkarkhii, Veenia (Veenia) ibnhazmi, Protobuntonia Khasibaensis, Dumontina? sp.A, Acanthocythereis aff. ibnbuttutai, Occultocythereis sp. A, Dumontina? ibnmadjidi, Cythereis ibnalnadimi, Dumontina? cf. ibnmadjidi, Acanthocythereis sp. B, Acanthocythereis sp. A, and Brachycythere ibnalnafisi. Buntonia ibnalbaitari and Acanthocythereis musabnnusairi first appear in this zone but extend into higher zone of Peloriops (Peloriops) alrazii.

The following species probably first appear in this zone although they have been found in the topmost samples of the underlying zone of Dumontina? mdaouerensis in South Rumaila Well-104 (see discussion of South Rumaila Well-104): Veeniacythereis ibnalhaithami, Buntonia ibnrushdi, Iraqicythereis kadisiya, Cythereis? ibnyunusi, Acanthocythereis ibnbattutai, Brachycythere basrahaensis, Acanthocythereis ibnkhalduni and Isohabrocythere ? aldinawarii. B. basrahaensis also occurs with D.? mdaouerensis in a single sample at the top of Mishrif Formation in Safawi Well-1. Veeniacythereis ibnalhaithami, Brachycythere basrahaensis, Brachycythere hatraensis, Brachycythereis ibnalnafisi are the characteristic species for this zone. Some species occurring in this zone are also found as rare specimens in lower zones where their presence is due to contamination: Peloriops (Hemipeloriops) djabirbnhaiyani, Ovocytheridea ibnalmutazzi, Peloriops (Hemipeloriops) kufaensis, Paracytheridea ibnaltayyibi, Brachycythere hatraensis, Brachycythere basrahaensis, Dumontina? alfarhidii, Brachycythere ghalaisanaensis, and Acanthocythereis mustansariya. The Two species Limburgina? aldjahizi, and Ovocytheridea harunaldrashidi occur in this zone and as rare specimens in lower zones. Isohabrocythere? aldinawarii is found in this zone and as rare specimens in lower zones where its presence is probably due to contamination. The ranges of Ovocytheridea baghdadia in East Baghdad Well-3 and Archeocosta alkazwinii in Ghalaisan Well-1 and Kifl Well-2 extend into lower zones. The occurrence of Archeocosta alkazwinii in A-1b and A-1csubzones of Kifl Well-2 and Ghalaisan Well-1 is certainly due to contamination.

Age:

Sayyab (1956, M.S.) described identical specimens to Veeniacythereis ibnalhaithami from the Upper Cretaceous strata of the western Coast of the Arabian Gulf. Brachycythere hatraensis has been reported by Grosdidier (1973) from the Coniacian ? of the Coastal Fars Province of Iran. Cythereis ? ibnyunusi were described from the Upper Cretaceous of the Arabian Gulf Coast by Sayyab (op. cit.). Brachycythere ibnalnafisi was reported by Grosdidier (1973) from the Coniacian ? beds of Iran, and from the Upper Cretaceous strata of the Arabian Gulf area by Sayyab (op. cit.). Grosdidier (1973) found Buntonia ibnalbaitari in beds regarded as Coniacian ? to the basal part of the Santonian in Iran. Brachycythere ghalaisanaensis occurs in the Upper Cretaceous of the Arabian Coast areas (Sayyab, 1956, M.S.), Santonian of Iran (Grosdidier, 1973) and Upper Part of the Turonian-middle part of the Campanian? of Oman (Athersuch, Personal Commun.). Grosdidier illustrated forms which are identical to Iraqicythereis kadisiya from the Santonian rocks of the coastal Fars Province in Iran; Athersuch (Personal Commun.) recorded forms identical to Morphotypoe-5 of this species in the upper part of the Turonian ? Upper part of the Campanian strata of Oman.

A Coniacian age can be attributed to this zone on the basis of the species ranges; however its stratigraphic position and the range of other faunas, suggest an Upper Turonian-Coniacian age. Some authors supported this age determination for the Khasib and Tanuma Formations: Darmonian (1975) assigned an Upper Turonian age to the lowermost part of the Khasib Limestone and Shale Member defined as "Miliolid Limestone Bed" and a Coniacian age for the rest of the Khasib Limestone and Shale Member on the basis of the benthonic and planktonic foraminifera; he also suggested a Coniacian age for the Tanuma Shale Member. Chatton and Hart (1961, unpublished report indicated by Al-Naqib, 1967) date the Khasib Formation as Middle Turonian and Early Coniacian. Al-Siddiki (1978) suggested an Upper Turonian-Coniacian age for the Khasib Formation and Coniacian age for the Tanuma Formation. Other authors disagree with this age determination. Dunnington et al. (1959) proposed an Upper Campanian age for the Khasib and Tanuma Formations on the basis of the microfossils including Globotruncana lapparenti subs sp., and G. leupoldi Bolli (from Zubair Well-1) and G. stuart (de Lapparent) (from Nahr Umr Well-1) from the Khasib Formation; and Monolepidorbis sp., Cristellaria sp., and Bryozoa from the Tanuma Formation. Darmoian (1975) remarked that the fossils recorded from the Khasib were not recorded in wells of his study area in south eastern Iraq, and those found in the Tanuma Formation were found from beds probably younger than Upper Santonian.

The disappearance of Dumontina? mdaouerensis (which is restricted to and characteristic of the Lower Turonian in Iraq and areas outside the Arabian Gulf) beneath the Veeniacythereis ibnalhaithami zone supports the age assignment of the Veeniacythereis ibnalhaithami to the Upper Turonian-Coniacian.

Occurrence:

This zone occurs in the Khasib and Tanuma Formations of South Rumaila Well-104; the Tanuma and basal part of the Sadi Formations of Safawi Well-1; Khasib, Tanuma and the base of the Sadi Formation in Ghalaisan Well-1; the lower part of the Tanuma Formation of East Baghdad Well-3; Khasib and Tanuma Formations of Kifl Well-2.

4. Peloriops (Peloriops) alrazii - Partial Range Zone (A-4)

The zone is characterised by two species, Peloriops (Peloriops) alrazii and Phymacythereis santoniensis which have been found as rare specimens near the top of the Tanuma Formation and basal part of the Sadi Formation. No younger sediments have been studied so their exact range is unknown, and obviously it is difficult to be certain as to whether these few specimens are contaminants or not. Phymacythereis santoniensis was originally described by Al-Abdul-Razzaq (1977, M.S.) from the Santonian Gudair Formation of Kuwait, and Brachycythere ghalaisanaensis was regarded by Grosdidier (1973) as the characteristic Santonian species in Iran (Grosdidier named his species "Mehesella" IRC_{23}).

The following species are found in this zone but are also recorded from underlying zones: Brachycythere basrahaensis, Brachycythere hatraensis, Paracytheridea ibnaltayyibi, Veeniacythereis ibnalhaithami, Iraqicythereis kadisiya, Acanthocythereis musabnnusairi, Buntonia ibnalbaitari, and Brachycythere ghalaisanaensis.

Age:

As discussed above, the evidence suggests Santonian.

Occurrence:

This zone occurs in the topmost Tanuma Formation and the basal part of the Sadi Formation in South Rumaila Well-104; the uppermost Tanuma Formation and basal part of the Sadi Formation in Kifl Well-2; and the upper part of the Tanuma Formation of East Baghdad Well-3. This zone cannot be recognised in Ghalaisan Well-1 and Safawi Well-1.

Ostracod Biozones in the studied wells:

The ostracod biozones recognised in the five wells studied are as follows:

1. South Rumaila Well-104 (Fig. 7.2)

Four zones and three subzones can be distinguished in this well in South Eastern Iraq, as follows:

A - Glenocythere bahreinensis Subzone: (A-1a)

This subzone is easily recognised and is defined by the total range of Glenocythere bahreinensis. The other important species (Metacytheropteron hevyonensis) and the restricted species Louza amygdaloidea (=Brachycythere n. sp.), are present in this zone of South Rumaila Well-104.

