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# Zitteliana

Reihe A

Mitteilungen der Bayerischen Staatssammlung  
für Paläontologie und Geologie

43



MÜNCHEN 2003

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## HINWEIS DES HERAUSGEBERS

Vom Jahr 2003 an erscheint die Zeitschrift *Zitteliana* in zwei Reihen.

Die *Reihe A: Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-412X) ersetzt die bisherigen „Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0077-2070). Die Bandzählung (zuletzt erschienen: Heft 42, 2002) wird fortgesetzt.

Die *Reihe B: Abhandlungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-4138) führt die bisherige „Zitteliana - Abhandlungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0373-9627) fort.

Hinweise für Autoren beider Reihen sind am Ende dieses Bandes enthalten.

## EDITORIAL NOTE

Starting in 2003 the journal *Zitteliana* is published in two series.

The *Reihe A: Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-412X) replaces the former „Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0077-2070). The numbering of issues is continued (last published: Heft 42, 2002).

The *Reihe B: Abhandlungen der Bayerischen Staatssammlung für Paläontologie und Geologie* (ISSN 1612-4138) continues the previous „Zitteliana - Abhandlungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie“ (ISSN 0373-9627).

Instructions for authors are included at the end of this volume.



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# Freshwater Ostracods from Neogene deposits of Develiköy (Manisa, Turkey)

By  
WOLFGANG WITT

## ABSTRACT

Eleven species of freshwater ostracods are documented from the upper Urla Formation of the Develiköy area, Manisa Province, Western Anatolia, Turkey. The ostracod associations from the Develiköy area confirm the already established Late Miocene to Early Pliocene age for the upper Urla Formation. A slightly brackish lacustrine depositional environment is interpreted for the Late Miocene ostracod-bearing part of

the section at the adjacent location Düzpinar. In the Early Pliocene of the Develiköy section a change to fresh water is recognized, followed by a return to slightly brackish lacustrine conditions.

**Key words:** Neogene, Urla Formation, Western Anatolia, Turkey, ostracods, freshwater, brackish water.

## RESUME

Onze espèces d'ostracodes d'eau douce sont décrites, qui appartiennent à la Formation d'Urla supérieur de l'aire de Develiköy, province de Manisa dans l'ouest de l'Anatolie, Turquie. La faune ostracode recueillie à la région de Develiköy confirme l'appartenance de cette formation à l'âge du Miocène Supérieur au Pliocène Inférieur. La faune ostracode récoltée à la localité avoisinante de Düzpinar, datée Miocène Supérieur, indique des conditions de déposition lacustre en

eaux légèrement saumâtres, suivi d'une déposition en eau douce dans les dépôts de la section de Develiköy, datés du Pliocène Inférieur, et ensuite le retour aux conditions de déposition en eaux légèrement saumâtres.

**Mots-clé:** Néogène, Formation d'Urla, Ouest de l'Anatolie, Turquie, ostracodes, eau douce, eau saumâtre.

## KURZFASSUNG

Elf Süßwassostracoden-Arten aus der oberen Urla Formation von Develiköy, Manisa Provinz, Westanatolien, Türkei, werden dokumentiert. Die Ostracodenfaunen des Gebiets von Develiköy bestätigen die Einstufung der oberen Urla Formation in das Ober-Miozän bis Unter-Pliozän. Ein schwach brackisches lakustrisches Ablagerungsmilieu wird für das ostracodenführende Ober-Miozän der benachbarten

Lokalität Düzpinar angenommen, gefolgt im Unter-Pliozän des Develiköy-Profiles von Süßwasser und wiederum schwach brackischen lakustrischen Bedingungen.

**Schlüsselwörter:** Neogen, Urla Formation, Westanatolien, Türkei, Ostracoden, Süßwasser, Brackwasser.

# 1. INTRODUCTION

Fresh- and brackish water ostracods from the Neogene of Turkey have been recently studied by BASSIOUNI (1979), GÖKÇEN (1979a,b), FREELS (1980), ŞAFAK et al. (1992), NAZIK et al. (1992), TUNOĞLU (1984), TUNOĞLU & ÇELİK (1995), TUNOĞLU et al. (1995), and TUNOĞLU & GÖKÇEN (1985, 1997). This paper is a further contribution to the knowledge of the distribution of Neogene freshwater ostracods in Turkey based on material described in KAYA et al. (1998), a paper including an introduction into the regional geology and the stratigraphical succession of the sampled profile at Develiköy.

The results of a detailed study of these samples are given in RÜCKERT-ÜLKÜMEN et al. (2002). In this publication fishes (otoliths, teeth and other osteological remains), one mammalian taxon and charophytes are studied and figured in detail, and gastropods are listed. The contribution on ostracods comprises the distribution and the stratigraphical and environmental

interpretation of this faunal element. The missing taxonomical treatment of the ostracod fauna is the subject of this paper.

The ostracods from the adjacent mammalian locality Düzpınar, considered to be derived from the same horizon or pocket as H (= horizon) 111 of the Develiköy section, were acquired and studied later and therefore are not treated in above paper.

The illustrated specimens are stored in the Bayerische Staatssammlung für Paläontologie und Geologie, Munich, under the inventory numbers BSP 1980 X 1131/7, 9-30 (H 69); 1132/12-14 (H 70) and 1134/4 (H118), further material under BSP 1980 X 1131/1-6, 8 (H 69); 1132/1-11 (H 70); 1133/1-3 (H 52); 1134/1-3 (H 118); 1135/1 (H 124) and 1169/1-8 (Düzpınar). All figures of the plates were digitally processed to compensate for the distortion produced by the SEM used.

## 2. MATERIAL

The material is derived from the upper Urla Formation, a unit of light-coloured limestones, mudrocks and sands, Late Miocene to Early Pliocene in age, from the area of Develiköy, Manisa Province, Western Anatolia, Turkey. A location map and a stratigraphical column of the sampled profile are shown in RÜCKERT-ÜLKÜMEN et al. (2002).

The washed residues are dominated by pelecypod and gastropod debris. The mostly well preserved ostracod fauna is accompanied by rare characean gyrogonites, rhizoconcretions, plant debris, fish scales and other fish remains, and very rare otoliths.

## 3. OSTRACODS

Samples H 69 and H 70 contain a very rich and well preserved ostracod fauna (tab. 1). Düzpınar is moderately rich, the remaining samples are rather poor:

### Sample H 69

*Candona decimai* FREELS, 1980 (very abundant)  
*Ilyocypris* sp. (common)  
*Heterocypris salina* (BRADY, 1868) (very abundant)  
*Heterocypris* cf. *karasi* (KRSTIĆ, 1971) (rare)  
*Zonocypris membranae* (LIVENTAL, 1929) (very abundant)  
*Potamocypris* cf. *reflexa* SCHNEIDER in MANDELSTAM & SCHNEIDER, 1963 (rare)  
*Leucocythere levisreticulata* (STANCHEVA, 1963) (very rare)  
*Scordiscia* aff. n. sp. SCHORNIKOV in KRSTIĆ & SCHORNIKOV, 1993 (rare)

### Sample H 70

*Darwinula stevensoni* (BRADY & ROBERTSON, 1870) (common)  
*Candona decimai* FREELS, 1980 (very abundant)  
*Candonopsis* ? sp. (very rare)  
*Ilyocypris* sp. (abundant)  
*Cypris* sp., juv. (very rare)  
*Heterocypris salina* (BRADY, 1868) (very abundant)  
*Heterocypris* cf. *karasi* (KRSTIĆ, 1971) (rare)  
*Dolerocypris* ? sp. (rare)

*Zonocypris membranae* (LIVENTAL, 1929) (very abundant)  
*Cyprideis* sp. (rare)  
*Cyprideis* ? sp. (very rare)

### Sample H 52

*Darwinula stevensoni* (BRADY & ROBERTSON, 1870) (very rare)  
*Candona decimai* FREELS, 1980, juv. (common)  
*Zonocypris membranae* (LIVENTAL, 1929) (very rare)

### Sample H 118

*Candona decimai* FREELS, 1980, juv. (abundant)  
*Pseudocandona* cf. *compressa* (KOCH, 1838) (rare)  
*Zonocypris membranae* (LIVENTAL, 1929) (rare)

### Sample H 124

*Candona decimai* FREELS, 1980 (very rare)

### Düzpınar (correlated with H 111)

*Darwinula stevensoni* (BRADY & ROBERTSON, 1870) (rare)  
*Candona decimai* FREELS, 1980 (common)  
*Ilyocypris* sp. (rare)  
*Eucypris dulcifons* DIEBEL & PIETRZENIUK, 1969 (very rare)  
*Herpetocypris* sp. (very rare)  
*Heterocypris salina* (BRADY, 1868) (abundant)  
*Zonocypris membranae* (LIVENTAL, 1929) (abundant)  
*Scordiscia* aff. n. sp. SCHORNIKOV in KRSTIĆ & SCHORNIKOV, 1993 (rare)

H (=horizon)	<i>Candona decimai</i> FREELS, 1980	<i>lyocypris</i> sp.	<i>Heterocypris salina</i> (BRADY, 1888)	<i>Heterocypris</i> cf. <i>karasi</i> (KRSTIĆ, 1971)	<i>Zonocypris membranæ</i> (LIVENTAL, 1929)	<i>Potamocypris</i> cf. <i>reflexa</i> SCHNEIDER, 1963	<i>Leucocythere levisreticulata</i> (STANCHEVA, 1963)	<i>Scordiscia</i> aff. n. sp. SCHORNIKOV, 1993	<i>Darwinula stevensoni</i> (BRADY & ROBERTSON, 1870)	<i>Candonopsis</i> ? sp.	<i>Cypris</i> sp., juv.	<i>Dolerocypris</i> ? sp.	<i>Cyprideis</i> sp.	<i>Cyprideis</i> ? sp.	<i>Pseudocandona</i> cf. <i>compressa</i> (KOCH, 1838)	<i>Eucypris dulcifrons</i> DIEBEL & PIETRZENIUK, 1969	<i>Herpetocypris</i> sp.
H 69	■	○	■	/	■	/	■	/									
H 70	■	●	■	/	■				○	■	■	/	/	■			
H 52	○				■				■								
H 118	●				/										/		
H 124	■																
Düzpınar	○	/	●		●			/	/							■	■

Tab. 1: Vertical distribution of ostracods in the Develiköy section and at the Düzpınar locality.

