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Cover illustration: The ammonite *Dorsetensia liostraca* Buckman from the Lower Bajocian (Middle Jurassic) Giganteuston Member of Öschingen, Middle Swabian Alb, Germany. For details, see Dietze, V. et al.: The Giganteuston Member of Öschingen (Humphriesianum Zone, Lower Bajocian, Swabian Alb), with comments on the genera *Dorsetensia* Buckman, 1892 and *Nannina* Buckman, 1927, pp. 209–236 in this issue.
Back cover: Atrium of the Munich Palaeontological Museum, view from the main entrance.

Umschlagbild: *Dorsetensia liostraca* Buckman, ein Ammonit aus dem Giganteuston des Unter-Bajociums (Mittlerer Jura) von Öschingen, Mittlere Schwäbische Alb, Deutschland. Für weitere Informationen siehe Dietze, V. et al.: The Giganteuston Member of Öschingen (Humphriesianum Zone, Lower Bajocian, Swabian Alb), with comments on the genera *Dorsetensia* Buckman, 1892 and *Nannina* Buckman, 1927, S. 209–236 in diesem Heft.
Rückseite: Lichthof des paläontologischen Museums München, Blick vom Haupteingang.

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Mixed ostracod faunas, co-occurrence of marine Oligocene and non-marine Miocene taxa at Pınarhisar, Thrace, Turkey

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Abstract

New samples from the Ergene Formation, the Manganese Beds at the base and the Fish Beds in the upper part of the unit at the Pınarhisar section (Thrace, Turkey), contain both fresh- and brackish water (mesohaline) ostracod assemblages with some taxa hitherto unknown from this locality. The assemblage is indicative of a late Middle to Late Miocene (Sarmatian) age. This corresponds to previously published brachyhaline to marine taxa of the Early Oligocene, which are, however, reworked. In Turkish literature similar faunas have been recorded at other sections near the northern rim of the Ergene Basin south of the İstıranca Massif, but have not been interpreted as taphocoenoses. Other fossils, inlcuding palynomorphs and other plant remains, pelecypods, otoliths, fishes and mammalia, from these sections are also indicative of a Miocene age. In deeper neritic Oligocene deposits at Kartal Tepe ostracod species of the genus *Pokornyella* have been found that also occur reworked in the Miocene at Pınarhisar. Fifteen taxa from both the autochthonous Miocene and the allochthonous Oligocene are taxonomically considered and illustrated, and their stratigraphical and salinity ranges are summarized.

Key words: Ostracoda, Middle/Late Miocene, Ergene Formation, freshwater, brackish water, Early Oligocene, seawater, reworking, Ergene Basin, Thrace, Turkey.

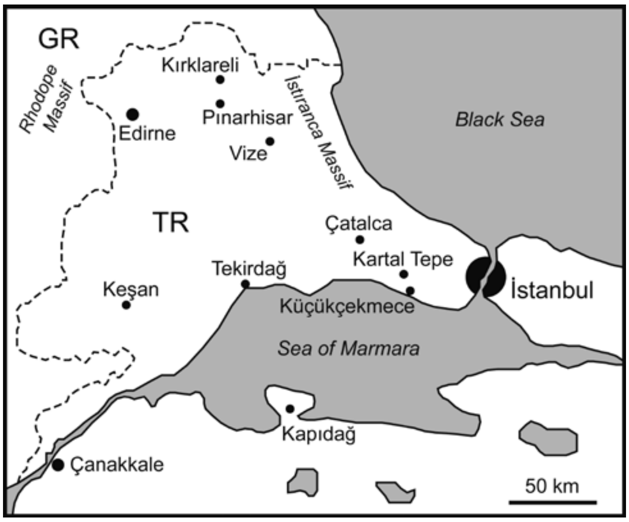
Kurzfassung

Neue Proben aus den Ergene Schichten, den Mangan-Schichten an der Basis und den Fisch-Schichten im oberen Teil des Pınarhisar Profils enthielten eine limnische bis brackische (mesohaline) Ostracodenfauna des höheren Mittel- bis Obermiozäns (Sarmat) mit einigen von dieser Lokalität bisher nicht bekannten Arten, sowie bereits publizierte brachyhaline bis marine unteroligozäne Taxa, die jedoch umgelagert sind. In der türkischen Literatur wurden vergleichbare Faunen in anderen Profilen nahe dem nördlichen Rand des Ergene Beckens südlich des İstıranca Massivs nachgewiesen, jedoch nicht als Taphozönosen angesprochen. Andere Fossilgruppen, wie Palynomorphen, Pflanzenreste, Pelecypoden, Otolithen, Fisch- und Säugetierreste aus diesen Profilen weisen ebenso auf ein Miozän-Alter hin. Im tiefneritischen oligozänen Sedimenten von Kartal Tepe wurden *Pokornyella*-Arten aufgefunden, die auch umgelagert im Miozän von Pınarhisar vorkommen. Fünfzehn Taxa aus dem autochthonen Miozän und dem allochthonen Oligozän wurden taxonomisch bearbeitet und abgebildet, ihre stratigraphische Verbreitung und ihre Aussagen zur Salinität zusammengefasst.

Schlüsselwörter: Ostracoden, Mittel/Obermiozän, Ergene Schichten, Süßwasser, Brackwasser, Unteroligozän, Meerwasser, Umlagerung, Ergene Becken, Thrazien, Türkei.

1. Introduction

Initial identification of ostracods from the upper part of the Manganese Beds at Pınarhisar (Textfig. 1) were conducted in 2006 by Prof. Dr. Tunoğlu, Haccetepe University, Ankara, on request of Dr. Rückert-Ülkümen, Bayerische Staatssammlung für Paläontologie und Geologie, Munich. His results, i.e. the co-occurrence of the Neogene freshwater species *Fabaeformiscandona balatonica* (Daday, 1894) and the Palaeogene marine genus *Aequacytheridea* in the same sample, warrant further investigation of the Pınarhisar material. Consequently ostracods from the Fish Beds and the deeper in the section situated ca. 1–2 m max. thick manganese-bearing bed at Pınarhisar have been studied and well-preserved faunas composed of non-marine (freshwater and brackish) Miocene and marine Oligocene taxa have been encountered. These assemblages are identical to the so-called “mixed faunas” of Malz (1992: 87)



Textfigure 1: Turkey, Thrace, location map, adapted from Rückert-Ülkümen et al. (2009: fig. 1).

that are interpreted as a result of reworking (Malz in Rückert-Ülkümen 1990: 30; Malz 1992: 88).

A long-lasting disput exists between Rückert-Ülkümen (1960, 1963) and Sönmez-Gökçen (1964, 1973) with regard to the age of these faunas. The former author proposed a Miocene age based on fishes. Sönmez-Gökçen, however, attributes an Early Oligocene age (Stampian) to the Fish Beds, the underlying Manganese and Congeria Beds based on ostracods. More recently, Rückert-Ülkümen (1990) presented further evidence in support of a Miocene (Samatian s. l.) age of the Fish Beds based on fish fossils but also one gastropod index species and sporomorphs.

In NE Thrace, near the basin margin S of the İstıranca Massif, additional "mixed faunas" have been documented by Sönmez-Gökçen (1964, 1973), Gökçen (1975), Malz in Rückert-Ülkümen (1990) and Witt (2010); the localities include Akviran-İnceğiz and Çatalca (Sönmez-Gökçen 1973: fig. 1, tab. 5 and 6), Pınarhisar and Poyralı (Gökçen 1975: figs 1, 3 and 4) and Hoşdere (Witt 2010: 98). In these studies, with the exception of the paper by Witt, the ostracod assemblages are considered Oligocene in age, but without giving credit to taxa of differing ecological requirements and stratigraphical distribution. Sönmez-Gökçen (1973: 5–22) discusses in detail the various views about the stratigraphy of NE Thrace, but the discrepancy remains, especially with regard to those sections with unique lithological successions, including the succession Congeria Beds to Fish Beds. This sequence is considered Oligocene by Sönmez-Gökçen and Miocene (Sarmatian s.l.) by Rückert-Ülkümen.

Ostracods from the Oligocene of Kartal Tepe have also been investigated previously, with the result that a small number of marine ostracods encountered at Kartal Tepe in deeper neritic Oligocene strata (Hagn & Martini in Rückert-Ülkümen & Kaya 1993: 54–56) appear also in sediments containing the fresh- to brackish water ostracod taxa *Darwinula, Candona*, *Fabaeformiscandona*, *Cypria*, *Cypridopsis*, *Miocyprideis*, *Cyprideis* and *Amplocypris.* Authors such as Öztürk & Frakes (1995), Gültekin (1998) and İslamoğlu et al. (2008: fig. 8) follow Sönmez-Gökçen, and only occasionally (e.g., in the paper by İslamoğlu et al. 2010: 185) the discrepancy of the age assignments has been noticed.

