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Famennian ostracods from the İstanbul Zone (Gebze, Kocaeli, NW Turkey) and their paleogeographical relations

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Abstract: Famennian (Late Devonian) ostracods of the Thuringian Mega-Assemblage were recovered for the first time from three incomplete sections of the Ayineburnu Member of the Büyükada Formation in the Denizliköy area (Gebze, NW Turkey), which were sampled for conodonts. Conodont faunas define an interval extending from the Upper *rhomboidea*? or Lower *marginifera* Zone into the Middle *expansa* Zone of the standard Upper Devonian conodont zonation. The ostracod faunas found here consist of species mainly with thin-walls, long spines and often smooth surfaces such as *Rectonaria*, *Tricornina*, *Orthonaria*, *Triplacera*, *Beckerhealdia*, *Timorhealdia*, *Bohemina*, *Paraberounella* and *Acratia.* These taxa indicate faunal relationship with Thuringia and the Rhenish Massif in Germany, the Cantabrian Mountains and Pyrenees in Spain, Holy Cross Mountains in Poland, North Africa and China.

Key words: Ostracods, conodonts, Famennian, İstanbul Zone, NW Turkey.

Introduction

The study area is in the İstanbul Zone of the Pontides (Fig. 1). The Paleozoic sequence of this zone has been the subject of much study including stratigraphy (Abdüsselamoğlu 1963; Haas 1968; Kaya 1973; Göncüoğlu 1997; Gedik & Önalan 2001; Gedik et al. 2005), stratigraphy and sedimentology (Önalan 1987/1988, Yalçın & Yılmaz 2010), tectonics and global tectonics (Göncüoğlu & Kozur 1998, 1999; Yanev et al. 2006), conodonts (Çapkınoğlu 1997, 2000, 2005a,b; Göncüoğlu et al. 2004) and radiolarians (Noble et al. 2008). Some papers concentrate on the Devonian ostracods such as beyrichioideans (Paeckelmann & Sieveters 1932; Paeckelmann 1938; Nazik et al. 2007), Thuringian (Dojen et al. 2004), beyrichioideans and entomozoaceans (Yalçın et al. 2007; Nazik & Groos-Uffenorde 2008, 2009, 2011; Nalcıoğlu et al. 2009), entomozoaceans and Thuringian (Şeker 2011). The aim of the present paper is to analyse the first Famennian ostracods of the Thuringian Mega-Assemblage record from the Ayineburnu Member in İstanbul Zone, NW Turkey, and to correlate them with the Thuringian Mega-Assemblage ostracods and zonation of North Africa, Europe and China.

Stratigraphy

The Paleozoic sequence of the İstanbul Zone comprises rock units ranging from Ordovician into Carboniferous. Its tectonic and stratigraphic features were investigated by different authors (Kaya 1973; Şengör et al. 1984; Göncüoğlu & Kozur 1998; Gedik et al. 2005; Yanev et al. 2006; Yalçın & Yılmaz 2010). In this research, the Famennian ostracods were determined from the Ayineburnu Member of the Büyükada Formation that was divided into the Bostancı (basal), Yörükali and Ayineburnu (top) Members by Kaya (1973).

