THE LATE ALBIAN–EARLY CENOMANIAN OSTRACODES FROM NAUR FORMATION, JORDAN

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ABSTRACT – Thirty-nine species of podocopid and platycopid ostracodes were recovered from the well NH-1, in Al-Khaldeh, Jordan. Typical Cenomanian taxa such as *Metacytheropteron berbericus* Bassoulet & Damotte, *Cytherella aegyptiensis* Colin & El Dakkak, *Cythereis namousensis* Bassoulet & Damotte, *Cythereis algeriana* Bassoulet & Damotte, *Veeniacythereis jezzineensis* Bischoff and *Doloccytheridea atlasica* Bassoulet & Damotte, common in other South Tethyan regions, were recorded. Pore-clusters, a typical Eucytherurinae morphological feature, are recorded in *Aracajuia distincta* (Gerry & Rosenfeld).

Key words: Tethys, paleozoogeography, taxonomy, Cretaceous, pore-clusters.

RESUMO – Trinta e nove espécies de ostracodes podocópídeos e platycopídeos foram recuperadas do poço NH-1, em Al-Khaldeh, Jordânia. Táxons tipicamente cenomanianos como *Metacytheropteron berbericus* Bassoulet & Damotte, *Cytherella aegyptiensis* Colin & El Dakkak, *Cythereis namousensis* Bassoulet & Damotte, *Cythereis algeriana* Bassoulet & Damotte, *Veeniacythereis jezzineensis* Bischoff e *Doloccytheridea atlasica* Bassoulet & Damotte, comuns em outras regiões do sul do Tétis foram registrados. Grupos de poros, uma característica morfológica típica dos Eucytherurinae, são observadas em *Aracajuia distincta* (Gerry & Rosenfeld).

Palavras-chave: Tétis, paleozoogeografia, taxonomia, Cretáceo, grupos de poros.

INTRODUCTION

The Cretaceous ostracodes from Southern Tethys have already been extensively studied, revealing some stratigraphical markers (e.g. *Veeniacythereis jezzineensis*, *Metacytheropteron berbericus*, *Cythereis algeriana* and *Doloccytheridea atlasica*) useful in some localities (Grosdidier, 1973; Rosenfeld & Raab, 1974; Majoran, 1989; Athersuch, 1994). Paleobiogeographic analyses allowed also the proposal of faunal provinces for the Aptian and younger deposits (Babinot & Colin, 1988; Luger, 2003).

In spite of that, there are few published studies on Cenomanian ostracodes of Jordan. Babinot & Basha (1985) registered 17 species from six sections of Naur and Fuhies formations (early Cenomanian), east of the Jordan Rift Valley. They were the first to discuss the similarity of those faunas to

others of the Tethyan realm. Powell (1989) in his study on the groups Kurnub, Ajlun and Belqa mentioned the occurrence of five species in the Naur Formation: *Metacytheropteron berbericus*, *Veenia jezzineensis*, *Schuleridea* sp., *Bythocypris* sp. and *Cytherura* sp. Later, Schultze *et al.* (2004) detailed the paleoecology and biostratigraphy of the Jordanian carbonate platform based on ostracodes and foraminifers, which improved the understanding of the shelf development during the late Albian-Turonian. More recently, Morsi & Wendler (2010) carried out a study on the Cenomanian-Turonian deposits of Jordan discussing not only biostratigraphical aspects, but also parameters influencing the ostracode distribution.

The main objective of this study is, therefore, to present an updated contribution to the knowledge of the late Albian–early Cenomanian ostracodes from Naur Formation. The specimens

herein illustrated are deposited in the collections of the Museu de Paleontologia, Universidade Federal do Rio Grande do Sul, section "Ostracoda" (MP-O), under the curatorial numbers 2201 to 2233 and 2565 to 2582. **Morphological abbreviations:** C, carapace; RV, right valve; LV, left valve; l, length; h, height; w, width.

STUDY AREA

In Jordan, thick Upper Cretaceous to Paleogene successions crop out over a wide area. These successions are subdivided into two groups: the upper Albian-Turonian Ajlun Group and the Coniacian to Paleogene Belqa Group. The Ajlun Group is further subdivided into the Naur (base), Fuheis, Hummar, Shuayb, and Wadi As Sir formations (Burdon, 1959; Parker, 1970; Powell, 1989).

During the Cenomanian and Turonian stages, shallow warm seas covered Jordan depositing the strata of the Ajlun Group. The Naur Formation consists of clayed siltstone, sandstone, silty mudstone, marls, dolomites and limestone with abundant *Thalassinoides* burrows. The Fuheis Limestone is dominated by marl and marly limestone. The Hummar Formation is dominated by limestone, micrite and shelly wackestone. The Shuayb Formation is overlain by the limestones of the Wadi As Sir Formation. The Shuayb Formation consists of a rhythmic alternation of thinly bedded limestones and mostly fossiliferous marly limestones. The overall composition of this formation becomes totally marly towards its top (Powell, 1989).

The mostly marine Ajlun Group overlies the Lower Cretaceous Kurnub throughout most of the territory. The boundary between Kurnub and Ajlun groups is diachronous, marking the transition from terrestrial to marine environments. According to benthic foraminifera data these deposits correspond to a transgression of the north and northwest parts of Tethys Ocean during the Albian-early Cenomanian (Basha, 1985).