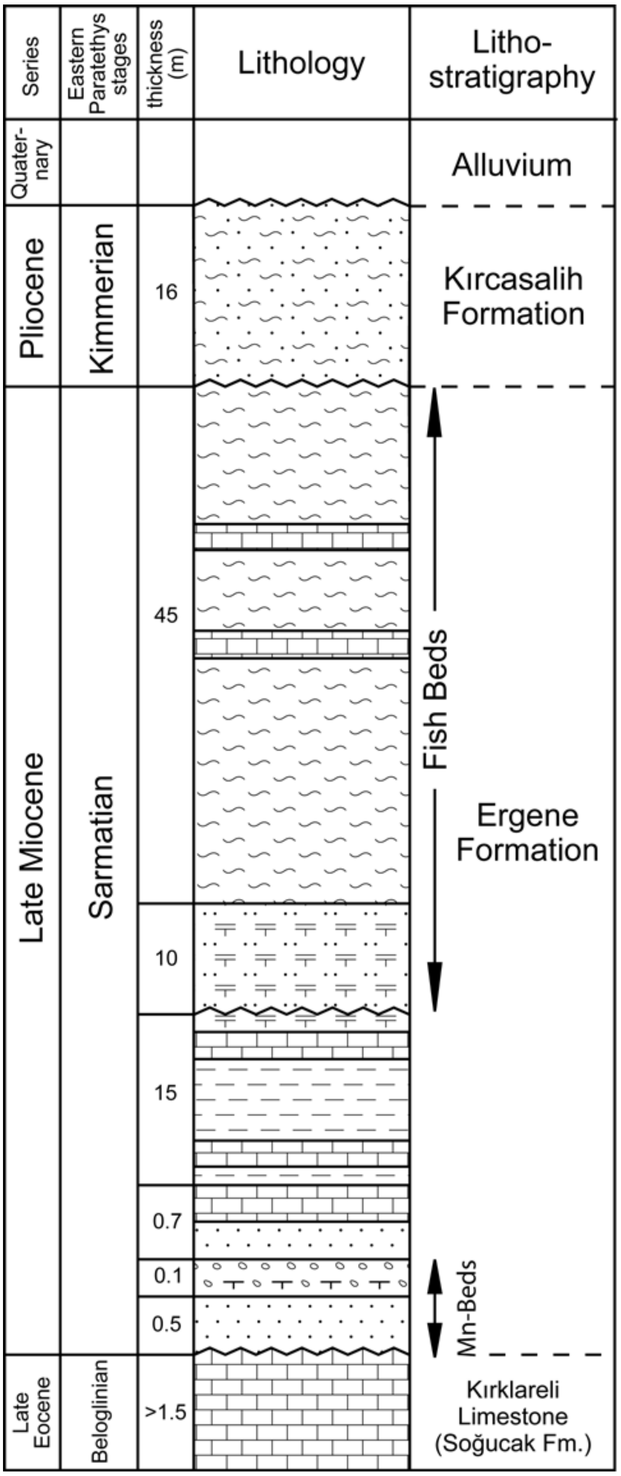
Sönmez-Gökçen's (1973) new Oligocene species are biostratigraphically only partly used here, since the author of the present paper rejects Sönmez-Gökçen's stratigraphical interpretation, i.e. the succession Congeria, Manganese and Fish Beds being attributed to the Oligocene. Instead, the author claims and attempts to demonstrate that the Oligocene taxa are reworked into Miocene strata.

The hypothesis of reworking is supported by the results of a sequence stratigraphical study of the eastern Thrace Basin. Turgut & Eseller (2000: 83) distinguish an early normal faulting, Late Eocene to Early Oligocene, controlling subsidence and basin growth, and younger tectonic events, e.g., reverse faulting of the earlier normal faults in Early Miocene peaking in the Middle to Late Miocene. The beginning of these later tectonic events is believed to be associated with a major relative sea level fall in the Early Miocene and uplift and erosion of much of the earlier sedimentary succession in the Middle to Late Miocene, most intensive in the centre and the northeastern margin of the study area (Turgut & Eseller 2000: 93). Thus alluvial fan, fluvial channel and various lagoonal deposits constitute the facies of the last sequence that is Early Miocene in age (Turgut & Eseller 2000: 61)

Differences in the position of base Late Miocene corresponding to base Tortonian and base Pannonian exist between Harzhauser & Piller (2007: fig. 1), Piller et al. (2007: fig. 1) and Popov et al. (2004). In the first 2 papers the base is established at 11.6 ma, in Popov et al. at 11 ma with the exception base Pannonian at ca. 11.8 ma. In the present paper Harzhauser & Piller's (2007: fig. 1) subdivision is accepted und used. The classification of brackish and sea water follows generally Hiltermann (1966: tab. 4).

2. Stratigraphy

The stratigraphy follows Rückert-Ülkümen et al. (2009: fig. 8). The Late Miocene Ergene Formation overlies unconformably the Late Eocene Soğucak Formation, which consists of shallow marine limestones and is unconformably overlain by the Kırcasalih Formation that is composed of greenish grey laminated sandy marls, Pliocene (Kimmerian) in age. The Ergene Formation, Sarmatian in age, measures at Pınarhisar ~71 m of which the upper 55 m are informally called here the Fish Beds since they preserve a rich fish fauna. The remaining 16 m



Textfigure 2: Pınarhisar, generalized lithological columnar section, adapted from Rückert-Ülkümen et al. (2009: fig. 8).

exhibit a variety of clastics and in the lower part a bed bearing Manganese ores, the Manganese Beds (Textfig. 2) These characteristic lithologies have been sampled for (micro)fossils, and the ostracod fauna warrants a detailed study due to its diversity and excellent preservation.

The Panarhisar Formation is considered by Gökçen (1975: figs 3–8) as Oligocene in age. This author distinguishes between a Sannoisian and a Stampian ostracod association (Sönmez-Gökçen 1973: tab. 7). On table 6 in Sönmez-Gökçen (1973), the columnar section of the Çatalca outcrops, the Sannoisian unit, is named "Conglomerates and Congeria Limestones" superimposed by the Fish Beds, finely laminated shales and marls (Rückert-Ülkümen 1990: fig. 2). The Fish Beds were considered Neogene by previous authors, but have been attributed to the Early Oligocene (Stampian) by Sönmez-Gökçen (1964: 49), which is disputed by Rückert-Ülkümen and the present author. In the Akviran–İnceğiz region the Manganese Beds have been encountered below the Fish Beds by Sönmez-Gökçen (1973: fig. 7) in man-made excavations, resulting in small Manganese open-cast-mines. In her table 6, the Manganese Beds, maximum thickness 2 m, are included in the Fish Beds. The Mn-bearing beds are generally ~30–35 cm thick according to Aslaner (1966: 142).

3. Material

The samples were collected, washed and picked by Dr. N. Rückert-Ülkümen. The first series consisted only of 1 slide with ostracods from the upper part of the Manganese Beds. The second patch of 23 slides comprised a varying amount of ostracods. Apart from ostracods, several of the slides also contain fish remains and fish teeth, small gastropods and rare foraminifera. The slides originate from the lower part of the Fish Beds, and the upper and lower parts of the Manganese Beds at Pınarhisar. The list below of ostracod taxa was supplemented by data taken from Gökçen (1975: fig. 3) for the Congeria Beds, which underlay the Manganese Beds. The sample location is shown on Textfigure 1, and a generalized columnar section of the area in Textfigure 2.

The material is deposited in the collection of the the Bayerische Staatssammlung für Palaeontologie und Geologie, Munich, under accession numbers: Pınarhisar, Sarmatian 1st series: BSPG 1980 X 1380–1412; Pınarhisar, Sarmatian 2nd series: BSPG 1980 X 1500–1537; Kartal Tepe, Rupelian: BSPG 1980 X 1538–1551.

4. Ostracoda at Pınarhisar

Abbrevations: vr = very rare, 1 specimen; r = rare, 2–5 specimens; c = common, 6–20 specimens; a = abundant, 21–100 specimens; va = very abundant, >100 specimens. C = carapace, R = right valve, L = left valve, V = valve. l = length, h = height, w = width.

4.1 Synopsis of recorded taxa

The following taxa (those marked by an asterisk are considered reworked) have been recognized in the Pınarhisar samples:

Lower part of the Fish Beds:
Fresh- to oligohaline taxa
?Candonopsis sp.; vr
Cypria lucida Sönmez-Gökçen, 1973; r
Cypridopsis modesta Sönmez-Gökçen, 1973; a
Meso- to brachyhaline taxa
Amplocypris pamiri (Sönmez, 1963) ; c
Marine taxa
**Callistocythere* sp. ; c
**Serrocytheridea* sp., aff. *eberti* (Lienenklaus, 1894) ; r
**Pokornyella amygdaliformis* Sönmez-Gökçen, 1973 ; c
**Pokornyella* cf. *lattorfiana* (Lienenklaus, 1900) ; vr
**Xestoleberis* sp.; r

Upper part of the Manganese Beds:
Fresh- to oligohaline taxa
Darwinula stevensoni (Brady & Robertson, 1870); vr
Candona sp., juv.; c
Candona sp. (small); r
Fabaeformiscandona cf. *balatonica* (Daday, 1894); r
?Candonopsis sp.; vr
Cypria lucida Sönmez-Gökçen, 1973; adults r; juv. c
Heterocypris formalis (Mandelstam, 1963); vr
Cypridopsis modesta Sönmez-Gökçen, 1973; c
Meso- to brachyhaline taxa
Amplocypris pamiri (Sönmez, 1963); c
**Hemicyprideis istanbulensis* Bassiouni, 1979; c
Miocyprideis sarmatica (Zalányi, 1913); vr
Cyprideis pannonica (Méhes, 1908); vr
Cyprideis sp., r
Marine taxa
**Paracypris* sp.; r
**Serrocytheridea* sp., aff. *eberti* (Lienenklaus, 1894); c
**Schuleridea (Aequacytheridea)* sp.; a
**Cuneocythere (C.)* sp.; vr
**Pontocythere* sp.; r
**Paracytheridea* sp.; r
**Cytheretta* sp.; vr
**Bosquetina* sp. in Sönmez-Gökçen 1973: 40, pl. 9, figs 7–9; c
**Leguminocythereis* sp.; vr
**Pokornyella amygdaliformis* Sönmez-Gökçen, 1973; a
**Pokornyella bituberculata* Sönmez-Gökçen, 1973 + juv.; r
**Pokornyella* cf. *lattorfiana* (Lienenklaus, 1900); c
**Pokornyella* sp.; r
**Loxoconcha* sp. 1 Sönmez-Gökçen, 1973; r
**Xestoberis* div. sp.; r

Lower part of the Manganese Beds:
Freshwater to oligohaline taxa
Cypridopsis modesta Sönmez-Gökçen, 1973; a
Meso- to brachyhaline taxa
Amplocypris pamiri (Sönmez, 1963); c
**Hemicyprideis istanbulensis* Bassiouni, 1979; vr
Marine taxa
**Cuneocythere (C.)* sp.; r
**Pokornyella bituberculata* Sönmez-Gökçen, 1973, juv.; vr

Congeria Beds (after Gökçen 1975: fig. 3)**:**
Freshwater to oligohaline taxa
Cypridopsis modesta Sönmez-Gökçen, 1973
Meso- to brachyhaline taxa
Amplocypris pamiri (Sönmez, 1963)
Hemicyprideis sp.
**Neocyprideis* cf. *williamsoniana* (Bosquet, 1852)
Marine taxa
**Aulocytheridea faboides* (Bosquet, 1852)
**Schuleridea (Aequacytheridea)* sp.
**Cushmanidea* cf. *scrobiculata* (Lienenklaus, 1894)
**Paracytheridea pulvinata* Sönmez-Gökçen, 1973
**Cytheretta* cf. *tenuistriata* (Reuss, 1853)
**Bosquetina* sp. in Sönmez-Gökçen 1973: 40, pl. 9, figs 7–9
**Leguminocythereis* cf. *sorneana* Oertli, 1956
**Pokornyella bituberculata* Sönmez-Gökçen, 1973
**Pokornyella* cf. *lattorfiana* (Lienenklaus, 1900)
**Pokornyella limbata* (Bosquet, 1852)