B - Soudanella? alkhansai Subzone: (A-1b)

This subzone is well defined; it is characterised by the total range of Peloriops (Peloriops) sphaerommata, Rehacythereis alkindii, Peloriops (Peloriops) ulosa, Peloriops (Peloriops) elassodictyota, Soudanella? Alkhansai. Kuwaitella turgida, Peloriops (Peloriops) ibnalkasimi.

C - Cythereis alfarazdaki Subzone: (A-1c)

This subzone is distinguished by the presence of rare species, lacking distinctive species apart from Veeniacythereis streblolophata and Veeniacythereis maghrebensis which have a longer stratigraphical range.

D - Dumontina? mdaouerensis Zone: (A-2)

Dumontina? mdaouerensis has been found in a single sample at the base of the Veeniacythereis ibnalhaithami zone; this probably indicates the presence of the Dumontina? mdaouerensis zone, but it is difficult to separate out as it overlaps with the base of the Veeniacythereis ibnalhaithami zone; the base of the Dumontina? mdaouerensis zone may occur lower in the succession but lack of information prevents any attempt at its recognition.

E - Veeniacythereis ibnalhaithami Zone: (A-3)

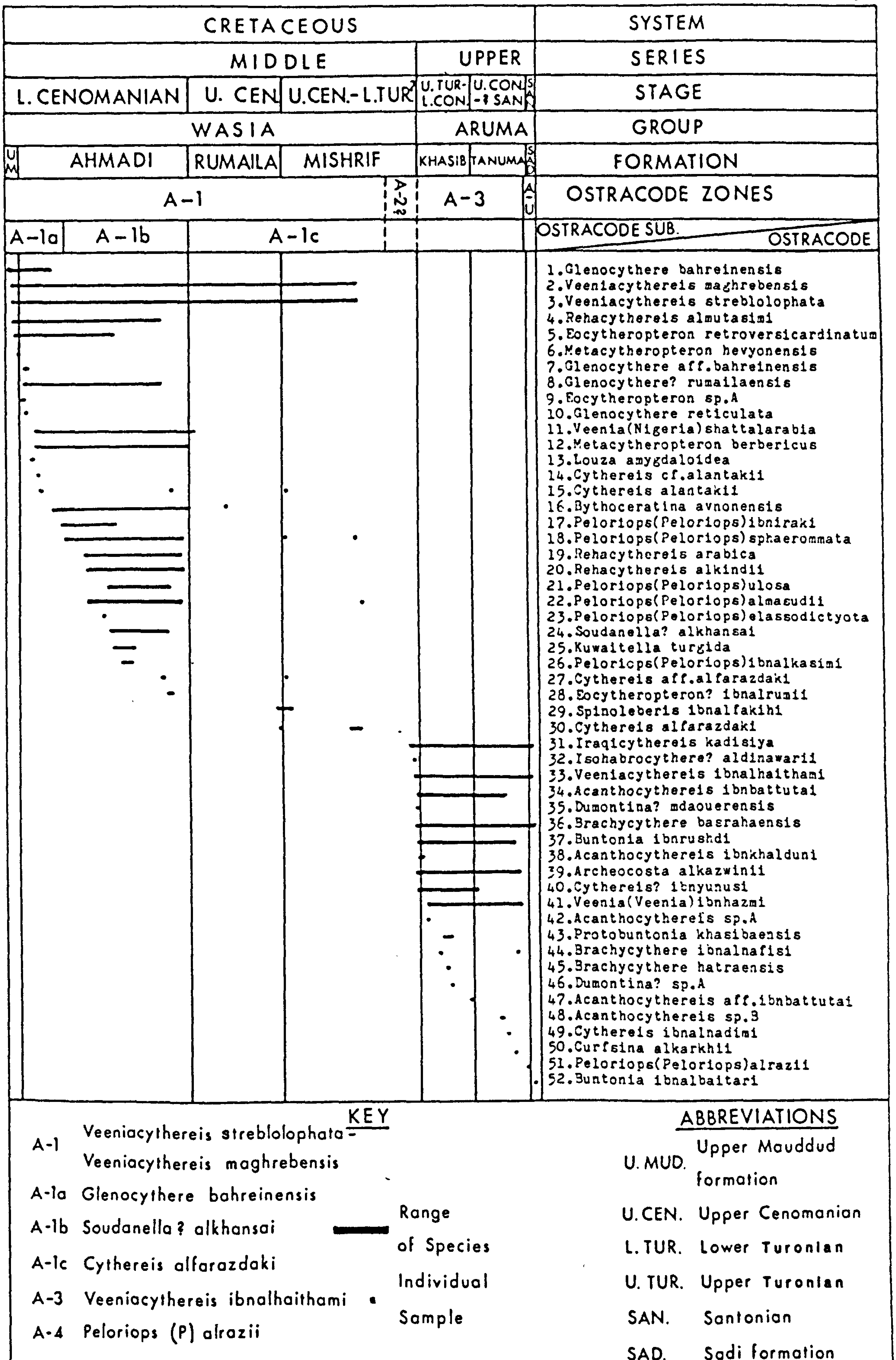


Fig-7-2:- Stratigraphic Range chart of Ostracodes from South Rumaila Well—104

The boundary between this zone and the underlying subzone Cythereis alfarazdaki is evidenced by the first appearance of Veeniacythereis ibnalhaithami and Iraqicythereis kadisiya; the last appearance of Acanthocythereis ibnbattutai, Buntonia ibnrushdi, Archeocosta alkazwinii and Veenia (Veenia) ibnhazmi appear to coincide with top of this zone.

F - Peloriops (Peloriops) alrazii Zone: (A-4)

This zone is recognised by first appearance of Peloriops (Peloriops) alrazii at the base of this zone.

2. Kifl Well-2 (Fig. 7.3)

In Kifl Well-2, middle western Iraq, three zones and two subzones can be recognised: Glenocythere bahreinensis and Cythereis alfarazdaki Subzones; Veeniacythereis ibnalhaithami, Peloriops (Peloriops) alrazii, and Dumontina? mdaouerensis zones.

A - Glenocythere bahreinensis subzone: (A-1a)

This subzone can be recognised by the range of Glenocythere bahreinensis.

B - Soudanella? alkhansai and Cythereis alfarazdaki Sub Zones: (A-1b) and (A-1c)

Ostracods are only found at two horizons in the strata lying between the Glenocythere bahreinensis and Dumontina? mdaouerensis Zones. The presence of Cythereis alfarazdaki in the upper of these 2 horizons indicates the Cythereis alfarazdaki Subzone. The ostracods of the lower horizon do not enable an accurate dating, but on their stratigraphical position could indicate the Soudanella? alkhansai Subzone. It is impossible to locate zonal boundaries with any accuracy.

C - Dumontina? mdaouerensis Zone: (A-2)

The base of this zone is marked by the first appearance of Archeocosta alkazwinii.