Symbols: ■ = very rare, / = rare, ○ = common, ● = abundant, ■ = very abundant

### 3.1 SYSTEMATIC DESCRIPTIONS

The systematics follows MEISCH (2000).

Abbreviations:

C	carapace
V	valve(s)
R	right valve(s)
L	left valve(s)
l	length
w	width
h	height
$h_a$	height anterior
$h_p$	height posterior

The synonymy and the listing of other occurrences are generally restricted to the Balkans, Greece, the Aegean region, Anatolia, the Near East and the southern part of the former USSR.

Superfamily Darwinuloidea BRADY & NORMAN, 1889

Family Darwinulidae BRADY & NORMAN, 1889

Genus *Darwinula* BRADY & ROBERTSON, 1885

*Darwinula stevensoni* (BRADY & ROBERTSON, 1870)  
pl. 1, fig. 1

- 1975 *Darwinula stevensoni* (BRADY & ROBERTSON) - KAZMINA: 42, pl. 1, fig. 1-5; pl. 17, fig. 1-9.  
1978 *Darwinula stevensoni* (BRADY & ROBERTSON, 1870) - SOKAČ: 20, pl. 10, fig. 9-10.  
1979a *Darwinula stevensoni* (BRADY & ROBERTSON) - GÖKÇEN: 68, pl. 5, fig. 16-17.  
1980 *Darwinula stevensoni* (BRADY & ROBERTSON 1870) - FREELS: 14, pl. 1, fig. 12-14.

- 1980 *Darwinula stevensoni* (BRADY & ROBERTSON, 1870) - SOKAČ: 138, pl. 2, fig. 6-7.  
1988 *Darwinula stevensoni* (BRADY & ROBERTSON 1870) - MOSTAFAWI: 182, pl. 1, fig. 14.  
1989b *Darwinula stevensoni* (BRADY & ROBERTSON 1870) - MOSTAFAWI: fig. 4/15.  
1992 *Darwinula stevensoni* (BRADY & ROBERTSON) - NAZIK et al.: pl. 1, fig. 3.  
1994a *Darwinula stevensoni* (BRADY & ROBERTSON 1870) - MOSTAFAWI: fig. 6/8.  
1995 *Darwinula stevensoni* (BRADY & ROBERTSON) - KRSTIĆ: 404, pl. 8, fig. 10; text-fig. 8.  
1996 *Darwinula stevensoni* (BRADY & ROBERTSON 1870) - MOSTAFAWI: pl. 3, fig. 47.  
1998 *Darwinula stevensoni* (BRADY & ROBERTSON) - PIPÍK: pl. 1, fig. 6.  
2001 *Darwinula stevensoni* (BRADY & ROBERTSON, 1870) - PIPÍK: 213, pl. 1, fig. 1-5; pl. 22, fig. 1.

Further synonyms in SOKAČ (1978: 20), FREELS (1980: 14) and PIPÍK (2001: 213).

Material: H 70: 1 C, 1 R, 4 L; H 52: 1 R; Düzpınar: 2R.

Measurements (mm), H 70: R:  $l = 0.660$ ,  $h = 0.278$ ;  $l/h = 2.378$ .

Other occurrences: In the Upper Miocene of the Turric Basin (PIPÍK 2001), and in the Pannonian of the western Danube Basin (PIPÍK 1998), both Slovakia. In the Miocene of Sinjsko polje (Croatia) (SOKAČ 1980), and in the Pleistocene of the Pannonian Basin of Croatia (SOKAČ 1978). In the Paludian Beds (Dacian) of Serbia (KRSTIĆ 1995). Greek islands and mainland: In the upper Serravallian and/or lower Tortonian of Crete (MOSTAFAWI 1989b), in the Upper Pontian of the Thessaloniki region (MOSTAFAWI 1996), and in the Upper Pliocene of Kos (MOSTAFAWI 1988) and northern Evia (MOSTAFAWI 1994a). Widely spread from the Upper Miocene to the lower Pleistocene of Anatolia (FREELS 1980), in the Sarmatian - Pannonian of South-western Anatolia (GÖKÇEN 1979a,b), and in the Pliocene of the Adana area, Turkey (NAZIK et al. 1992). In the Pliocene - lower Pleistocene of the southern part of Western Siberia (KAZMINA 1975).

Ecology: The recent *Darwinula stevensoni* prefers ponds, lakes and slow streams and tolerates salinity increases up to 15‰. The species occurs on both muddy and sandy substrates (MEISCH 2000: 51; PIPÍK 2000: tab. 1).

Superfamily Cypridoidea BAIRD, 1845

Family Candonidae KAUFMANN, 1900

Subfamily Candoninae KAUFMANN, 1900

Genus *Candona* BAIRD, 1845

*Candona decimai* FREELS, 1980  
pl. 1, fig. 2-7

- 1963 *Candona angulata* MÜLLER - DECIMA: 94, pl. 3, fig. 1-8.  
1963 *Candona angulata* Müller - STANCHEVA: 6, pl. 1, fig. 3.  
1963 *Candona neglecta* Sars - MANDELSTAM & SCHNEIDER: 63, pl. 24, fig. 6, 9.  
1969 *Candona neglecta* Sars, 1888 - CARBONNEL: 39, pl. 1, fig. 19; pl. 3, fig. 20-21.  
1969 *Candona neglecta* n. subsp.? - GRAMANN: 491, text-fig. 1; pl. 32, fig. 6.

- ? 1976 *Candona angulata* MÜLLER - GUERNET et al.: 66, pl. 1, fig. 1-3.  
 1979 *Candona* cf. *neglecta* SARS - GUERNET: 34, pl. 3, fig. 3-4.  
 \* 1980 *Candona (Candona) decimai* n. sp. - FREELS: 94, pl. 16, fig. 12-19.  
 1981 *Candona angulata* G. W. MÜLLER 1900 - MOSTAFAWI: 175, pl. 17, fig. 4-5.  
 ? 1981 *Candona angulata* G. W. Müller 1900 - ROSENFELD et al.: pl. 1, fig. 12.  
 pars 1988 *Candona (Candona) nobilis* (BRADY 1866) - MOSTAFAWI: 183, pl. 1, fig. 11.  
 1989a *Candona (Candona) nobilis* (BRADY 1866) - MOSTAFAWI: 141, pl. 6, fig. 135-136.  
 1990 *Candona angulata* Müller, 1900 - STANCHEVA: 19, pl. 2, fig. 1-2.  
 1992 *Candona (Candona) decimai* Freels, 1980 - ŞAFAK et al.: 178, pl. 1, fig. 3-4, pl. 3, fig. 1.  
 1992 *Candona (Candona) decimai* Freels - NAZIK et al.: pl. 2, fig. 6-7.

Material: H 69: ♂: 6 R, 6 L; ♀: 10 C, 28 R, 13 L; a-1: 1 R, 3 L; a-2: 46 V+C; a-3: 5 V; H 70: numerous adults and juveniles; H 52: juv.: 2 C, 2 R, 2 L; H 118: numerous juveniles; H 124: ♀: 1 C; Düzpınar: ♀: 1R; juv.: 1 R, 1L.

Measurements (mm): s. tab. 2

Remarks and relations: The pointed corner between the posterior and ventral margin of the left valves is not always as well developed as in the specimen illustrated on pl. 1, fig. 5 in this paper.

The subtle differences with *C. angulata*, a species only known from the Lower Pleistocene to Recent (MEISCH 2000: 89), are outlined by GRAMANN (1969: 491) and FREELS (1980: 96). *C. decimai*, occurring in the Upper Miocene to the Lower Pleistocene, is in dorsal view slimmer ( $l/w$  of C ♀ =  $2.449 \pm 0.041$  after FREELS 1980: 96) than *C. angulata* ( $l/w$  of C ♀ = 2.34 after MEISCH 2000: fig. 31E). Furthermore *C. decimai* shows an anterior cardinal angle in contrast to *C. angulata*.

STANCHEVA's (1963, 1990) specimens from the Upper Miocene are *C. decimai*, not only based on stratigraphical considerations, but also on the gently sloping dorsal margin of the ♀♀ and the well developed anterior cardinal angle (STANCHEVA 1990: pl. 2, fig. 2).

SCHNEIDER's specimens in MANDELSTAM & SCHNEIDER (1963) from the Pliocene of Kazakhstan have been already considered by GRAMANN (1969) as very similar with his specimens of *Candona neglecta* n. subsp.?, here interpreted as *C. decimai*.

CARBONNEL's (1969: pl. 1, fig. 19) specimen, a female right valve shows clearly a well developed anterior cardinal angle. This feature combined with the dimensions ( $l = 0.99$ ,  $h = 0.51$  mm) and the stratigraphical distribution, Upper Miocene to Pliocene, permits to consider this form as *C. decimai*.