MATERIAL AND METHODS

The ditch cutting samples here studied are from the well NH-1 drilled in Al-Khaldeh north-northeastern Jordan (Figure 1), between the coordinates 32°12'21"N; 36°13'58"E. They were collected from 330-50 m depth and treated for their faunal content with hydrogen peroxide bath (for disaggregation) and water washing (for sieving). The occurrence of species previously recorded in other South Tethyan localities, such as *Veeniacythereis jezzineensis* (Bischoff, 1963), *Dolocytheridea atlasica* Bassoulet & Damotte, 1969, *Metacytheropteron berbericum* (Bassoulet & Damotte, 1969), *Cythereis algeriana* Bassoulet & Damotte, 1969, *C. namousensis* Bassoulet & Damotte, 1969 and *Cytherella gigantosulcata* Rosenfeld, 1981, give support to a late Albian–Cenomanian age for the strata herein studied.

Representative specimens of each species were selected for imaging in SEM. The suprageneric classification follows Liebau (2005) and the generic one is based mostly on Benson *et al.* (1961).

SYSTEMATIC PALEONTOLOGY

Subclass OSTRACODA Latreille, 1802
Superorder PODOCOPOMORPHA Kozur, 1972
Order PLATYCOPIDA Sars, 1866
Superfamily CYTHERELLOIDEA Sars, 1866
Family CYTHERELLIDAE Sars, 1866

Cytherella Jones, 1849

Type species. *Cytherina ovata* Roemer, 1841.

Cytherella aegyptiensis Colin & El Dakkak, 1975
(Figures 2A-E)

Figure 1. A, Study area with the location of the well NH-1; B, The well NH-1 log with the respective sampling depths (m).

1975 *Cytherella aegyptiensis* Colin & El Dakkak, p. 50, pl. 1, figs. 2, 3.

1991 *Cytherella aegyptiensis* Colin & El Dakkak. Szczechura *et al.*, pl. 1, figs. 1-6.

Figured specimens. MP-O-2201, female C, l: 0.96 mm, h: 0.65 mm, w: 0.51 mm; MP-O-2202, male C, l: 0.93 mm, h: 0.54 mm, w: 0.47 mm; MP-O-2203, female RV, l: 1.0 mm, h: 0.70 mm; MP-O-2204, female LV, l: 0.89 mm, h: 0.54 mm.

Origin. sample 250 m (MP-O-2201/02), sample 60 m (MP-O-2203), sample 220 m (MP-O-2204).

Material. 481 specimens.

Cytherella gigantosulcata Rosenfeld, 1981
(Figures 2F-G)

1973 *Cytherella* U-10 Glintzboeckel & Magné. Grosdidier, p. 141, pl. 1, figs. 2a-c.

1974 *Cytherella sulcata* Rosenfeld, pl. 1, figs. 6-8.

1981 *Cytherella sulcata* Rosenfeld. Bismuth *et al.*, p. 223, pl. 6, figs. 3 and 4.

1981 *Cytherella sulcata* Rosenfeld. Al-Abdul-Razzaq & Grosdidier, p. 181, pl. 1, fig. 1.

1988 *Cytherella posterosulcata* Rosenfeld. Athersuch, p. 202, pl. 5, fig. 1.

1991 *Cytherella gigantosulcata* Rosenfeld. Szczechura *et al.*, pl. 1, figs. 7-12 (see this for a more complete synonymic list).

Figured specimen. MP-O-2205, C, l: 0.72 mm, h: 0.58 mm, w: 0.42 mm.

Origin. sample 240 m.

Material. Two specimens.

Remarks. *C. gigantosulcata* is a typical Cenomanian species described in Hamakhtesh Hagadol (Israel), easily identified by the well developed sulcus in the RV. It is rare in the material studied and occurs only in the sample NH1 240 m.

Cytherella dhalalensis Morsi & Bauer, 2001
(Figures 2H-I)

?1991 *Cytherella* cf. *eosulcata* Colin. Szczechura *et al.*, pl. 2, fig. 7a.

2001 *Cytherella dhalalensis* Morsi & Bauer, p. 399, pl. 1, figs. 3-5.

2010 *Cytherella dhalalensis* Morsi & Bauer. Morsi & Wendler, p. 194, fig. 5.4-5.

Figured specimen. MP-O-2206, C, l: 0.77 mm, h: 0.42 mm, w: 0.33 mm.

Origin. Sample 260 m.

Material. 21 specimens.

Remarks. This species, described in the Sinai Peninsula (Egypt) is common in Cenomanian deposits of South Tethyan region.

Cytherella sp. 1
(Figures 2J-K)

Figured specimen. MP-O-2207, C, l: 0.89 mm, h: 0.51 mm, w: 0.40 mm.

Origin. Sample 110 m.

Material. One C.

Remarks. *Cytherella* sp. 1 is very rare in the material studied and occurs only in the sample 110 m. Puckett *et al.* (2012) recorded a similar species identified as *Cytherella tuberculifera* Alexander in the Maastrichtian of Jamaica. Honigstein (1984) found a *Cytherella* species with a median caudal process which was identified as *C. coryelli* Benson & Tatro, 1964, in Santonian/Campanian deposits of Israel.

Cytherella sp. 2
(Figures 2L-M)

1991 *Cytherella* sp. cf. *Cytherella* IRC 6 Grosdidier. Szczechura *et al.*, pl. 2, figs. 1-6.

Figured specimen. MP-O-2208, C, l: 0.96 mm, h: 0.61 mm, w: 0.49 mm.

Origin. Sample 60 m.

Material. 16 specimens.

Remarks. *Cytherella* sp. 2 is similar to *Cytherella aegyptiensis* but differ in the outline of the anterior margin, which is more broadly rounded, while in *C. aegyptiensis* it is slightly more acute.

