Cenomanian—Turonian ostracods from Gebel Nezzazat, southwestern Sinai, Egypt, with observations on $\delta^{13}$C values and the Cenomanian/Turonian boundary.

ABDALLA SHAHIN
Geology Department, Faculty of Science, Mansoura University, Egypt

ABSTRACT — 96 surface samples from the Cenomanian—Turonian succession of Gebel Nezzazat, southwestern Sinai, Egypt were examined for ostracods. 45 species and varieties have been recognised with one new species, Pterygocythere bisulcata sp. nov., and four left in open nomenclature. Most species have been recorded in rocks of the same age in the Middle East and North Africa, and some from West Africa, Europe and South America suggesting biogeographic relationships between these regions. Three local ostracod zonal assemblages are established, two in the Cenomanian and one in the Turonian. The ostracods and associated foraminifera and megafossils, suggest a shallow marine environment, sometimes with restricted marine water and in part brackish. The Oceanic Anoxic Event of the Late Cenomanian is recognised on the evidence of $\delta^{13}$C values; ostracod diversity has a negative relationship to $\delta^{13}$C values.

INTRODUCTION

This study deals with the systematic examination of Cenomanian—Turonian ostracods from Gebel Nezzazat, southwestern Sinai (Fig. 1). The Cenomanian—Turonian marine exposure is represented herein by three lithostratigraphic units:

Wata Formation (Turonian)
Dolomitic limestone with shale, marl and sandstone intercalation (80m).

Abu Qada Formation (Late Cenomanian)
Shale, marl and limestone intercalation (35m).

Raha Formation (Early Cenomanian)
This is divided into the Mellaha sand Member, sandstone with some shale and limestone intercalation (35m), and the Abu Had Member, shale, marl and limestone intercalation (32m) overlying the Malha Formation of Early Cretaceous age.

The age determination of these formations is based on the foraminiferal and megafossil content (Shahin 1988). The present study is carried out to complete the picture of the Cenomanian—Turonian ostracods and to shed some light on their habitat and palaeogeographic distribution.

Few studies have been carried out on the Cenomanian—Turonian ostracods of Egypt. Bold (1964) described 33 species from the Cenomanian—Campanian of the Abu Roash area. Colin & El Dakkak (1975) studied the Cenomanian ostracods of Gebel Nezzazat and recorded only 5 species. Boukhary et al. (1977) recorded 10 species from the Cenomanian of northern Galala, Eastern Desert.

The systematics and terminology follow that of the Treatise (Moore, 1961). The abbreviations, L, H, W in the descriptions refer to length, height and width (in µm) respectively. All material is deposited in the Department of Geology, Faculty of Science, Mansoura University, Egypt under the catalogue number SHN.

SYSTEMATIC DESCRIPTIONS

Subclass: Ostracoda Latreille, 1806
Order: Podocopida Müller, 1894
Suborder: Platycopina Sars, 1866
Family: Cytherellidae Sars, 1866
Genus: Cytherella Jones, 1849

Cytherella anterornarginata Babinot, 1980
(Pl. 1, figs 1-2)

Material. 5 carapaces; SHN 100
Horizon. Samples 16, 18, 31 (Cenomanian) and 90 (Late Turonian)
Dimensions. L 460, W 200, H 340
Remarks. This species was recorded from the Early Cenomanian of France (Babinot, 1980).

Cytherella cf. eosulcata Colin, 1973
(Pl. 1, figs 3-4)

Material. 29 well preserved carapaces and 4 right valves; SHN 101
Horizon. Samples 16-31, 56 (Cenomanian) and 90 (Late Turonian)
Dimensions. L 720, W 380, H 640
Remarks. Cytherella eosulcata was originally described from the Cenomanian of France (Colin, 1973). It was also recorded in the Late Turonian of France (Babinot, 1980). The Egyptian species differs from Colin's by having a thicker carapace and more pointed posterior end. It is distinguished from Cytherella sulcata Rosenfeld 1974 by the absence of the characteristic longitudinal sulcus in the right valve.

Cytherella cf. ovata Roemer, 1840
(Pl. 1, fig. 5)

1840 Cytherina ovata Roemer: 104, Pl. 16, Fig. 21
Material. 6 carapaces; SHN 102
Horizon. Samples 16, 18, Early Cenomanian
Cytherella cf. parallela (Reuss, 1845)
(Pl. 1, figs 6, 7)
1958 Cytherella cf. parallela (Reuss); Oertli: 1501, Pl. 1, figs 1-9
1974 Cytherella cf. parallela (Reuss); Rosenfeld & Raab: 3, Pl. 1, figs 1, 2
1980 Cytherella cf. parallela (Reuss); Babinot: Pl. 2, figs 4, 5
Material. 6 carapaces; SHN 103
Horizon. Samples 31, 47 (Cenomanian) and 90 (Late Turonian)
Dimensions. L 520, W 180, H 260
Remarks. This species was recorded from the Early Cretaceous and Cenomanian to Coniacian of France (Oertli, 1958 and Babinot, 1980) and the Cenomanian—Turonian of Algeria (Bassoullet & Damotte, 1969) and Israel (Rosenfeld & Raab, 1974).

Cytherella postangulata Babinot, 1980
(Pl. 1, figs. 8, 9)
1980 Cytherella postangulata Babinot: Pl. 2, figs 6-10
Material. 6 carapaces and some valves; SHN 104
Horizon. Samples 16, 22, 30 and 31, in the Cenomanian
Dimensions. L 560, W 240, H 340
Remarks. This species was recorded from the Cenomanian of France (Babinot, 1980).

Cytherella sulcata Rosenfeld, 1974
(Pl. 1, figs 10, 11)
1959 Ostracod U-10 Glintzboekel & Magné: 64, Pl. 3, fig. 31
1969 Cytherella U-10 (Glintzboekel & Magné); Grekoff: 233, Pl. 1, fig. 6
1973 Cytherella U-10 (Glintzboekel & Magné); Grosdidier: Pl. 1, fig.
### Cenomanian/Turonian Ostracods from Sinai, Egypt