GRAMANN's (1969) description of *C. neglecta* n. subsp.? from the Upper Pontian of Macedonia is absolutely reminiscent of *C. decimai*.

*Candona angulata* from the Levantian (Pliocene to Lower Pleistocene) of Kos in GUERNET et al. (1976: pl. 1, fig. 1-3) is possibly also *C. decimai*. The  $l/h$ -ratio of  $>2.150$ , calculated from these figures, is too high, possibly resulting from distorted SEM-images.

GUERNET's (1979) *Candona* cf. *neglecta* from the Levantian of Sparti is also *C. decimai*, since the illustrated female right

valve shows clearly the anterior cardinal angle and is found in strata older than Pleistocene to Recent. Left valves are not illustrated to judge the presence of the pointed corner between posterior and ventral margin.

ROSENFELD's et al. (1981) specimens from the Pliocene are not well preserved, and judging the presence of an anterior cardinal angle is difficult. Based on their stratigraphical distribution, they are *C. decimai*.

MOSTAFAWI's (1981) specimens are from the Upper Pliocene, and exhibit an anterior cardinal angle, especially well illustrated on pl. 17, fig. 4.

*Candona angulata* in JIŘÍČEK (1983) is probably *C. decimai* based on its range given (see below).

A very similar form is *Candona nobilis* (BRADY, 1866) in MOSTAFAWI (1988 and 1989a), which is considered to be also *C. decimai*. The male left valve of this species (MOSTAFAWI 1989a: pl. 6, fig. 135-136) shows like those of *C. decimai* and *C. angulata* a pointed corner between posterior and ventral margin. The anterior cardinal angle of this specimen is not clearly developed in contrast to the one of the male right valve from the Upper Pliocene of Kos (MOSTAFAWI 1988: pl. 1, fig. 11). The Pleistocene forms are probably not *C. decimai*. MOSTAFAWI (1988: 183) states that in literature the stratigraphically younger, Plio-Pleistocene forms are named *C. angulata* and that the older, Upper Miocene ones are either considered a subspecies of *C. neglecta* (GRAMANN 1969) or as a new species, *C. decimai*.

*Candona (Candona) stupelji* KRSTIĆ, 1974 is a species with a similar stratigraphical distribution, which, however, lacks the pointed corner between posterior and ventral margin of the left valves judging from the English version of the original description and figure 3, the only illustrated left valve in KRSTIĆ (1974). SOKAČ (1978: 26; pl. 14, fig. 1, 3; pl. 15, fig. 5) only depicted right valves of this species.

Other occurrences: In the Upper Miocene to Pliocene of the Rhône Basin (CARBONNEL 1969). In the Pleistocene of Sicily (DECIMA 1963). In the Upper Miocene (Chersonian) of North-western and Northern Bulgaria (STANCHEVA 1963; 1990). Greek mainland and islands: In the Upper Pontian of Macedonia (GRAMANN 1969; MOSTAFAWI 1996), in the Levantian (Pliocene to Lower Pleistocene) of Sparti (GUERNET 1979), and in the Upper Pliocene of Kos (MOSTAFAWI 1981; 1988) and Rhodes (MOSTAFAWI 1989a). Widely found from the Upper Miocene to the lower Pleistocene in Anatolia (FREELS 1980), and in the Pliocene of the Kayseri (ŞAFAK et al. 1992) and Adana areas, Turkey (NAZIK et al. 1992). Possibly in the Pliocene of the Jordan Valley (ROSENFELD et al. 1981). In the Dacian - Lower Pleistocene (Zones NO 23-25) of the Paratethys region (JIŘÍČEK 1983).

Palaeoecology: *Candona decimai* is considered by FREELS (1980: 120) as a limnic, possibly also slightly brackish species. The related *C. angulata* prefers slightly salty waters. It is common in slightly brackish coastal ponds, ditches and river mouths with a salinity of 0.2-14 ‰. Not rarely found together with *Heterocypris salina*, which prefers similar salty conditions, and *Cyprideis torosa*, a true brackish water species (MEISCH 2000: 87).



Genus *Pseudocandona* KAUFMANN, 1900

*Pseudocandona* cf. *compressa* (KOCH, 1838)

pl. 2, fig. 8

1980 *Candona (Pseudocandona) compressa* (KOCH 1837) sensu  
BRADY 1868 - FREELS: 64, pl. 10, fig. 1-10.

1988 *Candona (Pseudocandona) sp. cf. compressa* (KOCH 1836)

- MOSTAFAWI: pl. 2, fig. 1.

1990 *Candona (Pseudocandona) cf. compressa* (KOCH 1837) -  
MOSTAFAWI: 177, pl. 4, fig. 58.

1994a *Pseudocandona cf. compressa* (KOCH 1836) - MOSTAFAWI: fig.  
5/4.

1996 *Pseudocandona cf. compressa* (KOCH 1837) - MOSTAFAWI: pl.  
3, fig. 48.

Material: H 118: ♀: 1 R; juv. (a-2): 2 R, 2 L.

	n	l	$\bar{x}$	h	$\bar{x}$	l/h	$\bar{x}$	w	$\bar{x}$
C	♀	5	1.218-1.291	1.253	-	-	-	0.491-0.509	0.495
R	♀	7	1.145-1.295	1.215	0.556-0.636	0.590	1.970-2.115	2.058	-
L	♀	6	1.171-1.345	1.265	0.587-0.636	0.609	1.973-2.176	2.078	-
R	♂	3	1.164-1.362	1.278	0.600-0.724	0.677	1.851-1.940	1.891	-
L	♂	3	1.236-1.637	1.406	0.600-0.767	0.679	2.004-2.134	2.066	-
R	a-1	1	0.898	-	0.454	-	1.978	-	-
L	a-1	2	0.818-0.973	0.896	0.416-0.491	0.454	1.966-1.982	1.974	-
C	a-2	1	0.691	-	0.351	-	1.969	-	-
R	a-2	3	0.676-0.693	0.684	0.329-0.345	0.338	1.977-2.106	2.024	-
L	a-2	4	0.715-0.745	0.729	0.364-0.382	0.369	1.950-1.997	1.976	-

Tab. 2: Measurements (mm) of *Candona decimai* FREELS, 1980; sample H 69.

	n	l	$\bar{x}$	$h_a$	$\bar{x}$	l/ $h_a$	$\bar{x}$	$h_p$	$\bar{x}$
H 69									
R	3	1.100-1.218	1.167	0.587-0.640	0.609	1.874-1.970	1.916	-	-
H 69, type 1									
L	4	1.125-1.236	1.203	0.573-0.656	0.630	1.884-1.963	1.911	0.545-0.607	0.589
H 70, type 1									
L	4	0.925-1.093	1.003	0.505-0.545	0.519	1.817-2.006	1.931	0.455-0.509	0.480
H 69, type 2									
L	2	1.182-1.264	1.223	0.629-0.645	0.637	1.879-1.960	1.920	0.584-0.627	0.606

Tab. 3: Measurements (mm) of *Hlyocypris* sp.

	n	l	$\bar{x}$	h	$\bar{x}$	l/h	$\bar{x}$	w	$\bar{x}$
C	2	1.042-1.109	1.073	-	-	-	-	0.491-0.545	0.506
R	4	1.040-1.115	1.076	0.640-0.682	0.664	1.581-1.652	1.621	-	-
L	8	0.982-1.187	1.085	0.673-0.789	0.722	1.459-1.540	1.502	-	-
R	a-1	2	0.873-0.927	0.900	0.511-0.582	0.547	1.593-1.594	1.594	-
L	a-1	2	0.851-0.909	0.880	0.538-0.591	0.565	1.538-1.582	1.560	-
R	a-2	1	0.691	-	0.429	-	1.611	-	-
L	a-2	1	0.655	-	0.433	-	1.513	-	-

Tab. 4: Measurements (mm) of *Heterocypris salina* (BRADY, 1868); sample H 69.

	n	l	$\bar{x}$	h	$\bar{x}$	l/h	$\bar{x}$	w	$\bar{x}$
R	2	0.791-0.816	0.804	0.464-0.473	0.469	1.672-1.759	1.716	-	-
L	1	0.782	-	0.469	-	1.667	-	-	-

Tab. 5: Measurements (mm) of *Heterocypris cf. karasi* (KRSTIC, 1971); sample H 69.

	n	l	$\bar{x}$	h	$\bar{x}$	l/h	$\bar{x}$	w	$\bar{x}$
C	6	0.582-0.673	0.623	-	-	-	-	0.423-0.545	0.479
R	5	0.549-0.602	0.575	0.327-0.347	0.332	1.679-1.775	1.730	-	-
L	5	0.545-0.618	0.585	0.327-0.367	0.353	1.610-1.700	1.659	-	-

Tab. 6: Measurements (mm) of *Zonocypris membranae* (LIVENTAL, 1929); sample H 69.

	n	l	$\bar{x}$	h	$\bar{x}$	l/h	$\bar{x}$	w (n=2)	$\bar{x}$
C	4	0.465-0.527	0.485	0.291-0.364	0.313	1.531-1.599	1.553	0.200-0.213	0.207

Tab. 7: Measurements (mm) of *Potamocypris cf. reflexa* SCHNEIDER in MANDELSTAM & SCHNEIDER, 1963; sample H 69.

Measurements (mm): R♀: l = 0.965, h = 0.529; l/h = 1.824.

Remarks: The identity of *Pseudocandona compressa* (KOCH 1838) sensu BRADY, 1868 with *Pseudocandona steinheimensis* (SIEBER, 1905) as suggested by FREELS (1980: 64) is questionable (JANZ 1992: 14-16). The limited material does not permit contributing towards a solution. Therefore MOSTAFAWI's approach is followed here.