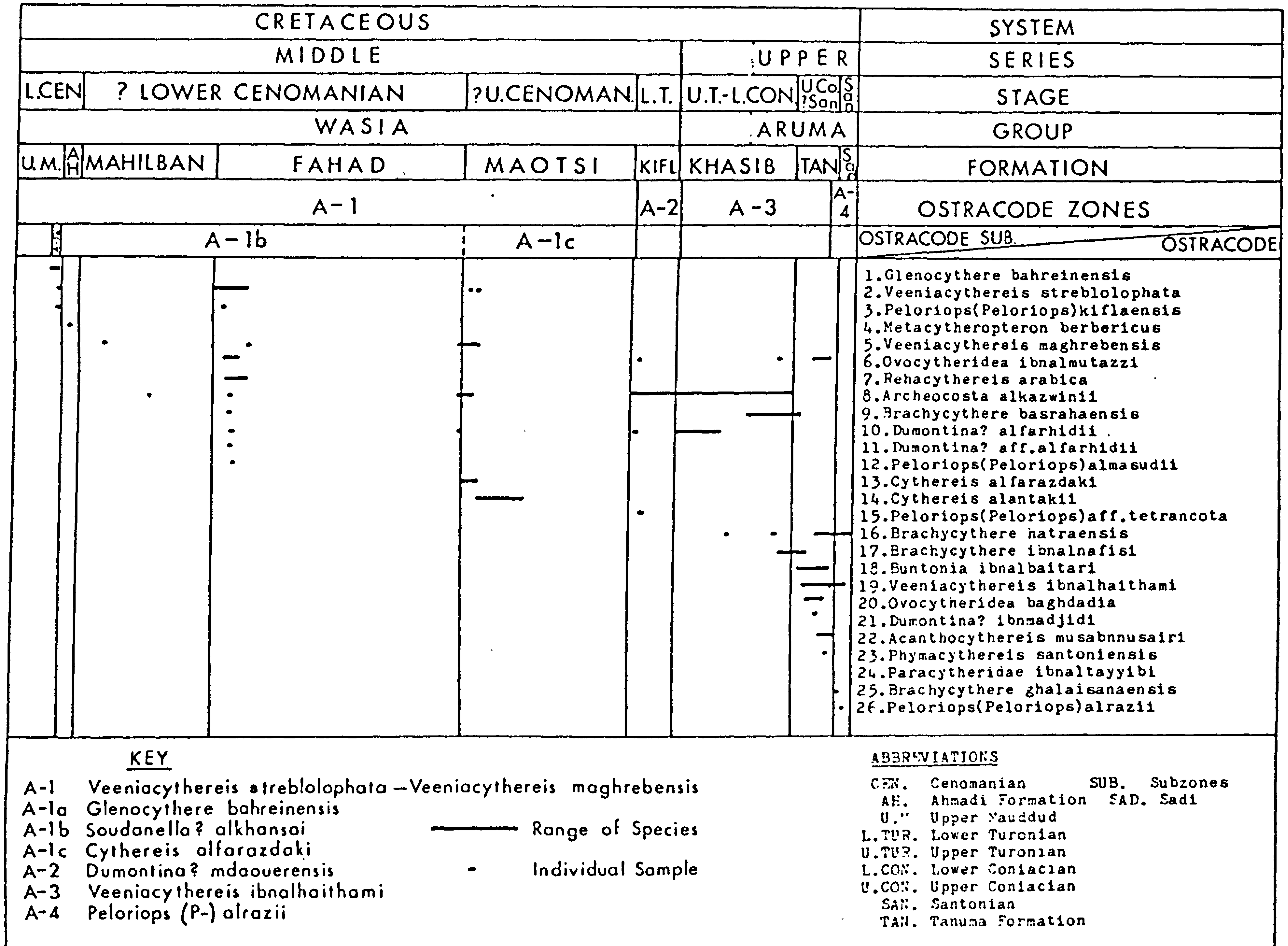


Fig. 7.3 :- Stratigraphic Range Chart of Ostracodes from KIFL Well - 2

D - Veeniacythereis ibnalhaithami Zone: (A-3)

This zone is well defined, its base characterised by the first appearance of Dumontina? alfarhidii. The last appearance of Ovocytherldea ibnalmutazzi and Ovocytheridea baghdadia seem to coincide with the upper boundary of this zone. The zonal species is only found in the upper part of the zone.

E - Pelorlops (Pelorlops) alrazii Zone: (A-4)

This zone is distinct; the base of the zone is recognised by the appearance of Phymacythereis santoniensis, and Pelorlops (Pelorlops) alrazii.

3. Safawi Well-1 (Fig. 7.4)

This well is located in south western Iraq and the Glenocythere bahreinensis Subzone, Dumontina? mdaouerensis and Veeniacythereis ibnalhaithami zones can be recognised. Soudanella? alkhansai and Cythereis alfarazdaki Subzones are difficult to separate. There is no evidence for the Peloriops (Peloriops) alrazii zone.

A - Glenocythere bahreinensis Subzone: (A-1a)

It is difficult to recognise the Glenocythere bahreinensis Subzone in this well. Veeniacythereis streblolophata and Veeniacythereis maghrebensis occur in the lower part of the section, but could indicate subzone A-1a, A-1b, or A-1c. The first appearance of Amphicytherura mishrifensis has been taken to indicate the base of Subzone Soudanella? alkhansai, thus allocating the lowest part of the section to the Gelonocythere bahreinensis Subzone.

B - Soudanella? alkhansai and Cythereis alfarazdaki Subzones: (A-1b) (A-1c)

The boundary between these two subzones is not clear, so they cannot be separated. The appearance of Amphicytherura mishrifnesis has been considered to indicate the Soudanella? alkhansai Subzone, there is no evidence for Cythereis alfarazdaki. The lower boundary of the Dumontina? mdaouerensis Zone is marked by the first

Fig. 7.4 :- Stratigraphic Range chart of Ostracodes from Safawi Well-1.

appearance of Dumontina? mdaouerensis, so the intervening strata between the first appearance of Amphicytherura mishrifensis and first appearance of Dumontina? mdaouerensis belong to the Soudanella? alkhansai and Cythereis alfarazdaki Subzones. The unfossiliferous strata indicated in Fig.7.4 probably belong to the Cythereis alfarazdaki Subzone.

C - Dumontina? mdaouerensis Zone: (A-2)

This zone is defined by the range of Dumontina? mdaouerensis.

D - Veeniacythereis ibnahaithami Zone: (A-3)

Veeniacythereis ibnalhaithami only occurs in a single sample, but another characteristic species Brachycythere basrahaensis is commonly present, and is taken to define this zone in Safawi Well-1; the base of the zone is taken just above the last appearance of Dumontina? mdaouerensis.

E - Peloriops (Peloriops) alrazii Zone: (A-4)

This zone cannot be recognised.

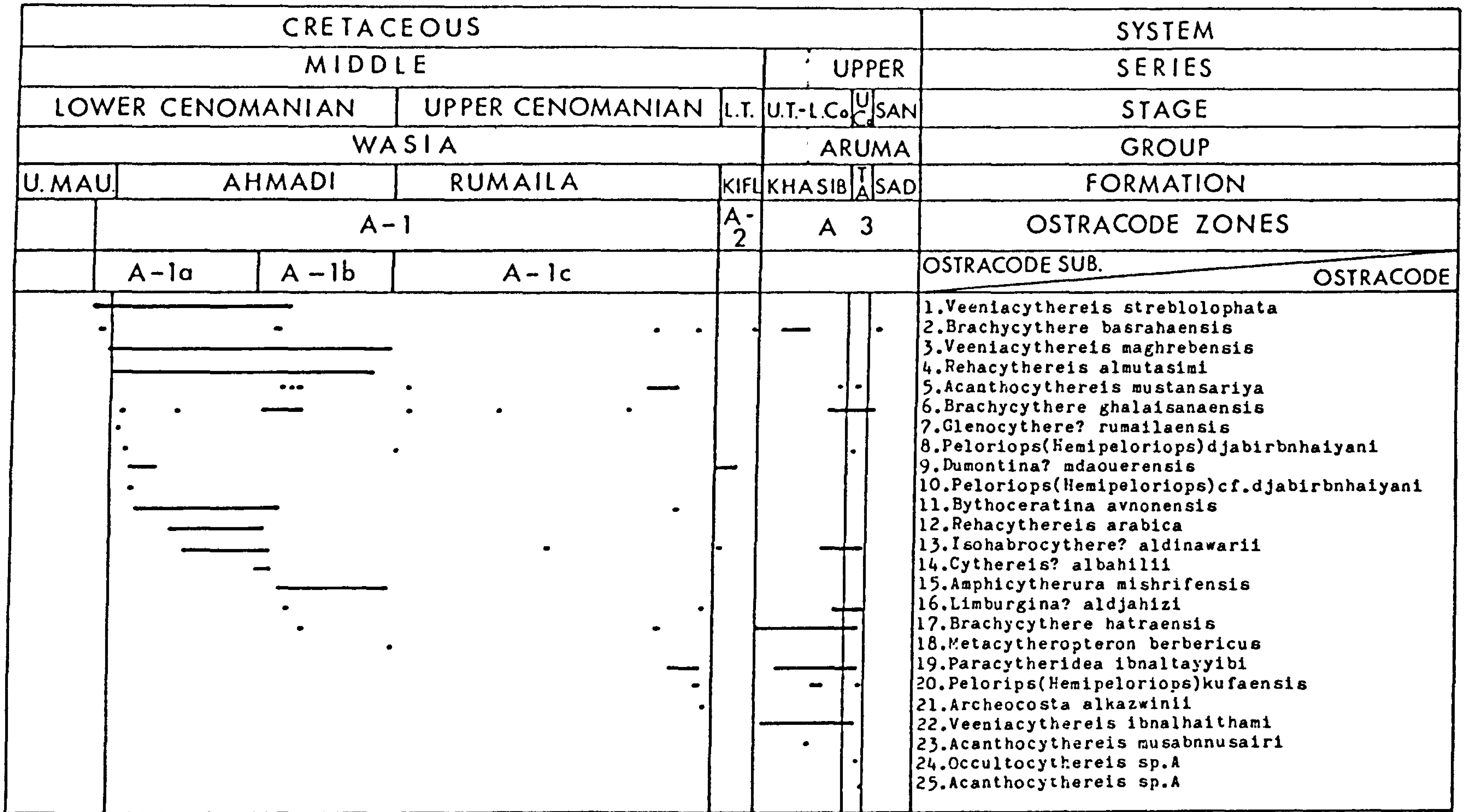
4. Ghalaisan Well-1 (Fig. 7.5)