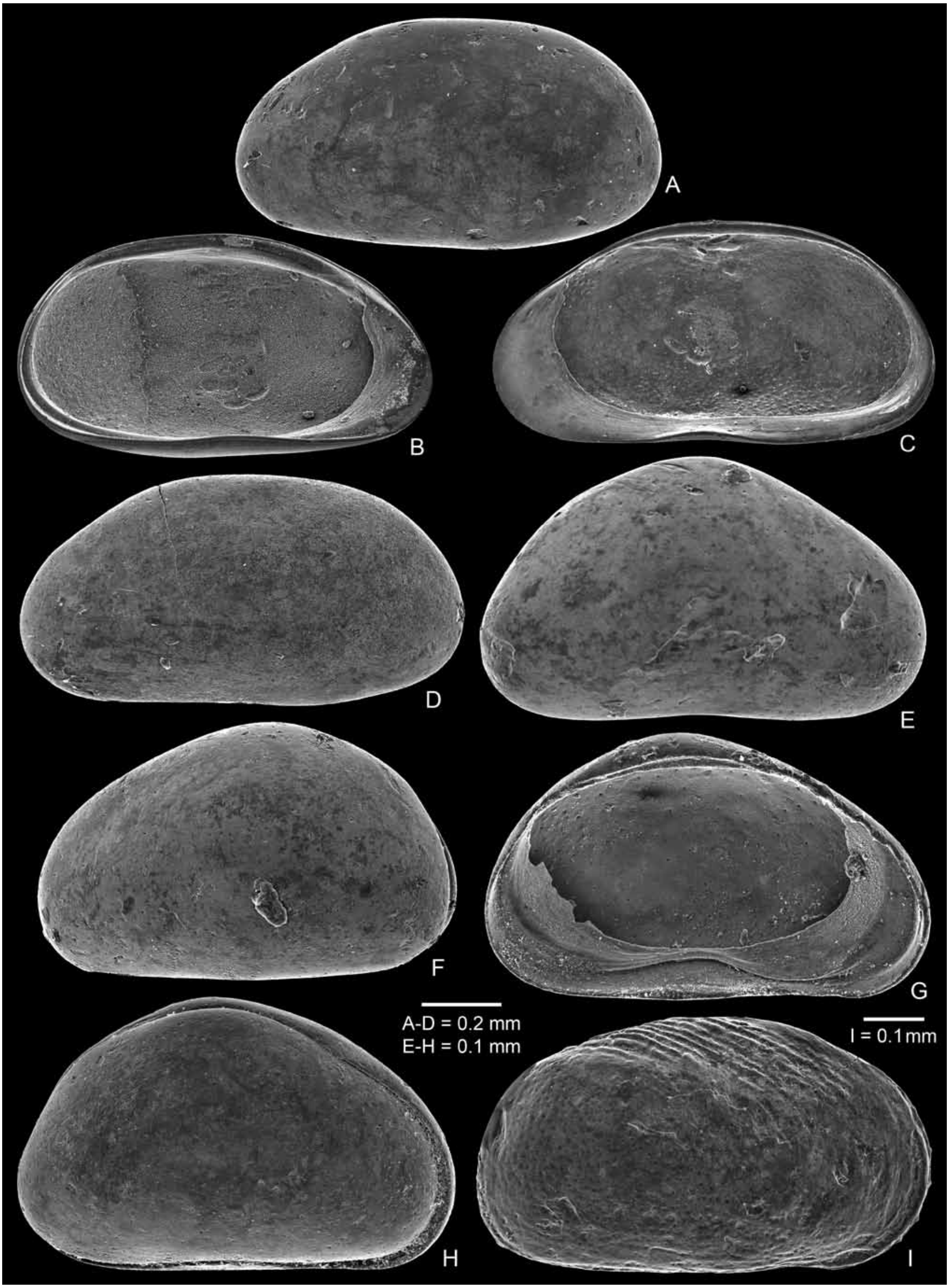
4.2 Systematics

An attempt has been made to distinguish between fresh- to brackish-water and marine taxa. The former can be subdivided into freshwater forms (fresh to oligohaline, 0–±5‰) and brackish water forms (mesohaline, ±5–±18‰). The marine forms are found in waters with > ±18‰ salinity. The systematic classification for the marine and brackish water taxa follows Hartmann & Puri (1974), that for the freshwater taxa Meisch (2000). The stratigraphical terminology used in this paper follows Harzhauser & Piller (2007: fig. 1).

Order Podocopida G.W. Müller, 1894
Suborder Podocopina Sars, 1866

Family Darwinulidae Brady & Norman, 1889

Plate 1: (A–D) *Amplocypris pamiri* (Sönmez, 1963); A: L ♀ (l = 1.155, h = 0.622 mm), external view, ca. x78, BSPG 1980 X 1380; B: L ♀ (l = 1.127, h = 0.607 mm), internal view, ca. x78, BSPG 1980 X 1381; C: R ♂ (l = 1.164, h = 0.584 mm), internal view, ca. x80, BSPG 1980 X 1382; D: L ♂ (l = 1.182, h = 0.602 mm), external view, ca.x80, BSPG 1980 X 1383. **(E–H)** *Cypridopsis modesta* Sönmez-Gökçen, 1973; E: R (l = 0.593, h = 0.350 mm), external view, ca. x160, BSPG 1980 X 1384; F: C from left (l = 0.585, h = 0.358 mm), ca. x150, BSPG 1980 X 1385; G: L (l = 0.604, h = 0.369 mm), internal view, ca. x155, BSPG 1980 X 1386; H: C from right (l = 0.589, h = 0.365 mm), ca. x160, BSPG 1980 X 1387. **(I)** *Cyprideis pannonica* (Méhes, 1908), R ♀ (l = 0.804, h = 0.442 mm), external view, ca.x120, BSPG 1980 X 1388. Locality Pınarhisar; Sarmatian (late Middle to Late Miocene): Lower part Fish Beds (C, E, G, H), Upper part Manganese Beds (D, F, I), Lower part Manganese Beds (A, B).



A
B
C
D
E
F
G
H
I
A-D = 0.2 mm
E-H = 0.1 mm
I = 0.1mm

Genus *Darwinula* Brady & Robertson, 1885

Darwinula stevensoni (Brady & Robertson, 1870)
Pl. 2, Fig. D

1980 *Darwinula stevensoni* (Brady & Robertson, 1870) – Freels: 14, pl. 1, figs 12–14.
2000 *Darwinula stevensoni* (Brady & Robertson, 1870) – Meisch: 49, fig. 16.
2002 *Darwinula stevensoni* (Brady ve Robertson, 1885) – Atay & Tunoğlu: pl. 2, figs 15–17. (Further synonyms).
v 2003 *Darwinula stevensoni* (Brady & Robertson, 1870) – Witt: 95, pl. 1, fig. 1.

Material: Pınarhisar, Upper part Mn Beds: 1 C.

Measurements (mm): l = 0.636, h = 0.267, w = 0.235, l/h = 2.382.

Other regional occurrences: Data assembled by Witt (2003: 95) from the Central and Eastern Paratethys, Greek islands and mainland, and from Anatolia show the occurrence of this species in these regions from Middle Miocene to Early Pleistocene. The fossil record of this species is Middle Oligocene to Recent (Meisch 2000: 52).

Palaeoecology: Freshwater, occasionally also in oligo- to mesohaline waters (van Morkhoven 1963: 29).

Superfamily Cypridoidea Baird, 1845
Family Candonidae Kaufmann, 1900
Subfamily Candoninae Kaufmann, 1900

Genus *Candona* Baird, 1845

Candona sp.
Pl. 2, Figs F, G

Material: Pınarhisar, Upper part Mn Beds: 2 R, 1 L slightly damaged.

Measurements (mm): R: l = 0.620–0.640, h = 0.290–0.305, l/h = 2.098–2.138; L: l = 0.602, h = 0.284, l/h = 2.120.

Remarks: This small form is characterized by a dorsal margin slightly sloping to the rear, a narrowly rounded posterior end and a pronounced centrally situated ventral concavity. This form does not constitute juveniles of *F.* cf. *balatonica.* These have been documented by Gross (2004: pl. 4).

Palaeoecology: As for *F. balatonica.*

Genus *Fabaeformiscandona* Krstić, 1972

Fabaeformiscandona cf. *balatonica* (Daday, 1894)
Pl. 2, Fig. E

cf. 2000 *Fabaeformiscandona balatonica* (Daday, 1894) – Meisch: 107, figs 41, 42.
cf. 2001 *Fabaeformiscandona balatonica* (Daday, 1894) – Pipík: 300, pl. 17, figs 8–13; pl. 25, fig. 1.
2004 *Fabaeformiscandona* ex gr. *balatonica* (Daday, 1894) – Gross: 68, pl. 4, figs 3–6, 9–19.
2009 *Fabaeformiscandona balatonica* (Daday, 1894) – Rückert-Ülkümen et al.: pl. 1, fig. 3.

Material: Pınarhisar, Upper part Mn Beds: 1 R damaged, 1 V lost.

Measurements (mm): R damaged**:** l = 0.934 (est.), h = 0.476; Pipík (2001: 300): l = 0.814–0.902, h = 0.439–0.490, l/h = 1.854–1.841.

Remarks: Meisch's fig. 41 of the ♀♀ valves of recent specimens corresponds in outline better with the present Middle to Late Miocene Thracian specimens than Pipík's specimens from the Pannonian of Slovakia. The latter show a rather pointed posterior end. The highest point of the posterior margin of the Recent forms is situated lower than in the Thracian ones.

Recent specimens of *F. balatonica* show a more pronounced posterior cardinal angle. For recent specimens Meisch (2000: 110) gives the following measurements (mm): ♀♀: 1.0–1.2, ♂♂: 1.2–1.3.

Other regional occurrences: In Europe, the *F. balatonica*-group occurs from the Middle Miocene (Badenian) to Recent (Pipík 2001: fig. 7).

Palaeoecology: *F. balatonica* prefers shallow ponds and the very shallow zone of lakes, periodically drying up. Occurs also in the littoral of lakes and rivers, probably tolerating oligohaline waters (Gross 2004: 69).