Order PODOCOPIDA Sars, 1866
Suborder BAIRDIOCOPINA Gründel, 1967
Superfamily BAIRDIOIDEA Sars, 1887
Family BAIRDIIDAE Sars, 1887

Bairdia McCoy, 1844

Type species. *Bairdia curtus* McCoy 1844

Remarks. Coryell *et al.* (1935) proposed the genus *Bairdoppilata* based on the assumption that such a conservative form as *Bairdia* would be unusual among the arthropods, due to its long stratigraphic range. The genus erected by them is characterized by the presence of transverse teeth in the hingement. Later, Maddocks (1969) in a revision of the recent Bairdiidae reinforced the reasoning that the genus *Bairdia* should be restricted to the Paleozoic. According to her, the carapace morphology would be enough for the distinction between *Bairdia* and *Bairdoppilata*, although this statement partly disagrees with the remark on page 68 of the same work, where that author argues that the data on soft parts anatomy are congruent "or even more consistent than the hinge composition" of *Bairdoppilata*. Moreover, besides the hingement composition, no other carapace characters are listed as diagnostic for either *Bairdia* or *Bairdoppilata*. What makes this assumption even more questionable is the occurrence of denticles in Paleozoic species (= bairdoppilate denticles *sensu* Liebau, 2005).

We agree with the statements of both Maddocks (1969) and Coryell *et al.* (1935) that *Bairdia* is an overextended, and, probably, not a natural taxa. A similar pattern has been demonstrated by the revision of the genus *Darwinula* Brady &

Robertson, 1885 for instance, which resulted in the proposal of a few other genera (Rossetti & Martens, 1998). However, we do not believe that the criteria presented by Maddocks (1969) would be satisfactorily applied to all species of *Bairdia*/*Bairdoppilata* without previous knowledge of the soft anatomy and the chronostratigraphic distribution of a species. The distinction of these two genera based solely on the denticles is not adequate for fossil species, and can promote more confusion to the ostracode taxonomy. Therefore, in the present study both taxa are considered synonym and the species assigned to the genus *Bairdia*.

Bairdia youssefi Bassiouni, 2002
(Figures 2N-P)

2002 *Bairdia youssefi* Bassiouni, pl. 1, figs. 1, 3.
2010 *Bairdia youssefi* Bassiouni. Morsi & Wendler, p. 194, fig. 5.10.

Figured specimens. MP-O-2209, female C, l: 0.93 mm; h: 0.63 mm, w: 0.54 mm; MP-O-2210, male C, l: 0.93 mm, h: 0.58 mm, w: 0.49 mm.

Origin. Sample 200 m.

Material. 38 specimens.

Remarks. *Bairdia youssefi* is similar to *Bairdia* sp. (T-378) illustrated by Rosenfeld & Raab (1974), however, differs in the outline of posterior margin.

Bairdia sp. 1
(Figures 2Q-R)

Figured specimen. MP-O-2211, C, l: 1.0 mm; h: 0.84 mm, w: 0.47 mm.

Origin. Sample 130 m.

Material. Two specimens.

Bairdia sp. 2
(Figures 3A-B)

Figured specimen. MP-O-2212, C, l: 1.0 mm; h: 0.58 mm, w: 0.51 mm.

Origin. Sample 200 m.

Material. 14 specimens.

Bairdia sp. 3
(Figures 3C-D)

Figured specimen. MP-O-2213, C, l: 1.3 mm; h: 0.63 mm, w: 0.49 mm.

Origin. Sample 130 m.

Material. One specimen.

Suborder CYPRIDOCOPINA Jones, 1901
Superfamily CYPRIDOIDEA Baird, 1845
Family CANDONIDAE Kaufmann, 1900

Candoniella Schneider, 1956

Type species. *Candoniella suzini* Schneider, 1956

Remarks. According to Benson *et al.* (1961) *Candoniella* has a questionable status. No internal morphological details were observed in the specimens herein studied, which would contribute to the precise taxonomic assignment of these species.

Candoniella? sp. 1
(Figures 3E-F)

Figured specimen. MP-O-2214, C, l: 0.82 mm, h: 0.44 mm, w: 0.30 mm.

Origin. Sample 300 m.

Material. Four specimens.

Candoniella? sp. 2
(Figures 3G-H)

Figured specimen. MP-O-2215, C, l: 0.82 mm, h: 0.44 mm, w: 0.40 mm.

Origin. Sample 300 m.

Material. Three specimens.

Remarks. *Candoniella?* sp. 2 has the maximum height in the middle part of the carapace while in the *Candoniella?* sp. 1 it is positioned slightly backward.

Candoniella? sp. 3
(Figures 3I-J)

1991 *Candoniella* cf. *qeturaensis* Honigstein & Rosenfeld. Szczechura *et al.*, pl. 8, fig. 11.

Figured specimen. MP-O-2216, C, l: 0.86 mm, h: 0.47 mm, w: 0.42 mm.

Origin. Sample 320 m.

Material. Four specimens.

Remarks. *Candoniella?* sp. 2 and *Candoniella?* sp. 3 differ in the curvature of the posterodorsal, dorsal and anterodorsal margins, which seem to be more evenly rounded in the latter. Szczechura *et al.* (1991) recorded this species in early/mid Cenomanian deposits of the locality Ras el Abd (Galala Plateau, Egypt).