#### Ostracodal Assemblage

| FORAMINIFERAL ZONES (Shahin, 1988) | OSTRACODAL ASSEMBLAGE |
|-----------------------------------|------------------------|
| 1 Cytherella anteromarginata      | 1 Cytherella anteromarginata |
| 2 Cytherella eusulcata             | 2 Cytherella eusulcata |
| 3 Cytherella gp. ovata             | 3 Cytherella gp. ovata |
| 4 Cytherella postangulata          | 4 Cytherella postangulata |
| 5 Horrigocythere donzei            | 5 Horrigocythere donzei |
| 6 Metacytheropteron berericus      | 6 Metacytheropteron berericus |
| 7 Paracypris acutocaudata          | 7 Paracypris acutocaudata |
| 8 Veenia (Nigeria) inornata        | 8 Veenia (Nigeria) inornata |
| 9 Veeniacythereis jezzineensis     | 9 Veeniacythereis jezzineensis |
| 10 Veeniacythereis maghrebensis    | 10 Veeniacythereis maghrebensis |
| 11 Bairdia pseudoseptentriohalis   | 11 Bairdia pseudoseptentriohalis |
| 12 Dolacytheridea atlantica        | 12 Dolacytheridea atlantica |
| 13 Ovocytheridea hispanica         | 13 Ovocytheridea hispanica |
| 14 Bairdia alexanderi             | 14 Bairdia alexanderi |
| 15 Bairdia cenomanica              | 15 Bairdia cenomanica |
| 16 Cytherella sulcata              | 16 Cytherella sulcata |
| 17 Cythereis cretaria acuta        | 17 Cythereis cretaria acuta |
| 18 Xestoleberis derorimensis       | 18 Xestoleberis derorimensis |
| 19 Brachycythere angulata          | 19 Brachycythere angulata |
| 20 Brachycythere sapaucarinsis     | 20 Brachycythere sapaucarinsis |
| 21 Bythocypris windhami            | 21 Bythocypris windhami |
| 22 Cythereis fahlioni              | 22 Cythereis fahlioni |
| 23 Cythereis namkusensis           | 23 Cythereis namkusensis |
| 24 Cythereis rawashensis rawashensis | 24 Cythereis rawashensis rawashensis |
| 25 Cytherella cf. paraliella       | 25 Cytherella cf. paraliella |
| 26 Ovocytheridea caudata           | 26 Ovocytheridea caudata |
| 27 Paracypris mdaouerensis         | 27 Paracypris mdaouerensis |
| 28 Pterygowythere bisulcata        | 28 Pterygowythere bisulcata |
| 29 Planileberis praetexata arta    | 29 Planileberis praetexata arta |
| 30 Ovocytheridea apiformis         | 30 Ovocytheridea apiformis |
| 31 Dondoniella sp.                 | 31 Dondoniella sp. |
| 32 Bythocypris adunca              | 32 Bythocypris adunca |
| 33 Cythereis hirsuta               | 33 Cythereis hirsuta |
| 34 Krithe whitecliffensis          | 34 Krithe whitecliffensis |
| 35 Krithe sp.                      | 35 Krithe sp. |
| 36 Bairdopilata cuvillierion omnipraesens | 36 Bairdopilata cuvillierion omnipraesens |
| 37 Cythereis cretaria              | 37 Cythereis cretaria |
| 38 Rehacythereis guadalajarensis   | 38 Rehacythereis guadalajarensis |
| 39 Isoxythere elongata             | 39 Isoxythere elongata |
| 40 Oertliella donzei               | 40 Oertliella donzei |
| 41 Dolocytheridea crassa           | 41 Dolocytheridea crassa |
| 42 Ovocytheridea reniformis        | 42 Ovocytheridea reniformis |
| 43 Xestoleberis semenulata         | 43 Xestoleberis semenulata |
| 44 Asciocythere polita             | 44 Asciocythere polita |
| 45 Neocyprideis vandenboldi        | 45 Neocyprideis vandenboldi |

Fig. 2. Ostracod range chart and lithostratigraphy of the Cenomanian—Turonian succession in Gebel Nezzazat.
Horizon. 4 Cenomanian of Israel (Rosenfeld Remarks. Dimensions. Material.

Grosdidier, 1973). 

Dimensions. horizon. 3-6; P1.1, figs 1-4

1981 Cythereella sulcata Rosenfeld; Bismuth et al.: 223, Pl. 6, figs 3-4

Material. 15 carapaces; SHN 105

Horizon. Samples 20-56 (Cenomanian) and 90 (Late Turonian)

Remarks. This species was characterized by a longitudinal sulcus on the right valve of the carapace. It was recorded from the Cenomanian of Israel (Rosenfeld & Raab, 1974), Tunisia (Glintzboekel & Magné, 1959, Grekoff, 1969 and Bismuth et al., 1981) and Iran (Grosdidier, 1973).

Superfamily: Bairdiacea Sars, 1888

Family: Bairdiidae Sars, 1888

Genus: Bairdia McCoy, 1844

Bairdia cf. alexanderi Blake 1950

(Pl. 1, figs/12, 13)

Material. 7 carapaces; SHN 106

Horizon. Samples 20, 31, 56 (Cenomanian) and 90 (Late Turonian)

Dimensions. L 780, W 400, H 480

Remarks. Bairdia alexanderi was originally described by Blake (1950) from the Cenomanian of the Gulf Coast area and to that of Breman (1976) recorded from the Early Turonian of central Spain.

Bairdia pseudoseptentrionalis (Mertens, 1956)

(Pl. 1, figs 16, 17)

1956 Bairdoppilata pseudoseptentrionalis Mertens: 182, Pl. 8, figs 7-10, Pl. 13, figs 89-90

1965 Bairdia pseudoseptentrionalis (Mertens); Kaye: 223, Pl. 2, figs 3-6

1971 Bairdia pseudoseptentrionalis (Mertens); Keen & Siddiqui: 63, Pl. 1, fig. 2

1980 Bairdia pseudoseptentrionalis (Mertens); Babinot: Pl. 3, figs 8-12

Material. 18 carapaces; SHN 108

Horizon. Samples 18, 56 (Cenomanian)

Dimensions. L 800, W 380, H 520

Remarks. This species was first described from the Cenomanian of northwest Germany by Mertens (1956) and subsequently recorded from the Albian of England (Kaye, 1965), the Cenomanian of North Ireland (Keen & Siddiqui, 1971) and France (Babinot, 1980).

Genus: Bairdoppilata Coryell, Sample and Jenning, 1935

Bairdoppilata sp.

(Pl. 1, fig 18)

Diagnosis. This species is characterized by its punctate surface, strongly arched dorsal margin and slightly convex ventral margin.

Material. 2 carapaces and 1 deformed valve; SHN 109

Horizon. Samples 46 (Cenomanian) and 90 (Late Turonian)

Dimensions. L 260, W 140, H 160

Remarks. This species is very similar to Bairdoppilata sp. of Craneford (1965) recorded from the Late Cenomanian of the Gulf Coast area and to that of Breman (1976) recorded from the Early Turonian of central Spain.

Genus: Bythocypris Brady, 1880

Bythocypris adunca Esker, 1958

(Pl. 2, fig 1)

1968 Bythocypris adunca Esker: 321, Pl. 2, figs 10-12; Pl. 4, fig. 4

1982 Abyssocypris ? adunca (Esker); Donze et al.: 281, Pl. 2, figs 3-4

Material. 3 carapaces and 2 valves; SHN 110

Horizon. Samples 43-46, 50 (Late Cenomanian)

Dimensions. L 520, W 220, H 160

Remarks. This species was originally described from the Danian of Tunisia (Esker, 1968). It is very similar to Abyssocypris ? adunca (Esker) described by Donze et al. (1982) from the Maastrichtian of Tunisia.

