

SYSTEMATICS AND BIOSTRATIGRAPHY OF THE PONTIAN CANDONIDAE (OSTRACODA) FROM THE EASTERN BLACK SEA REGION (NORTHERN TURKEY)

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Abstract: In this study, 33 species (ten subgenera and one indet. subgenus) of Candonidae have been taxonomically determined from the Eastern Black Sea region of Turkey. These are *Candona*, *Caspiolla*, *Caspiocypris*, *Pontoniella*, *Bakunella*, *Lineocypris*, *Reticulocandona*, *Typhlocypris*, *Metacandona* and indet. subgenus. Five species are described as new namely: *Candona (Caspiolla) ataensis*, *Candona (Pontoniella) turcica*, *Candona (Lineocypris) bafraensis*, *Candona (Caspiocypris) trabzonensis*, *Candona (Reticulocandona) stanchevae*. *Candona* and its subgenera are dominant fossils in the sedimentary record of the Eastern Black Sea during the Pontian. These localities could be described as the “*Candona* Sea” due to this fact. The “*Candona* Sea” extended along the northern Anatolian coast from the Sinop Peninsula to the Trabzon (Arakli) area during the whole Pontian and contains few endemic species. On the basis of the environmental properties of *Candona* and the other identified Ostracoda species, this aquatic environment could have had oligohaline (0.5–5 ‰) and mesohaline (5–18 ‰) salinity conditions in Pontian. This “*Candona* Sea” was located on the southern border of Paratethys bioprovince and it has connections directly with Pontian, Euxinian and Caspian Basin bioprovinces during this time interval.

Key words: Pontian, Turkey, systematic, Candonidae, Ostracoda.

Introduction

In general, Turkey’s Neogene Candonidae was researched by Freels, 1980 partly including the Black Sea Coast. Although there were some paleontological studies in the Black Sea region, the Ostracoda fauna of the Eastern Black Sea has not been investigated in detail. Previously, the Ostracoda fauna of the Sinop Peninsula (Central Black Sea region) has been investigated by Tunoglu (1984); Tunoglu & Gökçen (1985, 1991, 1995, 1997). The first paleontological and stratigraphic data on the Eastern Black Sea region was produced by Özsayar (1977a,b, 1980, 1983a,b, 1984) on the basis of the foraminifers and molluscan fauna. Tarkhanian Tschokrakian, Karaganian and Sarmatian Paratethys lower, middle and Upper Miocene local stages have been distinguished. Other paleontological (Ostracoda) studies on the same region by Tunoglu (2001a,b, 2002a,b) were based on the *Tyrrhenocythere*, *Loxoconcha*, Leptocytheridae, Cytheridae and Candonidae groups in the same stratigraphic levels.

The main aim of this study to define the Candonidae fauna obtained from 150 samples of the five different localities situated on the Black Sea Coast (Northeast Turkey), (Fig. 1).

The Pontian sedimentary sequence of the Trabzon (Arakli — Table 1, west of Degirmendere — Table 2 and east of Degirmendere — Table 3/Trabzon) and Samsun areas (Bafra-Gümüşyaprak/Samsun — Table 4) were studied in the investigated area.

Geological setting

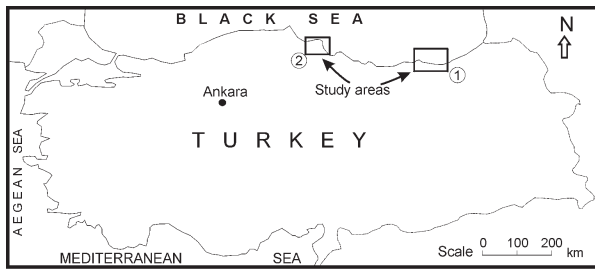
The study area is located in the eastern part of the Pontid Tectonic Unit (Ketin 1966). This area is very complex. The

dominant magmatic and volcano-sedimentary belts were formed during the Upper Cretaceous and Eocene periods. Pontian sedimentary units are unconformably located on the Eocene aged volcanic and volcanoclastic material (Tables 1, 2 and 3).

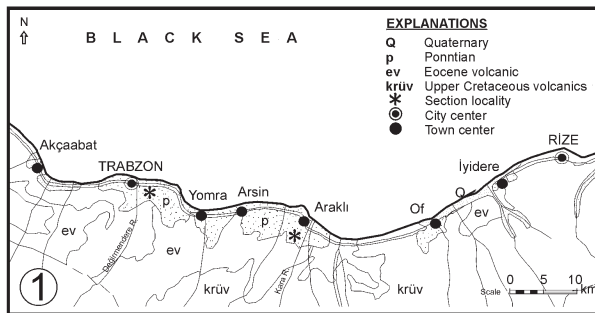
Neogene units are observed along the Sinop Peninsula, Bafra, Çarşamba (Samsun), Akçaabat, Arakli and Trabzon regions from west to east along the Black Sea Coast. There are very restricted and isolated sedimentary basins related to the Paratethys along the Black Sea Coast of Turkey from Bulgaria to the Georgian border. The most important of them was the Sinop Basin which is located in the center of the northern Anatolian coast and covers a wider area and contains a thicker stratigraphic interval than the others (Tunoglu 1984). Other relict Neogene Paratethys Basins are Igneada (near the Bulgarian border), Çarşamba, Bafra (Samsun) and Trabzon Rize area, which occur from west to east along the Black Sea Coast of Turkey.

Systematic description

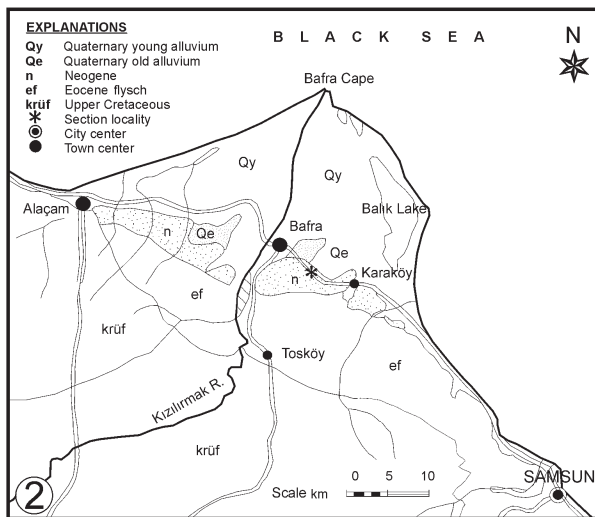
Thirtythree Candonidae species belonging to two genera and ten subgenera were identified from Pontian period. Previously one new genus and one new subgenus and their two new species were presented by Tunoglu (2002b) from this fauna. Within this fauna, five species are determined as new. Ostracoda assemblages and their photographic (SEM) and hand drawn illustrations are given in Figs. 3–9. The Classification of Hartmann & Puri 1974 is used for the systematic description of the species. Moore (1961), Van Morkhoven (1962, 1963) and Catalogue of Ostracoda (Ellis & Messina 1953–1985) have also been used for the identifications. All of



a



b



c

Fig. 1. a. Location map and subarea of the investigation regions. b. Geological map and section localities of first numbered subarea. c. Geological map and section locality of second numbered subarea (Geological maps simplified after the 1:500,000 scaled Geological map of Turkey). (All the figures after Tunoglu 2002b.)

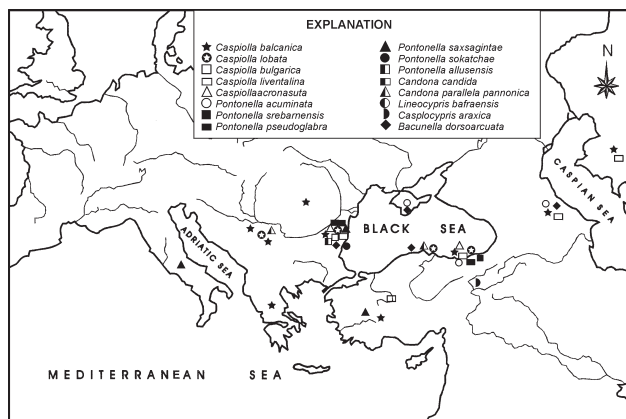


Fig. 2. Geographical distribution of known Candonidae species in this investigation.

the systematic and taxonomic descriptions are given below. The species are archived at the Geological Engineering Department of Hacettepe University.

Family: Candonidae Kaufmann, 1900

Genus: *Candona* Baird, 1845

Subgenus: *Caspiolla* Mandelstam, 1960

Type-species: *Bairdia acronasuta* Livental, 1929

Stratigraphic distribution: Late Miocene–Recent.

Ecology: Generally in fresh-water, but also in semi-saline (oligohaline and mesohaline) conditions (Stancheva 1965).

Candona (Caspiolla) balcanica (Zalanyi, 1929)

Fig. 3.1

1929 *Paracypris balcanica* Zalanyi, Morpho-system. Studien, p. 52, figs. 19–20.

1966 *Caspiolla balcanica* (Zalanyi), Stancheva, p. 209, pl. 1, fig. 1,2.

1978 *Candona (Caspiolla) balcanica* (Zalanyi), Olteanu, p. 1018, pl. 9, figs. 1,2.

1980 *Candona (Caspiolla) balcanica* (Zalanyi), Freels, p. 54, 55, pl. 8, figs. 1–8.

1998 *Candona (Caspiolla) balcanica* (Zalanyi), Tunoglu, Ünal & Bilen, p. 82, 83, pl. 6, fig. 4.

Material: 5 carapaces, 46 valves.

Stratigraphic and geographic distribution: Bulgaria/Silistra, middle Pontian (Stancheva 1966), Serbia, late Pontian, Dacian Basin, Meotian; Caucasus, Turkmenistan and Beserabian, Pontian; Greece, Romania and Yugoslavia (Olteanu 1978); Turkey/Denizli Basin, Pliocene-early Pleistocene (Freels 1980); and Boztepe, Araklı (Trabzon), Gümüsyaprak village (Bafra/Samsun/Northern Turkey), Pontian (Tunoglu et al. 1998).

Candona (Caspiolla) lobata (Zalanyi, 1929)

Fig. 3.2

1929 *Paracypris lobata* Zalanyi, Morpho-systematische Studien, p. 55, figs. 21, 22.

1966 *Caspiolla lobata* (Zalanyi), Stancheva, p. 19, pl. 2, fig. 3

1980 *Candona (Caspiolla) lobata* (Zalanyi), Freels, p. 49, 50, pl. 7, figs. 1–5.

1998 *Candona (Caspiolla) lobata* (Zalanyi), Tunoglu, Ünal & Bilen, p. 83, pl. 6, fig. 5.

Material: 12 carapaces, 59 valves.

Stratigraphic and geographic distribution: NW Bulgaria, middle Pontian (Stancheva 1965); Pannonian Basin, Belgrade, Late Pontian (Sokac & Gagic 1968); Turkey; Samsun, Bafra, Hara and Çiriklar village, late Miocene-limnic, brackish Pannonian (Freels, 1980); Araklı (Trabzon), factory of brick-tile kilns, Boztepe (Trabzon); and west of Degirmendere, Pontian.

Candona (Caspiolla) bulgarica Stancheva, 1966

Fig. 3.3

1966 *Candona (Caspiolla) bulgarica* Stancheva, p. 220, pl. 1, figs. 3, 4.

1998 *Candona (Caspiolla) bulgarica* Stancheva, Tunoglu, Ünal & Bilen, p. 83, pl. 6, fig. 6.

Material: 63 valves.

Stratigraphic and geographic distribution: M. Preslavets village (Bulgaria), Middle Pontian (Stancheva 1966); Turkey, east of Degirmendere, Boztepe and Araklı (Trabzon/Northern Turkey), Pontian.

Candona (Caspiolla) liventalina (Evlachova)

Fig. 3.4,5

1965 *Caspiolla* aff. *liventalina* (Evlachova), Stancheva, p. 18, pl. 2, fig. 4.

1978 *Candona (Caspiolla) liventalina* (Evlachova), Olteanu, p. 1018, pl. 1, fig. 2; pl. 2, fig. 7.

Table 1: Stratigraphic distribution of Candonidae species and the other ostracod species of the Arakli (Trabzon) Section (after Tunoglu 2002a,b).