Paracypris Sars, 1866

Type species. *Paracypris polita* Sars, 1866

Paracypris dubertreti Damotte & Saint-Marc, 1972
(Figures 3K-L)

Figured specimen. MP-O-2217, C, l: 0.70 mm; h: 0.26 mm, w: 0.19 mm.

Origin. Sample 220 m.

Material. Six specimens.

Remarks. *P. dubertreti* was described in the Middle Cenomanian of Nahr Ibrahim (Lebanon).

Paracypris sp. 1
(Figures 3M-N)

Figure 2. A-E, *Cytherella aegyptiensis*, A, female C left view (MP-O-2201); B, same specimen right view; C, male C left view (MP-O-2202); D, female LV internal view (MP-O-2204); E, female RV internal view (MP-O-2203). F-G, *Cytherella gigantosulcata*, F, C left view (MP-O-2205); G, same specimen right view. H-I, *Cytherella dhalalensis*, H, C left view (MP-O-2206); I, same specimen right view. J-K, *Cytherella* sp. 1, J, C left view (MP-O-2207); K, same specimen right view. L-M, *Cytherella* sp. 2, L, C left view (MP-O-2208); M, same specimen right view. N-P, *Bairdia youssefi*, N, female C left view (MP-O-2209); O, same specimen right view; P, male C right view (MP-O-2210). Q, *Bairdia* sp. 1, C left view (MP-O-2211); R, same specimen right view. Scale bars = 100 μ m.

Figured specimen. MP-O-2218, C, l: 0.82 mm; h: 0.37 mm, w: 0.35 mm.

Origin. Sample 260 m.

Material. 117 specimens.

Paracypris sp. 2
(Figures 3O-P)

Figured specimen. MP-O-2219, C, l: 0.82 mm; h: 0.37 mm, w: 0.33 mm.

Origin. Sample 310 m.

Material. Three specimens.

Paracypris sp. 3
(Figures 3Q-R)

Figured specimen. MP-O-2220, C, l: 0.82 mm; h: 0.37 mm, w: 0.35 mm.

Origin. Sample 310 m.

Material. Five specimens.

Suborder CYTHEROCOPINA Gründel, 1967
Superfamily XESTOLEBERIDOIDEA Sars, 1928
Family XESTOLEBERIDIDAE Sars, 1928

Xestoleberis Sars, 1866

Type species. *Cythere aurantia* Baird, 1838.

Xestoleberis sp. 1
(Figures 4A-B)

Figured specimens. MP-O-2221, C, l: 0.49 mm, h: 0.30 mm, w: 0.35 mm.

Origin. Sample 210 m.

Material. 10 specimens.

Xestoleberis sp. 2
(Figures 4C-D)

Figured specimens. MP-O-2222, C, l: 0.63 mm, h: 0.30 mm, w: 0.30 mm.

Origin. Sample 150 m.

Material. One specimen.

Infraorder NOMOCYTHERININA Liebau, 1991
Superfamily CYTHEROIDEA Baird, 1850
Family CYTHERIDAE Baird, 1850
Subfamily SCHIZOCYTHERINAE Mandelstam, 1959

Aracajuia Krömmelbein, 1967 emend. Antonietto *et al.*, 2013

Type species. *Aracajuia benderi* Krömmelbein, 1967

Aracajuia distincta (Gerry & Rosenfeld, 1973)
(Figures 4E-H)

1973 *Amphicytherura distincta* Gerry & Rosenfeld, pl. 2, figs. 7-10.

2013 *Aracajuia distincta* (Gerry & Rosenfeld). Antonietto, Abrahão, Do Carmo & Meirelles, p. 9, fig. 5G.

Figured specimen. MP-O-2223, C, l: 0.40 mm, h: 0.21 mm, w: 0.16 mm.

Origin. sample 110 m.

Material. Three specimens.

Remarks. *A. distincta* was described in Cenomanian deposits of Israel. One of the specimens herein studied presents peculiar pore clusters (see “Results and discussion” section).

Family CYTHERURIDAE Müller, 1894

Metacytheropteron Oertli, 1957

Type species. *Metacytheropteron elegans* Oertli, 1957

Metacytheropteron berbericus (Bassoulet & Damotte, 1969)
(Figures 4J-K)

1969 *Cytheropteron berbericus* Bassoulet & Damotte, p. 143, pl. 2, figs. 7a-d.

2009 *Metacytheropteron berbericum* (Bassoulet & Damotte). Boukhary *et al.*, p. 23, pl. 1, figs. 16-20 (see this for a complete synonymy).

Figured specimen. MP-O-2224, C, l: 0.86 mm, h: 0.33 mm, w: 0.28 mm.

Origin. Sample 320 m.

Material. 19 specimens.

Remarks. *M. berbericus* is a typical Cenomanian species described in Algeria and widespread in the South Tethyan domain.

Metacytheropteron sp.
(Figures 4L-M)

1991 *Metacytheropteron* IRC 10 Szczechura *et al.*, pl. 4, fig. 5.

Figured specimen. MP-O-2225, C, l: 0.51 mm, h: 0.33 mm, w: 0.35 mm.

Origin. Sample 320 m.

Material. Three specimens.

Eocytheropteron Alexander, 1933

Type species. *Cytheropteron bilobatum* Alexander, 1929

Eocytheropteron retroversicardium Al-Abdul-Razzaq,
1980
(Figures 4N-O)

Figured specimen. MP-O-2226, C, l: 0.49 mm, h: 0.28 mm, w: 0.33 mm.

Origin. Sample 250 m.