Bythocypris windhami Butler & Jones, 1957

(Pl. 1, fig. 19)

Explanation of Plate 1.

Figs 1, 2 Cythereella anteromarginata Babinot, sample 16, lateral view, x85 and dorsal view, x82 respectively.

Figs 3, 4 Cythereella cf. eosaluta Colin, samples 16, 18, lateral view, x73 and dorsal view, x60 respectively.

Fig. 5 Cythereella gr. ovata (Roemer), sample 16, lateral view, x112.

Figs 6, 7 Cythereella parallela (Reuss), sample 31, lateral view, x135 and dorsal view, x145 respectively.

Figs 8, 9 Cythereella postangulata Babinot, sample 16, lateral view, x87 and dorsal view, x87 respectively.

Figs 10, 11 Cythereella sulcata Rosenfeld, sample 20, lateral and dorsal views, x115, 90 respectively.

Figs 12, 13 Bairdia cf. alexanderi Blake, sample 56, lateral and dorsal views, x82, 47 respectively.

Figs 14, 15 Bairdia cenomanica Babinot, sample 31, lateral and dorsal views, x82, 73 respectively.

Figs 16, 17 Bairdia pseudoseptentrionalis (Mertens), sample 18, lateral and dorsal views, x56, 55 respectively.

Fig. 18 Bairdoppilata sp. sample 46, x155.

Fig. 19 Bythocypris windhami Butler & Jones, sample 31, x66.
1957 *Bythocypris windhami* Butler & Jones: 12-13, Pl. 1, figs a-e
1965 *Bythocypris windhami* Butler & Jones; Crane: 197, Pl. 1, fig. 1
?1974 *Bythocypris* sp.1 Rosenfeld & Raab: 6, Pl. 1, figs 17-18
1984 *Bythocypris windhami* Butler & Jones; Honigstein: 10, Pl. 3, figs 1-3

**Material.** 3 carapaces; SHN 111

**Horizon.** Samples 31, 42, (Late Cenomanian)

**Dimensions.** L 680, W 260, H 320

**Remarks.** This species was first recorded from the Campanian of Louisiana (Butler and Jones, 1957). It was recorded from the Late Cenomanian of the Gulf Coast area (Crane, 1965), and the Coniacian to Campanian of Israel (Honigstein, 1984). *Bythocypris* sp.1 of Rosenfeld & Raab (1974) is similar to this species except for the prominent angular convexity of the dorsal margin of the former species.

Superfamily: Cypridacea Baird, 1845

Family: Paracyprididae Sars, 1923

Genus: *Paracypris* Sars, 1866

*Paracypris acutocaudata* Rosenfeld, 1974

(Pl. 2, fig. 2)

1974 *Paracypris acutocaudata* Rosenfeld: 8, Pl. 1, figs 22-24
1985 *Paracypris* sp. Honigstein & Rosenfeld, 451, Pl. 2, fig. 11

**Material.** about 40 carapaces; SHN 112

**Horizon.** Samples 16-56 (Cenomanian), 57 and 90 (Turonian)

**Dimensions.** L 520, W 220, H 160

**Remarks.** This species was described from the Late Cenomanian of Israel (Rosenfeld and Raab, 1974). It was also reported from the Cenomanian of the western side of the Gulf of Suez, Egypt (Boukhary et al., 1977). *Paracypris* sp. of Honigstein & Rosenfeld (1985) recorded from the Turonian of Israel is similar to this species. It is distinguished from *Paracypris siliqua* Jones & Hinde (1890) in having a concave ventral margin, and from *P. mdaouerensis* Bassoullet & Damotte (1969) by having a more pointed posterior end and concave ventral margin.

*Paracypris mdaouerensis* Bassoullet & Damotte, 1969

(Pl. 2, figs 2, 3)

1969 *Paracypris mdaouerensis* Bassoullet & Damotte: 140, Pl. 2, fig. 10 a-d
1974 *Paracypris mdaouerensis* Bassoullet & Damotte; Rosenfeld & Raab: 7, Pl. 2, figs 29-31
1985 *Paracypris mdaouerensis* Bassoullet & Damotte; Lipson-Benitah et al.: 107, Fig. 4g

**Material.** 9 carapaces and some valves; SHN 113

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**Explanation of Plate 2.**

- **Fig. 1** *Bythocypris adunca* Esker, sample 46, x135.
- **Fig. 2** *Paracypris acutocaudata* Rosenfeld, sample 18, x135.
- **Figs 3, 4** *Paracypris mdaouerensis* Bassoullet & Damotte, sample 31, lateral and dorsal views, x96, 70 respectively.
- **Fig. 5** *Brachycythere angulata* Grekoff, sample 31, x82.
- **Figs 6, 7** *Brachycythere sapaucariensis* Krömmelbein, sample 31, lateral and dorsal views, x102, 82 respectively.
- **Fig. 8** *Dorodoniella* sp. sample 42, x185.
- **Figs 9, 10** *Pterygocythere bisulcata* sp. nov., Holotype samples 31, 34, lateral and dorsal views, x124, 135 respectively.
- **Figs 11, 12** *Asciocythere cf. polita* Damotte, sample 93, lateral and dorsal views, x73.
- **Figs 13, 14** *Dolocythereidae atlantica* Bassoullet & Damotte, sample 31, lateral and dorsal views, x98.
- **Fig. 15** *Dolocythereidae crassa* Damotte, sample 50, x140.
- **Fig. 16** *Ovocythereidae apiformis* Breman, sample 31, x70.
- **Figs 17, 18** *Ovocythereidae caudata* Bold, sample 30, lateral and dorsal views, x73, 65 respectively.
- **Figs 19, 20** *Ovocythereidae hispanica* Breman, sample 31, lateral and dorsal views, x73, 96 respectively.

**Horizon.** Samples 16-54, (Cenomanian)

**Dimensions.** L 460, W 240, H 240

**Remarks.** This species was first described from the Cenomanian and Turonian of Algeria by Bassoullet & Damotte (1969). It occurs in the Cenomanian and Early Turonian of Israel (Rosenfeld & Raab, 1974 and Lipson-Benitah et al., 1985).

- Superfamily: Cytheracea Baird, 1850
- Family: Brachycytheridae Puri, 1954
- Genus: *Brachycythere* Alexander, 1933
- *Brachycythere angulata* Grekoff, 1951

(Pl. 2, fig. 5)

1951 *Brachycythere lediforme angulata* Grekoff: 28, Pl. 2, figs 11-12
1964 *Brachycythere angulata* Grekoff; Bold: 222, Pl. 13, Fig. 15
1984 *Brachycythere angulata* Grekoff; Honigstein: 16, Pl. 5, figs 1-7; Pl. 12, fig. 2

**Material.** 4 carapaces; SHN 114

**Horizon.** Samples 31, 50, (Cenomanian)

**Dimensions.** L 560, W 320, H 320

**Remarks.** This species was originally described from the Santonian of Cameroun by Grekoff (1951) and subsequently from the Coniacian—Santonian of Algeria (Grekoff, 1969), the Campanian of West Africa (Apostolescu, 1961), the Turonian of Egypt (Bold, 1964), the Santonian of Lebanon (Damotte & Saint-Marc, 1972) and the Senonian of Israel (Honigstein, 1984).