Other occurrences: Greek islands and mainland: In the upper Serravallian to lower Tortonian of Kithira (MOSTAFAWI 1990), in the Upper Pontian of the Thessaloniki region (MOSTAFAWI 1996), and in the Upper Pliocene of Evia (MOSTAFAWI 1994a) and Kos (MOSTAFAWI 1988). Widely known from the Middle Miocene to the upper Pleistocene from many regions of Anatolia (FREELS 1980).

Ecology: The ecological characterization of *Pseudocandona compressa* can probably also be accepted for *P. cf. compressa*: Lives in both permanent and temporary water bodies. In lakes it prefers the shallow areas of the littoral zone. The species occurs also in slightly salty coastal and inland waters up to a maximum salt content of some 8‰ (MEISCH 2000: 180). PÍPIK (2000: tab. 1) summarizes the ecological tolerance and habitat as follows: *P. compressa* is found in pools, oxbows, swamps and the littoral zone of lakes, the species is halophilic and lives on muddy and sandy substrates.

Family Ilyocyprididae KAUFMANN, 1900

Subfamily Ilyocypridinae KAUFMANN, 1900

Genus *Ilyocypris* BRADY & NORMAN, 1889

*Ilyocypris* sp.  
pl. 2, fig. 1-4

Material: H 69: 1 C, 8 R, 9 L; H 70: numerous adults and juveniles; Düzpınar: 2 L.

Measurements (mm): s. tab. 3

Description: In external view the specimens appear to be *Ilyocypris gibba*. However, the arrangements of the marginal ripples, as far as preservation permits observation, are different and are not coinciding with any arrangements of the marginal ripples so far described and illustrated by VAN HARTEN (1979), JANZ (1994; 1997), JANZ et al. (2001), PÍPIK (2001) or WITT (2002). Despite the imperfect preservation of the material, two different arrangements are observed:

The more common one, type 1 (pl. 2, fig. 3), shows at least 3 clearly visible marginal ripples in the median part of the inner lamella, in front of them possibly another short oblique one and behind them possibly 2 more. Distally, separated by a median list, there are a number of small ripples. The latter feature is atypical for *I. gibba*.

The rare one, type 2 (pl. 2, fig. 4), shows distally a number of not well arranged weakly developed ripples and possibly 2 short ripples widely separated in the median area.

Both types cannot be distinguished by any other feature of the valves. These two types also have been distinguished under the light microscope and measured. The measurements of the left valves of type 1 and 2 of sample H 69, shown above, coincide, whereas type 1 of H 70 shows different values. Additionally the specimens of sample H 69 exhibit in contrast to the specimens of H 70 strongly developed tubercles with a large tubercle pointing to the rear situated just behind the second sulcus.

## Plate 1

Figure 1: sample H 70; figures 2-7, 9-16: sample H 69; figure 8: sample H 118.

Fig. 1: *Darwinula stevensoni* (BRADY & ROBERTSON, 1870); R (l = 0.660, h = 0.278 mm), external view, ca. x 56; BSP 1980 X 1132/12.

Fig. 2-7: *Candona decimai* FREELS, 1980;

2: R, a-2 (l = 0.682, h = 0.345 mm), external view, ca. x 48; BSP 1980 X 1131/9.

3: R, a-1 (l = 0.898, h = 0.454 mm), internal view, ca. x 50; BSP 1980 X 1131/10.

4: L♀ (l = 1.255, h = 0.622 mm), internal view, ca. x 47; BSP 1980 X 1131/11.

5: L♀ (l = 1.200, h = 0.587 mm), external view, ca. x 48; BSP 1980 X 1131/12.

6: C♀ (l = 1.291, w = 0.509 mm), dorsal view, anterior end above, ca. x 55; BSP 1980 X 1131/13.

7: R♂ (l = 1.362, h = 0.724 mm), external view, ca. x 47; BSP 1980 X 1131/14.

Fig. 8: *Pseudocandona cf. compressa* (KOCH, 1838); R (l = 0.965, h = 0.529 mm), external view, ca. x 47; BSP 1980 X 1134/4.

Fig. 9-13: *Zonocypris membranæ* (LIVENTAL, 1929);

9: L (l = 0.591, h = 0.367 mm), internal view, ca. x 90; BSP 1980 X 1131/15.

10: R (l = 0.575, h = 0.331 mm), internal view, ca. x 84; BSP 1980 X 1131/16.

11: C (l = 0.596, w = 0.423 mm), dorsal view, anterior end above, ca. x 72; BSP 1980 X 1131/17.

12: R (l = 0.564, h = 0.327 mm), external view, ca. x 82; BSP 1980 X 1131/18.

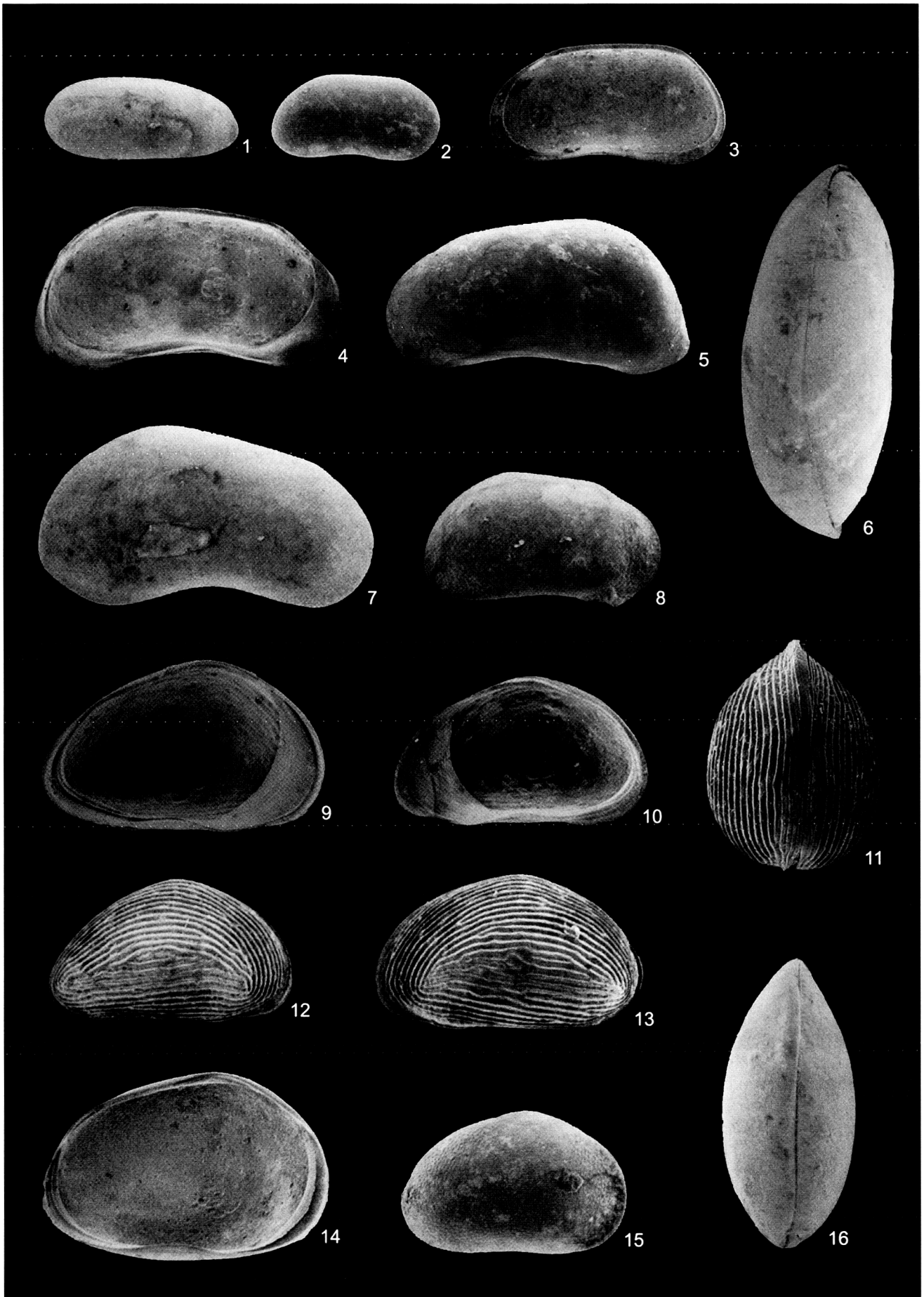
13: L (l = 0.618, h = 0.364 mm), external view, ca. x 82; BSP 1980 X 1131/19.

Fig. 4-16: *Heterocypris salina* (BRADY, 1868);

14: L (l = 1.145, h = 0.745 mm), internal view, ca. x 47; BSP 1980 X 1131/20.

15: R, a-1 (l = 0.927, h = 0.582 mm), external view, ca. x 46; BSP 1980 X 1131/21.

16: C (l = 1.095, w = 0.491 mm), dorsal view, anterior end above, ca. x 50; BSP 1980 X 1131/22.



WITT, W.: Freshwater Ostracods from Neogene deposits of Develiköy (Manisa, Turkey)

Remarks and relations: Type 1 shows much greater affinities to *Ilyocypris gibba* than type 2. The latter has some similarities with *Ilyocypris* sp. in JANZ (1994: 6; pl. 3, fig. 4) showing distally a larger number of weakly developed ripples, whereas the presence of marginal ripples in the median area is conjectural due to the imperfect preservation of the material.