Subfamily Cyclocypridinae Kaufmann, 1900

Genus *Cypria* Zenker, 1854

Cypria lucida Sönmez-Gökçen, 1973
Pl. 2, Figs B, C

* 1973 *Cypria lucida* n. sp. – Sönmez-Gökçen: 33, pl. 3, figs 18–20.

Material: Pınarhisar, Lower part Fish Beds: 1 R, 1 L juv.; Pınarhisar, Upper part Mn Beds: 2 R (damaged), 2 L (damaged), 15 V juv.

Measurements (mm): R: l = 0.567–0.682, h = 0.345–0.420, l/h = 1.643–1.624; R: l = 0.689, h = 0.426, l/h = 1.617 (based on fig. 20 in Sönmez-Gökçen, 1973: pl. 3); L: l = 0.667, h = 0.471, l/h = 1.416 (based on fig. 18 in Sönmez-Gökçen, 1973: pl. 3); L: l = 0.70, h = 0.48, w = 0.35, l/h = 1.458 (average dimensions, Sönmez-Gökçen 1973: 34).

Remarks: All specimens of this thin-shelled taxon are somewhat damaged.

Relations: *Cypria lenticulata* Pipík & Bodergat (2003: 354) from the Late Miocene of Slovakia has comparable l/h-ratios of 1.393–1.503, but is much smaller; the holotype measures (mm): l = 0.490, h = 0.347, l/h = 1.412.

Other regional occurrences: Like a number of other fresh to brackish water taxa, this new species is considered derived from Early Oligocene (Stampian) deposits by Sönmez-Gökçen (1973). The Early Oligocene in this region is deeper neritic; it can be reasoned that the species is from the late Middle to Late Miocene fresh to brackish water deposits. In Thrace it has been also found at the localities İnceğiz, in the Manganese Beds (Sönmez-Gökçen 1973: tab. 5) and Çatalca, in the Fish Beds (Sönmez-Gökçen 1973: tab. 6), both are late Middle to Late Miocene.

Palaeoecology: The genus *Cypria* (Palaeocene to Recent) is one of the most common freshwater ostracods, preferring environments rich in plants (van Morkhoven 1963: 68). Generally limnic (0–0.5‰, possibly 5‰) (Sönmez-Gökçen 1973: 100, Faunizone IV).

Family Cyprididae Baird, 1845
Subfamily Herpetocyridinae Kaufmann, 1900

Genus *Amplocypris* Zalányi, 1944

Amplocypris pamiri (Sönmez, 1963)
Pl. 1, Figs A–D

* 1963 *Isomoenocypris pamiri* n. subg. n. sp. – Sönmez: 78, pl. 1, figs 1–6; pl. 2, figs 19–25.
1973 *Moenocypris (Isomoenocypris) pamiri* Sönmez, 1963 – Sönmez-Gökçen: 31, pl. 1, figs 6–12; pl. 3, figs 3–10.
1975 *Isomoenocypris pamiri* Sönmez – Gökçen: pl. 1, figs 1, 2.

Material: Pınarhisar, Lower part Fish Beds: ♀: 1 R, ♂: 3 R; Pınarhisar, Upper part Mn Beds: ♀: 2 C, 1 R, 5 L, ♂: 1 C, 7 R, 6 L, juv.: 3 C, 1 R, 1 L; Pınarhisar, Lower part Mn Beds: ♀: 3 R, 4 L, ♂: 3 R, 1 L.

Measurements (mm): R ♀: l = 1.055, h = 0.560, l/h = 1.884; L ♀: l = 1.076–1.155, h = 0.569–0.622, l/h = 1.824–1.857; C ♀: l = 0.933, h = 0.500, w = 0.415, l/h = 1.866; R ♂: l = 1.125–1.182, h = 0.562–0.595, l/h = 1.987–2.002; L ♂: l = 1.178–1.182, h = 0.602–0.636, l/h = 1.852– 1.963.

Relations: This species is characterized by a low arched dorsal margin, which straightens in the centre of the left valves. None of the *Amplocypris* species described and depicted by Sokač (1972: encl. 2) and Krstić (1973: 92) show this feature.

Remarks: The name *Isomoenocypris* has been introduced by Sönmez since the new subgenus is related to *Moenocypris* Triebel, 1959, but differs from the latter in the structure of the marginal zone and the marginal pore canals (Sönmez 1963: tab. 2). However, *Isomoenocypris* is considered here as being a junior synonym of *Amplocypris*. The oldest species is *A. snegotini* (Krstić, 1966) from the post-Egerian Lower Miocene (Pipík 2001: 217). For the Late Miocene, Pannonian to Pontian, of the Central Paratethys, Sokač (1972: encl. 2) and Krstić (1973: 92) have established the ranges for a number of *Amplocypris* index-species. Benson et al. (1961: Q213) give Neogene as the range for the genus.

Regional occurrences: In the Ergene Basin this Neogene index species occurs commonly in late Middle to Late Miocene (Sarmatian s. l.) brackish water sediments together with reworked Oligocene marine ostracods. In Thrace the species is common in the Fish Beds and Manganese Beds. It has been recorded for the locality İnceğiz, in sands of the Manganese Beds and in the overlying Fish Beds (Sönmez-Gökçen 1973: tab. 5), both late Middle to Late Miocene in age. The type-locality is Poyralı SW of Pınarhisar (Sönmez 1963: 78), where it has been found in sandy clays and marls intercalated by minor sandy limestone and argillaceous sandy limestone beds (Sönmez 1963: tab. 1). This succession has been attributed to the Fish Beds, which are also known under the name «schistes carton». In the Küçükçekmece area (Gökçen 1975: fig. 8), the species occurs from the late Middle to Late Miocene (Witt 2010: 99).

Palaeoecology (genus): Summarized by Gross (2004: 74) as mesohaline (±5–±10‰), littoral. Basically brackish (5–18‰) (Sönmez-Gökçen 1973: 99–100, Faunizone III–IV).

Subfamily Cyprinotinae Bronshtein, 1947

Genus *Heterocypris* Claus, 1892

Heterocypris formalis (Mandelstam, 1963)
Pl. 2, Fig. A

* 1963 *Cyprinotus formalis* Mandelstam sp. n. – Mandelstam & Schneider: 202, pl. 20, fig. 9a–b.
1995 *Heterocypris* ex gr. *formalis* (Mandelstam) – Krstić: 402, pl. 9, fig. 1.
v 2005 *Heterocypris formalis* (Mandelstam, 1963) – Matzke-Karasz & Witt: 125, pl.2, figs 12, 13.

Material: Pınarhisar, Upper part Mn Beds: 1 R.

Measurements (mm): R: l = 0.755, h = 0.436, l/h = 1.732.

Regional occurrences: In the Miocene to Pliocene of Dzungaria (Mandelstam & Schneider 1963), in the Pliocene of Serbia (Krstić 1995) and Late Pannonian or Khersonian of the Yalova area, NW-Anatolia (Matzke-Karasz & Witt 2005).

Palaeoecology: Most *Heterocypris* species are freshwater forms, some prefer oligo- to mesohaline habitats (van Morkhoven 1963: 46). *H. formalis* has been described from freshwater deposits (Mandelstam & Schneider 1963: 203).

Subfamily Cypridopsinae Kaufmann, 1900

Genus *Cypridopsis* Brady, 1867

Cypridopsis modesta Sönmez-Gökçen, 1973
Pl. 1, Fig. E–H

* 1973 *Cypridopsis modesta* n. sp. – Sönmez-Gökçen: 32, pl. 3, figs 14–17.

Material: Pınarhisar, Lower part Fish Beds: 13 C, 17 R, 25 L; Pınarhisar, Upper part Mn Beds: 3 C, 14 R, 7 L.; Pınarhisar, Lower part Mn Beds: 13 + 3 juv. C, 29 R, 11 L.

Measurements (mm): C: l = 0.578–0.589, h = 0.327–0.365, w = 0.309–0.355, l/h = 1.614–1.780; R: l = 0.570–0.593, h = 0.327–0.329, l/h = 1.743–1.802; L: l = 0.567–0.604, h = 0.349–0.369, l/h = 1.625–1.637; C: l = 0.59, h = 0.38, w = 0.31, l/h = 1.553 (medium dimensions Sönmez-Gökçen, 1973).

Remarks: Sexual dimorphism is not known (van Morkhoven 1963: 48); the genus is parthenogenetic (Meisch 2000: 376). The fossil *Cypridopsis modesta* shows a variability in size and shape and so does the cosmopolitan and very common *Cypridopsis vidua* (O. F. Müller, 1776) (Meisch 2000: 373).

Other regional occurrences: This common to abundant species is considered by Sönmez-Gökçen (1973) to originate from Early Oligocene (Sannoisian and Stampian) sediments, like a number of other fresh to brackish water species. Since the Early Oligocene in this region is deeper neritic, it can be concluded that this freshwater species is from the Middle to Late Miocene. In Thrace it has also been found at the localities İnceğiz, in the Manganese Beds and the overlying Fish Beds (Sönmez-Gökçen 1973: tab. 5) and Çatalca, in the Congeria Beds (Sönmez-Gökçen 1973: tab. 6), both late Middle to Late Miocene in age. In the Küçükçekmece area (Gökçen 1975: fig. 8) the species occurs in Middle to Late Miocene sandy limestones and marls (Witt 2010: 91, 99).

Palaeoecology (genus): Freshwater and oligo-mesohaline environments, benthonic, depth to ±70 m (van Morkhoven 1963: 48). Limnic-brackish (0–5‰) (Sönmez-Gökçen 1973: 100, Faunizone IV).