*Brachycythere sapaucariensis* Krömmelbein, 1964

(Pl. 2, figs 6, 7)

1964 *Brachycythere sapaucariensis* Krömmelbein: 490, Pl. 44, figs 1-5
1981 *Brachycythere sapaucariensis* Krömmelbein; Bismuth et al.: 228, Pl. 6, figs 13-16

**Material.** SHN 115

**Horizon.** Samples 31, 42, in the Late Cenomanian

**Dimensions.** L 440, W 220, H 240

**Remarks.** This species was first described from the Early Turonian of Brazil by Krömmelbein (1964) and subsequently from the Coniacian of Gabon (Krömmelbein, 1966). Other occurrences of this species are in the Late Turonian of Tanzania (Bate & Bayliss, 1969), the Cenomanian—Turonian of western Africa (Grosdidier, 1979) and in the Cenomanian of Tunisia (Bismuth et al., 1981).
Cenomanian/Turonian Ostracods from Sinai, Egypt
Genus: *Dordoniella* Apostolescu, 1955

*Dordoniella* sp.

(Pl. 2, fig. 8)

**Diagnosis.** Concave ventral margin and pointed end

**Material.** 1 carapace - SHN 116

**Horizon.** Sample 42, Late Cenomanian

**Dimensions.** L 420, W 100, H 170

**Remarks.** This is similar to *D. insolita* Babinot (1980, Pl. 8, figs 9-14) but is distinguished from it by having a concave ventral margin and a more pointed posterior end. Due to its rarity, it is left in open nomenclature.

Subfamily: *Pterygocythereidae* Puri, 1957

Genus: *Pterygocythere* Hill, 1954

*Pterygocythere bisulcata* sp. nov.

(Pl. 2, figs 9, 10)

**Derivation of name.** From the sulcus present on each valve, just posterior to the eye spot.

**Holotype.** - SHN 117, Paratypes- SHN118.

**Diagnosis.** A species of *Pterygocythere* with triangular shape, compressed anterior and posterior ends, sulcus on both valves and posteroventral alar prolongation.

**Description.** Carapace triangular, elongate; dorsal margin curved, ventral margin straight, anterior margin rounded with thin margin, posterior margin pointed and caudate, eye spot pronounced, surface slightly tuberculate with sulcus posterior to the eye spot, posteroventral alar prolongation pronounced, maximum width between the central and the posterolateral areas, dorsal view arrow-like.

**Material.** 6 carapaces, samples 31-50; SHN 118

**Type Locality and Horizon.** Sample 31, Late Cenomanian, Gebel Nazzazat.

**Dimensions.** L 460, W 260, H 240

**Remarks.** This species is similar to *Pterygocythere* sp. of Honigstein (1984) from the Santonian of Israel, but is distinguished from it in having a sulcus on both valves.

Family: *Cytherideidae* Sars, 1925

Subfamily: *Cytherideinae* Sars, 1925

Genus: *Asciocythere* Swain, 1952

*Asciocythere cf. polita* Damotte, 1962

(Pl. 2, figs 11, 12)

**Material.** 16 carapaces; SHN 119

**Horizon.** Sample 93, (Late Turonian)

**Dimensions.** L 500, W 280, H 320

**Remarks.** *Asciocythere polita* was described from the Turonian of France by Damotte (1962) and recorded from the Cenomanian—Turonian of central Spain (Breman, 1976) and the Turonian of France (Babinot, 1980). This species is similar to that of Damotte but differs in having a concave ventral margin and less pointed posterior end. It is also similar to *Ovocytheridea reniformis* Bold in outline and smooth surface. Bold (1964) stated that some species of the genus *Asciocythere* could belong to *Ovocytheridea*. The two genera differ in the structure of the median hinge element.

Genus: *Dolocytheridea* Trieble, 1936

*Dolocytheridea atlasica* Bassoullet & Damotte, 1969

(Pl. 2, figs 13, 14)

1969 *Dolocytheridea atlasica* Bassoullet & Damotte: 139, Pl. 2, fig. 9 a-d

1974 *Dolocytheridea atlasica* Bassoullet & Damotte; Rosenfeld & Raab: 11, Pl. 2, figs 12-13

**Material.** 11 carapaces and some valves; SHN 120

**Horizon.** It occurs sporadically in samples 18-51, (Cenomanian)

**Dimensions.** L 260, W 220, H 200

**Remarks.** This was described from the Cenomanian—Turonian of Algeria (Bassoullet and Damotte, 1969) and from the Cenomanian of Israel (Rosenfeld & Raab, 1974).

*Dolocytheridea crassa* Damotte, 1971

(Pl 2, fig. 15)

1971 *Dolocytheridea crassa* Damotte: 4, Pl. 1, fig. 2 a-c

1976 *Dolocytheridea crassa* Damotte; Breman: 99, Pl. IV, fig. 10a; Pl. XIII, fig. 36

1980 *Dolocytheridea crassa* Damotte; Babinot: Pl. 5, figs 7-13

**Material.** 4 carapaces - SHN 121

**Horizon.** Sample 50, Late Cenomanian

**Dimensions.** L 340, W 140, H 180

**Remarks.** This species was described from the Cenomanian to the Early Turonian of Spain (Damotte, 1971 and Babinot, 1980) and the Early Turonian of Spain (Breman, 1976).

Genus: *Ovocytheridea* Grekoff, 1951

*Ovocytheridea apiformis* Reyment, 1960

(Pl. 2, fig. 16)

1960 *Ovocytheridea apiformis* Reyment: 79, Pl. 2, fig. 5; Pl. 3, fig. 4 a-c; Pl. 5, fig. 5; Pl. 14, figs 2-3

1964 *Ovocytheridea apiformis* Reyment; Bold: 117, Pl. 14, fig. 3

**Material.** 3 carapaces; SHN 122

**Explanation of Plate 3.**

Fig. 1 *Ovocytheridea reniformis* Bold, sample 90, x 110.

Fig. 2 *Neocypridella vandenboldi* Gerry & Rosenfeld, sample 93, lateral views, x120.

Fig. 3 *Krithe whitecliffensis* Crane, sample 46, x135.

Fig. 4 *Krithe* sp., sample 43, lateral view, x65.

Figs 5, 6 *Metacytheropteron berbericus* (Bassoullet & Damotte), sample 16, lateral and dorsal views, x110, 115 respectively.

Fig. 7 *Veenia* (Nigeria) inornata Bertels, sample 55, x142.

Figs 8, 9 *Veeniacytheridea jezzineensis* (Bischoff), sample 16, lateral and dorsal views, x58, 73 respectively.