Figure 3. A-B, *Bairdia* sp. 2, A, C left view (MP-O-2212); B, same specimen right view. C-D, *Bairdia* sp. 3, C, C left view (MP-O-2213); D, same specimen right view. E-F, *Candoniella*? sp. 1, E, C left view (MP-O-2214); F, same specimen right view. G-H, *Candoniella*? sp. 2, G, C left view (MP-O-2215); H, same specimen right view. I-J, *Candoniella*? sp. 3, I, C left view (MP-O-2216); J, same specimen right view. K-L, *Paracypris dubertreti*, K, C left view (MP-O-2217); L, same specimen right view. M-N, *Paracypris* sp. 1, M, C left view (MP-O-2218); N, same specimen right view. O-P, *Paracypris* sp. 2, O, C left view (MP-O-2219); P, same specimen right view. Q-R, *Paracypris* sp. 3, Q, C left view (MP-O-2220); R, same specimen right view. Scale bars = 100 μ m.

Material. Nine specimens.

Remarks. This species was described in the early Cenomanian Ahmadi Limestone (Kuwait). In the type-locality it was noticed that some specimens presented valve reversion.

Superfamily TRACHYLEBERIDOIDEA

Sylvester-Bradley, 1948

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Subfamily TRACHYLEBERIDINAE Sylvester-Bradley,
1948

Sergipella Krömmelbein, 1967 emend. Do Carmo *et al.*, 2012

Type species. *Sergipella transatlantica* Krömmelbein, 1967

Sergipella sp.
(Figures 4P-R)

Figured specimens. MP-O-2227, female C, l: 0.61 mm, h: 0.35 mm, w: 0.28 mm; MP-O-2228, male C, l: 0.63 mm, h: 0.33 mm, w: 0.30 mm.

Origin. sample 310 m.

Material. Three specimens.

Remarks. This species is similar to *Hechticythere croutensis* (Damote & Grosdidier, 1963) recorded in the late Aptian of Sinai (Egypt) by Bassiouni (2002). However, based on the work by Do Carmo *et al.* (2012) we believe that it fits better into the emended diagnosis of *Sergipella*.

Veeniacythereis Gründel, 1973

Type species. *Cythereis imparia* Gründel, 1968

Veeniacythereis jezzineensis (Bischoff, 1963)
(Figures 5A-D)

1963 *Cythereis jezzineensis* Bischoff, p. 42, pl. 16, figs. 128-130.
1969 *Cythereis maghrebenensis* Bassoulet & Damotte, p. 141, pl. 1, figs. 2a-c.

1981 *Veeniacythereis jezzineensis* (Bischoff, 1963). Al-Abdul-Razzaq & Grosdidier, p. 181, pl. 1, fig. 2.

1981 *Veeniacythereis maghrebenensis* (Bassoulet & Damotte). Al-Abdul-Razzaq & Grosdidier, p. 181, pl. 1, fig. 3.

1981 *Cythereis streblolophata streblolophata* Al-Abdul-Razzaq & Grosdidier, p. 181, pl. 1, figs. 7-10; p. 187, pl. 2, figs. 6-8.

1981 *Cythereis streblolophata schista* Al-Abdul-Razzaq & Grosdidier, p. 187, pl. 2, figs. 1-5.

1983 *Veeniacythereis jezzineensis* (Bischoff, 1963). Rosenfeld & Raab, pl. 1, figs. 1-15; pl. 2, figs. 1-13.

1988 *Veeniacythereis subrectangulata* Majoran, p. 693, pl. 1, figs. 1-15; pl. 2, figs. 1-8.

1988 "*Veeniacythereis*" sp. nov.? Majoran, p. 695, pl. 3, figs. 1-7.
1988 *Veeniacythereis* aff. *streblolophata*. Majoran, p. 695, pl. 3, figs. 8-10.

1991 *Veeniacythereis jezzineensis* (Bischoff, 1963). Szczechura *et al.*, pl. 7, figs. 4, 9-11.

1991 *Veeniacythereis* ex gr. *streblolophata*. Szczechura *et al.*, pl. 7, figs. 1-3, 5-8.

2002 *Veeniacythereis jezzineensis* (Bischoff, 1963). Bassiouni, pl. 19, figs. 1-7.

2002 *Veeniacythereis maghrebenensis* (Bassoulet & Damotte). Bassiouni, pl. 19, figs. 8-11.

2002 *Veeniacythereis streblolophata schista* (Al-Abdul-Razzaq & Grosdidier). Bassiouni, pl. 18, figs. 13-16; pl. 19, fig. 12.

2009 *Veeniacythereis streblolophata schista* (Al-Abdul-Razzaq & Grosdidier). Boukhary *et al.*, p. 27, pl. 2, figs. 11-15.

2010 *Veeniacythereis maghrebenensis* (Bassoulet & Damotte). Morsi & Wendler, p. 200, figs. 7.9-11, 13.

2010 *Veeniacythereis streblolophata schista* (Al-Abdul-Razzaq & Grosdidier). Morsi & Wendler, p. 200, figs. 7.12, 14, 15.

Figured specimens. MP-O-2229 adult C, l: 0.93 mm, h: 0.58 mm, w: 0.54 mm; MP-O-2230 A-1(?) C, l: 0.79 mm, h: 0.44 mm; MP-O-2231 A-2(?) C, l: 0.77 mm, h: 0.42 mm, w: 0.42 mm.

Origin. Sample 150 m.

Material. 109 specimens.