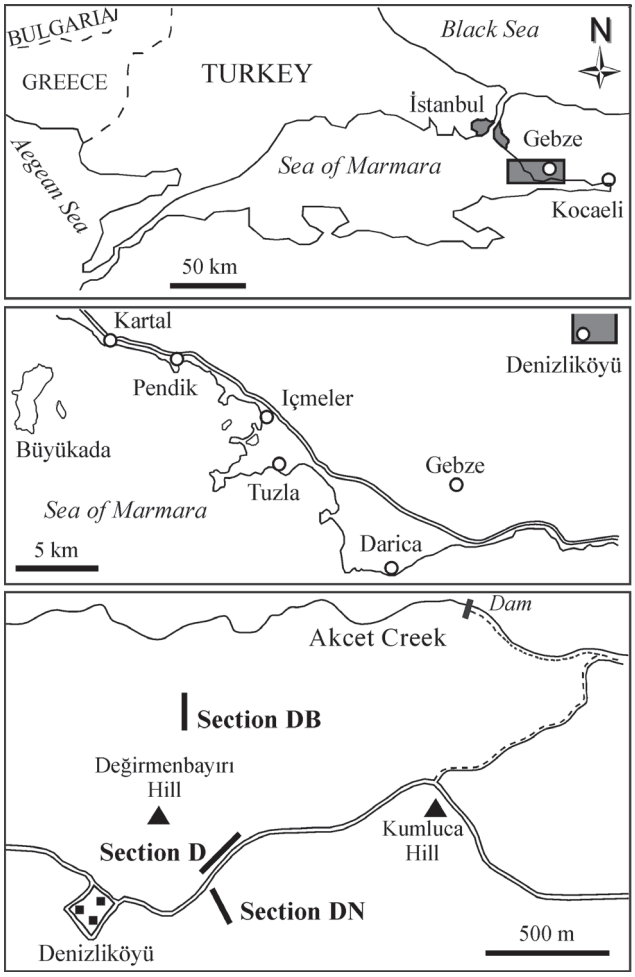


Fig. 1. Locality maps showing location of the studied sections (D, DN and DB) and adjacent areas (modified from Çapkinoğlu 2000).

The Ayineburnu Member consists of dark-grey, nodular- to planar-bedded micritic limestone and shale with locally some chert nodules and interbeds. The contacts with the underlying Yörükali Member and the overlying Baltalimanı Formation are conformable.

Material and methods

The studied sections (D, DN and DB) are located in the Denizliköy area of the town of Gebze, some 75 km southeast of İstanbul, and 20 km northeast of the town of Gebze, Kocaeli (Fig. 1). They are incomplete sections with faulted lower and upper contacts. A total of 93 limestone samples (0.5–1 kg each) were collected from these sections. Conodonts (Çapkınoğlu 2005a) and ostracods (herein) were recovered by formic acid-leaching of samples. Entomozoaceans and paleocopid ostracods are not found in the studied sections. Then, they were washed, dried and picked under the stereoscopic microscope. 50 of 93 samples produced ostracods, and they were identified using previous papers (Gründel 1961, 1962; Blumenstengel 1965, 1979, 1993, 1994, 1995; Becker 1977,