Figs 10, 11 *Veeniacytheridea mushebrensis* (Bassoullet & Damotte), sample 30, lateral and dorsal views, x65, 100 respectively.

Fig. 12 *Cythereis namousensis* Bassoullet & Damotte, sample 31, x89.

Figs 13, 14 *Cythereis rawashensis* rawashensis Bold, sample 46, lateral and dorsal views, x65, 55 respectively.

Figs 15, 16 *Cythereis fahritoni* Bischoff, sample 31, lateral and dorsal views, x55.

Figs 17, 18 *Cythereis cf. hirsuta* Damotte & Grosdidier, sample 43, lateral and dorsal views, x110, 113 respectively.
Cenomanian/Turonian Ostracods from Sinai, Egypt
Horizon. Sample 42, (Late Cenomanian)
Dimensions. L 680, W 240, H 360
Remarks. Reyment (1960) described this species from the Santonian of Nigeria. It is also found in the Santonian of Senegal (Apostolescu, 1961) and the Turonian of Egypt (Bold, 1964)

Ovocytheridea caudata Bold, 1964
(Pl. 2, figs 17, 18)
1964 Ovocytheridea caudata Bold: 119, Pl. 14, fig. 4 a,b
1985 Ovocytheridea caudata Bold; Honigstein & Rosenfeld: 453, Pl. 3, figs 3-4
Material. 15 complete carapaces and some deformed ones; SHN 123
Horizon. Samples 30, 31, 50 (Cenomanian)
Dimensions. L 680, W 280, H 440
Remarks. This species is recorded from the Turonian of Egypt (Bold, 1964), Spain (Swain, 1978) and Israel (Honigstein & Rosenfeld, 1985).

Ovocytheridea hispanica Breman, 1976
(Pl. 2, figs 19, 20)
1976 Ovocytheridea hispanica Breman: 99, Pl. 4, fig. 11; Pl. 5, fig. 11 a-f
Material. 6 carapaces; SHN 124
Horizon. Samples 18, 30, 31, (Early Cenomanian)
Dimensions. L 600, W 220, H 320
Remarks. Breman (1976) described this species from the Early Turonian of central Spain. It is similar to Ovocytheridea caudata Bold and O. apiformis Reyment in the Paracypris-like shape, but the greatest height of this species is located more posteriorly. These three species may be related.

Ovocytheridea reniformis Bold, 1964
(Pl. 3, fig. 1)
1964 Ovocytheridea reniformis Bold: 118, Pl. 14, fig. 1 a-f
1981 Ovocytheridea aff. reniformis Bold; Bismuth et al.: 229, Pl. 6, fig. 8
1985 Ovocytheridea reniformis Bold; Honigstein & Rosenfeld: 452, Pl. 3, figs 1-2
Material. 5 carapaces and 2 valves; SHN 125
Horizon. Samples 90, 94, 95, (Late Turonian)
Dimensions. L 420, W 160, H 200
Remarks. Bold (1964) described this species from the Turonian to Early Campanian of Egypt. It is also reported from the Turonian of Israel (Rosenfeld & Raab, 1974 and Honigstein & Rosenfeld, 1985) and Tunisia (Bismuth et al. 1981).

Genus: Neocyprideis Apostolescu, 1956

Neocyprideis vandenboldi Gerry & Rosenfeld, 1973
(Pl. 3, fig. 2)
1964 Fabanella ? sp. A Bold: 120, Pl. 14, fig. 5 a-d
1973 Neocyprideis vandenboldi Gerry & Rosenfeld: 103-104, Pl. 1, figs 1-9; Pl. 2, figs 1-6
1985 Neocyprideis vandenboldi Gerry & Rosenfeld; Lipson-Benitah et al.: Fig. 4h
Material. 12 carapaces and 7 valves; SHN 126
Horizon. Samples 93, 100, 104, (Late Turonian)
Dimensions. L 600, W 340, H 380
Remarks. This species is recorded from the Late Cenomanian and Early Turonian of Israel (Gerry & Rosenfeld, 1973; Rosenfeld & Raab, 1974; Lipson-Benitah et al. 1985). Fabanella ? sp. A described by Bold (1964) from the Cenomanian of Egypt is very similar and is considered synonymous with it. This species differs from Neocyprideis flexeri Honigstein & Rosenfeld in having a more rounded anterior end and a more convex dorsal margin.

Subfamily Krithinace Mandelstam in Bubikan, 1958
Genus: Krithe Brady, Crosskey & Robertson, 1874
Krithe whitecliffensis Crane 1965
(Pl. 3, fig. 3)
1965 Krithe whitecliffensis Crane: 204, Pl. 2, fig. 9 a-c
Material. 5 carapaces and a few valves; SHN 127
Horizon. Samples 43-50, (Late Cenomanian)
Dimensions. L 600, W 200, H 280
Remarks. K. whitecliffensis was described from the Late Cretaceous of the Gulf Coast area by Crane (1965).
Krithe sp.
(Pl. 3, fig. 4)
Material. 5 carapaces and some valves; SHN 128
Horizon. Samples 43-50, (Late Cenomanian)
Dimensions. L 560, W 200, H 280
Remarks. This species is differentiated from K. whitecliffensis Crane by having a straight to slightly convex ventral margin and a less truncated posterior end. They are very similar, and as they are recorded from the same horizon, they may belong to one species.

Family Cytheruridae Müller, 1894
Genus Metacytheropteron Oertli, 1894
Metacytheropteron berbericus (Bassoullet & Damotte, 1969)
(Pl. 3, figs 5, 6)
1969 Metacytheropteron berbericus Bassoullet & Damotte: 137-138, Pl. 2, fig. 7 a-d
1981 Metacytheropteron berbericus (Bassoullet & Damotte); Bismuth et al.: 225, Pl. 8, figs 7-8
1988 Metacytheropteron berbericus (Bassoullet & Damotte);

Explanation of Plate 4.

Fig. 1 Cythereis cretaria Bold, sample 46, x70.
Fig. 2 Cythereis cretaria acuta Honigstein, sample 47, x104.
Figs 3, 4 Planileberis praeexta arta (Damotte), sample 31, lateral and dorsal views, x73.
Figs 5, 6 Rehacythereis guadalajarensis Breman, sample 51, lateral and dorsal views, x96, 48 respectively.
Fig. 7 Oeritellla cf. donzei Weaver, sample 53, x82.
Fig. 8 Herrigocyrthere cf. donzei (Weaver), sample 16, x110.
Figs 9, 10 Isocythere elongata Weaver, sample 51, lateral and dorsal views, x145, 108 respectively.
Figs 11, 12 Xestoleberis ? X. derorimensis Rosenfeld, sample 30, lateral and dorsal views, x130, 124 respectively.
Fig. 13 Xestoleberis seminullata Crane, sample 90, x200.