Remarks. *Veeniacythereis jezzineensis* is a typical late Albian–Cenomanian species described in Jezzine, Lebanon. According to Rosenfeld & Raab (1983), *Veeniacythereis streblolophata streblolophata* (Al-Abdul-Razzaq & Grosdidier, 1981) and *V. s. schista* (Al-Abdul-Razzaq & Grosdidier, 1981) are instars (A-1 to A-3) of *V. jezzineensis*. The species *Cythereis maghrebenensis* Bassoulet & Damotte, 1969, *Veeniacythereis subrectangulata* Majoran, 1988, "*Veeniacythereis*" sp. nov.? Majoran, 1989 and *V. streblolophata tunisiaensis* Majoran, 1996 are also junior synonyms of *V. jezzineensis*. Colin & El Dakkak (1975) were the first authors who considered the *streblolophata* morphs as juveniles of *jezzineensis*.

Viviére (1985), Athersuch (1994) and Colin *et al.* (2001) follow this synonymy. But it is not accepted by Majoran (1996) who claims that "this assignation is improbable since *Veeniacythereis streblolophata* displays a fully developed amphidont hinge and sexual dimorphisms which are characters usually associated with adult forms". Although the occurrence of precocious sexual dimorphism is not uncommon in ostracodes, other authors (e.g. Szczechura *et al.*, 1991 and Bassiouni, 2002) follow Majoran's separation of species.

Cythereis Jones, 1849

Type-species. *Cytherina ciliata* Reuss, 1846

Cythereis algeriana Bassoulet & Damotte, 1969
(Figures 5E-F)

1969 *Cythereis algeriana* Bassoulet & Damotte, p. 141, pl. 1, figs. a-d.

1981 *Cythereis algeriana* Bassoulet & Damotte. Al-Abdul-Razzaq & Grosdidier, p. 181, pl. 1, fig. 4.

Figure 4. A-B, *Xestoleberis* sp. 1., A, C left view (MP-O-2221); B, same specimen right view. C-D, *Xestoleberis* sp. 2., C, C left view (MP-O-2222); D, same specimen right view. E-H, *Aracajuia distincta*, E, C left view (MP-O-2223); F, same specimen right view. G, detail of a posteromedian pore-cluster, H, detail of a posterodorsal pore-cluster. I, *Xylocythere* sp., LV (MP-O-2052), detail of pore-clusters. J-K, *Metacytheroan berbericus*; J, C in right view (MP-O-2224); K, same specimen left view. L-M, *Metacytheroan* sp., L, C left view (MP-O-2225); M, same specimen right view. N-O, *Eocytheroan retroversicardiatum*, N, C left view (MP-O-2226); O, same specimen right view. P-R, *Sergipella* sp., P, male C left view (MP-O-2228); Q, same specimen right view; R, female C left view (MP-O-2227). Scale bars = 100 µm, unless otherwise stated.

Figured specimen. MP-O-2232 C, l: 0.89 mm, h: 0.49 mm, w: 0.49 mm.

Origin. Sample 80 m.

Material. Six specimens.

Remarks. *Cythereis algeriana* was described in the late Cenomanian of Algeria.

Cythereis namousensis Bassoulet & Damotte, 1969
(Figures G-H)

Figured specimen. MP-O-2233 C, l: 0.70 mm, h: 0.40 mm, w: 0.44 mm.

Origin. Sample 200 m.

Material. Eight specimens.

Remarks. *Cythereis namousensis* was described in the late Cenomanian of Algeria.

Cythereis sp. 1
(Figures 5I-J)

1974 *Veeniacythereis jezzineensis* (Bischoff, 1963). Rosenfeld & Raab, pl. 3, fig. 28.

Figured specimen. MP-O-2565 C, l: 1.05 mm, h: 0.56 mm, w: 0.56 mm.

Origin. Sample 170 m.

Material. One specimen.

Remarks. The specimen figured by Rosenfeld & Raab (1974) clearly differs from *Veeniacythereis jezzineensis* and is conspecific to *Cythereis* sp. 1.

Cythereis sp. 2
(Figures 5K-L)

Figured specimen. MP-O-2566 C, l: 0.75 mm, h: 0.44 mm, w: 0.42 mm.

Origin. Sample 70 m.

Material. One specimen.

Ayseculina (Deroo, 1966) Özdikman, 2010

1966 *Limburgina* Deroo

Type species. *Cypridina ornata* Bosquet, 1847

Ayseculina sp.
(Figures 5M-N)

Figured specimen. MP-O-2567 C, l: 0.86 mm, h: 0.44 mm, w: 0.49 mm.

Origin. Sample 220 m.

Material. One specimen.

Peloriops Al-Abdul-Razzaq, 1979a

Type species. *Peloriops sphaeromata* Al-Abdul-Razzaq, 1979a

Peloriops ulosa Al-Abdul-Razzaq, 1979a
(Figures 5O-P)

1979a *Peloriops ulosa* Al-Abdul-Razzaq, p. 51, pl. 1, figs. 4-5, 11, 15.

1994 *Peloriops ulosa* Al-Abdul-Razzaq. Athersuch, pl. 12.2, fig. 4.

Figured specimen. MP-O-2568 C, l: 0.82 mm, h: 0.40 mm, w: 0.30 mm.

Origin. Sample 190 m.

Material. Three specimens.

Glenocythere Al-Abdul-Razzaq, 1979b

Type species. *Glenocythere bahreinsis* Al-Abdul-Razzaq, 1979b

Glenocythere abdulrazzaqae Morsi & Bauer, 2001
(Figures 5Q-R; 6A)

Figured specimens. MP-O-2569 female C, l: 0.77 mm, h: 0.49 mm, w: 0.44 mm; MP-O-2570 male C, l: 0.96 mm, h: 0.56 mm, w: 0.54 mm.