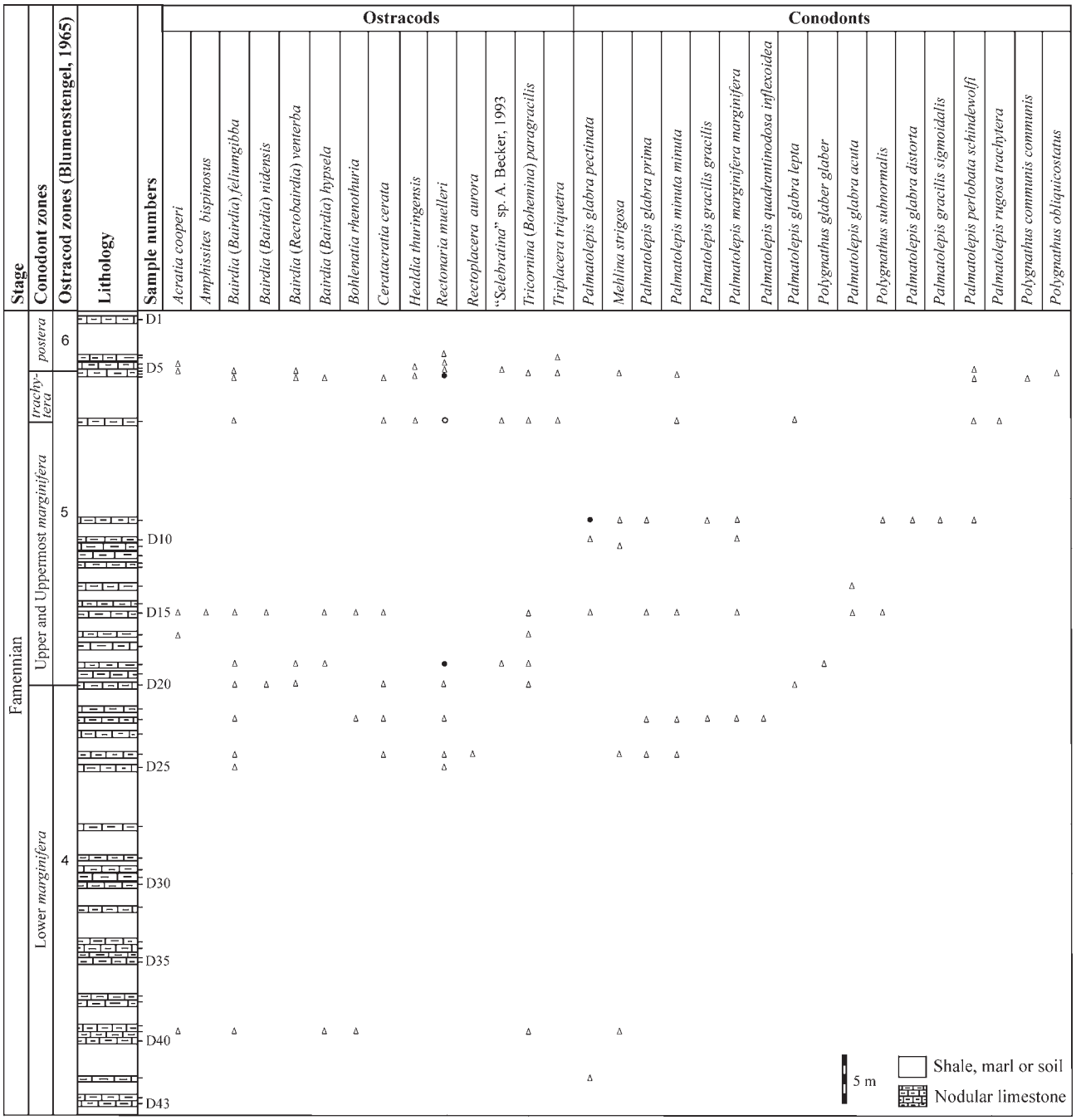


Fig. 2. Stratigraphical distribution of the Famennian ostracod and conodont species in the D section.