Two zones and three subzones can be distinguished in Ghalaisan Well-1, south western Iraq, which contain the following:

A - Glenocythere bahreinensis subzone: (A-1a)

It is difficult to recognise the Glenocythere bahreinensis in this well because the lowest part of the section contains Ostracods characteristic of subzones A-1a, A-1b, A-1c and lacks the characteristic species of Glenocythere bahreinensis Sub Zone.

The first appearance of Cythereis? albahilii and Amphicytherura mishrifensis are taken to indicate the approximate base of Subzone Soudanella? alkhansai, earlier strata being placed in the Glenocythere bahreinensis Sub Zone.



KEY

A-1 Veeniacythereis streblolophata — Veeniacythereis maghrebensis
A-1a Glenocythere bahreinensis
A-1b Soudanella? alkhansai
A-1c Cythereis alfarazdaki
A-2 Dumontina? mdaouerensis
A-3 Veeniacythereis ibnalhaithami

——— Range of Species
• Individual Sample

ABBREVIATIONS

L.TRU.	Lower Turonian
U.TRU.	Upper Turonian
L.CON.	Lower Coniacian
U.CON.	Upper Coniacian
SAN.	Santonian
TA.	Tanuma
U MAU	Upper Mauddud

Fig. 7.5 :- Stratigraphic Range Chart of Ostracodes from Ghalaisan Well - 1.

B - Soudanella? alkhansai subzone: (A-1b)

The base of this subzone is marked by the first appearance of *Cythereis? albahilii*, and *Amphicytherura mishrifensis* appears just above the base. *Metacytheropteron berbericus* is found in a single sample and although it is found in this subzone and the underlying *Glenocythere bahreinensis* Subzone in South Rumaila Well-104, its last appearance in South Rumaila Well-104 is at the top of this subzone, so this record in Ghalaisan Well-1 has been used to locate the top of the subzone.

C - Cythereis alfarazdaki subzone: (A-1c)

This subzone is recognised by the lack of species, and all the species are rare and contaminates. The first appearance of *Dumontina? mdaouerensis* has been used to evidence the upper boundary of this subzone.

D - Dumontina? mdaouerensis Zone: (A-2)

This zone is distinguished by the first appearance of *Dumontina? mdaouerensis*.

E - Veeniacythereis ibnalhaithami Zone: (A-3)

The lower boundary of this zone corresponds to the first appearance of *Veeniacythereis ibnalhaithami* and *Brachycythere hatraensis*.

F - Peloriops (Peloriops) alrazii Zone: (A-4)

This zone is not observed in Ghalaisan Well-1.

5. East Baghdad Well-3 (Fig. 7.6)

In this well, two zones and one subzone can be recognised while the other two subzones and the *Dumontina? mdaouerensis* zone are difficult to distinguish.

A - Glenocythere bahreinensis Subzone: (A-1a)

The nominate species *Glenocythere bahreinensis* is only found in a single sample, but other characteristic species (*Metacytheropteron hevyonensis*, *Rehacythereis almutasimi*,

KEY

A-1	Veeniacythereis streblolophata — Veeniacythereis maghrebensis	L.TUR.	Lower Turonian
A-1a	Glenocythere bahreinensis	U.TUR.	Upper Turonian
A-1b	Soudanella? alkhansai	L.CON.	Lower Coniacian
A-1c	Cythereis alfarazdaki	U.CON.	Upper Coniacian
A-2	Dumontina? mdaouerensis	SAN.	Santonian
A-3	Veeniacythereis ibnalhaithami	SAD.	Sadi formation
A-4	Peloriops (P-) alrazii	MAU.	Mauddud
		SUBZ.	Subzones

——— Range of Species

• Individual Sample

Fig-7-6:– Stratigraphic Range chart of Ostracodes from East Baghdad well — 3

Veeniacythereis streblolophata) occur more extensively and have been used to define the subzone in East Baghdad Well-3.

B - *Soudanella? alkhansai, Cythereis alfarazdaki* Subzones and *Dumontina? mdaouerensis* Zone: (A-1b) (A-1c) and (A-2)

These subzones and zone are difficult to define in East Baghdad Well-3. The occurrence of *Amphicytherura mishrifensis* in the top half of the Rumaila Formation indicates the presence of the *Soudanella? alkhansai* subzone or the *Cythereis alfarazdaki* and *Soudanella? alkhansai* subzones, i.e. definite Cenomanian, but the next marker horizon occurs near the base of the Tanuma Formaiton with the appearance of *Veeniacythereis ibnalhaithami* indicating the *Veeniacythereis ibnalhaithami* zone i.e. Upper Turonian-Coniacian. It is possible that the intervening strata which lie between the last appearance of *Glenocythere bahreinensis* and the first appearance of *Veeniacythereis ibnalhaithami*, belong to A-1b, A-1c and A-2. There is no evidence for the zone of *Dumontina? mdaouerensis*. Two characteristic species of East Baghdad Well-3 are *Ovocytheridea harunalrashidi* and *Ovocytheridea baghdadia*, but these are almost unknown in the other wells, apart from a rare occurrence of *Ovocytheridea baghdadia* in Kifl Well-2. They probably indicate different environmental conditions at East Baghdad Well-3, and could range through zones and Subzones A-1b, A-1c, A-2 and A-3.

C - *Veeniacythereis ibnalhaithami* zone: (A-3)

This zone is marked by the first appearance of *Veeniacythereis ibnalhaithami*. The last appearance of *Ovocytheridea baghdadia* and *Ovocytheridea harunalrashidi* seem to correspond with the top of this zone.

D - *Peloriops (Peloriops) alrazii* Zone: (A-4)

The base of this zone is taken as the first appearance of *Peloriops (Peloriops) alrazii*.

Age of the formations according to the Ostracode fauna:

The age of the formations studied have been determined by the ranges of the ostracods, together with stratigraphic position.

1. Mauddud Formation:

Only the uppermost part of this Formation was sampled. The presence of Lower Cenomanian ostracod species of the *Glenocythere bahreinensis* Subzone, indicate a basal Cenomanian age; however see the previous discussion of *G. bahreinensis* subzone.

2. Ahmadi Formation:

A Lower Cenomanian age is assigned to these rocks on the basis of the two subzones of *Glenocythere bahreinensis* and *Soudanella*? *alkhansai*. The first subzone is characterised by Lower Cenomanian species in general and basal Cenomanian species in particular (see *Glenocythere bahreinensis* Subzone), and this subzone is regarded as basal Cenomanian in Kuwait (Al-Abdul-Razzaq, 1977, M.S., 1983) as well as in this study. The upper part of the Ahmadi Formation where the *Soudanella*? *alkhansai* is found is regarded as Lower Cenomanian due to its stratigraphic position as well as the opinion of several authorse mentioned in discussion of the *Soudanella*? *alkhansai* subzone. The age of the upper part of the Ahmadi Formation is a matter of controversy, however (see *Soudanella*? *alkhansai* subzone).