*Ilyocypris* sp. 1 in TUNOĞLU et al. (1995: pl. 1, fig. 6-11) is very similar, especially in dorsal view, to the specimens with strongly developed tubercles of sample H 69. Measurements derived from TUNOĞLU et al.'s figures indicate *Ilyocypris* sp. 1 being somewhat smaller (L:  $l = 0.946$ ,  $h_a = 0.470$  mm; R:  $l = 0.904$ ,  $h_a = 0.458$  mm), with the  $l/h_a$ -ratio (L = 2.013; R = 1.974) lying just outside the range of the specimens from Develiköy. In view of the missing illustration and description of the marginal ripples, the identity of the two species cannot be proven, however is likely, considering the geographical proximity and stratigraphical position of both occurrences.

Ecology: *Ilyocypris* lives in fresh to oligohaline water. Most species are mud-dwellers, but some can swim (VAN MORKHOVEN 1963: 91).

#### Family Cyprididae BAIRD, 1845

##### Subfamily Eucypridinae BRONSHTEIN, 1947

##### Genus *Eucypris* VÁVRA, 1891

##### *Eucypris dulcifons* DIEBEL & PIETRZENIUK, 1969

- 1975 *Eucypris foveatus* POPOVA - KAZMINA: 54, pl. 4, fig. 15-16; pl. 19, fig. 8-12.  
 1979a *Eucypris straubi* n. sp. - GÖKÇEN: 91, pl. 8, fig. 5-8.  
 1980 *Eucypris dulcifons* DIEBEL & PIETRZENIUK 1969 - FREELS: 17, pl. 1, fig. 17-19.  
 1992 *Eucypris dulcifons* Diebel ve Pietrzeniuk, 1969 - ŞAFAK et al.: 179, pl. 4, fig. 2-5.  
 1993 *Eucypris dulcifons* Diebel & Pietrzeniuk - KRSTIĆ: pl. 1, fig. 8-10.

Material: Düzpinar: 1R, damaged.

Measurements (mm):  $l = 1.118$ ,  $h = 0.636$ ,  $l/h = 1.758$ .

Other occurrences: In the Dacian of Serbia (KRSTIĆ 1993). Widespread in the Lower?/Middle Miocene - Pleistocene of Anatolia (FREELS 1980), in the Sarmatian - Pontian of South-western Anatolia (GÖKÇEN 1979a,b), and in the Pliocene of the Kayseri area, Turkey (ŞAFAK et al. 1992). In the Middle Pliocene - Upper Pleistocene of the southern part of Western Siberia (KAZMINA 1975).

##### Subfamily Herpetocypridinae KAUFMANN, 1900

##### Genus *Herpetocypris* BRADY & NORMAN, 1889

##### *Herpetocypris* sp.

Material: Düzpinar: 1R, damaged.

Measurements (mm):  $l = \text{ca. } 2.109$ ,  $h = 0.945$ ,  $l/h = \text{ca. } 2.232$ .

Remarks: General outline, dimensions and the central muscle scars observable from the outside permit the generic determination. Since the valve is filled with sediment, the inner lamella could not be observed, therefore a specific determination is not attempted.

##### Subfamily Cyprinotinae BRONSHTEIN, 1947

##### Genus *Heterocypris* CLAUS, 1892

##### *Heterocypris salina* (BRADY, 1868)

pl. 1, fig. 14-16

- 1955 *Heterocypris salina* (BRADY, G. S.) - KRUIT: 477, pl. 4, fig. 1 a-d.  
 1966 *Cyprinotus salinus* Brady - HANGANU: pl. 38, fig. 2.  
 1966 *Cyprinotus salinus* (Brady) - STANCHEVA: 213, pl. 3, fig. 1.  
 1972 *Cyprinotus salinus* (Br.) - KRSTIĆ: fig. 18-19.  
 1978 *Cyprinotus salinus* (Brady, 1868) Sars, 1891 - SOKAČ: 35, pl. 18, fig. 10-11.  
 1980 *Heterocypris salina salina* (BRADY 1868) - FREELS: 28, pl. 3, fig. 1-6.  
 1980 *Heterocypris salina barneri* (LÜTTIG 1955) - FREELS: 29, pl. 3, fig. 7-8.  
 1981 *Cyprinotus salinus* (BRADY 1868) - MOSTAFAWI: 176, pl. 17, fig. 8.  
 1988 *Heterocypris* cf. *fretensis* (BRADY & ROBERTSON 1870) - MOSTAFAWI: 183, pl. 1, fig. 12-13.  
 1994a *Heterocypris salina* (BRADY 1868) - MOSTAFAWI: fig. 5/5.  
 2001 *Heterocypris salina* (BRADY 1868) - JANZ et al.: 188, pl. 6, fig. 57-58.  
 2001 *Heterocypris salina* (Brady, 1868) - PÍPÍK: 215, pl. 1, fig. 10-15; pl. 22, fig. 3.

For further synonyms see FREELS (1980: 28), MEISCH (2000: 354) and PÍPÍK (2001: 215).

Material: H 69: 17 C, 18 R, 17 L; juv.: 2 C, 9 R, 6 L; H 70: numerous adults and juveniles; Düzpinar: 17 G, 3 R, 5 L.

Measurements (mm), H 69: s.tab. 4

Remarks and relations: *Heterocypris salina* is a variable form (MEISCH 2000: 355), which also includes *Heterocypris salina barneri* (LÜTTIG, 1955) (JANZ et al. 2001: 188), although solely on palaeontological considerations the latter subspecies is distinguishable from *H. salina salina*. A younger synonym is *Heterocypris fretensis* (BRADY & ROBERTSON, 1870) (MEISCH 2000: 354), as already suggested by MOSTAFAWI (1988: 183).

The attribution to the juveniles stages is based on measurements in JORDAN et al. (1962: fig. 14).

Other occurrences: In the present Rhône delta living under permanent swampy conditions (oligo-mesohaline) (KRUIT 1955). In the Upper Miocene of the Turiec Basin, Slovakia (PÍPÍK 2001). In the Miocene of Serbia (KRSTIĆ 1972). In the Pliocene of Romania (HANGANU 1966). In the Levantian (Pliocene) of Bulgaria (STANCHEVA 1966). Greek islands: In the Upper Pliocene and Pleistocene of Kos (MOSTAFAWI 1981, 1988), and in the Upper Pliocene of Evia (MOSTAFAWI 1994a). Widely known from the Upper Miocene to the Pleistocene of Anatolia (FREELS 1980). In the Holocene of Iran (JANZ et al. 2001).

Ecology: *Heterocypris salina* prefers small and slightly

salty coastal and inland waters, often coexisting with other halophilic ostracods. It also occurs in pure freshwater habitats (MEISCH 2000: 355). According to JANZ et al. (2001: 188) the species is indicative of a high salt content in limnic waters and occurs frequently in brackish water. PÍPIK (2000: tab. 1) considers *H. salina* a halobiont species, living in springs and pools on muddy substrate.

*Heterocypris* cf. *karasi* (KRSTIĆ, 1971)  
pl. 2, fig. 10

- cf. \* 1971 *Cyprinotus karasi* n. sp. - KRSTIĆ: 89, pl. 2, fig. 1-5, text-fig. 2-7.  
cf. 1990 *Cyprinotus karashi* KRSTIĆ, 1971 - STANCHEVA: 13, pl. 1, fig. 9.  
1996 *Heterocypris* cf. *karasi* (KRSTIĆ 1971) - MOSTAFAWI: pl. 3, fig. 57.

Material: H 69: 2 R; H 70: 3 C, 1 L.

Measurements (mm): s. tab. 5

Remarks and relations: *Heterocypris karasi* (KRSTIĆ, 1971), described from the Portaferrian (upper Pontian) of Yugoslavia and also known from the Dacian of Bulgaria (STANCHEVA 1990), is much larger, the ♀♀ measure  $l = 1.04-1.11$ ,  $h = 0.64-0.70$  mm, resulting in  $l/h$ -values of 1.600 in average, since these forms are relatively higher.

*Heterocypris formalis* (MANDELSTAM, 1963) in MANDELSTAM & SCHNEIDER (1963: 202; pl. 20, fig. 9a-b) from the Neogene of the former USSR is also in outline rather similar, but is as well larger ( $l = 0.96$ ,  $h = 0.51$  mm), and with a  $l/h$ -value of 1.882 relatively lower. The same holds for *Heterocypris* ex. gr. *formalis* (MANDELSTAM) in KRSTIĆ (1995: 402; pl. 9, fig. 1). The depicted ♀ right valve measures  $l = 0.97$ ,  $h = 0.53$  mm, resulting in a  $l/h$ -value of 1.830. The right valve illustrated in MOSTAFAWI (1996) is unusually small for the genus ( $l = 0.60$ ,  $h = 0.35$  mm), and is possibly a juvenile. The  $l/h$ -value of 1.690 is rather similar to the one of the Turkish specimens.

Other occurrences: In the upper Pontian (Portaferrian) of the Thessaloniki region (MOSTAFAWI 1996).

Ecology: *Heterocypris* species occur mostly in freshwater, more rarely in brackish waters (MALZ 1976: 192; VAN MÖRKHOVEN 1963: 46).

Subfamily Cypridopsinae KAUFMANN, 1900

Genus *Zonocypris* G. W. MÜLLER, 1898

*Zonocypris membranae* (LIVENTAL, 1929)  
pl. 1, fig. 9-13

- 1963 *Zonocypris membrana* (Liventall) - MANDELSTAM & SCHNEIDER: 222, pl. 40, fig. 6a-b.  
1966 *Zonocypris membranae membranae* (Liventall) - STANCHEVA: 216, pl. 3, fig. 8.  
1966 *Zonocypris membranae quadricella* ssp. nov. - STANCHEVA: 217, pl. 3, fig. 7.  
1975 *Zonocypris membranae* (Liventall) - KAZMINA: 62, pl. 8, fig.