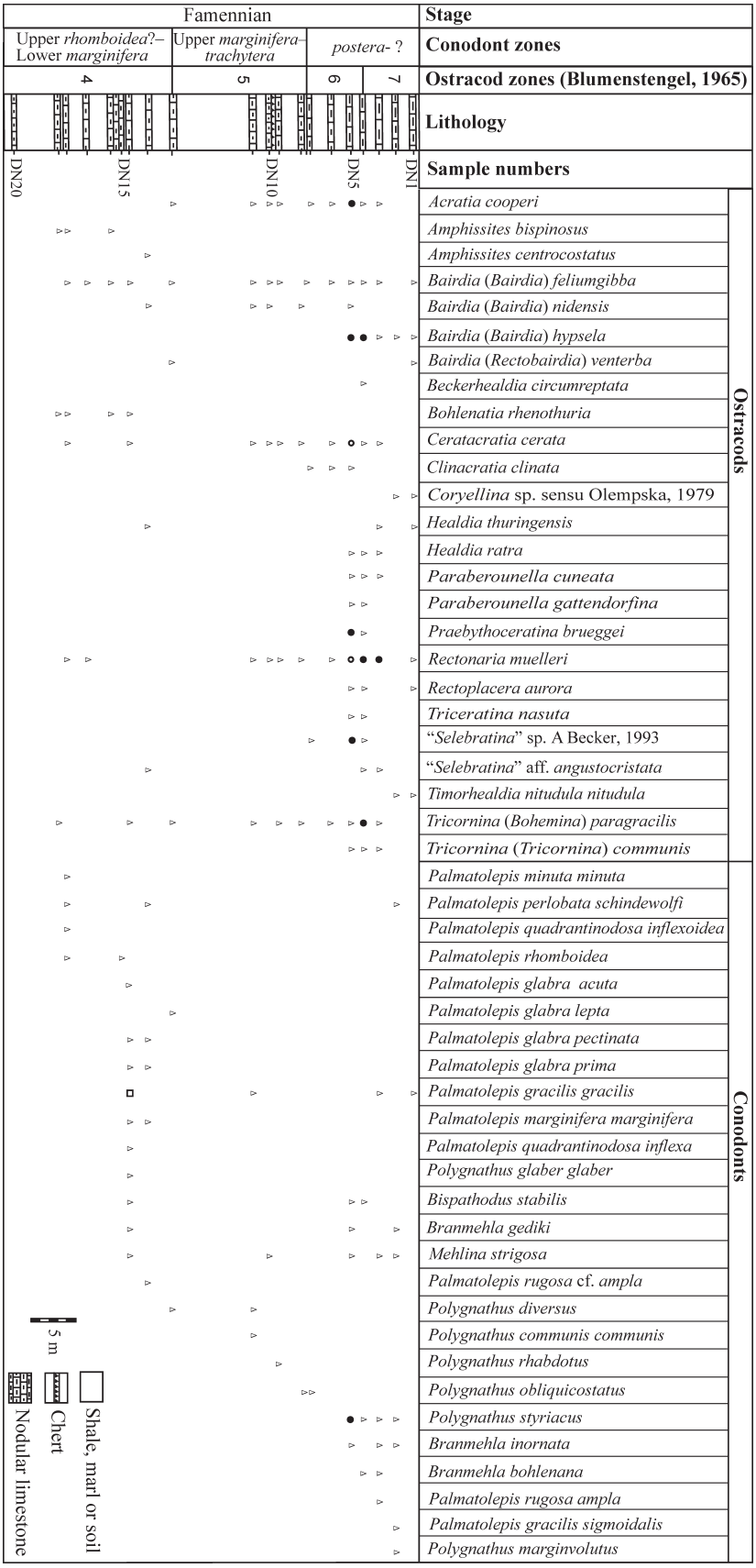


Fig. 3. Stratigraphical distribution of the Famennian ostracod and conodont species in the DN section.

1999; Olempska 1979, 1997; Becker et al. 1993). In general, they are preserved as single valves and observed, but a few closed carapace of bairdiid ostracods were also observed. Ostracods (single valve) and conodonts (Pa element) were counted and their frequency (△ = 1–5, ● = 6–10, □ = 11–15, ◊ = 16–20, ○ > 20) is shown in Figs. 2–4. Photographs were taken with a SEM at the İnönü University, Scientific and Technological Research Center. The conodonts are housed in the Department of Geological Engineering at the Karadeniz Technical University (Trabzon, Turkey), and the ostracods in the Department of Geological Engineering at the Çukurova University (Adana, Turkey).

Thuringian Mega-Assemblage of the Ayineburnu Member

The Thuringian Mega-Assemblage ostracods, studied herein, are found together with conodonts in the three sections (D, DN and DB) of the Ayineburnu Member. The conodont faunas of these sections were published by Çapkınoğlu (2005a) who also collected and processed the samples. Ostracod faunas are described herein and shown in Figs. 5 and 6. The studied ostracods identified from the Upper *rhomboidea*? or Lower *marginifera* into the Middle *expansa* Zones of the Famennian are correlated with the ostracod zones from 5 to 7 of Blumenstengel (1965, 1994) (Fig. 7).

Section D. This section, about 67 meters thick, is located on the north side of the Gebze-Denizliköy highway and parallel to the road (Fig. 1). Conodont fauna defines an interval extending from the Lower *marginifera* Zone into the *postera* Zone of the Famennian (Upper Devonian). The observed ostracods from this section are shown in Fig. 2. *Ceratacratia cerata* Blumenstengel, 1965, *Rectonaria muelleri* Gründel, 1961, *Tricornina* (*Bohemina*) *paragracilis* Blumenstengel, 1965 are common species. *Amphissites bispinosus* Blumenstengel, 1965 is also found in the samples from this section. This assemblage is similar to ostracod zones from 5 to 6 of Blumenstengel (1965).