In South Rumaila Well-104 the contact between the Ahmadi and Rumaila Formations coincides with the upper boundary of the *Soudanella*? *alkhansai* Subzone and this fact can be used to recognise the Ahmadi/Rumaila contact in other wells where it is not as clear. Thus the contact is located by this method in Ghalaisan Well-1 where it was previously found to be difficult to determine. In East Baghdad Well-3 it is now clear that the Rumaila Formaiton recognised by Iraqi National Oil Company includes strata in its lower part equivalent to the Ahmadi Formation because of the presence of the Glenocythere bahreinensis Subzone. This subzone also suggests a Lower Cenomanian age for part of the sequence rather than assigning the whole of the East Baghdad Rumaila Formation to the Middle-Upper Cenomanian as done previously. The Ahmadi Formation in Kifl Well-2 has only yielded Metacytheropteron berbericus in its lower part, the remainder of the Formation has yielded no ostracods. Therefore, its age is determined on the basis of lithostratigraphic composition and stratigraphical position.

3. Rumaila Formation:

The faunal evidence for the age of this formation in South Rumaila Well-104 is not clear. The ostracods indicate a Cenomanian age and its stratigraphic position above the Soudanella? alkhansai Subzone suggests post Lower Cenomanian. The low diversity subzone which is found throughout the Rumaila and Mishrif Formations in South Rumaila Well-104 is overlain by the undoubtedly Lower Turonian Dumontina? mdaouerensis Zone. The Rumaila is traditionally regarded as Upper Cenomanian and there is no reason for disputing this from the evidence of the ostracods. In East Baghdad Well-3 the lower part of the Rumaila Formation is of Lower Cenomanian age (see previous disucssion of Ahmadi Formation), and is possibly of Lower Cenomanian age in Safawi Well-1. This suggests that the Ahmadi/Rumaila contact is diachronous. In Ghalaisan Well-1 the uppermost part of the Rumaila Formation lies within the Dumontina? mdaouerensis zone which is Lower Turonian, suggesting that the upper boundary of the formation is also probably diachronous. In Kifl Well-2 the presence of the Cythereis alfarazdaki Subzone in the Maotsi Formation indicates that the latter is of Upper Cenomanian age. The underlying Mahilban and Fahad Formations may belong to the Soudanella? alkhansai Subzone; if so, this indicates a Lower Cenomanian age.

4. Mishrif Formation:

This formation includes two ostracod zones, the Upper Cenomanian _Cythereis_ _alfarazdaki_ (low diversity subzone) in its lower half and the Lower Turonian _Dumontina_? _mdaouerensis_ zone in its upper half, so it is regarded as being Upper Cenomanian-Lower Turonian in age.

5. _Kifl Formation_:

This formation is only recognised in three wells, Kifl Well-2, Ghalaisan Well-1 and East Baghdad Well-3. In the first two the whole formation lies within the _Dumontina_? _mdaouerensis_ Zone, giving a Lower Turonian age to the formation. The _Dumontina_? _mdaouerensis_ Zone cannot be recognised in East Baghdad Well-3, but the disappearance of the characteristic Cenomanian species _Amphicytherura_ _mishrifensis_ at the Kifl/Rumaila contact suggests a Turonian age for the Kifl Formation at this locality as well.

6. _Khasib Formation_:

The base of this formation is marked by the appearance of many new ostracod species as well as genera such as _Acanthocythereis_ _Brachycythere_, _Buntonia_, _Paracytheridea_, _Phymacythereis_, and _Protobuntonia_. Elements of this new fauna persist through the remainder of the Upper Cretaceous of Iraq, indicating a major faunal break with older Cretaceous horizons. The Khasib Formation in Kifl Well-2, South Rumaila Well-104 and Ghalaisan Well-1 contains the lower part of the _Veeniacythereis_ _ibnalhaithami_ Zone, suggesting an Upper Turonian-Lower Coniacian age. In East Baghdad Well-3 the Khasib Formation has yielded very few ostracods so its age is determined by lithostratigraphic comparison and stratigraphic position.

7. _Tanuma Formation_:

Two ostracods zones may be found in this formation. In Ghalaisan Well-1 and Safawi Well-1 only the _Veeniacythereis_ _ibnalhaithami_ Zone is present; in Kifl Well-2 and South Rumaila Well-104, most of the formation lies within the upper part of Veeniacythereis ibnalhaithami Zone but the topmost part of the formation contains species of Peloriops (Peloriops) alrazii Zone, although these may be due to contamination. In East Baghdad Well-3 the lower half of the formation is within the Veeniacythereis ibnalhaithami Zone and the upper half in the Peloriops (Peloriops) alrazii zone, the latter again may be due to contamination. The older of these zones is regarded as Upper Turonian-Coniacian, the younger as Santonian. This suggests that the Tanuma Formaiton is mainly of Upper Coniacian age, but may include Santonian sediments in East Baghdad Well-3 and perhaps also in Kifl Well-2 and South Rumaila Well-104.

The Khasib Formation has not been recognised in Safawi Well-1 where the lower Tanuma Formation may be contemporaneous with the Khasib Formation of other localities. Thus both the lower and upper boundaries of the Tanuma Formation may be diachronous.

8. Sadi Formation:

Only the base of this formation was sampled and only a few species of ostracods were found in South Rumaila Well-104 and Kifl Well-2. The Peloriops (Peloriops) alrazii zone ranges from the topmost Tanuma Formation to the lower Sadi Formation and together with stratigraphical position this suggests a Santonian age for the Sadi Formation, which is in agreement with Al-Siddiki (1978) and Darmoian (1975).

Correlation of the Ostracod Biozones of Iraq and the Middle East Area:

The biozones erected in Iraq have been correlated with equivalent biozones in the Arabian Gulf, Tunisia and Palestine (Fig. 7.7).

1. Palestine:

The Glenocythere bahreinensis Subzone of Iraq is correlated in age with the basal part of the Neocythere? N. bisulcata Zone and Veeniacythereis jezzineensis Zone of Palestine (Rosenfeld and Raab). The upper part of the Neocythere? N. bisulcata and part of the V. jezzineensis Zone is equivalent to the Soudanella? alkhansai Subzone in this study. The Amphicytherura distincta Zone, Metacytheropteron berbericum Zone and lower part of the Neocyprideis vandenboldi Zone are the correlative of the Cythereis alfarazdaki Subzone of Iraq. The Dumontina? mdaouerensis Zone corresponds to the upper part of the Neocythere vendenboldi Zone and Cythereis rawashensis kenaanensis Zone. Based on the similarities of the zonal index species the Veeniacythereis streblolophata and Veeniacythereis maghrebensis Zone is equivalent in age to the Veeniacythereis jezzineensis Zone.

2. Northern Central Tunisia:

The uppermost "Dicrorygma" aff. GA A22 Zone of Tunisia (Bismuth et al., 1981a) correlates with lower parts of the Glenocythere bahreinensis Subzone, while the basal part of Ostracode B3 zone is equivalent to the upper part of the Glenocythere bahreinensis Subzone in the present work.