1-2; pl. 21, fig. 1-3.

- 1981 *Virgatocypris* sp. - ROSENFELD et al.: pl. 1, fig. 12.  
1983 *Zonocypris* aff. *membrana* (LIVENTAL) - JIRIČEK: pl. 9, fig. 51 (tab.: *Zonocypris membranae*).  
1988 *Zonocypris* sp. - MOSTAFAWI: pl. 2, fig. 14 (p. 186: *Paracyprretta* ? sp.).  
1990 *Paracyprretta* ? sp. - MOSTAFAWI: 176, pl. 4, fig. 57.  
1994a *Zonocypris* sp. 6 - MOSTAFAWI: fig. 5/6-7.  
1995 *Zonocypris membranae* (Liventall), 1929 - OLTEANU: 285, pl. 36, fig. 5.  
1995 *Zonocypris membranae* Livental in Suzin 1956 - KRSTIĆ: 404, pl. 8, fig. 8; pl. 10, fig. 5-6; text-fig. 7.  
1995 *Zonocypris* sp. - TUNOĞLU et al.: pl. 2, fig. 26-28.  
Further synonyms in KRSTIĆ (1995).

Material: H 69: 34 C, 7 R, 16 L; H 70: numerous adults and few juveniles; H 52: 1 R; H 118: 1 R, 1L; Düzpınar: 32 G, 2 R, 2 L.

Measurements (mm), H 69: s. tab.6

Relations: The similar *Z. rippeae* MOSTAFAWI, 1994b is characterized by an at least centrally present irregular reticulation.

Other occurrences: In the Middle and Upper Paludian Beds (Dacian) of Serbia (KRSTIĆ 1993; 1995). In the Pliocene (Levantian) of Bulgaria (STANCHEVA 1966). In the Romanian of Romania, its first occurrence marking the Dacian/Romanian boundary in the Dacian Basin (OLTEANU 1995). Greek islands: In the Upper Pliocene of Kos (MOSTAFAWI 1988) and Evia (MOSTAFAWI 1994a). In the Pliocene of Central Anatolia (TUNOĞLU et al. 1995). In the Pliocene of the Jordan Valley (ROSENFELD et al. 1981). In the Pliocene of the southern part of the former USSR: in the Caucasus, Uzbekistan (Fergana Basin), and Turkmenistan (Cheleken) (MANDELSTAM & SCHNEIDER 1963) and in the Pliocene to lower Pleistocene of the southern part of Western Siberia (KAZMINA 1975). The latter author states a general distribution from the Upper Miocene to the Middle Pleistocene (KRSTIĆ 1995).

This species occurs as well in the lower Tortonian of the island Kithira south of the Peloponnisos (MOSTAFAWI 1990). Two samples of section Gonies III contain a few specimens of this species associated with other freshwater ostracods sandwiched by sediments with marine ostracods indicating an early Tortonian age (MOSTAFAWI 1990: tab. 1). Marine Pliocene is overlying the Tortonian with an angular unconformity (MOSTAFAWI 1990: 162).

Palaeoecology: *Zonocypris membranae* is a limnic to brackish species (MANDELSTAM & SCHNEIDER 1963: 222). KRSTIĆ & SCHORNIKOV (1993: 252) consider *Z. membranae* a rheophilic species.

Genus *Potamocypris* BRADY, 1870

*Potamocypris* cf. *reflexa* SCHNEIDER in  
MANDELSTAM & SCHNEIDER, 1963  
pl. 2, fig. 7

- cf. \* 1963 *Potamocypris reflexa* Schneider - MANDELSTAM & SCHNEIDER: 220, pl. 41, fig. 4.  
2002 *Potamocypris* sp. - WITT in RÜCKERT-ÜLKÜMEN et al.: 63.

Material: H 69: 4 C.

Measurements (mm): s. tab. 7

Relations: The present form is similar to *Potamocypris reflexa* from the Pliocene of the Iliisk valley in Kazakhstan, however, in contrast to *P. reflexa* the largest height is somewhat off the middle. Furthermore *P. reflexa* is slightly larger ( $l = 0.57$ ,  $h = 0.38$  mm), its  $l/h$ -ratio of 1.5 tends to match the one of the Turkish form.

Ecology: *Potamocypris* species live mostly in freshwater, some in mesohaline environments (VAN MORKHOVEN 1963: 49).

Superfamily Cytheroidea BAIRD, 1850

Family Limnocytheridae KLIE, 1938

Subfamily Limnocytherinae KLIE, 1938

Genus *Leucocythere* KAUFMANN, 1892

*Leucocythere levisreticulata* (STANCHEVA, 1963)  
pl. 2, fig. 11

\* 1963 *Limnocythere levisreticulata* sp. n. - STANCHEVA: 11, pl. 1, fig. 8.

1969 *Limnocythere acquensis* n. sp. - CARBONNEL: 158, pl. 2, fig. 25-26.

1990 *Limnocythere levisreticulata* Stancheva, 1963 - STANCHEVA: 84, pl. 28, fig. 10.

Material: H 69: 1 L.

Measurements (mm):  $l = 0.709$ ,  $h = 0.364$ ;  $l/h = 1.948$ .

Remarks and relations: The SEM-image in STANCHEVA (1990) does not show in contrast to the drawn figure in STANCHEVA (1963) the lower part of the anterior margin reaching far beyond the ventral margin. According to CARBONNEL (1969: 159) it is this feature that distinguishes *L. levisreticulata*

from his species *Leucocythere acquensis*. Measurements and description indicate the identity of both species.

The measurements given by STANCHEVA (1990),  $l = 0.700-0.720$  and  $h = 0.375-0.400$  mm check well with those of the Turkish specimen.

Other occurrences: In the Upper Miocene of the Rhône Basin, France (CARBONNEL 1969). In the Chersonian (Upper Miocene) of North-western and Northern Bulgaria (STANCHEVA 1963; 1990).

Ecology: Limnocytherinids are bottom dwellers which can not swim (JANZ 1992: 64). The type-species of this genus, *Leucocythere mirabilis*, prefers the sublittoral and profundal zones of cold oligotrophic lakes. Also recorded from slightly brackish waters (MEISCH 2000: 448).

Subfamily Dinarocytherinae KRSTIĆ, 1987

Genus *Scordiscia* KRSTIĆ & SCHORNIKOV, 1993

*Scordiscia* aff. n. sp. SCHORNIKOV in  
KRSTIĆ & SCHORNIKOV, 1993  
pl. 2, fig. 5-6

aff. 1975 *Limnocythere baltica* Diebel - KAZMINA: 89, pl. 16, fig. 1-2, 5-8; pl. 27; fig. 11-12, 18-20.

aff. 1993 *Scordiscia* n. sp. Schornikov - KRSTIĆ & SCHORNIKOV: fig. 2.14.

2002 *Scordiscia* sp. - WITT in RÜCKERT-ÜLKÜMEN et al.: 63.

Material: H 69: ♂: 1 R; ♀: 1 R, 2 L; Düzpinar: ♀: 1 G.

Measurements (mm), H 69:

	l	h	l/h	w
R ♀	0.755	0.444	1.700	0.145
L ♀	0.727	0.445	1.634	-
R ♂	0.764	0.385	1.984	-

## Plate 2

Figures 1-7, 10-11: sample H 69; figures 8-9: sample H 70.

Fig.1-3: *Ilyocypris* sp.; Type 1: *Ilyocypris* aff. *gibba* (RAMDOHR, 1808);

1: R ( $l = 1.182$ ,  $h = 0.600$  mm), external view, ca. x 48; BSP 1980 X 1131/23.

2: L ( $l = 1.218$ ,  $w = 0.273$  mm), dorsal view, anterior end above, ca. x 47; BSP 1980 X 1131/24.

3: L ( $l = 1.218$ ,  $h = 0.627$  mm), internal view, marginal ripples, ca. x 300; BSP 1980 X 1131/25.

Fig. 4: *Ilyocypris* sp.; Type 2: cf. *Ilyocypris* sp. JANZ, 1992; L ( $l = 1.264$ ,  $h = 0.645$  mm), internal view, marginal ripples, ca. x 300; BSP 1980 X 1131/26.

Fig.5-6: *Scordiscia* aff. n. sp. SCHORNIKOV in KRSTIĆ & SCHORNIKOV, 1993;

5: R♀ ( $l = 0.755$ ,  $h = 0.444$  mm), external view, ca. x 72; BSP 1980 X 1131/27.

6: R♂ ( $l = 0.764$ ,  $h = 0.385$  mm), external view, ca. x 73; BSP 1980 X 1131/28.

Fig. 7: *Potamocypris* cf. *reflexa* SCHNEIDER in MANDELSTAM & SCHNEIDER, 1963; C from left ( $l = 0.473$ ,  $h = 0.309$  mm), ca. x 92; BSP 1980 X 1131/29.