Family Cytherideidae Sars, 1925
Subfamily Cytherideinae Sars, 1925

Genus *Serrocytheridea* Carbonnel & Ballesio, 1982

Serrocytheridea sp., aff. *eberti* (Lienenklaus, 1894)
(Pl. 2, Figs K, L)

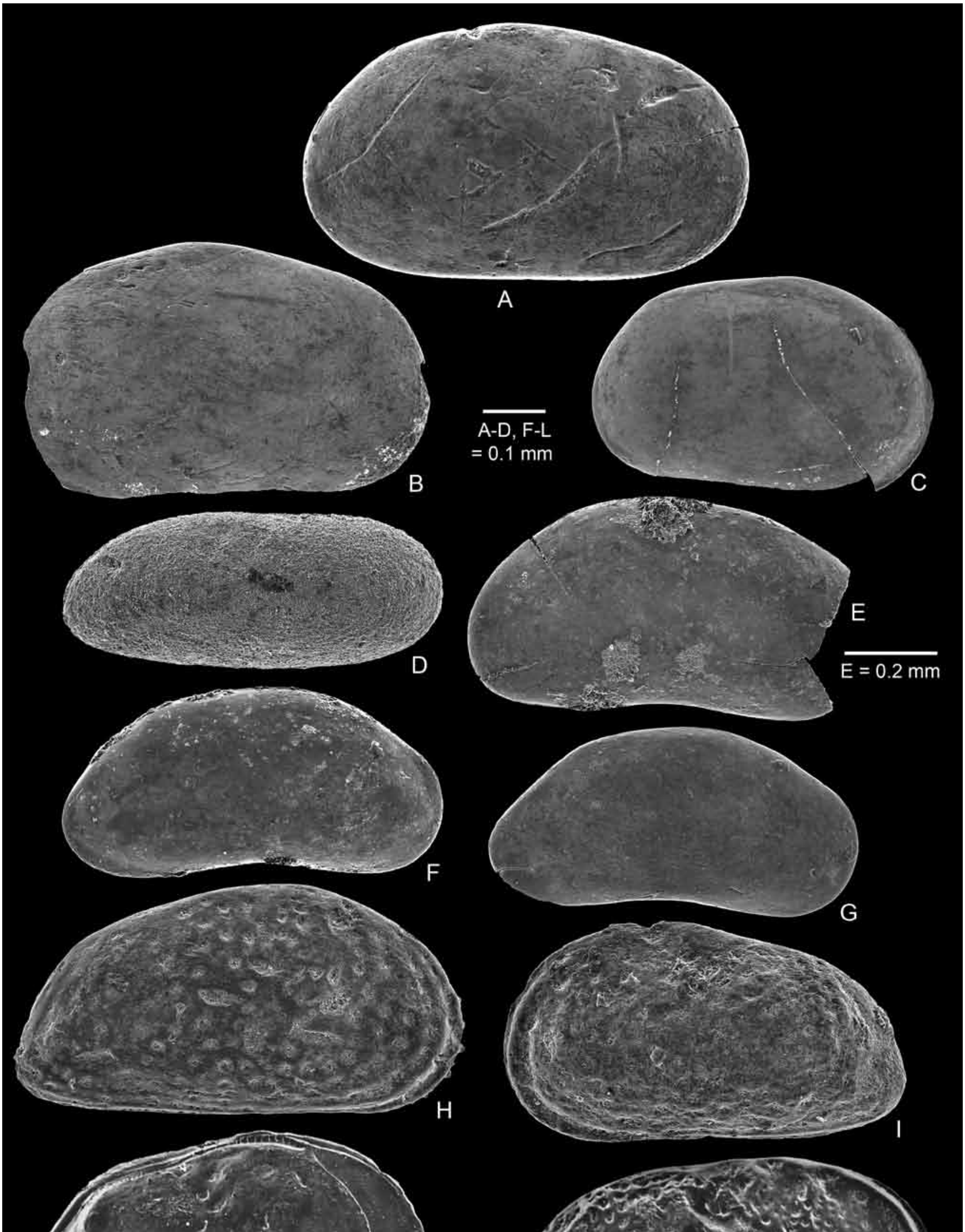
1973 *Cytheridea eberti* Lienenklaus, 1894 – Sönmez-Gökçen: 46, pl. 6, figs 2, 3.
1975 *Cytheridea eberti* Lienenklaus – Gökçen: pl. 1, figs 4, 5.
aff. 2008 *Serrocytheridea eberti* (Lienenklaus, 1894) – Uffenorde & Radtke: 81, pl. 2, fig. 8.

Material: Pınarhisar, Lower part Fish Beds: L♀: 1, R♂: 1; Pınarhisar, Upper part Mn Beds: R♀: 7, L♀: 10, 1 juv., R♂: 6, L♂: 4.

Measurements (mm): R♀: l = 0.691–0.760, h = 0.355–0.367, l/h = 1.946–2.071; L♀: l = 0.715–0.760, h = 0.385–0.404, l/h = 1.857–1.881; R♂: l = 0.796–0.800, h =0.345–0.364, l/h = 2.198–2.319; L♂: l = 0.802–0.811, h = 0.400–0.402, l/h = 1.995–2.028.

Remarks & relations: The specimens from Thrace are considerably larger and relatively higher than the ones from Germany and Switzerland. Dorsally the highest point is situated at the anterior cardinal angle, whereas the specimens from Germany and Switzerland show it at about half length. Oertli (1956: 38) gives the following measurements (mm): l = 0.61–0.65 mm, Faupel (1975: 25) l = 0.61, h = 0.26,

Plate 2: (A) *Heterocypris formalis* (Mandelstam, 1963), R (l = 0.755, h = 0.436 mm), external view, ca. x125, BSPG 1980 X 1389. **(B–C)** *Cypria lucida* Sönmez-Gökçen, 1973; B: R, damaged (l = 0.682, h = 0.420 mm), external view, ca. x125, BSPG 1980 X 1390; C: L juv., damaged (l = 0.567, h = 0.345 mm), external view, ca. x125, BSPG 1980 X 1391; specimen lost. **(D)** *Darwinula stevensoni* (Brady & Robertson, 1870), C from left (l = 0.636, h = 0.267 mm), ca. x110, BSPG 1980 X 1392. **(E)** *Fabaeformiscandona* cf. *balatonica* (Daday, 1884); R, damaged (l = ~0.782, h = 0.476 mm), external view, ca.~x110, BSPG 1980 X 1393. **(F, G)** *Candona* sp.; F: R (l = 0.640, h = 0.305 mm), external view, ca. x 110, BSPG 1980 X 1394; G: R (l = 0.620, h = 0.290 mm), external view, ca. x 125, BSPG 1980 X 1395. **(H, I)** *Hemicyprideis istanbulensis* Bassiouni, 1979; H: R ♂ (l = 0.765, h = 0.400 mm), external view, ca. x 125, BSPG 1980 X 1396; I: L ♀ (l = 0.682, h = 0.373 mm), external view, ca. x 110, BSPG 1980 X 1397. **(K, L)** *Serrocytheridea* sp., aff. *eberti* (Lienenklaus, 1894); K: L ♀ (l = 0.760, h = 0.404 mm), internal view, ca. x 110, BSPG 1980 X 1398; L: R ♂ (l = 0.800, h = 0.345 mm), external view, ca. x 115, BSPG 1980 X 1399. Locality Pınarhisar; Sarmatian (late Middle to Late Miocene): Lower part Fish Beds (B, C); Upper part Manganese Beds (A, D–L)


A
B
A-D, F-L
= 0.1 mm
C
D
E
E = 0.2 mm
F
G
H
I
K
L

l/h = 2.346. The measurements (mm) of R♂ from the Upper Oligocene type-locality in Germany are l = 0.650, h = 0.323, l/h = 2.013 (Uffenorde & Radtke 2008: 85). Measurements (mm) taken from the illustrated specimen in Sönmez-Gökçen (1973: pl. 6, fig. 2): R♂: l = 0.838, h = 0.400, l/h = 2.095.

Other regional occurrences: Early Oligocene (Sannoisian and Stampian) species reworked in Middle to Late Miocene strata, at both localities İnceğiz and Çatalca, Congeria Beds and Fish Beds (Sönmez-Gökçen 1973: tabs 5, 6). Related forms in the Oligocene of the Swiss Molasse (Oertli 1956) and Late Oligocene of Southern North Sea Basin, Northern Germany (Lienenklaus 1894; Faupel 1975; Uffenorde & Radtke 2008).

Palaeoecology: Based on the distribution given for *S. eberti* in Faupel (1975: 24), the species occurs in shallow, coastal marine and marginal marine environments.

Genus *Hemicyprideis* Malz & Triebel, 1970

Hemicyprideis istanbulensis Bassiouni, 1979
Pl. 2, Figs H, I

1973 *Haplocytheridea* cf. *helvetica* (Lienenklaus, 1895) – Sönmez-Gökçen: 50, pl. 6, figs 4–7.
1975 *Haplocytheridea helvetica* (Lienenklaus) – Gökçen: pl. 1, figs 6–8.
* 1979 *Hemicyprideis istanbulensis* n. sp. – Bassiouni: 54, pl. 13, figs 16–20.

Material:Pınarhisar, Upper part Mn Beds: ♀: 8 R, 1 L, ♂: 1 R, 1 L.

Measurements (mm): R ♀: l = 0.727–0.751, h = 0.405–0.418, l/h = 1.795–1.797; L ♀: l = 0.655–0.682, h = 0.365–0.373, l/h = 1.828–1.913; R ♂: 0.764, h = 0.382, l/h = 2.000; L ♂: 0.765, h = 0.400, l/h = 1.913.

Remarks and relations: Figures 6–8 on plate 1 in Gökçen (1975) are identical with figures 4–6 on plate 6 in Sönmez-Gökçen (1973). The specimens from Pınarhisar are reworked since they co-occur with Middle to Late Miocene non-marine ostracods. The majority of specimens are stained and/or corroded, especially the anteroventral denticulations are missing. The genus *Haplocytheridea* is characterized by a large number of fine anteroventral denticulations and simple, unbranched marginal pore canals, whereas *Hemicyprideis* shows only few stronger anteroventral denticulations and centrally enlarged and partly branching marginal pore canals.

Other regional occurrences: In Thrace generally in the Early to Middle Oligocene (Bassiouni 1979: 56). Reworked in the Miocene Fish Beds of Çatalca (Sönmez-Gökçen 1973: 50, tab. 6; Gökçen 1975: fig. 7), at Pınarhisar reworked into the Middle to Late Miocene Upper Manganese Beds. İslamoğlu et al. (2008: 189) encountered this species in lignite-bearing Oligocene clastics in the Keşan-Malkara area (SW-Thrace).

Palaeoecology (genus): Brackish-limnic to brackish (Malz & Triebel 1970: 9). *Haplocytheridea*: brackish to marine (0.5–18‰) (Sönmez-Gökçen 1973: 99, Faunizone III).