The soudanella? alkhansai Subzone of Iraq correlates with the Veeniacythereis streblolophata schista Zone and Ostracode B3 zone. Veeniacythereis streblolophata schista has been used as a zonal marker for the Lower Cenomanian of Tunisia (Bismuth et al., 1981a), but regarded as Upper Cenomanian in Kuwait (Al-Abdul-Razzaq, 1983) although as already discussed it is probable that the Kuwaiti zone is Lower Cenomanian. The Cythereis algeriana and

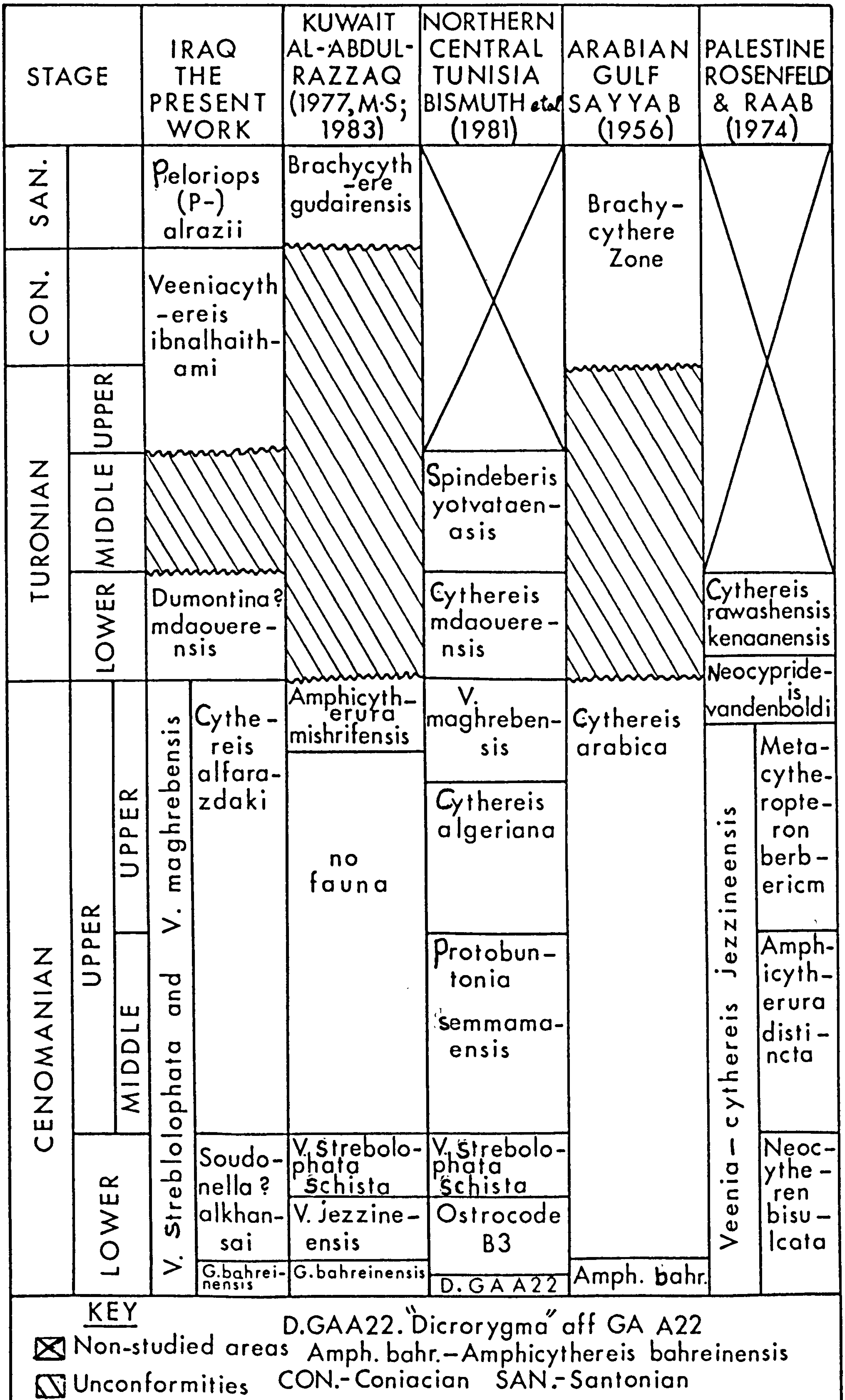


Fig-7-7:-Correlation of the Ostracod Biozones of Iraq and the Middle East areas.

Veeniacythereis maghrebensis zones (Bismuth et al. 1981a), are correlated with the upper half of the Cythereis alfarazdaki Subzone. The Protobuntonia semmamaensis Zone of Tunisia correlates with the lower half of the Cythereis alfarazdaki Subzone. The Dumontina? mdaouerensis Zone is correlated with the Cythereis mdaouerensis Zone on the basis of the same zonal marker and other evidence for a Lower Turonian age. There is a faunal break between the Mishrif Formaiton and the Khasib Formation as well as unconformity. This break probably coincides with the Middle Turonian Spinoleberis yotvataensis zone of Bismuth et al. (1981a) of Tunisia.

3. Arabian Gulf:

The Glenocythere bahreinensis Subzone was first recognised as the Amphicythereis bahreinensis zone by Sayyab (1956, unpublished work). The Cythereis arabica zone of the Arabian Gulf is correlated with the Soudanella ? alkhansai and Cythereis alfarazdaki Subzones. Sayyab remarked that "no proven Turonian rocks have been identified in the south western flank of the Arabian Gulf as yet", indicating a faunal break of Turonian age. The "Brachycythere" zone of the Arabian Gulf is probably equivalent to the upper part of the Veeniacythereis ibnalhaithami and Peloriops (Peloriops) alrazii Zones of Iraq. Sayyab (1956) pointed out that the fauna of the "Brachycythere" zone is clearly Upper Cretaceous, but its exact age is uncertain.

4. Kuwait

The Glenocythejre bahreinensis Subzone was first defined in Kuwait by Al-Abdul-Razzaq (1983), distinguished by the same index species. The Veeniacythereis jezzineensis Zone of Kuwait is not distinguished in Iraq, but some of its species in Iraq cross the boundary of the Glenocythere bahreinensis and Soudanella? alkhansai Subzones, and the others are not recorded in the present work; it and the overlying Veeniacythereis streblolophata schista Zone are correlated with the Subzone Soudanella?

alkhansai of Iraq. Al-Abdul-Razzaq (1983) regarded the Veeniacythereis streblolophata schista zone as Upper Cenomanian; the age determination for the latter zone is not accepted in this study, so it is considered to be Lower Cenomanian (see Soudanella? alkhansai subzone); this species is also used as a zonal marker for the Lower Cenomanian of Tunisia (Bismuth et al 1981a). There is a gap with no recorded fauna in the Upper Cenomanian Rumaila Formation of Kuwait; this is correlated with the Cythereis alfarazdaki Subzone. Al-Abdul-Razzaq recognised the Amphicytherura mishrifensis zone at the base of the Mishrif Formation of Kuwait which she considered as questionable Turonian and she recorded deformed specimens of the species from the Ahmadi Formation of Kuwait. Thus Amphicytherura mishrifensis appears to have a fairly long stratigraphic range but does seem to be characteristic of the Cenomanian. From these observations and from the stratigraphic position of the Mishrif Formation in Iraq, it appears more likely that Al-Abdul-Razzaq's zone is of Upper Cenomanian age rather than Lower Turonian.

Further evidence for this is the lack of any evidence for the Turonian such as the widespread basal Dumontina? mdaouerensis Zone. The absence of the Dumontina? mdaouerensis and Veeniacythereis ibnalhaithami zones of Iraq and the Spinoleberis yotvataenasis and Cythereis mdaouerensis Zones of Northern Central Tunisia indicates the presence of a faunal break in Kuwait of a longer duration than in Iraq. This is equivalent to the Turonian and Coniacian, and is marked by a break in sedimentation, i.e. an erosional unconformity at the top of the Mishrif Formation. The Peloriops (Peloriops) alrazii zone is of Santonian age and corresponds to the lower part of the Brachycythere gudairensis Zone of Kuwait.

The Upper Tanuma Formation may belong to the Peloriops (Peloriops) alrazii Zone and if so it is probably contemporaneous with the lower part of the Gudair Formation of Kuwait.

Conclusions:

The main paleontological conclusions are as follows:

1. Four zones and three subzones can be recognised in the succession of the wells studied in Iraq.

2. The Ahmadi/Rumaila contact is placed at the top of the Soudanella? alkhansai Subzone in Ghalaisan Well-1.

3. The lower part of the Rumaila Formation in East Baghdad Well-3 is considered to be of Lower Cenomanian age and is contemporaneous with the Ahmadi Formation.