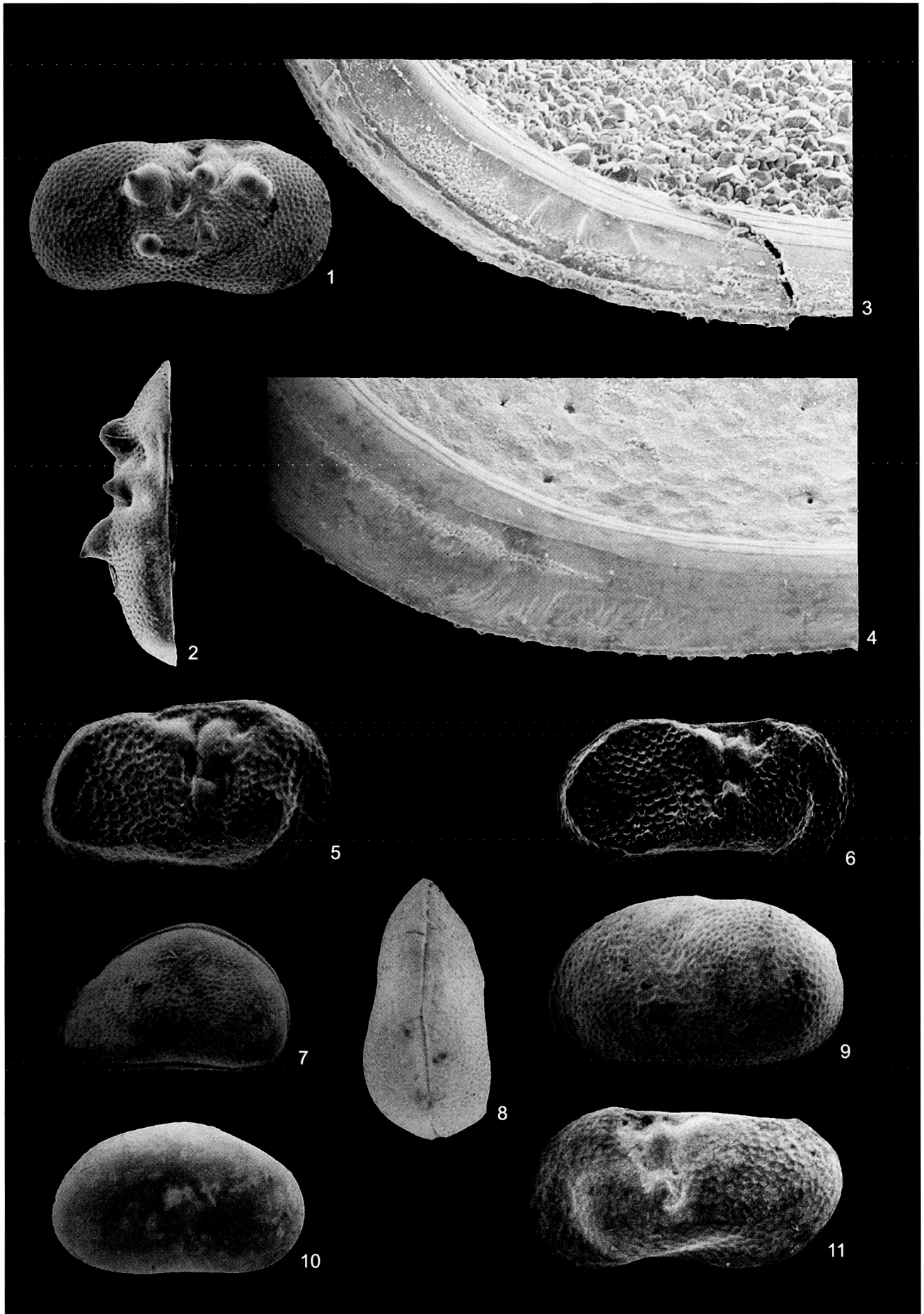
Fig.8-9: *Cyprideis* sp.;

8: C♀ ( $l = 0.855$ ,  $w = 0.418$  mm), dorsal view, anterior end above, ca. x 57; BSP 1980 X 1132/13.

9: L♀ ( $l = 0.927$ ,  $h = 0.527$  mm), external view, ca. x 60; BSP 1980 X 1132/14.

Fig. 10: *Heterocypris* cf. *karasi* (KRSTIĆ, 1971); R ( $l = 0.791$ ,  $h = 0.473$  mm), external view, ca. x 60; BSP 1980 X 1131/30.

Fig. 11: *Leucocythere levisreticulata* (STANCHEVA, 1963); L ( $l = 0.709$ ,  $h = 0.364$  mm), external view; ca. x 82; BSP 1980 X 1131/7.



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**Remarks and relations:** The present species is characterized by its trapezoidal outline. The prominent ridge along the ventral and posterior margin shows a narrow curvature, which is situated rather low on the depicted ♀ valve, on others it is approaching the middle of the posterior margin.

*Scordiscia* n. sp. SCHORNIKOV, 1993 is much smaller. Measurements taken from fig. 2.14 in KRSTIĆ & SCHORNIKOV (1993), rather depicting a female than a male left valve, being not elongate and missing the distinct concave ventral margin, are  $l = 0.470$ ,  $h = 0.272$  mm, resulting in  $l/h$  of 1.728, a value rather coinciding with the one of the Turkish material. In comparison, the smallest female valve of *Scordiscia baltica* in KAZMINA (1975: pl. 16, fig. 7) from the Pliocene - lower Pleistocene of the southern part of Western Siberia measures  $l = 0.546$ ,  $h = 0.302$  mm,  $l/h = 1.808$ .

*Scordiscia grinfeldi* (LIEPIN & KAZMINA, 1960), although trapezoidal in outline, has larger pits than the present form. The highest point of the right valve of *S. grinfeldi* is situated further towards the middle of the dorsal margin than the one of the present form.

*Scordiscia baltica* (KAZMINA, 1975) in KAZMINA (1975: pl. 16, fig. 1-8; pl. 27, fig. 13-20) belongs to two different taxa (pers. comm. Dr. KRSTIĆ 25.9.02). The valves depicted on pl. 16, fig. 3-4 and pl. 27, fig. 13-17 belong to the genus *Leucocythere*. *Scordiscia baltica* in KAZMINA differs from *Leucocythere baltica* (DIEBEL, 1965) in its smaller size. The outline of the latter, especially of the male valves, is rather rectangular with parallel dorsal and ventral margins. A ventral-posterior ridge is furthermore lacking. *Scordiscia quadrata* (MANDELSTAM, 1962) in MANDELSTAM et al. (1962) is smaller and the prominent ridge along the ventral and posterior margin is absent.

**Other occurrences:** *Scordiscia* n. sp. SCHORNIKOV, 1993, is possibly reworked from the Pliocene (pers. comm. Dr. KRSTIĆ 21.9.02) and redeposited in Lake Chebakly, Novosibirsk district, southern region of Western Siberia (KRSTIĆ & SCHORNIKOV 1993).

**Palaeoecology:** The genus *Scordiscia* occurred typically in lacustrine environments, in well oxygenated lakes often with moderate water energy, including those that were slightly saline (KRSTIĆ & SCHORNIKOV 1993: 249, 252).

#### Family Cytherideidae Sars, 1925

##### Genus *Cyprideis* Jones, 1857

##### *Cyprideis* sp. pl. 2, fig. 8-9

**Material:** H 70: ♀ only: 3 C, 1 R, 1 L.

**Measurements (mm):**

	l	h	l/h	w
C	0.855	0.491	1.741	0.418
R	0.927	0.527	1.759	-
L	0.827	0.473	1.748	-

**Remarks and relations:** In size, outline, reticulation and a characteristic incision reaching from the dorsal margin to the central muscle scars, the present form agrees with *Cyprideis* sp. in MOSTAFAWI (1989b: 191; fig. 4/8-9), encountered in the upper Serravallian and/or lower Tortonian of Crete (MOSTAFAWI 1989b). The right valves of the present material exhibit a minor posteroventral node, on the left valves missing or only very weakly developed. Marginal denticulations could not be observed. The pear-shaped dorsal outline indicates that only female carapaces and valves are present. *Cyprideis torosa* (JONES, 1850) is similar, but differs from the present form by a larger  $l/h$ -ratio, in the region of 1.80 to 1.88 for ♀ valves, due to their lesser height.

**Ecology and Palaeoecology:** The large majority of *Cyprideis* species inhabit brackish (meso-polyhaline) environments (VAN MORKHOVEN 1963: 290).

#### Further ostracods

In sample H 70 a few ostracod valves have been encountered, which due to the rough shell surface and the calcareous filling of the valves are considered to originate from a limestone streak. The specimens are not suitable for further study, since central muscle scars and inner lamella could not be observed:

*Candonopsis* ? sp., 1 R:  $l = 1.582$ ,  $h = 0.655$  mm;  $l/h = 2.415$ .

*Cypris* sp., juv., 1 R:  $l = 1.513$ ,  $h = 0.909$  mm;  $l/h = 1.664$ .

*Dolerocypris* ? sp., 1 R juv.; 1 R:  $l = 1.873$ ,  $h = 0.782$  mm;  $l/h = 2.395$ .

*Cyprideis* ? sp., 1 G:  $l = 0.909$ ,  $h = 0.471$ ,  $w = 0.232$  mm;  $l/h = 1.930$ .

### 3.2 FAUNAL RELATIONS AND AGE

Faunal relations exist as far as it could be ascertained with the Upper Miocene and Plio-Pleistocene of the Paratethys area: the Vienna Basin and Turiec Depression (Slovakia), the Pannonian Basin (Croatia, Serbia), the Dacian Basin (Northern Bulgaria and Romania) and the Aralo-Caspian Basin (Caucasus region, Kazakhstan, Uzbekistan, Turkmenistan). Furthermore relations can be demonstrated with the West Siberian Plain, the Strimon Basin and other Greek Neogene basins, the Aegean Islands, a considerable number of other Anatolian Neogene basins and the Jordan Valley (Near East).