Upper Miocene		? Pliocene																SERIES																
Pontian																		STAGE																
Middle-Upper																		SUBSTAGE																
?		?																FORMATION																
Y-33	Y-32	Y-31	Y-30	Y-29	Y-28	Y-27	Y-26	Y-25	Y-24	Y-23	Y-22	Y-21	Y-20	Y-19	Y-18	Y-17	Y-16	Y-15	Y-14	Y-13	Y-12	Y-11	Y-10	Y-9	Y-8	Y-7	Y-6	Y-5	Y-4	Y-3	Y-2	Y-1	Y-1a	
																																		SAMPLE NUMBER
																																		LITHOLOGY
																																		OSTRACODA
																																		<i>Amplocypris odessaensis</i> Ilnitskaya, 1962 <i>Tyrrhenocythere batmani</i> Tunoglu, 2001 <i>Tyrrhenocythere arakliensis</i> Tunoglu, 2001 <i>Candona (Pontoniella)</i> sp. 2 <i>Candona (Caspiolla)</i> sp. <i>Candona (Pontoniella) acuminata</i> Mandelstam, 1963 <i>Aurila cicatricosa</i> (Reuss,1850) <i>Cytherissa pannonica</i> n. sp. <i>Candona (Caspiolla) bulgarica</i> Stancheva, 1966 <i>Candona (Candona) parallela pannonica</i> (Zalanyi, 1929) <i>Candona (Caspiocypris)</i> sp. <i>Candona (Lineocypris)</i> sp. <i>Cyprideis</i> sp.1 <i>Loxoconcha gibboides</i> (Livent, 1929) <i>Euxinocythere (Maeotocythere) pontica</i> Tunoglu 2002a <i>Loxoconcha</i> sp. <i>Loxoconcha petasus</i> (Livent, 1929) <i>Xestoleberis (Xestoleberis)</i> sp. <i>Xestoleberis (Xestoleberis) ovulum</i> (Reuss, 1850) <i>Xestoleberis (Pontoleberis) pontica</i> Stancheva, 1990 <i>Candona (Caspiolla) balcanica</i> (Zalanyi, 1929) <i>Candona (Caspiolla) lobata</i> (Zalanyi, 1929) <i>Candona (Bakunella) dorsoarcuata</i> (Zalanyi, 1929) <i>Candona (Bakunella)</i> sp. 1 <i>Tyrrhenocythere turcica</i> Tunoglu, 2001 <i>Tyrrhenocythere alatum</i> Tunoglu, 2001 <i>Tyrrhenocythere alatum reticulata</i> Tunoglu, 2001 <i>Tyrrhenocythere trabzonensis</i> Tunoglu, 2001 <i>Cytherissa bogatschovi</i> (Livent, 1929) <i>Cyprideis krstici</i> Tunoglu 2002a <i>Candona (Pontoniella) sokachae</i> Stancheva, 1981 <i>Candona</i> sp. 1 <i>Candona</i> sp. 2 <i>Candona (Pontoniella)</i> sp. 3 <i>Candona (Pontoniella)</i> sp. 4 <i>Tyrrhenocythere</i> sp. 2 <i>Candona (Pontoniella) pseudoglabra</i> Stancheva, 1981 <i>Euxinocythere (Maeotocythere) krstici</i> Tunoglu 2002a <i>Tyrrhenocythere goeckena</i> Tunoglu, 2001 <i>Cytherissa</i> sp. 1 <i>Cytherissa</i> sp. 2 <i>Tyrrhenocythere filipescui</i> (Hanganu, 1962) <i>Tyrrhenocythere agalarovae</i> Tunoglu, 2001 <i>Tyrrhenocythere pontica</i> (Livent, 1929) <i>Tyrrhenocythere</i> sp.1 <i>Candona (Caspiolla) acronasuta</i> (Livent, 1929) <i>Euxinocythere (Maeotocythere) bosqueti</i> (Livent, 1929) <i>Leptocythere (Amnicythere) multituberculata</i> (Livent, 1929) <i>Cypria dorsoconcava</i> Krstic, 1975 <i>Cypria</i> sp.1 <i>Cypria</i> sp. 2 <i>Leptocythere (Amnicythere)</i> sp. <i>Leptocythere (Leptocythere) cymbula</i> (Livent, 1929) <i>Candona (Candona)</i> sp. <i>Candona (subgenus indet)</i> sp.

Scale

5m

UNFOSSILIFEROUS ZONE

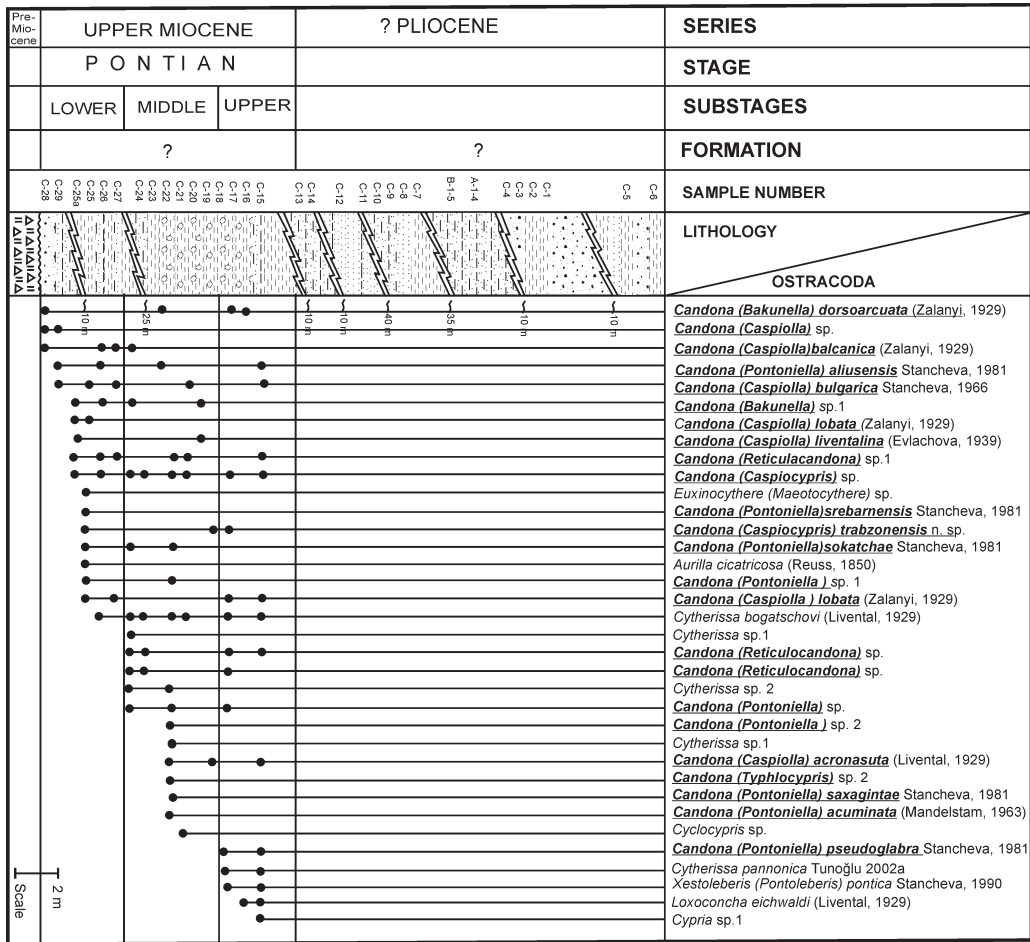
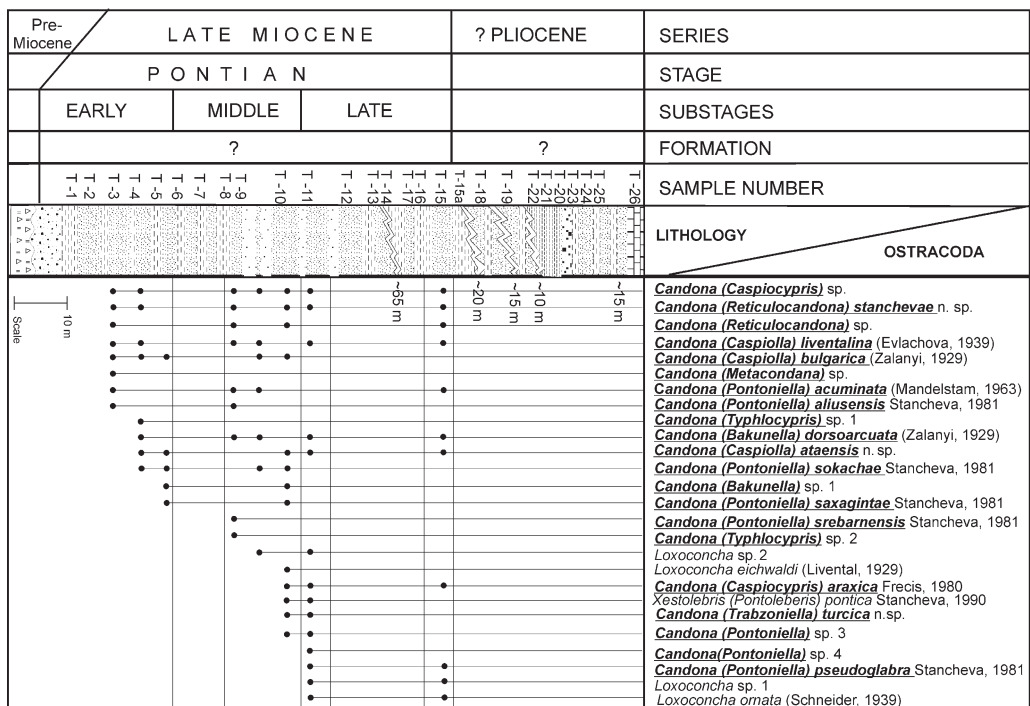
1998 *Candona (Caspiolla) liventalina* (Evlachova), Tunoglu, Ünal & Bilen, p. 84, pl. 6, figs. 7, 8.

Candona (Caspiolla) acronasuta (Livent, 1929)
Fig. 3.6-8

Material: 3 carapaces, 45 valves.

Stratigraphic and geographic distribution: NW Bulgaria, Middle Pontian (Stancheva 1965). West Turkmenistan and Azerbaijan, Pliocene and post Pliocene (Olteanu 1978); Turkey: Boztepe, east of Degirmendere (Trabzon/Northern Turkey), Pontian.

1929 *Paracypris acuminata* Zalanyi, Morpho-system. Studien, s. 47, figs. 13, 14.
 1965 *Caspiolla acronasuta* (Livent), Stancheva, p. 19, pl. 1, figs. 2a,b.
 1967 *Caspiolla acronasuta* (Livent), Agalarova, pl. 2, figs. 1, 3-5.
 1998 *Caspiolla acronasuta* (Livent), Tunoglu, Ünal & Bilen, p. 84, pl. 6, figs. 9-11.

Table 2: Stratigraphic distribution of Candonidae species and the other ostracod species of west of Degirmendere Section/Boztepe (Trabzon), (after Tunoglu 2002a,b).**Table 3:** Stratigraphic distribution of Candonidae species and the other ostracod species of east of Degirmendere (Trabzon), (after Tunoglu 2002a,b).

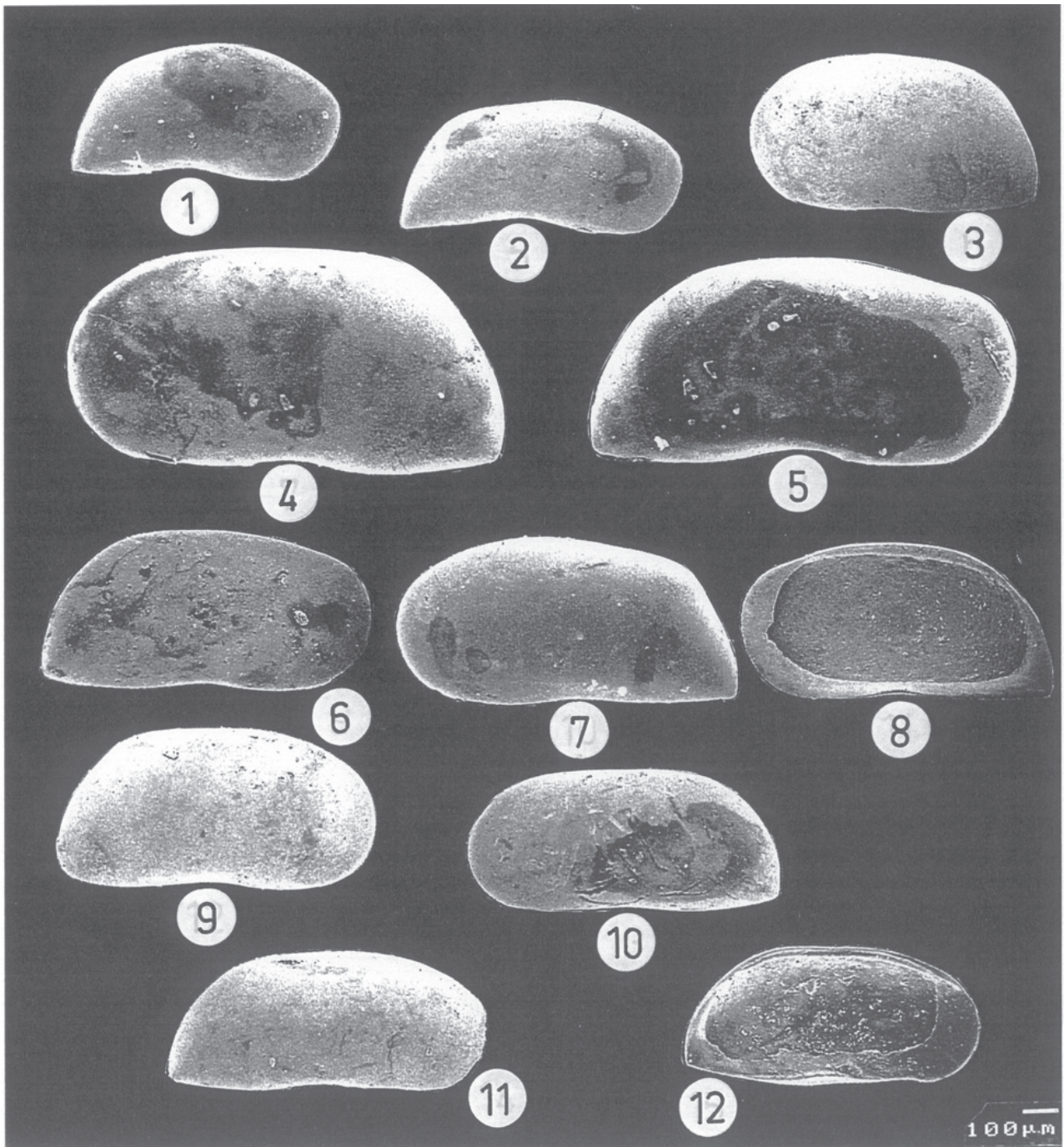


Fig. 3. Photographic (SEM) figures of Pontian Candonidae species from Eastern Black Sea region of Turkey. **1.** *Candonella (Casiolla) balcanica* (Zalanyi, 1929). Boztepe (Trabzon), sample number: C-25a, Pontian. Right valve, external view. **2.** *Candonella (Casiolla) lobata* (Zalanyi, 1929). Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-31, early-middle Pontian. Right valve, external view. **3.** *Candonella (Casiolla) bulgarica* Stancheva, 1960. Boztepe (Trabzon), sample number: C-20, Pontian. Left valve, external view. **4, 5.** *Candonella (Casiolla) liventalina* (Evlachova, 1939). East of Degirmendere (Trabzon), sample number: T-8, Pontian. **4.** Left valve, external view. **5.** Right valve, external view. **6-8.** *Candonella (Casiolla) acronasuta* Livental. Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-26, late Pontian. **6.** Right valve, external view. **7.** Left valve, external view. **8.** Right valve, internal view. **9.** *Candonella (Candonella) sp.* Arakli (Trabzon) factory of brick-tile kilns, sample number: Y-26, late Pontian. Right valve, external view. **10-12.** *Candonella (Casiolla) ataensis* n.sp. Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-33, middle-late Pontian. **10.** Left valve, external view, holotype. **11.** Right valve, external view, paratype. **12.** Left valve, internal view, paratype.