4. The lower part of the Rumaila Formation in Safawi Well-1 is possibly of Lower Cenomanian age and therefore would be contemporaneous with the Ahmadi Formation.

5. The Ahmadi/Rumaila contact is diachronous between Safawi Well-1 and East Baghdad Well-3. ~~and Ghalaisan Well-1.~~

6. The Maotsi Formation is probably of Upper Cenomanian age and the Mahilban and Fahad Formations may be of Lower Cenomanian age in Kifl Well-2.

7. A Lower Turonian age is assigned to the Kifl Formation.

8. The age of the Khasib Formation in East Baghdad Well-3 is based on lithological composition and stratigraphic position.

9. A Santonian age is probable for the topmost Tanuma Formation in Kifl Well-2 and South Rumaila Well-104, and the upper half of this Formation in East Baghdad Well-3.

10. The lowest part of the Tanuma Formation in Safawi Well-1 may be contemporaneous with the Khasib Formation of other localities.

11. The lower and upper boundaries of the Tanuma Formation may be diachronous.

12. The Ahmadi Formation in Kifl Well-2 is regarded as Lower Cenomanian by its lithostratigraphic composition and stratigraphic position.

13. The age of the upper part of the Mauddud Formation is considered more likely to be basal Cenomanian than Albian.

14. Three faunal breaks can be recognized, marked by unconformities (See Fig. 7.7). The first break in Iraq is of short duration during the Middle Turonian, between the ostracod biozones of Dumontina? mdaouerensis and Veeniacythereis ibnalhaithami. The second faunal break is found in the Arabian Gulf during the whole Turonian and lies between the Cythereis arabica Zone and Brachycythere Zone. The Third faunal break is recognized in Kuwait where it has a longer duration than in Iraq and other Arabian Gulf areas during the Turonian and Coniacian separating the Amphicytherura mishrifensis and Brachycythere gudairensis ostracod biozones.

CHAPTER - 8

ENVIRONMENTS OF DEPOSITIONS OF THE FORMATIONS STUDIED

ENVIRONMENTS OF DEPOSITIONS OF THE FORMATIONS STUDIED

The interpretation of the environment of deposition of the formations is based on the characteristic species and sediments of each formation.

1. Ahmadi Formation:

The occurrence of Cythereis, Veeniacythereis, and Metacytheropteron in the Ahmadi Formation indicates an open shallow water neritic environment (e.g. Bassoullet and Damotte, 1969, and Rosenfeld and Raab, 1974).

Al-Abdul-Razzaq (1977, M.S., 1983) suggested that the Ahmadi Formation of Kuwait was mainly deposited in shallow water (inner sub-littoral conditions) on the basis of the ostracods and type of sediments. She pointed out that as only benthonic ostracods and foraminifers are reported from the upper part of the Lower Ahmadi Limestone Member, deposition was under shallower water conditions than the basal strata of this member, while the Upper Ahmadi shale member was deposited under very shallow water with reducing conditions based on the decreasing number of ostracods species and the presence of abundant pyritic ostracods. Gaddo (1971); and Al-Naqib (1967) suggested shallow water neritic conditions for this Formation in Iraq.

Al-Siddiki (1978) pointed out that the Ahmadi Formation can be considered as a neritic and sub-basinal facies on the presence of shales with ostracods and biomicrite with Oligostegina spp., Lagenidea, Globigerina, and Alveolinidea. Buday (1980) indicated that the Ahmadi Formation represents shallow water conditions with strong terrigenous influence in a marine basin, fringing the huge Wasia delta in Saudi Arabia. Thus in general the diversity of ostracode species and the type of sediment in the Ahmadi Formation suggests open neritic conditions. The poor diversity of species in the Ahmadi Formation of Kifl Well-2 is probably due to preservation. Towards the south west of Iraq in Safawi Well-1 the lithological character of the Ahmadi Formation changes to become dominated by red, brown, and green fissile silty shales containing glauconite near the base; a rare fauna with only Veeniacythereis has been recorded. This may indicate some restriction in the area of deposition.

2. Rumaila Formation:

This Formation is distinguished by a low species diversity and poor ostracode fauna, but this is considered more likely to be due to preservation rather than a reflection of the environmental conditions, especially in Kifl Well-2, South Rumaila Well-104, Ghalaisan Well-1, and Safawi Well-1. In the latter well the lower part of the Rumaila Formation is marked by the presence of Veeniacythereis, Cythereis and Amphicytherura indicating open shallow water neritic conditions. The sediment of the uppermost part of the formation in the Ghalaisan Well-1 are recrystallised limestones with chert lenses at the top and with a poor ostracode fauna, suggesting a shallower marine environment. In East Baghdad Well-3, the upper part of the Rumaila Formation is a limestone and clay with a very poor ostracode fauna dominated by Ovocytheridea. This indicates near-shore coastal conditions possibly in an area with restricted access to the open sea. Al-Siddiki (1978) regarded the Rumaila Formation as being deposited in basinal neritic conditions due to the foraminiferal fauna of Globigerinidea, Heterohelix spp, Oligostegina ssp, and Alveolinidae. James and Wynd (1965) pointed out that the "Oligostegina" limestone bed in the upper part of the Sarvak Formation (which is equivalent to the Rumaila Formation) represents a deeper marine environment in parts of the Coastal Fars Province of Iran. Gaddo, 1971, and Al-Naqib, 1967, indicate a deeper sea during the deposition of this Formation than for the Ahmadi Formation. Buday (1980, p.148) mentioned that the "Rumaila Formation was deposited in a deeper, subsiding basin with locally and temporarily occurring lagoonal conditions, connected mainly in the north with anomalous salinity, testified by the dwarfed character of the fauna. The deeper basinal conditions were temporarily interrupted and neritic normal saline sedimentation took place. In the north terrigenous clastic indicates the nearby continent and local oscillations". Thus, generally the Rumaila Formation indicates deeper water conditions than those of the Ahmadi Formation. These conditions were shallower with some restriction from the sea in some areas.

3. Mishrif Formation:

The ostracod fauna of this formation is small with a low diversity. The presence of Dumontina and Veeniacythereis indicate open shallow water neritic conditions; the presence of the massive limestone with chert at the top of this Formation in Safawi Well-1 indicates neritic conditions, probably followed by shallowing of the sea. In South Rumaila, Well-104, fossiliferous calcareous and marly limestone and streaks of shale in the lower part of the formation pass upwards into compact, pyritic limestones with rare fossils, terminating with limonitic limestones, suggesting deeper water condition in the lower part, shallowing upwards and ending probably with an influx of fresh water causing deposition of the limonitic fresh-water limestone; the latter limestone contains charophytes according to Al-Siddiki, (1978); Buday, (1980); Dunnington et al., (1959); and Al-Naqib, (1967). El-Naggar and Al-Refaiy, (1972) (in Al-Abdul-Razzaq, 1977, M.S.) and Al-Abdul-Razzaq, (M.S., 1977) suggest that the basal part of the Mishrif in Kuwait indicates deeper water conditions than those for the Ahmadi Formation on the basis of the presence of planktonic foraminiferal assemblages and the ostracod Amphicytherura. The Mishrif Formation is a heterogenous Formation with Rudist biostromes and intervening lagoonal, algal, neritic and sub-basinal facies according to Gaddo (1971), Al-Siddiki (1978), reflected by the presence of reef detritus (mainly Rudist) with some corals, echinoids, biomicrites with Alveolinidae, Peneroplidae and Miliolidae and clayey biomicrite with Globigerinidae and Heteroheliv ssp (Al Siddik). These facies are terminated by a fresh-water facies, i.e. a biosparite with charophytes. This represents a shallowing phase associated with oscillation of sea level.