The stratigraphical framework within the Develiköy area is based on two levels dated by mammalia: Düzpınar, correlated with H 111 of the Develiköy section, is Turolian in age (KAYA et al. 1998: 5; RÜCKERT-ÜLKÜMEN et al. 2002: 67), corresponding to late Late Miocene to earliest Pliocene (STEININGER 1999: fig. 1.2). However, only a part of the mammalian taxa reported by OZANSOY (1960), ARSLAN (1984, 1987), ŞEN et al. (1989) and RÜCKERT-ÜLKÜMEN et al. (2002: 67) reach into MN 13, therefore excluding earliest Pliocene. Düzpınar is therefore late Late Miocene in age. The other level, H 130, about 22 m above H 111, is based on microvertebrates Ruscinian (Early Pliocene, MN 14) in age (KAYA et al. 1998: 5; RÜCKERT-ÜL-



KÜMEN et al. 2002: 67).

Although the ostracod fauna of Düzpınar resembles the ones of H 69 and H 70 from the uppermost part of the Urla Formation in all essential elements, Düzpınar is based on mammalia Upper Miocene, whereas H 69 and H 70 overlying H 130 is from the Lower Pliocene. Prof. T. KAYA, who took the sample at Düzpınar, reassured me (written comm. 12.03.2003), that the sample is from the same horizon or pocket as the sample H (= horizon) 111. Prof. KAYA described the sample as light greenish-grey, poorly to moderately indurated, very fine pebbly, clayey sandstone with abundant molluscs and bones. The remaining difference, H 111 being barren of ostracods (RÜCKERT-ÜLKÜMEN et al. 2002: tab. 1), can be explained by rapid changes of the biofacies within terrestrial deposits.

Düzpınar being correlative with H 111 implies, that the rather similar ostracod associations of levels H 69/70 and of Düzpınar indicate comparable depositional environments, and based solely on ostracods distinguishing between Lower Pliocene and Upper Miocene in the Develiköy area is not possible. It also implies that the genus *Scordiscia*, hitherto known as from the Pliocene, occurs already in the Late Miocene.

The stratigraphical distribution and the occurrences in the region under consideration of the encountered ostracod species are as follows:

*Darwinula stevensoni* is known to occur in the area since the Middle Miocene: Upper Serravallian and/or lower Tortonian of Crete (MOSTAFAWI 1989b), Upper Miocene of Slovakia (PIPIK 1998; 2001), Upper Pontian of the Thessaloniki region (MOSTAFAWI 1996), Upper Miocene to lower Pleistocene of Anatolia (FREELS 1980; NAZIK et al. 1992), Lower Pliocene of Serbia (KRSTIĆ 1995), Upper Pliocene of Evia (MOSTAFAWI 1994a) and Kos (MOSTAFAWI 1988), Pliocene to lower Pleistocene of the southern part of Western Siberia (KAZMINA 1975), and Pleistocene of Croatia (SOKAČ 1978).

*Candona decimai* is known in the region from the Upper Miocene to the Pleistocene: Upper Miocene of Bulgaria (STANCHEVA 1963; 1990), Upper Miocene to lower Pleistocene in Anatolia (FREELS 1980; ŞAFAK et al. 1992; NAZIK et al. 1992), Pliocene of Kazakhstan (MANDELSTAM & SCHNEIDER 1963), Upper Pliocene of Rhodes (MOSTAFAWI 1989a) and Kos (MOSTAFAWI 1981; 1984; 1988). ? Pliocene of the Jordan Valley (ROSENFELD et al. 1981). JIŘÍČEK (1983) summarizes the range of *Candona decimai* in the Paratethys as Dacian to Lower Pleistocene (Zones NO 23 -25).

*Pseudocandona cf. compressa* has been encountered in the area from the Middle Miocene to the Pleistocene: Serravallian-Tortonian of Kithira (MOSTAFAWI 1990), Middle Miocene to upper Pleistocene of Anatolia (FREELS 1980), Upper Pontian of the Thessaloniki region (MOSTAFAWI 1996), Upper Pliocene of Evia (MOSTAFAWI 1994a) and Kos (MOSTAFAWI 1988).

*Eucypris dulcifons* occurs in Anatolia from the Lower?/ Middle Miocene to the Pleistocene (FREELS 1980; GÖKÇEN 1979a,b) and Middle Pliocene to Upper Pleistocene in the southern part of Western Siberia (KAZMINA 1975).

*Heterocypris salina* has been proven in the area from the Middle Miocene to the Pleistocene: Middle Miocene of Serbia (KRSTIĆ 1972), Upper Miocene to Pleistocene of Anatolia

(FREELS 1980), Upper Miocene of Slovakia (PIPIK 2001), Pliocene of Bulgaria (STANCHEVA 1966), Upper Pliocene of Evia (MOSTAFAWI 1994a), and Upper Pliocene to Pleistocene of Kos (MOSTAFAWI 1981; 1988).

*Zonocypris membranae* occurs in the area under consideration from the Middle Miocene to the Pleistocene: Lower Tortonian of Kithira (MOSTAFAWI 1990), Pliocene of Bulgaria (STANCHEVA 1966), Lower Pliocene of Serbia (KRSTIĆ 1995), Upper Pliocene of Kos (MOSTAFAWI 1988) and Evia (MOSTAFAWI 1994a), Upper Pliocene of Romania (OLTEANU 1995), possibly in the Pliocene of the Jordan Valley (ROSENFELD et al. 1981), Pliocene of the southern part of the former USSR (MANDELSTAM & SCHNEIDER 1963) and Pliocene to lower Pleistocene of the southern part of Western Siberia (KAZMINA 1975). JIŘÍČEK (1983) attributes this species to the Lower - Middle Pleistocene (Paratethys Zones NO 25 - 26). After KRSTIĆ (1995: 387), however, Pliocene ostracod associations from the Dacian and Ponto-Caspian realms include *Zonocypris membranae*. STANCHEVA (in KOJUMDIEVA et al. 1989) has introduced a *Zonocypris membranae* local zone for the Romanian of the Carpathian fore-deep in Bulgaria.

*Leucocythere levisreticulata* has been described from the Upper Miocene of Bulgaria (STANCHEVA 1963; 1990).

The genus *Scordiscia* occurs in the Pliocene to Quaternary of Eurasia (KRSTIĆ & SCHORNIKOV 1993), and the genus *Cyprideis* is known from the Miocene to Recent (MEISCH 2000).

Middle to Upper Miocene (upper Serravallian to lower Tortonian) occurrences of the freshwater ostracods *Darwinula stevensoni*, *Pseudocandona cf. compressa*, and *Zonocypris membranae* on Crete and Kithira are of palaeogeographical importance and show lacustrine conditions resembling those in the Late Miocene and Early Pliocene of e.g. the Develiköy area. The Lower Pliocene at the studied locations on Crete and Kithira is marine (MOSTAFAWI 1989b: 184; 1990: 161; JACOBSHAGEN 1986: 238).

### 3.3 PALAEOECOLOGY

Inconsistent and sparse ecological data permit only an interpretation of the salinity of this shallow water habitat. The classification of brackish and saline waters follows HILTMANN (1966).

Samples H 69, H 70 and Düzpınar originate in environments with salinities higher than fresh- to oligohaline brackish water. Characteristic are here the abundantly occurring *Heterocypris salina* and *Zonocypris membranae* associated with *Cyprideis* sp. in H 70. *Heterocypris salina* points to a high salt content in limnic waters and also occurs abundantly in brackish water (JANZ et al. 2001: 188). MEISCH (2000: 355) considers this species as being mesohalophilic, occurring in waters with salinities ranging from  $\pm 5$ – $\pm 18$  ‰ in contrast to PIPIK (2001:161), who indicates 5–9 ‰. *Zonocypris membranae* is a limnic to brackish species (MANDELSTAM & SCHNEIDER 1963: 222) and the large majority of *Cyprideis* species is found in brackish (meso-polyhaline) habitats (VAN MORKHOVEN 1963: 290), which corre-

sponds to  $\pm 3$ – $\pm 30$  ‰ salt content. The not consistently found *Darwinula stevensoni* is tolerating increasing salinities up to 15 ‰ (MEISCH 2000: 51).

Considering the palaeoecological information of the associated species occurring partly in large numbers in H 69, H 70 and Düzpınar like *Candona decimai* and *Ilyocypris* sp., deposition in a salinity range at the limits of mio- to mesohaline brackish waters ( $\pm 5$  ‰) is likely. *Candona decimai* is a limnic, possibly also a species of slightly brackish waters (FREELS 1980: 120). *Ilyocypris* sp. occurs in fresh- and oligohaline brackish waters (VAN MORKHOVEN 1963: 91; PIPIK 2001: 162). This interpretation is supported by the rare presence of *Potamocypris*, mostly occurring in freshwater, but some also in mesohaline habitats

(VAN MORKHOVEN 1963: 49) and *Scordiscia*, a genus typical for lacustrine environments, including those which are slightly brackish (KRSTIĆ & SCHORNIKOV 1993: 249).

Summarizing, the ostracod association of sample Düzpınar points to mio- to mesohaline brackish waters, therefore deposition in a slightly saline lake is envisaged. The overlying samples H 124, H 118 and H 52 are dominated by *Candona decimai*, indicating a change to fresh- to oligohaline brackish water. The youngest samples H 70 and H 69 show a return to higher salinities, mio- to mesohaline waters, thus again indicating deposition in a slightly saline lake. BASSIOUNI (1979: 45) relates the low salinity of brackish waters during the early and middle Pliocene to higher rates of precipitation.

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