Material: 19 carapaces, 78 valves.

Stratigraphic and geographic distribution: NW Bulgaria, middle Pontian (Stancheva 1965); Azerbaijan, Pontian (Agalarova 1967); and Turkey: Arakli, factory of brick-tile kilns, Boztepe (Trabzon), Pontian.

Candona (Caspiolla) ataensis n.sp.
Fig. 3.10–12; Fig. 7.1–7

Derivation of name: It is named after the founder of the Turkish Republic, Mustafa Kemal Atatürk.

Holotype: Left valve.

Paratype: 12 carapaces, 27 valves.

Type-locality: Factory of brick-tile kilns, Arakli Town (Trabzon City/Northeast Turkey).

Type-level: Pontian.

Diagnosis: Carapace bean or kidney shaped in the lateral view. Dorsal margin convex, ventral margin concave, anterior margin well rounded, posterior margin tapering backwardly. Anterior margin is more tapered than the posterior in dorsal view. Surface of valve smooth.

Description: Carapace kidney or bean shaped in the lateral view. Dorsal margin slightly convex, but very slightly concave at the centre of dorsal margin. Ventral margin strongly concave. Antero-dorsal corner not angular and anterior margin is broadly rounded. Postero-dorsal area not angular. Posterior margin diagonal from postero-dorsal to postero-ventral, slightly convex and tapering at the postero-ventral. Maximum dimensions at the centre of carapace. Surface of valve smooth.

Central muscle scar, hinge adont. Marginal pore canals short, thin and dense, vestibule wide at the anterior and posterior area. Sexual dimorphism not observed.

Dimensions: Length: 0.80–0.87 mm. Height: 0.38–0.40 mm. Width: 0.36–0.40 mm.

Remarks: *C. ataensis* n.sp. is similar to *Candona (Caspiolla) venusta* (Zalanyi), but it differs from *C. venusta* by having longer and depressed posterior margin.

Locality and stratigraphic level in this study: Factory of brick-tile kilns of Arakli Town (Trabzon City, Northern Turkey). sample numbers: Y-28, Y-29, Y-30 and Y-33; west of Degirmendere River, sample numbers: T-4, T-5, T-10, T-11 and T-15; and Boztepe (Trabzon), sample numbers: C-28 and C-29, all of Pontian age.

Subgenus: *Pontoniella* Mandelstam, 1960
Type-species: *Paracyprina acuminata* Zalanyi, 1929

Stratigraphic distribution: Oligocene?, Pannonian–Recent (Van Morkhoven 1963).

Environment: Marine to brackish (Van Morkhoven 1963).

Candona (Pontoniella) acuminata (Zalanyi, 1929)
Fig. 4.1–4; Fig. 7.8–14

- 1929 *Paracyprina acuminata* Zalanyi, Morpho-system. Studien, s. 57, figs. 23, 24.
1967 *Pontoniella acuminata* (Zalanyi) Agalarova, pl. 5, figs. 1–6, pl. 6, figs. 1, 2.
1978 *Candona (Pontoniella) acuminata striata* Mandelstam, Olteanu, p. 1018, pl. 3, figs. 3–7.
1980 *Candona (Pontoniella) acuminata sinistruncata* (Zalanyi), Freels, p. 58, pl. 8, figs. 11–21.
1998 *Candona (Pontoniella) acuminata sinistruncata* (Zalanyi), Tunoglu, Ünal & Bilen, p. 87, pl. 7, figs. 6–9, pl. 14, figs. 9–15.

Material: 4 carapaces, 33 valves.

Stratigraphic and geographic distribution: Crimean Peninsula: Kerch (Ivanov area), Kabistan/Azerbaijan (Pontian); and Turkey: Boztepe (Trabzon), east of east of Degirmendere, fac-

tory of brick-tile kilns, Arakli Town (Trabzon City/Northern Turkey), Pontian.

Candona (Pontoniella) srebarnensis Stancheva, 1981
Fig. 4.5; Fig. 7.15, 16

- 1981 *Candona (Pontoniella) srebarnensis* Stancheva, p. 70, pl. 2, figs. 4–5.
1998 *Candona (Pontoniella) srebarnensis* Stancheva, Tunoglu, Ünal & Bilen, p. 87, pl. 7, fig. 10; pl. 14, fig. 16.

Material: 3 carapaces, 28 valves.

Stratigraphic and geographic distribution: Northern Bulgaria (Smirnski, Bukjovci), middle Pontian (Stancheva 1981). Turkey: east of Degirmendere and Boztepe (Trabzon), Pontian.

Candona (Pontoniella) pseudoglabra Stancheva, 1981
Fig. 4.6

- 1981 *Candona (Pontoniella) pseudoglabra* Stancheva, p. 73, 74, pl. 3, figs. 5, 6.
1998 *Candona (Pontoniella) pseudoglabra* Stancheva, Tunoglu, Ünal & Bilen, p. 88, pl. 7, fig. 11.

Material: 3 carapaces, 18 valves.

Stratigraphic and geographic distribution: North Bulgaria (Smirnski, Bukjovci), middle Pontian (Stancheva 1981); Turkey: Arakli (Trabzon), factory of brick-tile kiln, Boztepe, east of Degirmendere (Trabzon), Pontian.

Candona (Pontoniella) saxagintae Stancheva, 1981
Fig. 4.7

- 1981 *Candona (Pontoniella) saxagintae* Stancheva, p. 74, pl. 3, figs. 7, 8.
1998 *Candona (Pontoniella) saxagintae* Stancheva, Tunoglu, Ünal & Bilen, p. 88, pl. 7, figs. 12.

Material: 8 carapaces, 23 valves.

Stratigraphic and geographic distribution: Sitova, Staro Selo, Srebarna, Sarpovo (Northern Bulgaria), Middle-Late Pontian (Stancheva 1981); and Boztepe, east of Degirmendere River (Trabzon/ Northern Turkey), Pontian.

Candona (Pontoniella) sokachae Stancheva, 1981
Fig. 4.8

- 1981 *Candona (Pontoniella) sokachae*, Stancheva, p. 72, pl. 3, figs. 9, 10.
1998 *Candona (Pontoniella) sokachae*, Stancheva, Tunoglu, Ünal & Bilen, p. 88, pl. 7, fig. 13; pl. 14, fig. 17.

Material: 2 carapaces, 21 valves.

Stratigraphic and geographic distribution: Staro Selo, Brasljan Plain (Northern Bulgaria), Middle Pontian (Stancheva 1981); and Arakli (Trabzon)/factory of brick-tile kilns, east of Degirmendere River, Boztepe (Trabzon), Pontian.

Candona (Pontoniella) sp. 1
Fig. 4.9; Fig. 7.17

Description: Trapezoidal in lateral view. Dorsal margin straight and long, ventral margin broadly concave, antero-dorsal and postero-dorsal areas angular (150°). Anterior margin depressed towards the ventral part and well rounded. Posterior margin oblique towards the ventral part and blunt at the postero-ventral part and spindle-like shape in dorsal view. Maximum length at the ventral, maximum height and width at the centre of carapace. Valve surface smooth. Hinge adont, marginal zone narrow, vestibule wide at the anterior but narrow at the posterior part. Central muscle scar is that of the genus.

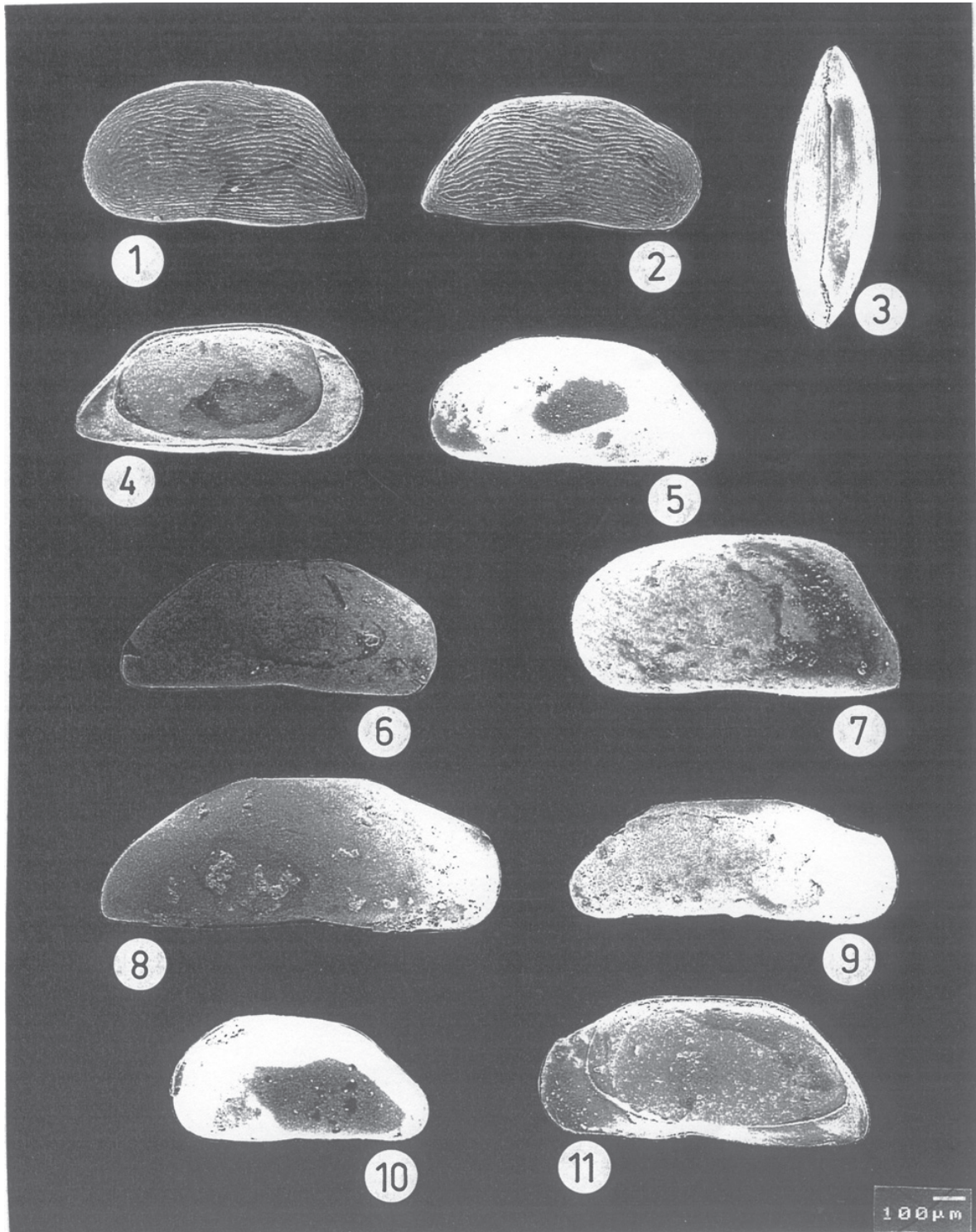


Fig. 4. Photographic (SEM) figures of Pontian Candonidae species from Eastern Black Sea region of Turkey. **1–4.** *Candonia (Pontoniella) acuminata* (Zalanyi, 1929). Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-29, Pontian. 1. Left valve, external view. 2. Right valve, external view. 3. Carapace, dorsal view. 4. Left valve, internal view. **5.** *Candonia (Pontoniella) srebarnensis* Stancheva, 1981; Boztepe (Trabzon), sample number: C-26, Pontian. Left valve, external view. **6.** *Candonia (Pontoniella) pseudoglabra* Stancheva, 1981; Arakli (Trabzon), factory of brick-tile kilns, sample number: Y-30, middle-late Pontian. Right valve, external view. **7.** *Candonia (Pontoniella) saxagintae* Stancheva, 1981; Boztepe (Trabzon), sample number: C-22, middle-late Pontian. Left valve, external view. **8.** *Candonia (Pontoniella) sokachae* Stancheva, 1981; Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-31, early-middle Pontian. Right valve, external view. **9.** *Candonia (Pontoniella)* sp. 1; Boztepe (Trabzon), sample number: C-26, early Pontian. Right valve, external view. **10.** *Candonia (Pontoniella)* sp. 2; Boztepe (Trabzon), sample number: C-22, middle Pontian. Left valve, external view. **11.** *Candonia (Pontoniella)* sp. 3; Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-28, middle-late Pontian. Right valve, internal view.