4. Kifl Formation:

The Kifl Formation has very rare ostracods and it is composed of evaporitic sediments with limestones, subordinate shale and dolomite. This suggests a shallowing of the sea accompanied by the development of totally or partly enclosed lagoons resulting from the tectonic movements which started during the early Turonian. The presence of a few open neritic and near-shore ostracods indicates partial connection with the open sea. This interpretation agrees with many workers such as Al-Naqib (1967) who proposed that a closed sea starting during the Upper Cenomanian and Early Turonian led to deposition of the evaporitic lagoonal Kifl Formation, and Buday (1980) who believed that the Kifl Formation represents a relict, hypersaline lagoon with some fresh-water influx in some places.

5. Khasib Formation:

The occurrence of Cythereis, Acanthocythereis, Dumontina, Brachycythere. Buntonia, Protobuntonia Paracytheridea, the diversity of the ostracod fauna, and the sediments (calcareous, shally marly, deterital limestones and chalk), indicate open shallow water marine conditions (infraneritic environment). In East Baghdad Well-3 Ostracods are rare, the only genus recorded being Ovocytheridea; this suggests coastal conditions, perhaps with restricted access to the open sea. In general many workers suggest a similar environment, e.g. Al-Siddiki (1978) suggested a sub-basinal facies with some lagoonal and neritic conditions as evidenced by the presence of clayey biomicrite containing Oligostegina spp, Heteroheliv spp. and Globigerinidae; biosparites with Textularidae and Miliodiae and Rudists reefs; Darmoian (1975) suggested that the basal part of the Khasib Limestone and Shale Member in some areas was deposited under warm shallow water conditions in partial communication with the open sea due to the abundance of porcelaneous and arenaceous species and the presence of small sized species, while in the upper part of the formation the abundance of planktonic foraminifers and rarity of benthonic foraminifera indicates an open sea, Buday (1980) stated that the environment of deposition of this formation was mostly lagoonal based on the predominance of an Oligosteginal fauna with other dwarfed fauna, although marine conditions are also indicated on the evidence of Globotruncana, Globigerina and Gumbelina.

This Formation represents the start of a transgressive phase of Late Turonian age.

6. Tanuma Formation:

An open shallow water infra-neritic environment is indicated by the diversity of the ostracod fauna with genera such as Acanthocythereis, Brachycythere, Dumontina, Paracytheridea, Protobuntonia, Buntonia and Cythereis, and also by the type of sediment, i.e. shales with some calcareous sediments. In East Baghdad Well-3 and Kifl Well-2, the presence of Ovocytheridea together with the genera listed above might indicate rather shallower more coastal conditions. Darmoian indicated that the Tanuma Shale Member was deposited in a sea with direct connections to the open sea due to the occurrence of rare benthonic forams and abundance of planktonic forams; Al-Siddiki (1978), considered subbasinal and shallow water conditions for this formation reflected by the shale with ostracods and Globigerinidae and the oosparite, while Buday (1980) suggested that the formation represents near shore conditions, sometimes with restricted communication with the open sea and with partly euxinic, partly lagoonal episodes during its development (oolitic limestones, pyrite contents, etc.).

CHAPTER - 9

CONCLUSIONS

CONCLUSIONS

The Cenomanian-Santonian of the area studied (i.e. south eastern, south western and central Iraq) has been dividied into four ostracod biostratigraphical zones and three subzones based on the superfamily Cytheracea.
These are from oldest to youngest, the Veeniacythereis streblolophata-Veeniacythereis maghrebensis - Total Range Zone (A-1), which is divided into three subzones: Glenocythere bahreinensis - Total Range Subzone (A-1a), Soudanella? alkhansai -Assemblage Sub Zone (A-1b), and the Cythereis alfarazdaki - Assemblage Subzone (A-1c); the Dumontina? mdaouerensis - Partial Range Zone (A-2); the Veeniacythereis ibnalhaithami Partial Range Zone (A-3); and the Peloriops (Peloriops) alrazii - Partial Range Zone (A-4).
A Cenomanian age is assigned to the A-1 zone, the A-1a and A-1b Subzones are of Lower Cenomanian age and the A-1c Subzone is of Upper Cenomanian age, a Lower Turonian age has been suggested for the A-2 Zone, Upper Turonian-Coniacian for the A-3 Zone, and a Santonian age has been determined to the A-4 Zone.
The Lower Cenomanian Glenocythere bahreinensis -Total Range Subzone is also recognised in Kuwait (Al-Abdul-Razzaq, 1977, M.s., 1983) and in the Western Coast of the Arabian Gulf (Sayyab, 1956); and the Veeniacythereis streblolophata-Veeniacythereis maghrebensis Total Range Zone is also recognised as the Veeniacythereis jezzineensis Zone in Palestine (Rosenfeld and Raab, 1974).

The environments of deposition of the formations studied has been determined as follows. The Ahmadi Formation was deposited in an open shallow water neritic environment with possible restriction in the area of Safawi Well-1. The Rumaila Formation is distinguished by a low species diversity and poor ostracods fauna which is considered to be due to preservation rather than a reflection of the environmental conditions; in East Baghdad Well-3 it has a

poor fauna dominated by Ovocytheridea which probably indicates near shore coastal conditions. In general the formation was deposited in deeper water than the Ahmadi Formation. The Mishrif Formation also has a small ostrcods fauna with low diversity and is indicational of open shallow water neritic conditions followed by a shallowing phase associated with oscillations of sea level, or with influx of fresh water causing the deposition of limonitic fresh-water limestones. The Kifl Formation has very rare ostracods and indicates a shallowing of the sea accompanied by the development of totally or partly enclosed lagoons; the presence of a few open neritic and near-shore ostracods indicates partial connection with the open sea. The Khasib Formation was deposited in open shallow water marine conditions (infra-neritic environment); in East Baghdad Well-3 ostracods are rare, but the dominance of Ovocytheridea suggests coastal conditions, perhaps with restricted acces to the open sea.
The diversity of the ostracods fauna and type of sediment of the Tanuma Formation suggests open shallower water infra-neritic environment; in East Baghdad Well-3 and Kifl Well-2 the presence of Ovocytheridea might indicate rather shallower more coastal conditions.

Studies on size variation indicate continuous rather than discontinuous variation, smaller specimens are considered to be adults, but no conclusions have been reached concerning environmental or genetic control.
Intraspecific variation in ornamentation of the ostracods studied may be continuous or discontinuous. In the first case it is difficult to separate them into morphotypes, while in the second case the recognition of distinct morphotypes is possible. Both types of variation are considered to be of genetic origin, the second type is believed to indicate polymorphism.

CHAPTER - 10

APPENDIX

APPENDIX

1. Sample preparation techniques:

The samples have been processed by soaking in 30% hydrogen peroxide containing five sodium hydroxide pellets for at least 5 hours, then water was added and the samples were boiled for 4 hours. The residue was washed to remove the finer inorganic particles and sieved into three fractions: 600μ, 600-250μ, 250-150μ classified as coarse, medium and fine. Finally the samples were dried in an oven at 50°C. The dried residue was packed in labelled vials, and the medium fraction of 550 picked for study.

2. Cleaning methods for specimens:

If necessary the following cleaning techniques were used:

A. Dacon method

The specimens were soaked in Dacon overnight, and the remaining particles were removed with a sharpened needle.

B. Manual method

The specimens were soaked in water for five to fifteen minutes, placed on a slide with a drop of water and the remaining particles removed with a sharp needle.

C. Hydrogen Peroxide method

The specimens were soaked in 20% hydrogen peroxide solution for 1-2 hours and the remaining particles were removed with a sharp needle. The duration of soaking is dependent upon the strength of the specimen and thickness of the dirt particles.

D. Ultrsonic method

This method was rarely used for cleaning specimens because of damage, breakage and recrystallisation which destroyed the ornamentation.

3. <u>S.E.M. preparation techniques</u>:

The stub was smeared with a thin film of Pritt adhesive and the specimens placed on the stub with a wet brush, left for 15 minutes and then placed under an intensity lamp for 30 minutes. The surface of the dry adhesive was scratched for better conductivity and then coated with gold and examined under the S.E.M. Specimens were removed from the stub by soaking in a drop of water using a wet brush.

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