Origin. Sample 310 m.

Material. Two specimens.

Remarks. This species was described in the Cenomanian deposits of Halal Formation (Sinai, Egypt).

Superfamily CYTHERIDEOIDEA Sars, 1925
Family PROGONOCYTHERIDAE Sylvester-Bradley, 1948

Neocythere Mertens, 1956

Type species. *Neocythere vanveeni* Mertens, 1956

Neocythere sp.
(Figures 6B-C)

Figured specimens. MP-O-2571 C, l: 0.49 mm, h: 0.30 mm, w: 0.30 mm.

Origin. Sample 200 m.

Material. Four specimens.

Family CYTHERIDEIDAE Sars, 1925

Perissocytheridea Stephenson, 1938

Type species. *Cytheridea matsoni* Stephenson, 1935

Perissocytheridea ignota Szczechura, Abd-Elshafy & Babinot, 1991

(Figures 6D-F)

Figured specimens. MP-O-2572 female C, l: 0.72 mm, h: 0.40 mm, w: 0.37 mm; MP-O-2573 male C, l: 0.68 mm, h: 0.30 mm, w: 0.30 mm.

Figure 5. A-D, *Veeniacythereis jezzineensis*, A, C left view (MP-O-2229); B, same specimen right view; C, A-1(?) C left view (MP-O-2230); D, A-2(?) C left view (MP-O-2231). E-F, *Cythereis algeriana*, E, C left view (MP-O-2232); F, same specimen right view. G-H, *Cythereis namousensis*, G, C left view (MP-O-2233); H, same specimen right view. I-J, *Cythereis* sp. 1, I, C left view (MP-O-2565); J, same specimen right view. K-L, *Cythereis* sp. 2, K, C left view (MP-O-2566); L, same specimen right view. M-N, *Aysegulina* sp., M, C left view (MP-O-2567); N, same specimen right view. O-P, *Peloriops ulosa*, O, C left view (MP-O-2568); P, same specimen right view. Q-R, *Glenocythere abdulrazzaqae*, Q, male C left view (MP-O-2570); R, same specimen right view. Scale bars = 100 μm.

Figure 6. A, *Glenocythere abdulrazzaqae*, female C left view (MP-O-2569). B-C, *Neocythere* sp., B, C left view (MP-O-2571); C, same specimen right view. D-F, *Perissocytheridea ignota*, D, female C left view (MP-O-2572); E, same specimen right view; F, male C right view (MP-O-2573). G-H, *Perissocytheridea* sp., G, C left view (MP-O-2574); H, same specimen right view. I-M, *Dolococytheridea atlasica*, I, morphotype 1, C left view (MP-O-2575); J, same specimen right view; K, morphotype 2, C left view (MP-O-2576); L, same specimen right view; M, morphotype 3, C left view (MP-O-2577). N-O, *Kalypsovalva tiffatinensis*, N, C left view (MP-O-2578); O, same specimen right view. P-Q, *Dordoniella* sp., P, C left view (MP-O-2579); Q, same specimen right view. R-S, Cytherideidae gen. et sp. indet., R, C left view (MP-O-2580); S, same specimen right view. T-U, *Parakrithe* sp., T, C left view (MP-O-2581); U, same specimen right view. Scale bars = 100 μ m.

Origin. Sample 260 m.

Material. 260 specimens.

Remarks. This species was described in the Cenomanian deposits of the Northern Galala (Egypt). It is one of the most abundant species in the samples herein studied and occurs mostly in the basal part of the well NH-1.

Perissocytheridea sp.
(Figures 6G-H)

Figured specimen. MP-O-2574 C, l: 0.61 mm, h: 0.33 mm, w: 0.26 mm.

Origin. Sample 200 m.

Material. One specimen.

Remarks. *Perissocytheridea* sp. differs from *P. ignota*, being narrower and strongly reticulated. Due to its scarcity, it might constitute a caved species.

Dolocytheridea Triebel, 1938

Type species. *Cytherina hilseana* Roemer, 1841

Dolocytheridea atlasica Bassoulet & Damotte, 1969
(Figures 6I-M)

1969 *Dolocytheridea atlasica* Bassoulet & Damotte, pl. 2, figs. 9a-d.

1991 *Dolocytheridea atlasica* Bassoulet & Damotte. Szczechura *et al.*, pl. 3, fig. 4

2009 *Dolocytheridea atlasica* Bassoulet & Damotte. Boukhary *et al.*, p. 23, pl. 1, figs. 5-8 (see this for a more complete synonymy).

Figured specimens. MP-O-2575 morphotype 1 C, l: 0.75 mm, h: 0.40 mm, w: 0.35 mm; MP-O-2576 morphotype 2 C, l: 0.56 mm, h: 0.30 mm, w: 0.26 mm; MP-O-2577 morphotype 3 C, l: 0.77 mm, h: 0.33 mm, w: 0.29 mm.

Origin. Sample 330 m (MP-O-2575), sample 80 m (MP-O-2576), sample 140 m (MP-O-2577).

Material. 415 specimens.

Remarks. This is a typical species from cenomanian deposits from the South Tethys, described in the late Cenomanian of Algeria. According to some authors *Dolocytheridea atlasica* presents variability and three morphotypes were registered in the present study, designated as morphotypes 1, 2 and 3. The occurrence of intraspecific variability is not uncommon in Cretaceous cytherideids (e.g. *Fossocytheridea ventrotuberculata* Bergue *et al.*, 2011) and is, probably, environmentally induced.