Material: 1 carapace, 7 valves.

Dimensions: Length: 0.98–1.05 mm. Height: 0.35–0.40 mm. Width: 0.32–0.36 mm.

Remarks: The species differs from *Candona (Pontoniella) acuminata sinistruncata* Freels by having concave ventral margin and beak shaped postero-ventral corner.

Locality and stratigraphic level in this study: Turkey: Boztepe (Trabzon), Pontian.

Candona (Pontoniella) sp. 2
Fig. 4.10

Description: Trapezoidal in lateral view. Dorsal margin straight, antero-dorsal margin angular ($\sim 150^\circ$), ventral margin sinuous, postero-ventral margin concave and centro-ventral margin convex. Half of antero-ventral margin slightly folded. Anterior and posterior marginal pore canals numerous, short and straight, with a wide anterior and posterior vestibulum. Hinge and central muscle scars are those of the genus.

Material: 6 valves.

Dimensions: Length: 0.80–0.85 mm. Height: 0.37–0.40 mm. Width: 0.34–0.38 mm.

Remarks: *Candona (Pontoniella) sp. 2* is morphologically very close to *Pontoniella acuminata* (Agalarova), but it differs from *P. acuminata* by having tapered postero-ventral and sinuous antero-ventral margin.

Locality and stratigraphic level in this study: Arakli (Trabzon)/factory of brick-tile kilns, sample numbers: Y-31 and Y-33; Boztepe (Trabzon), sample number: C-22, Pontian.

Candona (Pontoniella) sp. 3
Fig. 4.11; Fig. 7.18,19

Description: Trapezoidal in lateral view. Dorsal margin straight and antero and postero-dorsal corners angular (150°). Anterior margin depressed and longer towards anterior and well rounded. Posterior margin oblique toward the ventral margin and slightly curved near the postero-ventral corner. Postero-ventral corner tapered. Ventral margin broadly concave at the center. Maximum length near the ventral margin, maximum height and width at the antero-centre part. Carapace long, ovate at the dorsal view. Posterior end is more tapered than anterior end. Hinge adont. Marginal zone narrow, marginal pore canals short, simple, straight and dense. Central muscle scars are those of the genus and the subgenus. Sexual dimorphism not observed.

Material: 19 valves.

Dimensions: Length: 0.98–1.05 mm. Height: 0.43–0.45 mm. Width: 0.40–0.44 mm.

Remarks: This species is very similar to *Candona (Pontoniella) sp. 1* and *Candona (Pontoniella) sp. 2* described in this study. *C. sp. 3* has a short and straight dorsal margin and a longer posterior margin. A fold structure on the valve margin is absent.

Locality and stratigraphic level in this study: Medicine Faculty (Trabzon/North-east Turkey)/east of Degirmendere River, sample numbers: T-10, T-11; Arakli (Trabzon)/factory of brick-tile kilns, sample numbers: Y-27, Y-28, Y-30, Pontian.

Candona (Pontoniella) turcica n.sp.
Fig. 5.1,2; Fig. 8.1–6

Derivation of name: It is originated from Turkey.

Holotype: Right valve.

Paratype: 1 carapace, 17 valves.

Type-locality: Boztepe, west of Degirmendere River (Trabzon/Northern Turkey).

Type-level: Pontian.

Diagnosis: Trapezoidal in lateral view. Dorsal margin straight, ventral margin long and concave. Anterior margin forwardly extended and depressed to ventral margin. Posterior margin oblique and very pointed at the postero-ventral corner. Valve surface smooth. Anterior end more tapered than the posterior end in the dorsal view.

Description: Trapezoidal in lateral view. Dorsal margin straight or slightly convex, ventral margin concave, sinusoidal at the anterior and posterior half of the ventral valve. Posterior margin oblique and elongate. Postero-ventral corner is very tapered. Anterior margin depressed to ventral margin (longest and well rounded ahead). Dorsal view is spindle shaped, posterior end more tapered than the anterior end. Maximum length at the ventral margin, maximum height and width (at the anterior of mid-length). Valve surface smooth and shiny.

Marginal zone moderately wide. Marginal pore canals moderately dense, simple and straight. Vestibule wide at the anterior and postero-ventral corner. Hinge adont. Central muscle scars are those of the genus. Sexual dimorphism not observed.

Dimensions: Length: 1.30–1.40 mm. Height: 0.45–0.49 mm. Width: 0.36–0.40 mm.

Remarks: *C. turcica* is closely similar to *(Pontoniella) schemachensis* Mandelstham in general valve shape, but the former differs from the latter in having a longer carapace, more blunt anterior end, more undulated ventral margin of the left valve and more angular antero-dorsal corner angular ($\sim 160^\circ$ instead of *C. Pontoniella schemachensis*).

Locality and stratigraphic level in this study: Boztepe (Trabzon/Northern Turkey), sample numbers: C-21 and C-24, Pontian.

Candona (Pontoniella) aliusensis Stancheva, 1981
Fig. 5.3–5; Fig. 8.7–12

1981 *Candona (Pontoniella) aliusensis* Stancheva, p. 71, pl. 2, figs. 7–9.

1998 *Candona (Pontoniella) aliusensis* Stancheva, Tunoglu, Ünal & Bilen, p.91, pl. 8, figs. 3–5; pl. 15, figs. 7–12.

Material: 11 carapaces, 26 valves.

Stratigraphic and geographic distribution: Dacian Basin, Northern Bulgaria, Middle Pontian (Stancheva 1981).

Locality and stratigraphic level in this study: Medicine Faculty (Trabzon)/east of Degirmendere River, sample numbers: T-3, T-8 and T-15; Boztepe (Trabzon), sample numbers: C-15, C-22, C-27 and C-28, Pontian.

Subgenus: *Candona* Baird, 1845
Type-species: *Cypris candida* Müller, 1776

Stratigraphic distribution: Eocene, Oligocene–Recent.

Environment: Mainly continental, fresh-water (lacustrine, river, deltaic environments), rare in brackish (littoral) environments (Van Morkhoven 1962, 1963 and Moore 1961).

Candona (Candona) candida (O.F. Müller, 1776)
Fig. 5.6,7; Fig. 8.13–17

1776 *Candona candida* O.F. Müller, Zool. Danicae Prodr.: 199.

1900 *Candona studeri* O.F. Müller, Kaufmann, Zool. Anz. 23 (608): Rev. Suisse Zool. 8: 385; pl. 27, figs. 16–20, pl. 30, figs. 6–11, pl. 31, fig. 23.

1965 *Candona candida* O.F. Müller, Devoto, p. 337, fig. 36.

1973 *Candona (Candona) candida candida* O.F. Müller, Krstic, p. 151–153, pl. 1, figs. 1, 2.

1972 *Candona (Candona) candida*, O.F. Müller, Sokac, p. 24, 25, pl. 9, figs. 1–4.

1980 *Candona (Candona) aff. candida* O.F. Müller, Freels, p. 80–82, pl. 13, figs. 6–8.

1984 *Candona (Candona) cf. candida* O.F. Müller, Tunoglu, p. 118–119, pl. 9, figs. 1–3.

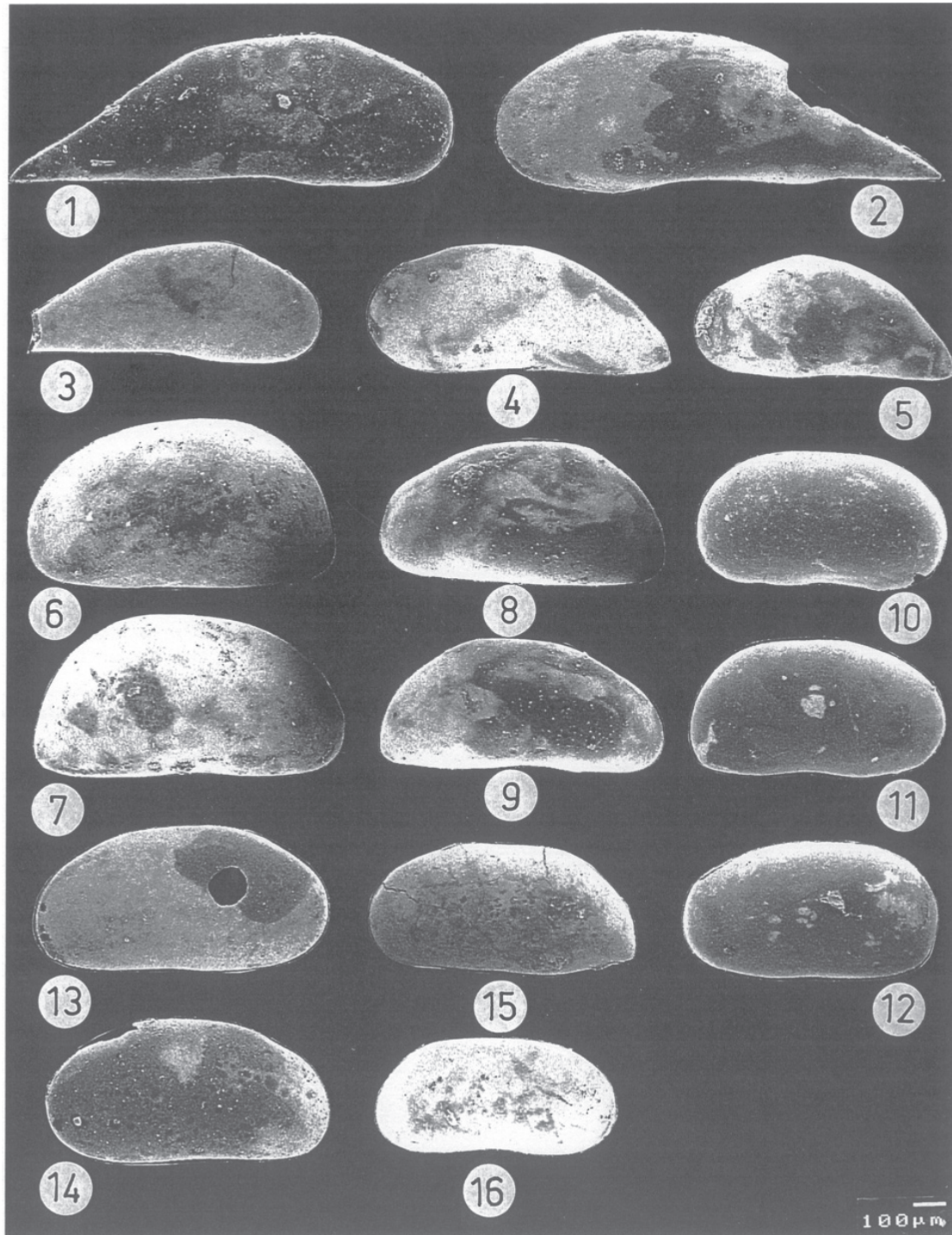


Fig. 5. Photographic (SEM) figures of Pontian Candonidae species from Eastern Black Sea region of Turkey. **1, 2.** *Candona (Pontoniella) turcica* n.sp.; Boztepe (Trabzon), sample number: C-22, middle-late Pontian. 1. Right valve, external view. 2. Left valve, external view. **3-5.** *Candona (Pontoniella) aliensis* Stancheva, 1981; Boztepe (Trabzon), sample number: C-22, Pontian. 3. Right valve, external view. 4. Left valve, external view. 5. Left valve, external view. **6, 7.** *Candona (Candona) candida* O.F. Muller, 1776; Gümüşyaprak village (Bafra/Samsun), sample number: G-1, Pontian. 6. Left valve, external view. 7. Right valve, external view. **8, 9.** *Candona (Lineocypris) bafraensis* n.sp.; Gümüşyaprak village (Bafra/Samsun), sample number: G-1, Pontian. 8. Left valve, external view, paratype. 9. Right valve, external view, holotype. **10.** *Candona (subgenus indet.)* sp.; Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y- 26, late Pontian. Left valve, external view. **11, 12.** *Candona (Casiocypris) trabzonensis* n.sp.; Boztepe (Trabzon), sample number: C-17, early Pontian. 11. Right valve, external view, holotype. 12. Left valve, external view, paratype. **13, 14.** *Cyclocypris* sp.; Boztepe (Trabzon), sample number: C-22, middle Pontian. 13. Left valve, external view. 14. Right valve, external view. **15.** *Candona (Casiocypris) araxica* Freels, 1980; East of Degirmendere (Trabzon), sample number: T-11, middle-late Pontian. Left valve, external view. **16.** *Candona (Candona) parallela pannonica* (Zalanyi, 199); Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-32, middle Pontian. Right valve, external view.

- 1998 *Candona (Candona) cf. candida* O.F. Müller, Tunoglu, Ünal & Bilen, p. 92, pl. 9, figs. 6, 7; pl. 15, figs. 13–17.
 2000 *Candona candida* O.F. Müller, Meisch, p. 65–70, figs. 20–22.

Material: 5 carapaces, 42 valves.