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Athersuch: Pl. 1, figs 12-13

Material. 18 carapaces; SHN 129

Horizon. Samples 16, 18, (Early Cenomanian)

Dimensions. L 400, W 240, H 220

Remarks. Bassoullet & Damotte (1969) described this species from the late Cenomanian of Algeria. It is reported from the Cenomanian of Israel (Rosenfeld & Raab, 1974) and of Gebel Nezzaarat, Sinai (Collin & El Dakkak, 1975). It is also recorded from the Late Valconian to Late Cenomanian of Tunisia (Bismuth et al., 1981) and the Cenomanian of Oman (Athersuch, 1988).

Grosdidier: 177, Pl. 1, fig. 2

1975 Veenia (Nigeria) inornata Bertels, 1975

(Pl. 3, fig. 7)

1975 Veenia (Nigeria) inornata Bertels: 110, Pt. 4, fig. 3

Material. 6 carapaces; SHN 130

Horizon. Samples 55 (Cenomanian) and 90 (Late Turonian)

Dimensions. L 320, W 140, H 180

Remarks. Bertels (1975) described this species from the Maastrichtian of Argentina. It is characterized by its almost smooth surface. Cythereis africana Bate & Bayliss (1969) from the Albian of Tanzania is similar differing in having more prominent dorsal and ventral ribs.

Genus: Veeniacythereis Gründel, 1914

Veeniacythereis jezzineensis (Bischoff, 1963)

(Pl. 3, fig. 8, 9)

1963 Cythereis jezzineensis Bischoff: 42, Pl. 16, figs 128-130

1974 Veeniacythereis jezzineensis (Bischoff); Rosenfeld & Raab: 21, Pl. 3, figs 28, 29

1981 Veeniacythereis jezzineensis (Bischoff); Al Abdul Razak & Grosdidier: 177, Pl. 1, fig. 2

1983 Veeniacythereis jezzineensis (Bischoff); Rosenfeld & Raab: 59-65, Pl. 1

1988 Veeniacythereis jezzineensis (Bischoff); Athersuch: Pl. 3, figs 9, 10

Material. 28 carapaces; SHN 131

Horizon. Samples 16, 30, (Early Cenomanian)

Dimensions. L 380, W 320, H 320

Remarks. Cythereis jezzineensis was described by Bischoff (1963) from the Albian to Cenomanian of Lebanon. It also occurs in the Coniacian—Santonian of Israel (Honigstein, 1984).

Veeniacythereis maghrebensis (Bassoullet & Damotte, 1969)

(Pl. 3, figs 10, 11)

1969 Cythereis maghrebensis Bassoullet & Damotte: 133-134, Pl. 1, fig. 1 a-c

1981 Veeniacythereis maghrebensis (Bassoullet & Damotte); Bismuth et al.: 232, Pl. 10 figs 1-2

1981 Veeniacythereis maghrebensis (Bassoullet & Damotte); Al Abdul Razak & Grosdidier: 182, Pl. 1, fig. 3

1983 Veeniacythereis maghrebensis (Bassoullet & Damotte); Rosenfeld & Raab: 59-65, Pl. 2

1988 Veeniacythereis maghrebensis (Bassoullet & Damotte); Athersuch: Pl. 3, figs 7, 8

Material. 4 carapaces: SHN 132

Horizon. Samples 16, 30, (Early Cenomanian)

Dimensions. L 740, W 420, H 400

Remarks. Cythereis maghrebensis was described by Bassoullet & Damotte (1969) from the late Cenomanian of Algeria and subsequently recorded from the Cenomanian of the western side of the Gulf of Suez, Egypt (Boukhary et al., 1977), Kuwait (Al Abdul Razak & Grosdidier, 1981), Tunisia (Bismuth et al., 1981) and Oman (Athersuch, 1988). Some of the Veeniacythereis jezzineensis (Bischoff) described by Rosenfeld & Raab (1974) from the Cenomanian of Israel (Pl. 2, fig. 30) seem to be V. maghrebensis (Bassoullet & Damotte).

Veeniacythereis jezzineensis closely resembles V. maghrebensis except for the extent of development of the main ridges on the surface of the carapace (see the description of Bischoff, 1963 and Bassoullet & Damotte, 1969 of both species).

Genus: Cythereis Jones, 1894

Cythereis cretaria Bold, 1964

Cythereis cretaria cretaria Bold 1964

(Pl. 4, fig. 1)

1964 Cythereis cretaria Bold: 126-127, Pl. 15, figs 3-4

1984 Cythereis cretaria Bold; Honigstein: 19, Pl. 6, figs 15-16, Pl. 7, figs 1-5

Material. 5 carapaces; SHN 133

Horizon. Sample 46, 47, (Late Cenomanian)

Dimensions. L 520, W 260, H 320

Remarks. Bold (1964) described this species from the Campanian of Egypt. It also occurs in the Coniacian—Santonian of Israel (Honigstein, 1984).

Cythereis cretaria acuta Honigstein, 1984

(Pl. 4, fig. 2)

1984 Cythereis cretaria acuta Honigstein: 19, Pl. 7, figs 8-10

Material. 2 carapaces; SHN 134

Horizon. Sample 47, (Late Cenomanian)

Dimensions. L 420, W 160, H 240

Remarks. Honigstein (1984) distinguished this subspecies from Cythereis cretaria cretaria Bold by its acute middle part of the posterior end. He recorded this species from the Santonian of Israel. The specimen described herein is similar to Honigstein's except for the nearly smooth posterior lateral area.

Cythereis fahrioni Bischoff, 1963

(Pl. 2, figs 15, 16)

1963 Cythereis fahrioni Bischoff: 31-33, Pl. 12, figs 90-93, fig. 94

1981 Cythereis cf. fahrioni Bischoff; Bismuth et al.: 231, Pl. 9, figs 6-8

1988 Cythereis cf. fahrioni Bischoff; Athersuch: Pl. 3, figs 5, 6

Material. 4 carapaces; SHN 135

Horizon. Samples 31, 47, the Late Cenomanian

Dimensions. L 860, W 380, H 480

Remarks. Bischoff (1963) described this species from the Albian of Lebanon. Bismuth et al. (1981) and Athersuch (1988) recorded C. cf. fahrioni from the Albian—Cenomanian of Tunisia and Albian of Oman respectively, which are here considered to be true members of the species.
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**Cythereis cf. hirsuta** Damotte & Grosdidier, 1963

**(Pl. 3, figs 17, 18)**

**Material.** 3 carapaces; SHN 136

**Horizon.** Samples 43, 50, (Late Cenomanian)

**Dimensions.** L 640, W 250, H 410

**Remarks.** *Cythereis hirsuta* was described from the Early Cenomanian of France by Damotte & Grosdidier (1963). These Egyptian specimens differ from the holotype of Damotte & Grosdidier in having a more rounded and spiney posterior end and a less spiney lateral surface.