Genus *Miocyprideis* Kollmann, 1960

Miocyprideis sarmatica (Zalányi, 1913)

* 1913 *Cytheridea punctillata* G. S. Brady var. *sarmatica* n. var. – Zalányi: 114, pl. 6, figs 9–11; textfigs 16a–c.
1990 *Miocyprideis sarmatica* (Zalányi, 1913) – Stancheva: 38, pl. 11, figs 5, 6.
2009 *Miocyprideis sarmatica* (Zalányi, 1913), juv. – Rückert-Ülkümen et al.: pl. 1, fig. 2.

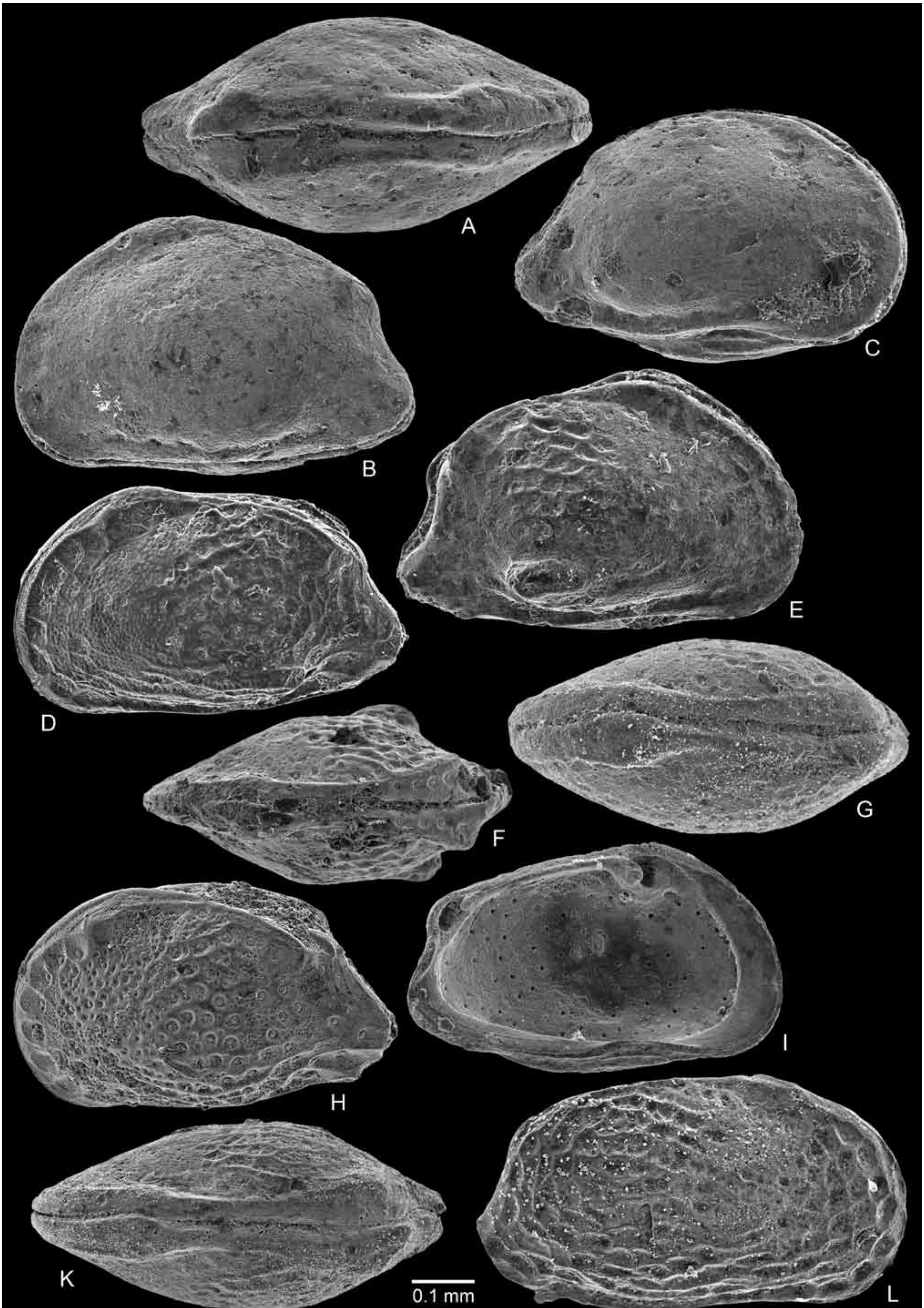
Material: Pınarhisar, Upper part Mn Beds: 1 L, juv. Specimen lost!

Measurements (mm): R: l = 0.800, h = 0.425, l/h = 1.882; L: l = 0.825, h = 0.450, l/h = 1.833 (Stancheva 1990: 38).

Remarks and relations: Bassiouni (1979: 68, pl. 14, figs 1–6) described and figured a *Miocyprideis* cf. *sarmatica* (Zalányi 1913) from the Early Miocene of Anatolia. His specimens are smaller: l = 0.675–0.775, h = 0.375–0.475 and are from a different stratigraphical level. Consequently they cannot be related to this index fossil.

Other regional occurrences: In the Eastern Paratethys in the late Middle to early Late Miocene, Volhynian to Bessarabien (Lower to Middle Sarmatian s. l.)

Plate 3: (A–C) *Pokornyella* sp.; A: C ♂ (l = 0.751, h = 0.442, w = 0.364 mm), dorsal view, ca. x 130, BSPG 1980 X 1400; B: C ♀ from left (l = 0.687, h = 0.422 mm), ca. x 125, BSPG 1980 X 1401; C: C ♀ from right (l = 0.709, h = 0.455 mm), ca. x 120, BSPG 1980 X 1402. **(D–F)** *Pokornyella bituberculata* Sönmez-Gökçen, 1973; D: C ♀ from left (l = 0.655, h = 0.382 mm), ca. x 130, BSPG 1980 X 1403; E: C ♀ from right (l = 0.656, h = 0.382 mm), ca. x 135, BSPG 1980 X 1404; F: C ♀ (l = 0.622, h = 0.364, w = 0.302 mm), dorsal view, ca. x 130, BSPG 1980 X 1405; specimen lost. **(G–I)** *Pokornyella amygdaliformis* Sönmez-Gökçen, 1973; G: C ♂ (l = 0.684, h = 0.426, w = 0.329 mm) dorsal view, ca. x 130, BSPG 1980 X 1406; H: C ♀ from left (l = 0.609, h = 0.400 mm), ca. x 140, BSPG 1980 X 1407; I: R ♀ int. view, l = 0.613, h = 0.389 mm) internal view, ca. x 135, BSPG 1980 X 1408. **(K, L)** *Pokornyella* cf. *lattorfiana* (Lienenklaus, 1900); K: C ♀ (l = 0.695, h = 0.382, w = 0.342 mm), dorsal view, ca. x 130, BSPG 1980 X 1410; L: R ♀ (l = 0.689, h = 0.376 mm) external view, ca. x 135, BSPG 1980 X 1411. Locality: Pınarhisar, Upper part Manganese Beds; Sarmatian (late Middle to Late Miocene) (A–C, E–G, I–L); Kartal Tepe; Rupelian (Early Oligocene) (D, H).


A
B
C
D
E
F
G
H
I
K
L
0.1 mm

(Stancheva 1990: 38).

Palaeoecology (genus): Predominantly in brackish (meso-brachyhaline) environments (van Morkhoven 1963: 294).

Genus *Cyprideis* Jones, 1857

Cyprideis pannonica (Méhes, 1908)
Pl. 1, Fig. I

1960 *Cyprideis pannonica* (Méhes, 1908) – Kollmann: 163, pl. 13, figs 1–4; Beil. 3: 12a–d.
1979 *Cyprideis (Cyprideis) pannonica* (Méhes, 1908) – Bassiouni: 84, pl. 1, figs 1–6.
1985 *Cyprideis pannonica* (Méhes, 1908) – Jiřiček: 396, pl. 53, figs 1–4.
1991 *Cyprideis pannonica* (Mehes) – Jiricek & Riha: pl. 4, fig. 8.
1999 *Cyprideis pannonica* (Mehes) – Şafak et al.: pl. 1, figs 12–14.
2002 *Cyprideis pannonica* (Mehes, 1908) – Atay & Tunoğlu: 124, pl. 1, figs 7–11. (Further synonyms).
2005 *Cyprideis pannonica* (Mehes, 1908) – Janz & Vennemann: pl. 1, fig. 6.

Material: Pınarhisar, Upper part Mn Beds: 1 R ♀.

Measurements (mm): R♀: l = 0.804, h = 0.442, l/h = 1.819.

Remarks: The pleated dorsal part of the illustrated specimen is possibly the result of the stress on the valve during the early part of skinning, during the process of biomineralisation.

Other regional occurrences: In the Inneralpine Vienna and Styrian Basins known from the Late Sarmatian s. str. to Early Pannonian C and in the Early Pannonian B? of Hungary (Kollmann 1960), equaling the Bessarabian to Khersonian (late Middle to early Late Miocene) in Eastern Paratethys terminology (Vrsaljko 1999: tab. 1, 2). In the Czech and Austrian parts of the Vienna Basin, in Hungary and the former Yugoslavia in the Early Pannonian A to C (Jiřiček 1985), which also corresponds with the Bessarabian to Khersonian in Eastern Paratethys terminology. Şafak et al. (1999: 17) encountered the species in Pliocene and Late Miocene sediments in W Anatolia, Bassiouni (1979: 84) in Late Miocene deposits of Anatolia.

Palaeoecology: The majority of *Cyprideis* species live in brackish (meso-brachyhaline) environments (van Morkhoven 1963: 290). Euryhaline, mainly mesohaline (5–18‰), but also oligohaline and hyperhaline (Gross 2004: 83, 101).

Family Trachyleberididae Sylvester-Bradley, 1948
Subfamily Hemicytherinae Puri, 1953

Genus *Pokornyella* Oertli, 1956

Pokornyella limbata (Bosquet, 1852)

1956 *Pokornyella limbata* (Bosquet, 1852) – Oertli: 98, pl. 14, figs 366–377.
non 1973 *Pokornyella limbata* (Bosquet, 1852) – Sönmez-Gökçen: 67, pl. 8, figs 25–30.
1985 *Pokornyella limbata* (Bosquet, 1852) – Ducasse et al. : pl. 82, fig. 16.

Measurements (mm): Swiss Molasse Basin, Early Oligocene, Oertli (1956: 98): ♀♀: 0.60–0.66; ♂♂: 0.64–0.67.