Stratigraphic and geographic distribution: Liri Valley (Italy), Pleistocene; Yugoslavia, Pontian (Krstic 1973); Pannonian Basin, Pontian (Sokac 1972); Aydin (Turkey), Late Miocene (Freels 1980), Gümüşyaprak Village (Bafra/Samsun/Turkey), Pontian.

Candona (Candona) parallela pannonica (Zalanyi, 1929)

Fig. 5.16

- 1929 *Paracypris parallela pannonica* (Zalanyi), Morpho-system. Studien, s. 58, figs. 25, 26.
 1995 *Candona (Candona) parallela pannonica* (Zalanyi), Tunoglu, Temel & Gençoglu, pl. 1, figs. 24–28.
 1998 *Candona (Candona) parallela pannonica* (Zalanyi), Tunoglu, Ünal, Bilen, p. 92, pl. 8, fig. 16.

Material: 15 carapaces, 42 valves.

Remarks: *Candona (Candona) parallela* is a synonym of *Pseudocandona albicans*.

Stratigraphic and geographic distribution: Turkey (Sivrihisar/Eskişehir), Pliocene (Tunoglu et al. 1995); Arakli (Trabzon)/factory of brick-tile kilns, Pontian.

Candona (Candona) sp.

Fig. 3.9

Definition: Carapace elongate kidney shaped, dorsal margin straight or slightly convex, ventral margin concave at the centre. Anterior margin depressed to ventral margin and well rounded, postero-dorsal corner angular (130°) and diagonal postwardly, postero-ventral corner blunt. Maximum length, height and width at the centre. Muscle scars, hinge, marginal pore canals, marginal zone and vestibule of genus character.

Material: 9 valves.

Dimensions: Length: 0.85–0.87 mm. Height: 0.44–0.46 mm. Width: 0.40–0.46 mm.

Remarks: This species differs from *Candona (Candona) parallela pannonica* Zalanyi by having a very tapered postero-ventral angle.

Locality and stratigraphic level in this study: Arakli (Trabzon), factory of brick-tile kilns, sample number: Y-26, Pontian.

Subgenus: *Lineocypris* Zalanyi, 1929

Type-species: *Lineocypris trapezoidea* Zalanyi, 1929

Stratigraphic distribution: (?Early Cretaceous), Pliocene–Recent.

Environment: Fresh-water, mainly in deep lakes (Van Morkhoven 1963).

Candona (Lineocypris) bafraensis n.sp.

Fig. 5.8,9; Fig. 8.18–23

Derivation of name: It is named after Bafra Town, Samsun City, Northern Turkey which is the type locality of this material.

Holotype: Right valve.

Paratype: 11 carapaces, 29 valves.

Type-locality: Gümüşyaprak village (Bafra Town/Samsun City).

Type-level: Pontian.

Diagnosis: Trapezoidal in the lateral view. Dorsal margin straight, antero-dorsal and postero-dorsal corners angular. Posterior margin oblique and slightly convex. Anterior margin long towards anterior and well rounded. Left valve of ventral margin slightly convex but concave at the right valve. Valve surface smooth, anterior end more tapered than the posterior end in the dorsal view.

Description: Trapezoidal in the lateral view. A straight dorsal margin presents one third of the total length. Antero-dorsal corner angular (160°). Anterior margin depressed to ventral margin and well rounded. Postero-dorsal corner angular (150°) and slightly convex. Ventral margin of right valve concave at the centre, ventral margin of the left valve nearly straight. Both ends equally tapered in dorsal view. Maximum length at the ventral margin, maximum height and width at the central part. Valve surface smooth and shiny. Hinge adont. Marginal zone moderately wide. Marginal pore canals moderately dense, straight, simple and thin. Vestibule wide at the anterior and posterior part. Muscle scars of genus and subgenus character.

Dimensions: Length: 0.85–0.88 mm. Height: 0.42–0.45 mm. Width: 0.36–0.44 mm.

Remarks: *C. (Lineocypris) bafraensis* is very similar to *Candona (Lineocypris) sp.* (Tunoglu & Gökçen 1997), but it differs from *C. (Lineocypris) aff. granulosa* by a straight dorsal margin and a long anterior margin.

Locality and stratigraphic level in this study: Gümüşyaprak Village (Bafra/Samsun, Turkey), sample numbers: G-1 and G-2, Pontian.

Candona (subgenus indet.) sp.

Fig. 5.10

Description: Bean shaped in the lateral view. Dorsal margin straight. Antero-dorsal and postero-dorsal corners not angular, anterior and posterior margins equal and well rounded. Ventral margin concave. Maximum length and width at the center of carapace. Maximum height at the anterior part. Valve surface smooth and shiny. Both ends equal and tapered from the dorsal view. Central muscle scars, marginal pore canals, hinge, marginal zone and vestibule of genus character.

Dimensions: Length: 0.75–0.78 mm. Height: 0.40–0.43 mm. Width: 0.36–0.42 mm.

Remarks: This specimen is closely similar to the *Candona* species, but it is inconsistent with known *Candona* subgenera. Its subgenus and species determination is still uncertain.

Locality and stratigraphic level in this study: Arakli (Trabzon), factory of brick-tile kilns, sample number: Y-26, Pontian.

Subgenus: *Caspiocypris* Mandelstam, 1956

Type-species: *Bairdia candida* Livental, 1929

Stratigraphic distribution: Miocene–Recent.

Environment: Limnic/fresh-water (Freels 1980).

Candona (Caspiocypris) trabzonensis n.sp.

Fig. 5.11,12

Derivation of name: Named after Trabzon City, the type locality in northern Turkey.

Holotype: Right valve.

Paratype: 3 carapaces, 26 valves.

Type-locality: Boztepe District/East side of Degirmendere River of Trabzon.

Type-level: Pontian.

Diagnosis: Bean to kidney shaped in lateral view. Dorsal margin convex. Antero-dorsal and postero-dorsal corners not angular.

Anterior and posterior margins well rounded, but posterior margin more broad. Ventral margin concave. Anterior end more tapering than the posterior end in dorsal view. Valve surface smooth and shiny.

Description: Bean to kidney shaped in lateral view. Dorsal margin long, straight or slightly convex. Ventral margin concave at the centre of the posterior part. Anterior margin depressed at the ventral margin and well rounded. Posterior margin oblique and well rounded at the postero-ventral corner. Both end equally obtuse and elipsoidal in dorsal view. Maximum length at the ventral margin. Maximum height and width at the centre of the carapace. Valve surface smooth and shiny. Hinge adont. Marginal zone narrow. Marginal pore canals straight, short and simple. Vestibule narrow along the anterior, posterior and ventral margins. Muscle scars of genus character. Sexual dimorphism not observed.

Dimensions: Length: 0.77–0.80 mm. Height: 0.40–0.43 mm. Width: 0.36–0.42 mm.

Remarks: *C. trabzonensis* differs from *Candona* (?) *protecta* and *Candona* (?) *distorta* by having more angular postero-dorsal and antero-dorsal corners. *C. trabzonensis* is also distinguished from *Candona* (*Caspiocypris*) *labiata* (Zalanyi) by having angular postero-dorsal corner (~ 95°), *Candona* (*Caspiocypris*) *alta* Zalanyi is distinguished from *C. trabzonensis* by not having longest posterior margin (Tunoglu 1984).

Locality and stratigraphic level in this study: Boztepe (Trabzon), sample numbers: C-16, C-17 and C-25a, Pontian.

Candona (*Caspiocypris*) *araxica* Freels, 1980
Fig. 5.15

1980 *Candona* (*Caspiocypris*) *araxica*, Freels, p. 42–44, pl. 5, figs. 8–14.

1998 *Candona* (*Caspiocypris*) *araxica*, Freels; Tunoglu, Ünal & Bilen, p. 95, pl. 8, fig. 15.

Material: 5 carapaces, 31 valves.

Dimensions: Length: 0.80–0.83 mm. Height: 0.40–0.42 mm. Width: 0.34–0.38 mm.

Stratigraphic and geographic distribution: Turkey (Erzurum-Pasinler Basin, Horasan-Azap), late Miocene-Pliocene (Freels 1980); Medicine Faculty of Black Sea Technical University/east of Degirmendere River (Trabzon), Pontian.

Candona (*Caspiocypris*) sp.
Fig. 6.15,16

Definition: Rectangular in side view. Dorsal margin straight. Ventral margin concave at the centre of the carapace. Antero-dorsal and postero-dorsal corners not angular and well rounded. Anterior margin depressed to ventral margin and well rounded. Posterior margin diagonal to posterior end. Maximum length, height and width at the centre of the carapace. Dorsal view ovate, anterior end more tapering than the posterior. Valve surface smooth and shiny. Hinge adont. Central muscle scars of genus character. Marginal zone broad. Vestibule narrow. Sexual dimorphism not observed.

Material: 2 carapaces, 12 valves.

Dimensions: Length: 0.82–0.85 mm. Height: 0.49–0.52 mm. Width: 0.40–0.42 mm.

Remarks: *C. (Caspiocypris) sp.* differs from *Candona* (*Caspiocypris*) *labiata* (Zalanyi) by having more angular postero-dorsal corner (~ 95°) and anterior margin more depressed to ventral margin. *C. (Caspiocypris) sp.* is also distinguished from *Candona* (*Caspiocypris*) *alta* (Zalanyi) by having more longer posterior margin to ventral margin.

Locality and stratigraphic level in this study: Medicine Faculty/east of Degirmendere (Trabzon), sample numbers: T-3, T-4, T-5, T-8, T-9, T-10, T-11 and T-15; Arakli (Trabzon), factory of brick-tile kilns, sample numbers: Y-26, Y-27, Y-32, Pontian.

Subgenus: *Bakunella* Schneider & Mandelstam, 1958

Type-species: *Pontocypris dorsoarcuata* Zalanyi, 1929

Stratigraphic distribution: Pliocene–Recent.

Environment: Marine, brackish water, rare in the fresh water (Van Morkhoven 1963).

Candona (*Bakunella*) *dorsoarcuata* Zalanyi, 1929
Fig. 6.1–3,9,10; Fig. 9.1–4

1965 *Bakunella dorsoarcuata* (Zalanyi); Stancheva, p. 15, 16; pl. 4, fig. 8.

1967 *Bakunella dorsoarcuata* (Zalanyi); Agalarova, pl. 3, fig. 3–5.

1969 *Candona* (*Bakunella*) *dorsoarcuata* (Zalanyi); Gramann, pl. 32, fig. 5a,b.

1978 *Bakunella dorsoarcuata* (Zalanyi), Olteanu, p. 1019, pl. 6, figs. 3–4.

1980 *Candona* (*Bakunella*) *dorsoarcuata* (Zalanyi); Freels, p. 32, pl. 3, figs. 10–15.

1991 *Candona* (*Bakunella*) *dorsoarcuata* (Zalanyi); Jiricek & Riha, pl. 6, fig. 4.

1998 *Candona* (*Bakunella*) *dorsoarcuata* (Zalanyi); Tunoglu, Ünal & Bilen, p. 96, 97, pl. 9, figs. 1–3, 9, 10; pl. 16, figs. 1–4.

Material: 29 carapaces, 78 valves.

Dimensions: Length: 0.72–0.82 mm. Height: 0.45–0.49 mm. Width: 0.48–0.52 mm.

Stratigraphic and geographic distribution: Black Sea coasts, Pliocene and Pontian stages (Agalarova 1967); Kabistan/Azerbaijan, Ukraine (Apsheron Peninsula), Keyzekişor, Northern Bulgaria (Antimova Village), Pontian (Stancheva 1965), Turkey, Black Sea coasts, Late Miocene (Freels 1980). Medicine Faculty/east of Degirmendere River (Trabzon), Boztepe (Trabzon), Arakli (Trabzon)/factory of brick-tile kilns, Pontian (Tunoglu et al. 1998).

Candona (*Bakunella*) sp. 1
Fig. 6.4,5; Fig. 9.7–10

Definition: Triangular in the lateral view. Dorsal margin strongly convex, ventral margin concave. Anterior margin depressed on antero-dorsal side and well rounded, posterior margin oblique and slightly convex. Maximum length near the ventral margin, maximum height at the anterior, maximum width at the posterior end. Anterior and posterior ends obtuse in the dorsal view. Valve surface covered with thin, pentagonal reticulates. Hinge, muscle scars and marginal pore canals of genus character.

Material: 1 carapace, 9 valves.

Dimensions: Length: 0.70–0.80 mm. Height: 0.42–0.44 mm. Width: 0.40–0.44 mm.

Remarks: This species is similar to *Bakunella dorsoarcuata* (Zalanyi), but differs from it in having more concave dorsal margin, shorter posterior margin and more depressed to ventral margin.

Locality and stratigraphic level in this study: Medicine Faculty/east of Degirmendere River (Trabzon), sample numbers: T-11, T-15; Boztepe (Trabzon), sample numbers: C-21, C-24, C-25a, C-27; Arakli (Trabzon)/factory of brick-tile kilns, sample numbers: Y-29, Y-31, Pontian.

Candona (*Bakunella*) sp. 2
Fig. 6.6–8; Fig. 9.5,6

Definition: Triangular in the lateral view. Dorsal margin short and slightly concave, antero-dorsal corner well rounded. Anterior margin depressed to ventral margin and well rounded, postero-dorsal corner well curved. Postero-ventral end shaped a beak. Ventral margin concave at the postero-central area. Anterior end more tapering than posterior in dorsal view. Posterior end blunt. Maximum length at the ventral margin, maximum height near the anterior margin, maximum width near the posterior end. Surface of the valve covered with definite and indefinite reticulates. Hinge adont, marginal zone narrow. Marginal pore canals short, thin and moderately

dense. Vestibule wide in anterior part, but narrow in posterior part and along ventral margin. Muscle scar of genus and subgenus character.