**Cythereis namousensis** Bassoulet & Damotte, 1969

**(Pl. 3, fig. 12)**

1969 *Cythereis namousensis* Bassoulet & Damotte: 134-135, Pl. 1, fig. 3 a-d

1981 *Cythereis namousensis* Bassoulet & Damotte; Bismuth et al.: 232, Pl. 9, figs 9-10

**Material.** 6 carapaces and 1 valve; SHN 137

**Horizon.** Samples 31, 47, (Late Cenomanian)

**Dimensions.** L 580, W 260, H 300

**Remarks.** Bassoulet & Damotte (1969) described this species from the Cenomanian of Algeria. It is also recorded from the Cenomanian of Egypt (Boukhary & al., 1977), and Tunisia (Bismuth et al., 1981).

**Cythereis rawashensis rawashensis** Bold, 1964

**(Pl. 3, figs 13, 14)**

1964 *Cythereis rawashensis rawashensis* Bold: 124, Pl. 15, fig 1 a,b

**Material.** 18 carapaces; SHN 138

**Horizon.** Samples 31-51 (Cenomanian) and 96-107 (Late Turonian)

**Dimensions.** L 680, W 320, H 320

**Remarks.** This species was described from the Turonian of the Abu Roash area, Egypt, by Bold (1964).

**Genus: Planileberis** Deroo, 1966

*Planileberis praetexta arca* (Damotte, 1962)

**(Pl. 4, figs 3, 4)**

1962 *Cythereis praetexta arca* Damotte: 9, Pl. 3, fig 14 a-d

1976 *Rehacythereis praetexta arca* (Damotte); Breman: 113, Pl. 9, fig 18 a,b

**Material.** 3 carapaces; SHN 139

**Horizon.** Samples 31, 33, (Late Cenomanian)

**Dimensions.** L 480, W 180, H 280

**Remarks.** Damotte (1971) described this subspecies from the Cenomanian of France. It is characterized by a compressed form, the less pronounced longitudinal ribs, and faint reticulation, suggesting the genus Planileberis Deroo.

**Genus: Rehacythereis** Gründel, 1973

*Rehacythereis guadalajarensis* Breman, 1976

**(Pl. 4, figs 5, 6)**

1976 *Rehacythereis guadalajarensis* Breman: 112, Pl. 9, fig 17 a-c

**Material.** 5 carapaces; SHN 140

**Horizon.** Samples 49-53, (Late Cenomanian)

**Dimensions.** L 740, W 400, H 380

**Remarks.** Breman (1976) described this species from the Early Turonian of Spain. It is similar to *Oeritilla supra* Babinot (1980) described from the Coniacian—Santonian of France in the form and deep reticulation, but is distinguished from it in its less spiney posterior end.

**Genus: Oeritilla** Pokorney, 1964

*Oeritilla donzei* Weaver, 1982

**(Pl. 4, fig. 7)**

1982 *Oeritilla donzei* Weaver: 74, Pl. 15, figs 6-11, text fig. 14

1988 *Oeritilla donzei* Weaver; Jarvis et al.: Fig. 19 (f)

**Material.** 6 carapaces; SHN 141

**Horizon.** Samples 49-53, (Late Turonian)

**Dimensions.** L 600, W 320, H 320

**Remarks.** This species was described from the Early and Middle Cenomanian of England (Weaver, 1982, and Jarvis, et al., 1988). It can be distinguished from *Oeritilla*? cf. *Rasaalbekensis* Damotte & Saint Marc figured by Honigstein (1985) in having more prominent spines and a subcentral node. *Acanthocythereis denticolata* Esker figured by Donze et al. (1982) is similar, but differs by having fewer posterior ventral spines and a thinner anterior margin.

**Genus: Herricythereis** Griündel 1973

*Herricythereis cf. donzei* (Weaver, 1982)

**(Pl. 4, fig. 8)**

**Material.** 1 carapace; SHN 142

**Horizon.** Sample 16, (Early Turonian)

**Dimensions.** L 400, H 200

**Remarks.** This is similar to *H. donzei* (Weaver) from the Middle and Late Cenomanian of England (Jarvis et al., 1988) but differs by having fewer anterior marginal spines.

**Genus: Isocythereis** Triebel, 1940

*Isocythereis elongata* Weaver, 1982

**(Pl. 4, figs 9, 10)**

1982 *Isocythereis elongata* Weaver: 72, Pl. 14, figs 9-11

1988 *Isocythereis elongata* Weaver; Jarvis et al.: Fig. 19 (d)

**Material.** 5 carapaces; SHN 143

**Horizon.** Samples 49, 51 and 53, (Late Cenomanian)

**Dimensions.** L 320, W 160, H 200

**Remarks.** This species was described from the Late Cenomanian of England (Weaver, 1982 and Jarvis et al., 1988). *Isocythereis* sp. of Breman (1976) is similar except for the denticulate ventroanterior margin. It is also distinguished from *Isocythereis fisticostis* Triebel (1949) by its spiney anterior and posterior margins.

**Family: Xestoleberididae** Sars, 1828

**Genus: Xestoleberis** Sars, 1928

*Xestoleberis ?X. derorimensis* Rosenfeld, 1974

**(Pl. 4, figs 11, 12)**

1974 *Xestoleberis ?X. derorimensis* Rosenfeld: in Rosenfeld & Raab, 22, Pl. 2, figs 34-37

1985 *Xestoleberis ?X. derorimensis* Rosenfeld; Honigstein & Rosenfeld: 452, Pl. 2, figs 4-7

**Material.** 6 carapaces; SHN 144

**Horizon.** Samples 30 (Cenomanian) and 90 and 95, (Late Turonian)

**Dimensions.** L 340, W 240, H 220

**Remarks.** This species is recorded from the Late Cenomanian of Israel (Rosenfeld & Raab, 1974; Lipson-Benitah et al. 1985 and Honigstein & Rosenfeld, 1985).

*Xestoleberis seminulata* Crane, 1965

**(Pl. 4, fig. 13)**

1965 *Xestoleberis seminulata* Crane: 234, Pl. 9, fig. 5

**Material.** 1 carapace and 3 valves; SHN 145
Horizon. Samples 90-95, (Late Turonian)
Dimensions. L 360, W 240, H 200
Remarks. This species was described from the Late Cretaceous of the Gulf Coast area (Crane, 1965). It is differentiated from Xestoleberis ovata Bonnema by having an elongate carapace and straight ventral margin and from X. ? X. derorimensis Rosenfeld in having a less tumid posterior end.

BIOSTRATIGRAPHY
The stratigraphic ranges of the species described here are shown in Fig. 2.

The Cenomanian—Turonian succession of Gebel Nezzazat has already been subdivided into biostratigraphic zones on the basis of foraminiferal and macrofossil content (Shahin, 1988). Three ostracod assemblages can be distinguished from oldest to youngest as follows:

1. Cytherella—Veeniacythereis—Metacytheropteron Assemblage

The lower part of this unit is characterized by the dominance of Cytherella spp., Veeniacythereis spp., Herrigocythere cf. donzei and Bairdia spp. This assemblage declines or even disappears in the middle part of the unit, reappearing towards the top. Brachycythere spp., Dolocytheridea atlacis and Paracypris acutocaudata occur sporadically within this unit, and extend upwards into the next unit. Most of this association is present in the Cenomanian of many parts of the world. It is equivalent to the Rotalipora brouzeni and R. reicheli Zones, of Early Cenomanian age (Shahin, 1988).