Pokornyella amygdaliformis Sönmez-Gökçen, 1973
Pl. 3, Figs G–I

* 1973 *Pokornyella amygdaliformis* n. sp. – Sönmez-Gökçen: 65, pl. 8, figs 13–17.

Material: Pınarhisar, Lower part Fish Beds: ♀: 3 C, 1 R, 1 L, ♂: 2 C; Pınarhisar, Upper part Mn Beds: ♀: 1 C, 1 R, 2 L, ♂: 1 L, 2 C; further numerous C, R, and L, sex not determined.
Kartal Tepe: ♀: 1 C.

Measurements (mm): Pınarhisar: R ♀: l = 0.622–0.644, h = 0.375–0.400, l/h = 1.659–1.610; L ♀: l = 0.613, h = 0.389, l/h = 1.576; C ♀: l = 0.640–0.684, h = 0.405–0.426, w = 0.318–0.329, l/h = 1.580–1.606; L ♂: l = 0.655, h = 0.382, l/h = 1.715; C ♂: l = 0.656, h = 0.382, w = 0.313, l/h = 1.717. Kartal Tepe: C ♀: l = 0.609, h = 0.400, w = 0.327, l/h = 1.523.

Description: Sönmez-Gökçen mentions in her description „La surface légèrement ponctuée, surtout au centre de la valve...". The SEM images, however, show a finely pitted first third of the valve. This feature is best observed with the stereo-microscope on gold sputtered specimens, since it is hardly noticable on untreated whitish specimens. The remainder of the valve is covered by circular depressions, some 0.02 mm in diameter. These are arranged in subhorizontal rows, about parallel to the ventral and dorsal margins.

Relations: In contrast to *P. amygdaliformis, P. limbata* has the whole valve ornamented with circular depressions.

Remarks: The dimensions of reworked specimens from the mixed fauna of Pınarhisar (Middle to Late Miocene) and Kartal Tepe (Early Oligocene) are similar.

Other regional occurrences: Reworked in the Akviran-İnceğiz region, in sands and clays of the upper part of the Mn Beds and above in the Fish Beds (Sönmez-Gökçen, 1973: tab. 5), at Çatalca in the Fish Beds (Sönmez-Gökçen, 1973: tab. 6), both occurrences late Middle to Late Miocene age.

Paleoeoecology: Epineritic (van Morkhoven 1963: 151). Marine (18–45‰) (Sönmez-Gökçen 1973: 97, 98, 99, 100, Faunizones I–IV).

Pokornyella bituberculata Sönmez-Gökçen, 1973
Pl. 3, Figs D–F

* 1973 *Pokornyella bituberculata* n. sp. – Sönmez-Gökçen: 66, pl. 8, figs 18–21.

Material: Pınarhisar, Upper part Mn Beds: ♀: 1 C, ♂: 2 C, 1 L; Pınarhisar, Lower part Mn Beds: R: 1 juv.; Kartal Tepe: ♂: 1 C.

Measurements (mm): Pınarhisar: C♀: l = 0.673, h = 0.420, w = 0.382, l/h = 1.620; C♂: l = 0.622–0.676, h = 0.364–0.382, w = 0.302–0.311, l/h = 1.709–1.770. Kartal Tepe: C♂: l = 0.655, h = 0.382, w = 0.302, l/h = 1.715.

Remarks: The dimensions of reworked specimens from the mixed fauna of Pınarhisar (Middle to Late Miocene) and Kartal Tepe (Early Oligocene) concur.

Other regional occurrences: The species has also been found reworked in the Akviran-İnceğiz region, in argillaceous limestones and sands underlying the Manganese Beds and in the overlying Fish Beds (Sönmez-Gökçen 1973: tab. 5), both Middle to Late Miocene in age. In the Pınarhisar, Poyralı and Küçükçekmece areas reworked in the Congeria Beds (Gökçen 1975: figs 3, 4, 8), late Middle to Late Miocene in age.

Palaeoecology: See above for *P. amygdaliformis*.

Pokornyella cf. *lattorfiana* (Lienenklaus, 1900)
Pl. 3, Figs K, L

cf. *1900 *Cythereis lattorfiana* n. sp. – Lienenklaus: 513, pl. 20, figs 1a–d.
1973 *Pokornyella* cf. *lattorfi* (Lienenklaus, 1900) – Sönmez-Gökçen: 67, pl. 8, figs 22–24.

Material: Pınarhisar, Lower part Fish Beds: ♀: 1 R; Pınarhisar, Upper part Mn Beds: ♀: 1 C, 1 R, ♂: 1 L; further numerous C, R, and L, sex not determined.

Measurements (mm): R ♀: l = 0.689–0.724, h = 0.376–0.384, l/h = 1.832–1.885; L ♂: l = 0.745, h = 0.387, l/h = 1.925; C ♀: l = 0.695, h = 0.382, w = 0.342 , l/h = 1.819.

Remarks: In the text the species is named *Cythereis lattorfiana* n. sp. (Lienenklaus 1900: 513), however, the plate caption reads *Cythereis lattorfi* Lks. The right valves are showing a posteroventral spur.

Other regional occurrences: In the Akviran-İnceğiz region, in the Fish Beds overlying the Mn Beds (Sönmez-Gökçen 1973: tab. 5), late Middle to Late Miocene in age. In the Pınarhisar area in the Congeria Beds (Sönmez-Gökçen 1975: fig. 3), Middle to Late Miocene in age.

Palaeoecology: See above for *P. amygdaliformis*.

Pokornyella sp.
Pl. 3, Figs A–C

Material: Pınarhisar, Upper part Mn Beds: C: 8, L: 1.

Measurements (mm): C: l = 0.687–0.751, h = 0.422–0.442, w = 0.347–0.387, l/h = 1.628–1.699.

Remarks: A smooth-shelled species, which is very similar in size and outline to *P. amygdaliformis*. However, the lack of ornamentation is believed to be a secondary feature, either the result of abrasion or microcrystalline calcite precipitation. The latter interpretation is supported by the irregularity of the lateral sulcus accompanying the ventral margin of the valves, very pronounced in Plate 3, Figure B.

Palaeoecology: See above, *P. amygdaliformis*.

5. Biostratigraphy

5.1 Earlier Studies

Kopp et al. (1969: 67) mention a 20–25 m thick section of lumachelle-limestone at Pınarhisar containing *Congeria* that is overlain by finely laminated marls with fish remains, a typical succession for northern Thrace. The authors consider this section as late Early Oligocene in age. Gökçen (1975: fig. 3) measured a composite section, ~40 m thick, near the cement factory WNW of Pınarhisar, composed of limestones, oolithic in the lower part, becoming sandy and argillaceous in the upper part. Gökçen attributes this section to the (Lower) Oligocene. The attached distribution chart shows a diversified ostracod fauna consisting of 23 taxa, the majority marine species. Comparing the above lithologies with the information in Rückert-Ülkümen (1963: 80–83), they fit best the Congeria Beds, conglomerates, oolithic and sandy limestones, attributed to the Middle to Late Miocene by the author of the present paper.

The marine taxa, marked * in Table 1, are generally Oligocene in age, as shown by Sönmez-Gökçen (1973: tab. 7, fig. 3). Those marked ** in Table 1 are also Oligocene in age, as shown by the added ref-

Table 1: Important faunal elements of the upper part of the Pınarhisar section, after Gökçen (1975: fig. 3).

Sample-number after Gökçen 1975 (figs 2, 3)	*Cypridopsis modesta* Sönmez-Gökçen, 1973 [1)]	* *Cushmanidea* cf. *scrobiculata* (Lienenklaus, 1894)	*Amplocypris pamiri* (Sönmez, 1963)[1)]	* *Pokornyella* cf. *lattorfiana* (Lienenklaus, 1900)	* *Paracytheridea pulvinata* Sönmez-Gökçen, 1973	** *Schuleridea (Aequacytheridea)* sp. – Eocene to Oligocene (v. Morkhoven 1963: 308-310)	** *Neocyprideis* cf. *williamsoniana* (Bosquet, 1852) Oligocene (Ducasse et al. 1985: tab. 14)	* *Leguminocythereis* cf. *sorneana* Oertli, 1956 – Oligocene (Oertli 1956: fig. 13)	* *Pokornyella bituberculata* Sönmez-Gökçen, 1973	** *Aulocytheridea faboides* (Bosquet, 1852) – Mid Eoc. to Oligoc. (Ducasse et al. 1985: tab. 14)	* *Pokornyella limbata* (Bosquet, 1852)	***Hemicyprideis* sp. – Oligocene to Miocene (Malz & Triebel 1970: 9)
13	x	x	x	x	x							
12						x						
11	x		x	x			x					
10	x							x	x	x		
9/8	x	x	x						x	x	x	x

erences. Recent compilations by Keen (1978), Ducasse et al. (1985) and Lord et al. (2009) corroborate above ages. They constitute the allochthonous elements of the fauna. However, the non-marine (fresh- to brackish water) taxa are the auchthonous elements. These taxa are marked [1)] in Table 1 and are Neogene in age, with the exception of the genus *Hemicyprideis*, which is known from the Oligocene to Miocene (Malz & Triebel 1970: 9) and is the ancestor of *Cyprideis* (Malz & Triebel 1970: 2); both taxa prefer meso- to brachyhaline habitats.

5.2 The Oligocene microfaunas

5.2.1 General

Rich and diverse foraminiferal associations, which also contained ostracods, were presented by Lindenberg in Rückert-Ülkümen (1965: 318), and by Hagn in Rückert-Ülkümen & Kaya (1993: 55). Lindenberg demonstrated by an extensive list of foraminifera including planktonics an Oligocene age for the localiy Vize E of Pınarhisar, comparing this marine fauna with the inneralpine Early to Middle Oligocene of Häring in Tyrol, Austria. Hagn dated a deeper neritic foraminiferal fauna from the locality Kartal Tepe in the Küçükçekmece area as Middle Oligocene (Rupelian). The foraminiferal fauna corresponds well with the *Tritaxia szaboi* (Hantken, 1875) bearing assemblage of the Kleinzeller Tegel of Budapest, Hungary. Martini in Rückert-Ülkümen & Kaya (1993: fig. 3) support this dating by studying calcareous nannoplankton from Kartal Tepe: NP 24. A similar fauna containing *Tritaxia szaboi* is quoted by İslamoğlu et al. (2008: 189) from the Oligocene of the Pınarhisar-Erenler area. Finally, Sönmez-Gökçen (1973: 102) provides a list of foraminifera including planktonics from her study area, distinguishing furthermore between Sannoisian and Stampian assemblages.