Material: 4 carapaces, 15 valves.

Dimensions: Length: 0.80–0.82 mm. Height: 0.50–0.52 mm. Width: 0.40–0.44 mm.

Remarks: *Candona* (*Bakunella*) sp. 2 differs from *Candona* (*Bakunella*) *dorsoarcuata* Zalanyi by having more and different surface ornamentation in posterior margin and postero-ventral corner.

Locality and stratigraphic level in this study: Gümü-şyaprak Village (Bafra/Samsun), sample numbers: G-1 and G-2, Pontian.

Subgenus: *Reticulocandona* Krstic, 1972

Stratigraphic distribution: Late Miocene–Recent.

Environment: Generally fresh-water, rare in brackish conditions (Krstic 1972, 1974).

Candona (*Reticulocandona*) sp.
Fig. 6.11

Definition: Rectangular in the lateral view. Dorsal margin straight and long, but right valve slightly concave, ventral margin convex at the center. Anterior margin depressed to ventral margin, antero-dorsal corner angular (150°) and well rounded. Postero-dorsal corner also angular (110°). Postero-ventral corner well rounded. Both ends equally tapered in dorsal view. Maximum width at the centre, maximum length near the ventral margin, maximum height near the anterior and posterior margin. Marginal zone narrow. Vestibule wide at the anterior and posterior. Hinge adont and central muscle scars of genus character.

Material: 2 carapaces, 14 valves.

Dimensions: Length: 0.94–0.96 mm. Height: 0.50–0.52 mm. Width: 0.44–0.48 mm.

Remarks: *Candona* (*Reticulocandona*) sp. is similar to *Candona* (*Reticulocandona*?) sp. (Stancheva, 1989) and *Candona* (*R.*) *reticulata* (Mehes), but *Candona* (*Reticulocandona*) sp. of Stancheva differs from *Candona* (*Reticulocandona*) sp. by having more angular (100°) postero-dorsal corner.

Locality and stratigraphic level in this study: Medicine Faculty/east of Degirmendere River (Trabzon), sample numbers: T-3, T-8, T-10 and T-15; Boztepe (Trabzon), sample numbers: C-16, C-24 and C-26; Pontian.

Candona (*Reticulocandona*) *stanchevae* n.sp.
Fig. 6.12–14; Fig. 9.11–17

Derivation of name: Maria Stancheva (Bulgaria).

Holotype: Right valve.

Paratype: 4 carapaces, 27 valves.

Type-locality: Boztepe (Trabzon).

Type-level: Pontian.

Diagnosis: Rectangular shaped in the lateral view. Dorsal margin straight, anterior margin well rounded. Posterior margin well rounded and depressed to ventral with angular antero-dorsal corner (120°). Marginal zone narrow. Vestibule wide. Hinge adont, muscle scars are those of the genus.

Description: Rectangular shaped in lateral view. Dorsal margin straight, antero-dorsal corner not angular and well rounded, anterior margin elongate and well rounded. Postero-dorsal corner angular (120°), ventral margin concave at the centre. Dorsal view ovate, anterior end more tapering than the posterior end. Maximum length near the ventral margin, maximum height and width at the centre. Valve surface smooth and shiny. Hinge adont, central muscle scars of genus and subgenus character. Marginal zone narrow,

marginal pore canals short, thin and rare. Vestibule wide along the anterior, posterior and ventral margin, sexual dimorphism not observed.

Dimensions: Length: 0.90–0.95 mm. Height: 0.50–0.52 mm. Width: 0.40–0.42 mm.

Remarks: *Candona* (*Reticulocandona*) *stanchevae* n.sp. is closely similar to *Candona* (*Reticulocandona*) sp. (Stancheva, 1989), but it differs from *Candona* (*Reticulocandona*) sp., because *Candona* (*Reticulocandona*) sp. has more tapering postero-ventral corner than *Candona* (*Reticulocandona*) *stanchevae* n.sp. For this reason, it is recognized as a new species in this investigation.

Locality and stratigraphic level in this study: Medicine Faculty (Trabzon)/east of Degirmendere, sample numbers: T-3, T-4, T-8, T-9, T-10, T-11 and T-15; Boztepe (Trabzon), sample numbers: C-15, C-17, C-23, C-24, C-25a and C-26, Pontian.

Subgenus: *Typhlocypris* Vejdosky
Type-species: *Cypris eremita* Vejdosky

Stratigraphic distribution: Late Miocene–Recent.

Environment: Fresh-water (Krstic 1974), rare in marine conditions/brackish waters.

Candona (*Typhlocypris*) sp. 1
Fig. 6.17; Fig. 9.24,25

Definition: Triangular shaped in lateral view. Dorsal margin straight and short. Ventral margin concave at the antero-centre. Anterior margin beak shaped. Antero-dorsal corner angular (135°) and well rounded. Postero-dorsal corner angular (145°) and postero-ventral corner tapering. Both ends equally tapered in the dorsal view. Maximum length at the ventral margin, maximum height at the antero-center area and maximum width at the center. Marginal zone very narrow, marginal pore canals moderately dense, straight, short and simple. Vestibule moderately wide at the anterior margin, but narrow at the posterior end. Hinge adont, muscle scars of genus character.

Material: 4 carapaces, 21 valves.

Dimensions: Length: 0.92–0.95 mm. Height: 0.54–0.55 mm. Width: 0.44–0.48 mm.

Remarks: *Candona* (*Typhlocypris*) sp. 1 could be differentiated from *Candona* (*Typhlocypris*) *centropunctata* Suzin by having longer carapace and shorter dorsal margin.

Locality and stratigraphic level in this study: Medicine Faculty/east of Degirmendere River (Trabzon), sample number: T-4, Pontian.

Candona (*Typhlocypris*) sp. 2
Fig. 6.18

Definition: Triangular shaped in lateral view. Dorsal margin strongly concave. Ventral margin broadly convex. Anterior margin slightly depressed to the ventral margin and well rounded. Anterior margin slightly folded at the antero-dorsal part. Posterior margin slightly concave and tapering at the postero-ventral. Spindle shape in dorsal view. Anterior end more tapering than the posterior. Maximum length at the ventral margin, maximum height and width at the centre. Valve surface smooth and shiny. Marginal zone narrow. Marginal pore canals short and thin and moderately numerous. Hinge adont. Central muscle scars of subfamily Candonidae.

Material: 3 carapaces, 10 valves.

Dimensions: Length: 0.54–0.56 mm. Height: 0.40–0.42 mm. Width: 0.34–0.38 mm.

Remarks: *Candona* (*Typhlocypris*) sp. 2 differs from *Candona* (*Typhlocypris*) sp. sensu Krstic by having very tapering postero-ventral corner and longest towards posterior.

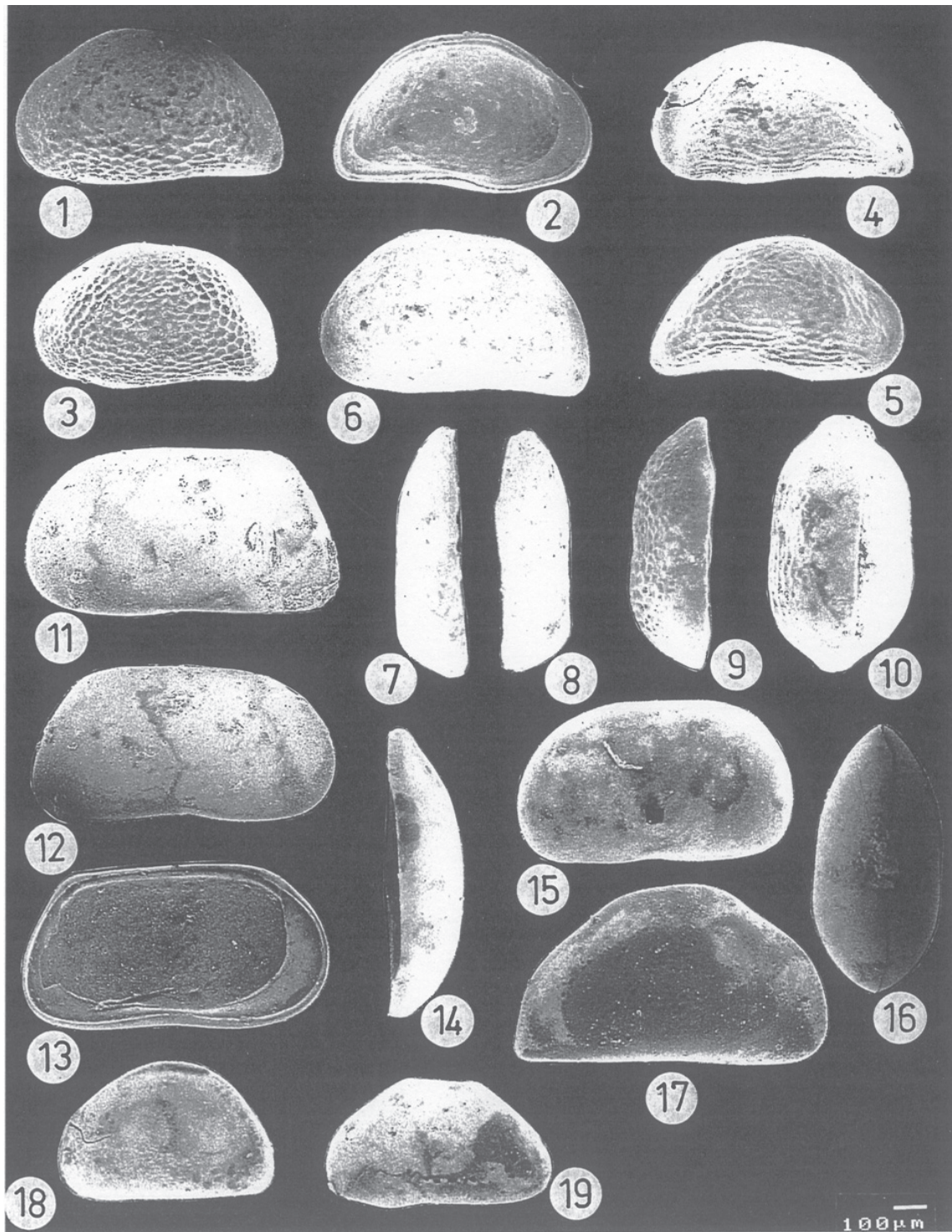


Fig. 6. Photographic (SEM) figures of Pontian Candonidae species from Eastern Black Sea region of Turkey. **1–3, 9, 10.** *Candona (Bakunella) dorsoarcuata* Zalanyi, 1929; Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-31, Pontian. 1. Left valve, external view. 2. Left valve, internal view. 3. Left valve, external view. 9. Left valve, dorsal view. 10. Carapace, dorsal view. **4, 5.** *Candona (Bakunella)* sp. 1; Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-31, Early-Middle Pontian. 4. Left valve, external view. 5. Right valve, external view. **6–8.** *Candona (Bakunella)* sp. 2; Gümüşyaprak village (Bafra/Samsun), sample number: G-1, Pontian. 6. Left valve, external view. 7. Left valve, dorsal view. 8. Right valve, dorsal view. **11.** *Candona (Reticulocandona)* sp.; East of Degirmendere (Trabzon), sample number: T-8, Pontian. Left valve, external view. **12–14.** *Candona (Reticulocandona) stanchevae* n.sp.; East of Degirmendere (Trabzon), sample number: T-9, Pontian. 12. Right valve, external view, holotype. 13. Left valve, internal view, paratype. 14. Right valve, dorsal view, paratype. **15, 16.** *Candona (Caspioocypris)* sp.; East of Degirmendere (Trabzon), sample number: T-4, Pontian. 15. Left valve, external view. 16. Carapace, dorsal view. **17.** *Candona (Typhlocypris)* sp. 1; East of Degirmendere (Trabzon), T-4, early-middle Pontian. Right valve, external view. **18.** *Candona (Typhlocypris)* sp. 2; East of Degirmendere (Trabzon), sample number: T-3, middle Pontian. Left valve, external view. **19.** *Candona (Metacandona)* sp.; East of Degirmendere (Trabzon), sample number: T-3, early Pontian. Left valve, external view.