Kalyptovalva Howe & Laurencich, 1958

Type species. *Cytheridea ovata* Bosquet, 1854

Kalyptovalva tifratinensis Andreu-Boussut, 1991
(Figures 6N-O)

Figured specimen. MP-O-2578 C, l: 0.89 mm, h: 0.47 mm, w: 0.40 mm.

Origin. Sample 220 m.

Material. One specimen.

Dordoniella Apostolescu, 1955

Type species. *Dordoniella strangulata* Apostolescu, 1955

Dordoniella sp.
(Figures 6P-Q)

1991 *Schuleridea baidarensis* Damotte & Saint-Marc. Szczechura *et al.*, pl. 10, figs. 4a,b.

Figured specimen. MP-O-2579 C, l: 0.49 mm, h: 0.33 mm, w: 0.26 mm.

Origin. Sample 330 m.

Material. One specimen.

Gen. *et* sp. indet.
(Figures 6R-S)

Figured specimen. MP-O-2580 C, l: 0.77 mm, h: 0.47 mm, w: 0.35 mm.

Origin. Sample 60 m.

Material. One specimen.

Family KRITHIDAE Mandelstam, 1958

Parakrithe Bold, 1958

Type species. *Cytheridea (Dolocytheridea) vermunti* Bold, 1946

Parakrithe sp.
(Figures 6T-U)

Figured specimen. MP-O-2581 C, l: 0.79 mm, h: 0.33 mm, w: 0.35 mm.

Origin. Sample 130 m.

Material. One specimen.

RESULTS AND DISCUSSION

Thirty-nine ostracode species belonging to 10 families and 20 genera were recorded. Tracyleberididae (nine spp.), Candonidae (eight spp.), Cytherideidae (six spp.), Cytherellidae (five spp.) and Bairdiidae (four spp.) are the richest families and constitute most of the ostracodes recovered from the NH-1 well. The assemblages are composed of several species previously recorded in Cenomanian deposits of Middle East and North Africa, such as *Metacytheropteron berbericus*, *Cytherella aegyptiensis*, *Cythereis namousensis*, *Veeniacythereis jezzineensis* and *Dolocytheridea atlasica*. Two of them, *V. jezzineensis* and *D. atlasica*, are common

Tethyan Cenomanian taxa with problematic taxonomy and for that reason they will be briefly discussed here.

Comprehensive discussions on *Veeniacythereis jezzineensis* were carried out by Rosenfeld & Raab (1983) and Majoran (1988). Those authors proposed, respectively, lumping and splitting approaches to deal with this species. *Dolocytheridea atlasica* is another intriguing Cenomanian species presenting morphological variability, where different patterns of outline (subtriangular to elongate) and ornamentation (smooth to punctate) are observed (Szczuchura *et al.*, 1991). Three morphotypes are illustrated in the present study.

To supply additional contribution to the complex taxonomy of these two taxa is far beyond the objectives and possibilities of the present study, inasmuch as it would demand careful sampling (coring and/or outcrop sampling), rigorous age calibration, and detailed morphological analyses. Due to the stratigraphic significance of those taxa, such a revision would be very contributive for biostratigraphic purposes. Considering that the present study is based in cutting samples and the majority of the specimens studied are carapaces, we adopt the lumping proposal by Rosenfeld & Raab (1983) for *Veeniacythereis jezzineensis*, since the splitting of those forms in different species was not possible in the material from the NH-1 well. In reference to *Dolocytheridea atlasica*, we also assume that the three morphotypes belong to the same species, although strong differences in outline are observed.

Despite the ubiquity of some species in the Maghreb and the Middle East there are also species with restricted occurrences. This can be exemplified by the richness of *Bairdia* (four spp.) where only *B. youssefi* could be identified. Among the cytherellids, *Cytherella* sp. 1 constitutes a very rare species in the NH-1 well and with no previous record in other studies. The presence of a median caudal process is a morphological pattern seen in Senonian representatives of the genus, and *Cytherella* sp. 1 might be a caved specimen. Other representatives of the family, however, in especial *C. aegyptiensis* present broader geographic occurrences and are very abundant in Naur Formation.

The occurrence of pore-clusters in *Aracajuia distincta* constitutes the first record of this morphologic feature in the genus. Similar groupings of pores – which have no relation to the porecanals – have already been found in Eucytherurinae, like *Microceratina* Swanson, and *Xylocythere* Maddocks & Steineck. Cabral *et al.* (2014) recorded comparable structures in Limnocytheridae, which were referred as sieve plates. The pore-clusters in *A. distincta* are always grouped in pairs and their pattern is vaguely similar to the observed in *Xylocythere* (Mazzini & Gliozzi, 2000, p. 143, figs. 1g-i). An image of the pore-clusters of *Xylocythere* sp. recorded by Bergue & Coimbra (2008) in the Quaternary of Santos Basin, Brazil, is presented in the Figure 4 for comparison. The function of these pores is still unknown, though van Harten (1993) proposed a possible relation to nutrient absorption. Apparently, they are morphological features that allow the entrance or elimination of substances through the carapace, either in feeding or chemosensory processes.

ACKNOWLEDGEMENTS

The authors are indebted to D. Danielopol and to the late J.-P. Colin whose discussion, comments and bibliographic supply improved the early version of this manuscript. T.M. Puckett and I. Slipper are thanked for the careful revision of the text. The third author is grateful to CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) for the financial support (proc. 304453/2013-7).

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Received in December, 2015; accepted in May, 2016.