Table 2: Ostracod fauna from the Oligocene of Kartal Tepe

Marine taxa	Occ.	Occurrences (in N European Basins & Paratethys)
Cytherella transversa Speyer, 1863 + juv.	c	Early Eocene to Oligocene (Ducasse et al. 1985: tab. 14)
Bairdia crebra Deltel, 1963 + juv.	r	Early Eocene to Oligocene (Ducasse et al. 1985: tab. 14)
Thracella bartonensis (Jones, 1857)	r	Mid to Late Eocene (Lord et al. 2009: 404)
Krithe obesa Sönmez-Gökçen, 1973	r	Lt. Eocene to Early Oligoc. (Sönmez-Gökçen 1973: tab. 7)
Costa rogeri Sönmez-Gökçen, 1973	r	Lt. Eocene to Early Oligoc. (Sönmez-Gökçen 1973: tab. 7)
Pokornyella amygdaliformis Sönmez-Gökçen, 1973	vr	Early Oligocene (Sönmez-Gökçen 1973: tab. 7)
Pokornyella bituberculata Sönmez-Gökçen, 1973	r	Early Oligocene (Sönmez-Gökçen 1973: tab. 7)
Pokornyella limbata (Bosquet, 1852)	r	Late Eocene to Oligocene (Ducasse et al. 1985: tab. 14)
Oertliella aculeata (Bosquet, 1852)	c	Eocene (Lord et al. 2009: 397)
Jugosocythereis macropora (Bosquet, 1852)	vr	Early Eocene to Oligocene (Ducasse et al. 1985: tab. 14)
Quadracythere apostolescui Deltel, 1963	vr	Middle to Late Eocene (Ducasse et al. 1985: tab. 14)
Loxocorniculum decoratum Sönmez-Gökçen, 1973	r	Early Oligocene (Sönmez-Gökçen 1973: tab. 7)
Uroleberis sp.	vr	Eocene to Recent (van Morkhoven 1963: 443)

5.2.2 Ostracods from the Oligocene of Kartal Tepe

The ostracod fauna of Kartal tepe is summarized in Table 2. Many specimens are only available as carapaces or valves infilled with sediment, and thus a number of specimens could not be determined since interior features, important for the generic definition, are not available. An Early Oligocene age can probably be attributed to this fauna based on ranges in recent literature. Only three taxa, out of 13, viz. *Thracella bartonensis*, *Oertliella aculeata* and *Quadracythere apostolescui*, do not reach into the Oligocene according to the consulted literature. Foraminifera and calcareous nannoplankton from this sample point to an outer neritic setting. This interpretation is supported by representatives of the (smooth shelled) ostracod genera *Cytherella*, *Bairdia*, *Thracella* and *Krithe*.

5.2.3 Reworked Oligocene taxa from the new Pınarhisar samples:

The reworked taxa from the new Pınarhisar samples are given in Table 3. In summary, they are indicative of an Early Oligocene age based on ranges in recent literature.

Table 3: Reworked Oligocene taxa from the new Pınarhisar samples

Meso- to brachyhaline taxa	Occ.	Occurrences (in the Paratethys)
Hemicyprideis istanbulensis Bassiouni, 1979	c	Early to Middle Oligocene (Bassiouni 1979: 56)
Cytheromorpha zinndorfi (Lienenklaus, 1905)	r	Early Oligocene (Ducasse et al. 1985: 258)
Marine taxa		
Serrocytheridea sp., aff. *eberti* (Lienenklaus, 1894)	c	*S. eberti*: Oligocene (Oertli 1956: fig. 13)
Schuleridea (Aequacytheridea) sp.	a	Palaeogene (van Morkhoven 1963: 310)
Pokornyella amygdaliformis Sönmez-Gökçen, 1973	a	Early Oligocene (Sönmez-Gökçen 1973: tab. 7)
Pokornyella bituberculata Sönmez-Gökçen, 1973	r	Early Oligocene (Sönmez-Gökçen 1973: tab. 7)
Pokornyella cf. *lattorfiana* (Lienenklaus, 1900)	c	Early Oligocene (Lienenklaus 1900: 513)
Pokornyella sp.	c	Eocene – Early Miocene (Witt, this paper)

Table 4: Miocene ostracod taxa described in this paper

Fresh- to oligohaline taxa	**Occ.**	**Occurrences (in the Paratethys)**
Darwinula stevensoni (Brady & Robertson, 1870)	r	Middle Miocene to Early Pleistocene (Witt 2003: 95)
Candona sp. (small)	r	Oligocene to Recent (van Morkhoven 1963: 58)
Candona sp., juv.	c	Oligocene to Recent (van Morkhoven 1963: 58)
?Candonopsis sp.	r	Late Oligocene to Recent (van Morkhoven 1963: 63)
Fabaeformiscandona cf. *balatonica* (Daday, 1894)	r	Middle Miocene (Badenian) to Recent (Pipík 2001: tab. 7)
Cypria lucida Sönmez-Gökçen, 1973	c	Late Middle to Late Miocene (Witt, this paper)
Heterocypris formalis (Mandelstam, 1963)	vr	Late Middle to Late Miocene (Witt, this paper)
Cypridopsis modesta Sönmez-Gökçen, 1973	a	Late Middle to Late Miocene (Witt, this paper)
Meso- to polyhaline taxa		
Amplocypris pamiri (Sönmez, 1963)	a	Late Middle to Late Miocene (Witt, this paper)
Miocyprideis sarmatica (Zalányi, 1913)	vr	Late Middle to early Late Miocene (Stancheva 1990: 38)
Cyprideis pannonica (Méhes, 1908)	vr	Late Middle to middle Late Miocene (Witt, this paper)
Cyprideis sp.	r	Miocene to Recent (van Morkhoven 1963: 289)

5.3 The Miocene taxa

The Miocene ostracod taxa described in this study are summarized in Table 4. The genus *Amplocypris* is only known from the Neogene (Benson et al. 1961: Q213). Summarizing, the co-occurrence of abundant to common *Cypria lucida, Cypidopsis modesta* and *Amplocypris pamiri* is indicative of a late Middle to Late Miocene age. The remaining taxa, only occurring rarely or as single specimens, support this dating.

5.4 Other fossil elements

Sönmez-Gökçen (1973: 10) attributed the Congeria Limestones to the Oligocene based on Oligocene ostracods, which are considered in the present paper as being reworked into Miocene strata. As Krumbiegel & Krumbiegel (1981: 328) succinctly state: "*Congeria*, the genus lends its name to the Congeria-Beds in the eastern European Neogene". Further evidence is found in Nuttal (1990: fig. 1) and Harzhauser & Mandic (2008: fig. 3): *Congeria* ranges in the Late Miocene from the Pannonian into the Pontian. I am not qualified to give a statement as to whether the specimens from the Thracian Congeria Beds, e.g., in Dr. Rückert-Ülkümen's collection, belong to this genus or not. It is, however, very likely, since from location 2 in Rückert-Ülkümen & Kaya (1973: 57) *Congeria* sp. is listed amongst other molluscs in a Late Miocene fauna. Moreover, *Congeria ornithopsis* Brusina, 1892 (or *Mytilopsis ornithopsis*) has been encountered in the Upper *Congeria* Beds (Rückert-Ülkümen 1965: 322), indicating an Early Pannonian age (Harzhauser & Mandic 2008) corresponding with late Bessarabian to early Khersonian (Vrsaljko 1999: tab.1). *Mactra vitaliana vitaliana* d'Orbigny, 1844 from the Pınarhisar section points to a Sarmatian s. l. age (Zapfe in Rückert-Ülkümen 1965) or more detailed Bessarabian (Popov et al. 2004). In contrast, Murray (1985: 96) gives the range of *Congeria* as Late Oligocene to Pliocene. The flora points also to a Sarmatian age (Jung in Rückert-Ülkümen 1965: 321).

6. Palaeoecological notes

6.1 Oligocene taxa

The Oligocene taxa are marine, which in the case of ostracods includes also brachyhaline sea water (Sönmez-Gökçen 1973: 100, Faunizone IV). Only a few species indicate brackish condition; most noteworthy are *Hemicyprideis istanbulensis* indicating limnic to pliohaline, and *Cytheromorpha zinndorfi* meso- to pliohaline conditions. *Serrocytheridea* sp. aff. *eberti* might indicate a marginal to coastal marine depositional environment.

6.2 Miocene taxa

The non-marine (fresh- to brackish water) ostracod faunas of the Pınarhisar samples can be differentiated into freshwater to oligohaline, possibly including mio- to mesohaline taxa and into meso- to brachyhaline taxa. The former are: *Darwinula stevensoni*, *Candona* div. sp. and juveniles, *Fabaeformiscandona* cf. *balatonica*, rare *Cypria lucida* and juveniles and *Cypridopsis modesta*, the latter include *Amplocypris pamiri*, *Miocyprideis sarmatica* and *Cyprideis pannonica*. Summarizing the above data, the common to abundant *Cypridopsis modesta* and *Amplocypris pamiri* are indicative of a mesohaline environment, which for the remaining taxa occurring only in very low numbers, is not the usual and prefered habitat.

7. Summary

Late Middle to Late Miocene ostracod assemblages consisting of fresh-water and brackish (mesohaline) taxa and reworked brachyhaline to marine Early Oligocene taxa have been encountered in recently collected and processed samples from the locality Pınarhisar in the Congeria, Manganese and Fish Beds. Reworked Early Oligocene foraminifera have not been found in the Pınarhisar samples. There are basically two explanations, however, not mutually exclusive. Sorting by water movement during the reworking process is the one, the foraminifera from the Kartal Tepe and Vize samples are generally larger than the ostracods. The second relates to salinity. marine ostracods can live and reproduce even in plio- to brachyhaline waters, foraminifera characterizing deeper neritic habitats are generally stenohaline. A Miocene age of these beds is also indicated by other fossil groups such as plant remains and molluscs, and the Early Oligocene age of Kartal Tepe and Vize is established by foraminifera, including planktonic and larger forms. Species of the Eocene to Early Miocene genus *Pokornyella* occur in both samples, reworked in the Middle to Late Miocene at Pınarhisar and in situ in the Early Oligocene at Kartal Tepe.

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