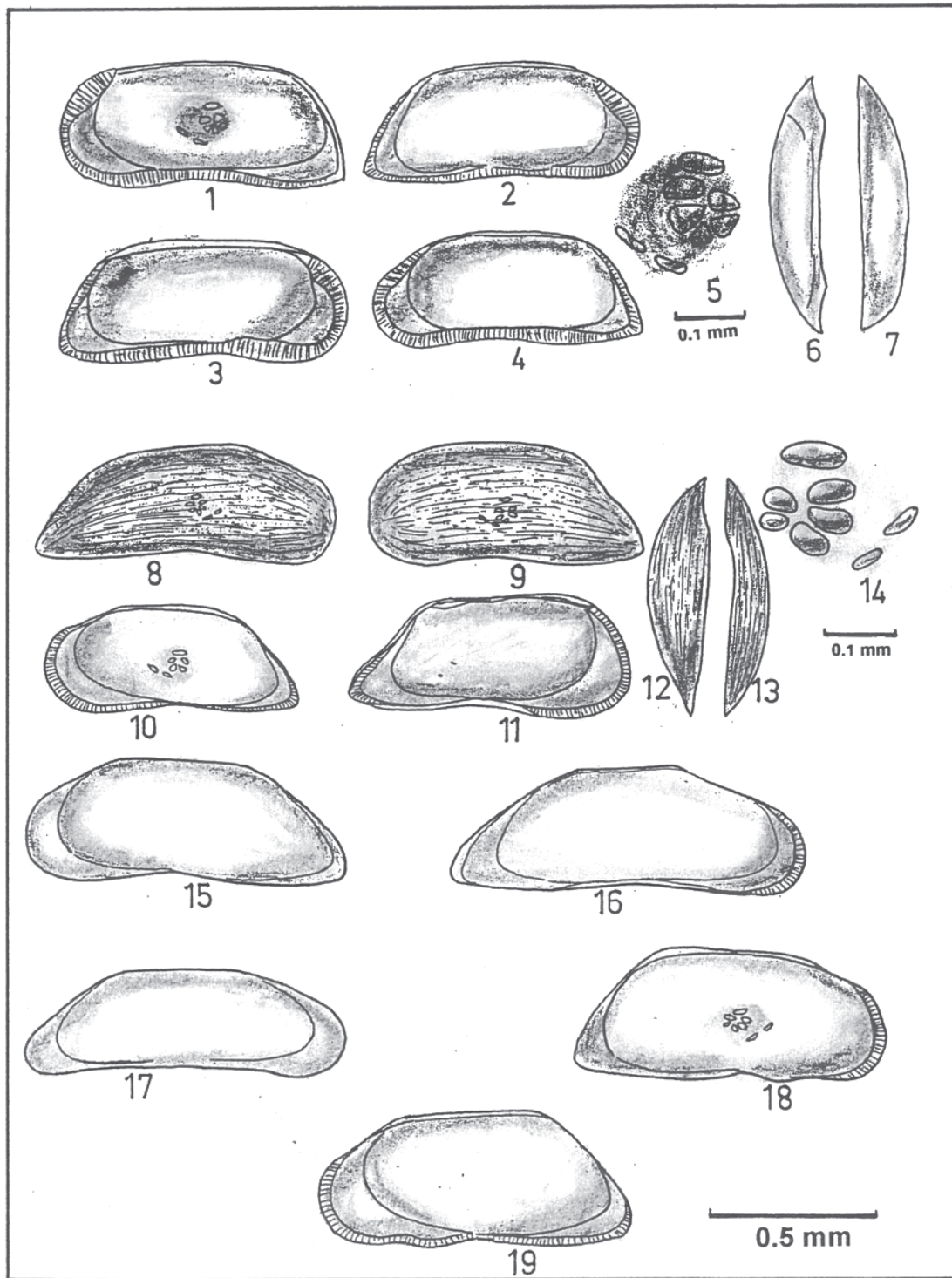


Fig. 7. Hand drawn figures of Pontian Candonidae species from Eastern Black Sea region of Turkey. **1-7.** *Candonia (Casiolla) ataensis* n.sp.; Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-29, Pontian. 1. Left valve, external view, holotype. 2. Right valve, external view, paratype. 3. Left valve, internal view, holotype. 4. Right valve, internal view, paratype. 5. Central muscle scars, holotype. 6. Left valve, dorsal view, holotype. 7. Right valve, dorsal view, paratype. **8-14.** *Candonia (Pontoniella) acuminata* (Zalanyi, 1929); Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-29, Pontian. 8. Right valve, external view. 9. Left valve, external view. 10. Right valve, internal view. 11. Left valve, internal view. 12. Left valve, dorsal view. 13. Right valve, dorsal view. 14. Central muscle scars, right valve, external view. **15, 16.** *Candonia (Pontoniella) srebarnensis* Stancheva, 1981; Boztepe (Trabzon), sample number: C-26, Pontian. 15. Left valve, external view. 16. Right valve, external view. **17.** *Candonia (Pontoniella)* sp. 1; Boztepe (Trabzon), sample number: C-26, early Pontian. Right valve, external view. **18, 19.** *Candonia (Pontoniella)* sp. 3; Arakli (Trabzon)/factory of brick-tile kilns, sample number: Y-28, middle-late Pontian. 18. Right valve, external view. 19. Right valve, internal view.

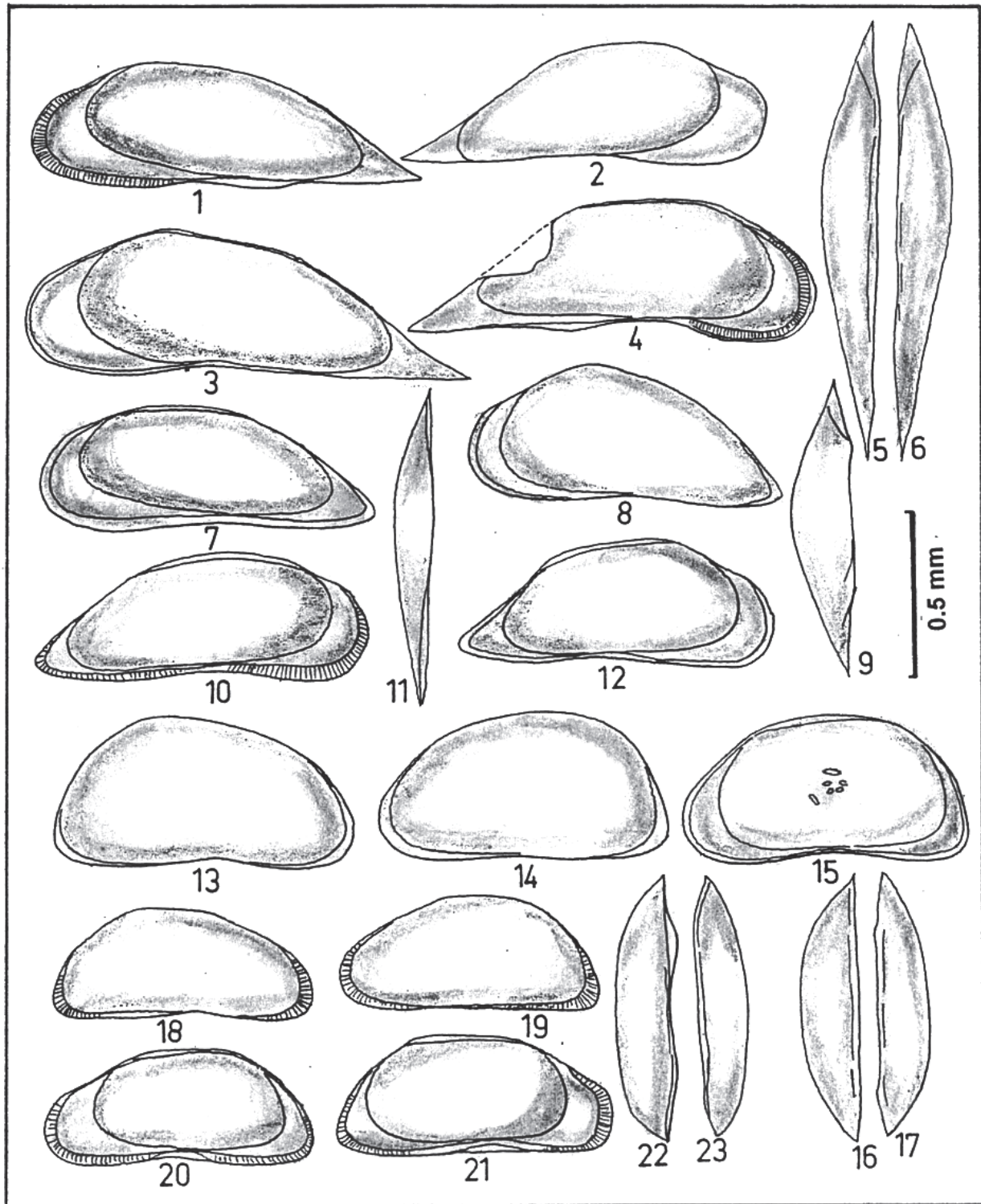


Fig. 8. Hand drawn figures of Pontian Candonidae species from Eastern Black Sea region of Turkey. 1-6. *Candonia (Pontoniella) turcica* n.sp.; Boztepe (Trabzon), sample number: C-22, middle-late Pontian. 1. Left valve, external view, paratype. 2. Right valve, external view, holotype. 3. Right valve, internal view, holotype. 4. Left valve, internal view, paratype. 5. Left valve, dorsal view, paratype. 6. Right valve, dorsal view, holotype. 7-12. *Candonia (Pontoniella) aliusensis* Stancheva, 1981; Boztepe (Trabzon), sample number: C-22, middle-late Pontian. 7. Left valve, external view, ♂; 8. Left valve, external view, ♀; 9. Left valve, dorsal view, ♀; 10. Left valve, internal view, ♂; 11. Left valve, dorsal view, ♂; 12. Left valve, internal view, ♀; 13-17. *Candonia (Candonia) candida* (O.F. Muller, 1776); Gümüsyaparak village (Bafra/Samsun), sample number: G-1, Pontian. 13. Right valve, external view. 14. Left valve, external view. 15. Right valve, internal view. 16. Left valve, dorsal view. 17. Right valve, dorsal view. 18-23. *Candonia (Lineocypris) bafraensis* n.sp.; Gümüsyaparak village (Bafra/Samsun), sample number: G-1, Pontian. 18. Right valve, external view, holotype. 19. Left valve, external view, paratype. 20. Right valve, internal view, holotype. 21. Left valve, internal view, paratype. 22. Left valve, dorsal view, paratype. 23. Right valve, dorsal view, holotype.

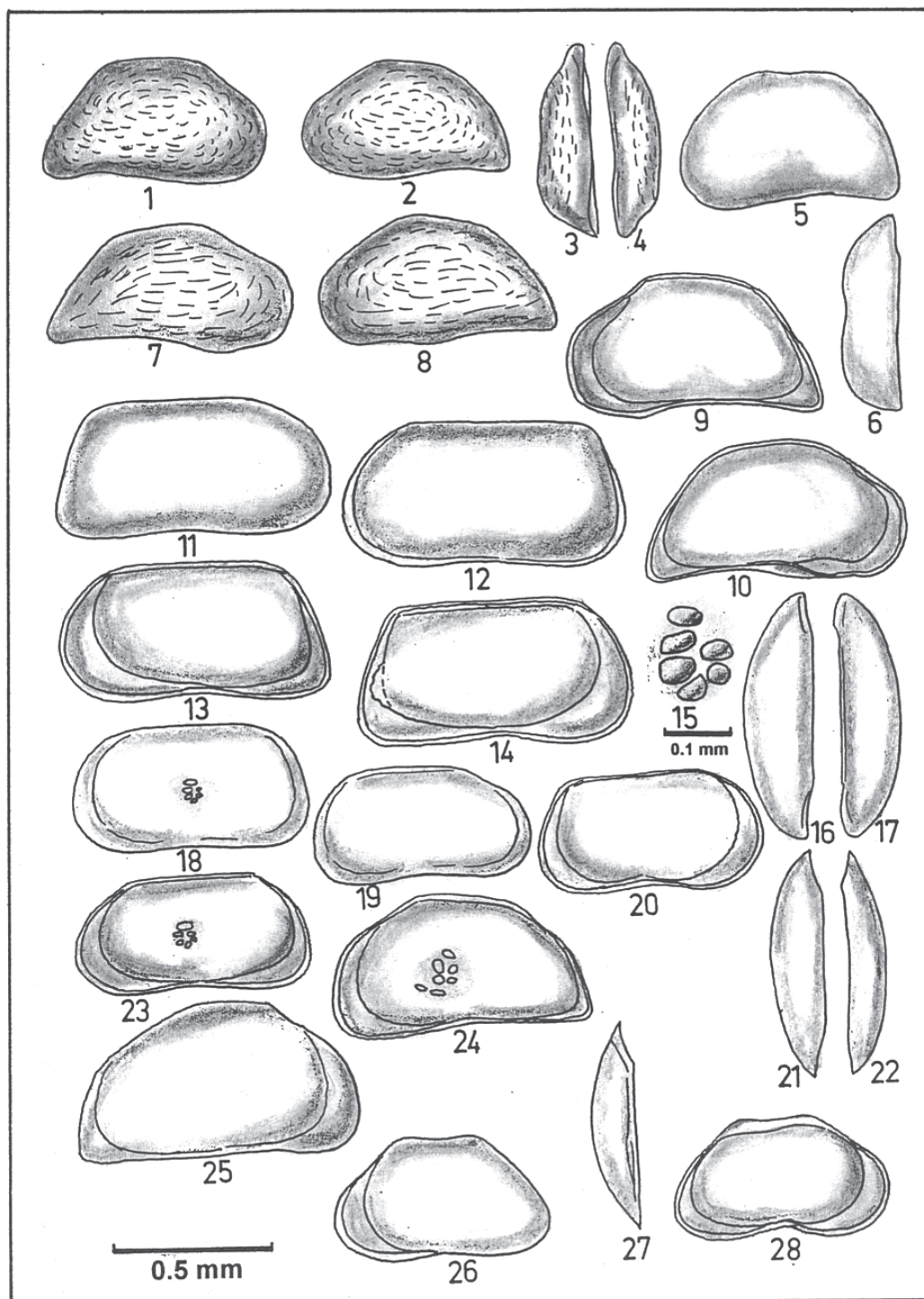
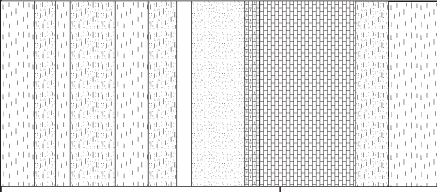