The presence of Cytherella and Veeniacythereis indicates open marine, moderately deep neritic conditions (Morkhoven, 1963), which are confirmed by the presence of Rotalipora and Thomasinella. Dolocytheridea spp. and Ovocytheridea spp. together with a few Xestoleberis derorimensis occur sporadically within this unit, perhaps suggesting littoral or even brackish water conditions at some horizons.

2. Cythereis spp. Assemblage

Most of the characteristic species of the previous assemblage disappear, although some of them (Paracypris acutocaudata Rosenfeld, Bairdia spp., Dolocytheridea atlacis Bassoullet & Damotte and some Cytherella) extend within this unit. It is characterized by the dominance of Cytherella spp. and other trachyleberids. The interval between samples 34 and 42 is devoid of ostracods, probably due to an anoxic event. The genera found below this barren interzone reappear above it where other important genera make their first appearance (see the range chart, Fig. 2).

This association is partly equivalent to the Rotalipora cushmani Zone and the lower part of the Heterohelix globulosa Zone of Late Cenomanian and earliest Turonian age respectively (Shahin, 1988).

Most of the aforementioned species abruptly disappear a few metres above the Cenomanian—Turonian boundary. However, some of them are long ranging and reappear in the Turonian. This disappearance is probably due to another anoxic event associated with the Cenomanian—Turonian boundary.

The abundance of Cythereis and related genera and Paracypris indicates open, relatively deep neritic conditions (cf. Morkhoven, 1963). However the presence of Ovocytheridea spp. again refers to shallow to restricted marine environments at least where it is present. These alternating marine conditions were also deduced from the foraminiferal and megafossil content (Shahin, 1988).

3. Asciocythere polita—Neocyprideis vandenbeldi Assemblage

Following the barren interzone, some species start to appear and extend upwards while others, which first appeared in the Cenomanian, are also reported (Fig. 2). This interval is equivalent to the Coiopoceras sp. Assemblage Zone of the Late Turonian (Shahin, 1988).

The sporadic occurrence of the brackish water Neocyprideis, Asciocythere and Xestoleberis together with a few deeper neritic genera Cythereis, Cytherella, Bairdia and Bairdoppilata indicate alternation of neritic, open marine and brackish environments. The top of this zone suggests brackish water conditions.

PALEOGEOGRAPHICAL DISTRIBUTION
During the Cenomanian a similar ostracod assemblage characterized a vast palaeogeographical province. This assemblage includes Metacytheropteron berbericus, Veeniacythereis jessineensis, V. maghrebensis and Cythereis namousensis. These are recorded from the Cenomanian of Libya, Tunisia, Algeria, Morocco, Israel, Lebanon, Iraq, Kuwait, Oman and Iran. Other elements of the fauna are present in France and Spain to the north, and Senegal and Tanzania to the south. Cythereis gr. ovata, Cytherella sulcata and Cytherella parallela are recorded from the Cenomanian of France, Spain, England, North Africa and Israel.

The Turonian assemblage, including Brachycythere saupaeniensis and similar forms, is known from the Early Turonian of Brazil, Tanzania, Gabon, Nigeria and Tunisia. Asciocythere polita, Ovocytheridea reniformis and Bairdia cenomanica are recorded from the Turonian of France, Spain, Tunisia and Israel.

The Cenomanian—Turonian ostracods recorded here link the area with Europe, North and West Africa, the southern shelf of Tethys, South America and the Middle East. At that time Tethys covered much of the aforementioned regions where shallow to slightly deep marine sediments were deposited including similar ostracod assemblages. This is due mainly to the similarity of environmental conditions, and the ability of the fauna to be distributed throughout the Tethyan province. This also supports the idea of a trans-Saharan seaway and direct connection between South America and West Africa (Furon, 1935 and Chancellor, 1982 respectively).

OSTRACOD DIVERSITY AND OXYGENATION LEVELS
Oxygen supply is an important ecological factor, and any reduction would lead to a reduction in the number of individuals. It is tentatively suggested therefore that a reduced ostracod fauna is the result of very low oxygen levels in the bottom water. When the ostracod diversity is plotted stratigraphically (Fig. 3), it is clear that there are repeated declines in the diversity of both platycopids and podocopids within the succession.

A fluctuation of ostracod diversity coinciding with δ13C values of normal marine salinity is clearly seen within the lower part of the Cenomanian. This change in diversity is partly explained by the sedimentological variation in the Raha Formation from shale to sand to limestone bands. The increased diversity may reflect a higher proportion of sand-sized bioclasts in the sediment.

The peak of δ13C, accompanied by a drop in the diversity of ostracods, is clearly observed at the base of the Abu Qada Formation (Fig. 3). This major increase in δ13C values refers in part to high productivity caused by incoming nutrients associated with the Cenomanian transgression. This increased surface productivity leads to the development of a marked oxygen-minimum zone in the underlying water column because oxygen is utilized during the breakdown of organic matter as it sinks downwards from the surface water (Jenkyns, 1980 and Summerhayes, 1987). Hume et al. (1920) stated that the dark
Cenomanian/Turonian Ostracods from Sinai, Egypt

The δ13C values again decrease just above the Cenomanian—Turonian boundary that lies within a region of already decreasing δ13C values. This decrease is accompanied by a continued drop in ostracod diversity (the podocopids are the only ostracods present). This is followed by a slight increase in the podocopids a few metres above the boundary, accompanied by an obvious increase in the planktonic foraminifera (*Heterohelix globulosa* Abundance Zone) (Shahin, 1988).

Arthur *et al.* (1987) stated that the earliest Turonian was a period of peak transgression, caused by a worldwide high stand of sea level. The large increase in the shelf sea areas caused by the transgression led to enhanced production of warm saline water, which sank to form bottom-water masses. This caused an increase in the rates of oceanic turnover because in the Cretaceous, oceanic circulation was salinity driven (Brass *et al.* 1982), and this triggered the anoxic event. This peak transgression led to the annihilation of most ostracod species (the barren interzone). Some of the ostracod species found in the Cenomanian reappear in the Late Turonian and other new species appear. It is clear that most of the ostracods are podocopids, corresponding to normal δ13C values of normal marine salinity, accompanied only by very low numbers of small size benthonic forams. The increase of ostracod diversity in sample 90 partly reflects a high proportion of sand-sized bioclasts.

The presence of some hydrocarbons, the high positive δ13C values, the sudden faunal change and the drop in ostracod diversity at the Cenomanian—Turonian boundary refer to an oceanic anoxic event at that time. This event may have caused a sequence of extinctions during the Late Cenomanian and the Early Turonian.

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