Fig. 9. Hand drawn figures of Pontian Candonidae species from Eastern Black Sea region of Turkey. **1-4.** *Candona (Bakunella) dorsoarcuata* Zalanyi, 1929; Arakli (Trabzon)/ factory of brick-tile kilns, sample number: Y-31, Ponsiyen. 1. Right valve, external view. 2. Left valve, external view. 3. Left valve, dorsal view. 4. Right valve, dorsal view. **5, 6.** *Candona (Bakunella)* sp. 2; Gümüşyaprak village (Bafra/Samsun), sample number: G-1, Pontian. 5. Left valve, external view. 6. Left valve, dorsal view. **7-10.** *Candona (Bakunella)* sp. 1; Arakli (Trabzon)/ factory of brick-tile kilns, sample number: Y-31, early-middle Pontian. 7. Right valve, external view. 8. Left valve, external view. 9. Right valve, internal view. 10. Left valve, internal view. **11-17.** *Candona (Reticulocandona) stanchevae* n.sp.; East of Degirmendere (Trabzon), sample number: T-8, Pontian. 11. Right valve, external view. 12. Left valve, external view. 13. Right valve, internal view. 14. Left valve, internal view. 15. Central muscle scars. 16. Left valve, dorsal view. 17. Right valve, dorsal view. **18-23.** *Candona (Caspiocypris)* sp.; East of Degirmendere (Trabzon), sample number: T-4, Pontian. 18. Left valve, external view. 19. Right valve, external view. 20. Left valve, internal view. 21. Left valve, dorsal view. 22. Right valve, dorsal view. 23. Right valve, internal view. **24, 25.** *Candona (Typhlocypris)* sp. 1; East of Degirmendere (Trabzon), sample number T-4, early-middle Pontian. 24. Right valve, internal view. 25. Right valve, external view. **26-28.** *Candona (Metacandona)* sp.; East of Degirmendere (Trabzon), sample number: T-3, early Pontian. 26. Left valve, external view. 27. Left valve, dorsal view. 28. Left valve, internal view.

Table 4: Stratigraphic distribution of Candonidae species and the other ostracoda species of Bafra-Gümüşyaprak Section (Samsun), (after Tunoglu 2001b, 2002a).

UPPER MIOCENE							SERIES
PONTIAN							STAGE
UPPER							SUBSTAGE
?							FORMATION
G-10	G-9	G-8	G-7	G-6	G-5	G-4	SAMPLE NUMBER
							LITHOLOGY
							OSTRACODA
							• <i>Ilyocypris</i> sp. • <i>Candona</i> sp. • <i>Candona (Lineocypris) bafraensis</i> n.sp. • <i>Candona (Candona) candida</i> (O.F.Muller, 1776) • <i>Loxoconcha valiente</i> Stancheva, 1963 • <i>Loxoconcha eichwaldi</i> (Livental, 1929) • <i>Cyprideis</i> sp. 1 • <i>Candona (Bakunella)</i> sp. 2 • <i>Candona (Caspiocypris) araxica</i> Freels, 1980 • <i>Cytherissa bogatschovi</i> (Livental, 1929) • <i>Cytherissa pannonica</i> Tunoğlu, 2002 • <i>Candona (Caspiolla) balcanica</i> (Zalanyi, 1929) • <i>Cyclocypris</i> sp. • <i>Zonocypris membranae</i> (Livental, 1929) • <i>Zonocypris</i> sp. • <i>Eucypris</i> sp. • <i>Pontocythere bayramensis</i> Tunoğlu, 1987 • <i>Loxoconcha laeta</i> Stancheva, 1963 • <i>Loxoconcha cf. hastata</i> (Reuss, 1950) • <i>Loxoconcha</i> sp. 3 • <i>Eucypris</i> sp. 2 • <i>Heterocypris salina salina</i> (Brady, 1868)

Locality and stratigraphic level in this study: Boztepe (Trabzon), sample number: C-22; Medicine Faculty of Black Sea Technical University/east of Degirmendere River (Trabzon), sample numbers: T-5 and T-10, Pontian.

Subgenus: *Metacandona* Bronshtein
Type-species: *Candona pubescens* Koch

Stratigraphic distribution: Miocene–Recent.

Environment: Fresh-water (Van Morkhoven 1963).

Affinity: *Metacandona* was first introduced by Bronshtein in 1930 for *Candona* species with a pitted surface from Lake Baikal (Bronshtein 1988). After than Bronshtein was renamed described species and supposed *Metacandona* as a younger synonym of *Pseudocandona*. *Metacandona* is also belived to be a synonym of *Lineocypris* (Van Morkhoven 1963).

Candona (Metacandona) sp.
Fig. 6.19; Fig. 9.26–28

Definition: Valve of conical shape in lateral view. Dorsal margin short and slightly convex. Postero-dorsal and antero-dorsal margins angular. Anterior margin broadly rounded. Ventral margin convex at the centre of carapace. Anterior part of the ventral margin

slightly concave. Maximum length near the ventral valve, maximum height and width at the central part. Carapace ovate in shape in dorsal view. Posterior end more tapering than the anterior. Surface of the valve smooth and shiny. Marginal zone narrow. Marginal pore canals not observed. Vestibule narrow at the posterior and ventral margins, but wide at the anterior margin. Hinge adont, central muscle scars of genus character.

Material: 1 carapace, 5 valves.

Dimensions: Length: 0.68–0.70 mm. Height: 0.37–0.39 mm. Width: 0.36–0.40 mm.

Remarks: *Candona (Metacandona)* sp. differs from *Candona (Metacandona) dasherahi* (Krstic) by having a more rising central part and more angular postero-dorsal corner.

Locality and stratigraphic level in this study: Medicine Faculty of Black Sea Technical University/east of Degirmendere River (Trabzon), sample number: T-3, Pontian.

Subfamily: *Cyclocypridinae* Kaufman

Genus: *Cyclocypris* Bardy & Norman
Type-species: *Cypris cinerea* Brady

Stratigraphic distribution: Miocene–Recent (Van Morkhoven 1963).

Table 5: Stratigraphic levels of known Candonidae and the other ostracod species in the investigated localities.

STAGES AND SUBSTAGES	SARMATIAN			PANNON.			PONTIAN			PLIOCENE			QUATERNARY
	E	M	L				E	M	L				
OSTRACODA SPECIES													
<i>Loxoconcha laeta</i>													
<i>Loxoconcha valiente</i>													
<i>Loxoconcha omata</i>													
<i>Loxoconcha eichwaldi</i>													
<i>Loxoconcha petasus</i>													
<i>Candona (Caspicola) lobata</i>													
<i>Aurila cicatricosa</i>													
<i>Bakunella dorsoarcurata</i>													
<i>Amplocypris odessaensis</i>													
<i>Leptocythere (Lep.) cymbula</i>													
<i>Cytherissa bogatschovi</i>													
<i>Cypria dorsoconca</i>													
<i>Xestoleberis ovulum</i>													
<i>Tyrrhenocythere filipescui</i>													
<i>Pontocythere bayramensis</i>													
<i>Tyrrhenocythere pontica</i>													
<i>Candona (Pont.) acuminata</i>													
<i>Candona (Casp.) acronasuta</i>													
<i>Candona (Casp.) bulgarica</i>													
<i>Candona (Pont.) aliusensis</i>													
<i>Candona (Pont.) srebariensis</i>													
<i>Candona (Pont.) sokactchae</i>													
<i>Candona (Pont.) saxagintae</i>													
<i>Candona (Pont.) pseudoglabra</i>													
<i>Xestoleberis pontica</i>													
<i>Candona (Casp.) araxica</i>													
<i>Candona (Casp.) balcanica</i>													
<i>Candona (Candona) candida</i>													
<i>Lept. (Amni.) multituberculata</i>													
<i>Eux. (Maeoto.) bosqueti</i>													
<i>Heterocypris salina salina</i>													
<i>Candona (Can.) par. liventalina</i>													
<i>Zonocypris membranace</i>													
<i>Candona (Can.) par. pannonica</i>													
<i>Loxoconcha gibboides</i>													

Table 6: Environmental definition by Candonidae genera and subgenera and the other ostracod genera in the study area.

ENVIRONMENTS OSTRACODA GENERA AND SUBGENERA	CONTINENTAL (Fresh water)	LITTORAL (Brackish water)	EPINERITIC	INFRANERITIC
	SHALLOW SEA			
ZONOCYPRIS				
ILYOCYPRIS				
CYPRIA				
EUCYPRIS				
CYCLOCYPRIS				
<u>ANATOLIA</u>				
<u>CANDONA (CASPIOCYPRIS)</u>				
<u>CANDONA (LINEOCYPRIS)</u>				
<u>CANDONA (TRABZONELLA)</u>				
<u>CANDONA (RETICULOCANDONA)</u>				
<u>CANDONA (TYPHLOCYPRIS)</u>				
<u>CANDONA (METACANDONA)</u>				
<u>CANDONA (CANDONA)</u>				
AMPLOCYPRIS				
XESTOLEBERIS (PONTOLEBERIS)				
LEPTOCYTHERE (AMNICYTHERE)				
EUXINOCYTHERE (EUXINOCYTHERE)				
EUXINOCYTHERE (MAEOTOCYTHERE)				
LEPTOCYTHERE (LEPTOCYTHERE)				
CYPRIDEIS				
CYTHERRISSA				
LOXOCONCHA				
TYRRHENOCYTHERE				
XESTOLEBERIS (XESTOLEBERIS)				
<u>CANDONA (CASPIOLLA)</u>				
<u>CANDONA (PONTONIELLA)</u>				
<u>CANDONA (BAKUNELLA)</u>				
PONTOCYTHERE				
AURILA				

Ecology: Cyclocypris generally live in freshwater and brackish water environments, rich in plants, active swimmers (Van Morkhoven 1963).

Cyclocypris sp.
Fig. 5.13,14

Description: External lateral view egg shape. Dorsal and ventral margins convex. Anterior and posterior margins well rounded. Posterior end broadly rounded, but anterior end depressed towards ventral margin. Dorsal view ovate and anterior end tapering more than the posterior end. Maximum length, height and width at the centre of the valve. Valve surface smooth and shiny. Marginal zone moderate width. Marginal pore canals simple and moderate dens. Hinge adont, muscle scars are of genus character.

Material: 12 valves.

Dimensions: Length: 0.84–0.89 mm. Height: 0.42–0.44 mm. Width: 0.36–0.40 mm.

Remarks: *Cyclocypris* sp. is similar to *Cyclocypris huckei* Triebel (Stancheva 1966) and *Cyclocypris arma* Schneider (Agalarova 1967) according to their valve shape, but *Cyclocypris* sp. has more spherical valve shape at the lateral view than the others.

Locality and stratigraphic level in this study: Boztepe (Trabzon), sample number: C-22; Gümüşyaprak Village (Bafra/Samsun), sample number: G-1, G-2, Pontian.

Results and interpretation

A total of 33 species (two genera, nine subgenera and one indet. subgenus) of the Candonidae family have been taxonomically determined from the eastern Black Sea Coast of Turkey. The high percentage of new species, genera and subgenera (Tunoglu 2001a and 2002a) within the fauna confirms the well known trend to endemism of brackish and freshwater ostracods. The studied species of Candonidae offer good biostratigraphic markers for the time span in the Pontian/Euxinian and Caspian Basins during the Pontian Stage (Table 5). The term brackish is used in this study to define only the salinity and represent brackish marginal facies of open marine conditions which includes bays and lagoons along this coastal zone. These bays and lagoons were characterized by mainly freshwater influence into the marine or brackish water.

Candona (Caspicola) acronasuta, *Candona (Caspicola) bulgarica*, *Candona (Pontoniella) aliusensis*, *Candona (Pontoniella) srebariensis* and *Candona (Pontoniella) sokachae* have very short stratigraphic distributions since the middle Pontian (Table 5). The stratigraphical distribution of *Candona (Pontoniella) pseudoglabra* was in the middle and upper Pontian. The investigated stratigraphic levels have been assigned to the Pontian and especially the Middle Pontian according to known Candonidae, the other ostracod species and endemic species and their stratigraphic distribution have been given in Table 5.

The Arakli Section deposits are interpreted as being a very shallow marine shelf, which was located in an important bay of this coastal area since the Pontian. In this littoral environment was a mixture of lagoonal, brackish and lacustrine coastal plain conditions (Table 6). It appears that both brackish, lacustrine and fluvial sediments were mixed, but strong influence is indicated by the fresh water ostracod faunal assemblages. *Candona* and its subgenera are dominant in this area (see Table 1, 2, 3 and 4). For this reason, “*Candona* Sea” was used terminologically for these localities. The *Candona* Sea was situated along the northern Anatolian coast from the Sinop Peninsula (Tunoglu 1984; Tunoglu & Gökçen 1985, 1991 and 1997) to the Trabzon area during the Early-Late Pontian and contained abundant endemic species (see Tables 1, 2, 3 and 4). On the basis of the environmental properties of *Candona* and the other ostracod species, this aquatic environment (very shallow coastal area) may have had oligohaline (0.5–5 ‰) and mesohaline (5–18 ‰) salinity conditions at this time (Table 6) according to the salinity values of Remane (1971). The southern border of the Paratethys bioprovince is related to the Pontian/Euxinian and Caspian Basins bioprovinces (see Figs. 1–2).

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