Section DN. This section, about 36 meters thick, is nearly normal to the Gebze-Denizliköy road (Fig. 1). The section DN produced conodont faunas defining an interval extending from the Upper *rhom-*

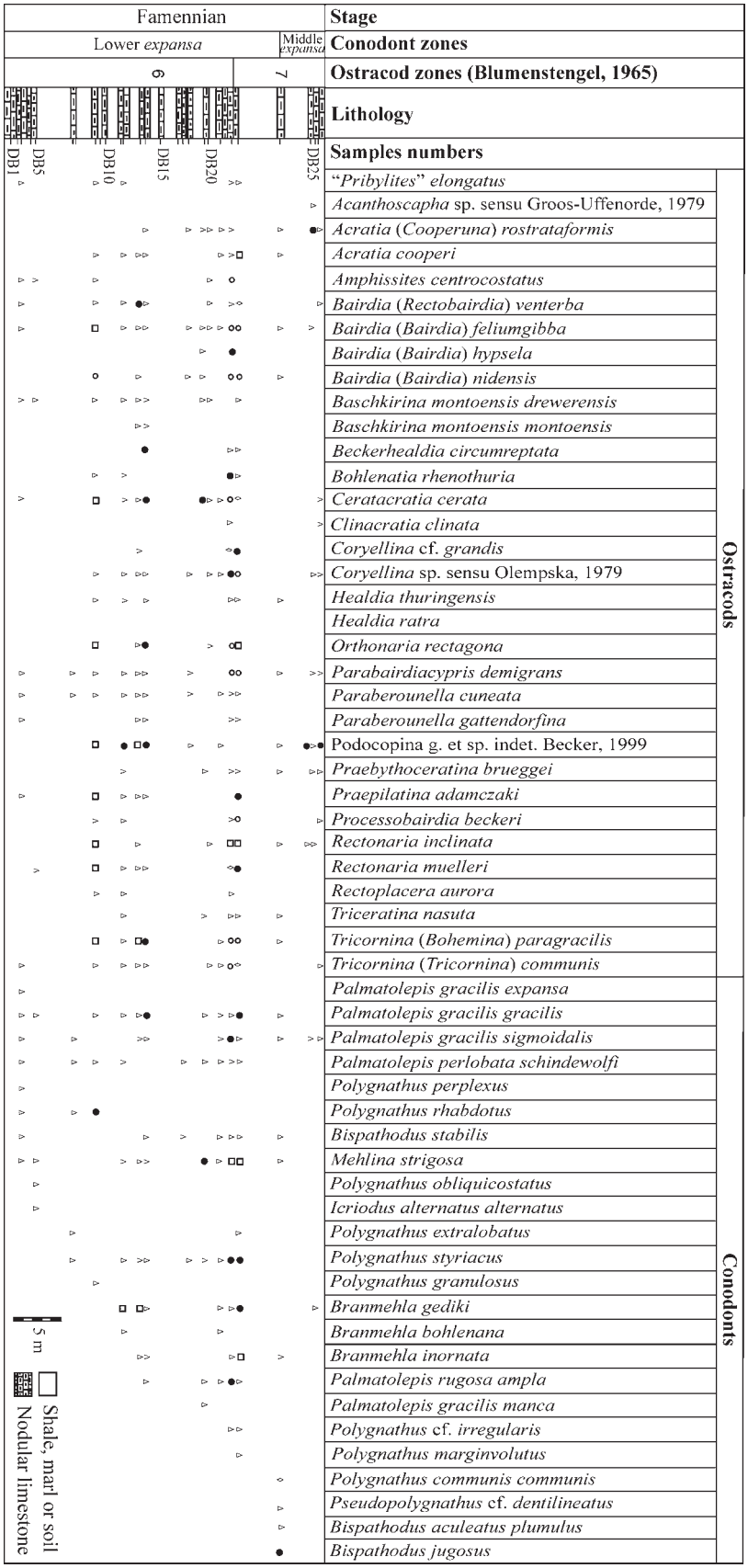


Fig. 4. Stratigraphical distribution of the Famennian ostracod and conodont species in the DB section.

boidea Zone or the Lower *marginifera* Zone into the *postera* Zone of Famennian (Upper Devonian). The determined ostracods from this section are given in Fig. 3. *Ceratacratia cerata* Blumenstengel, 1965 and *Rectonaria muelleri* Gründel, 1961 and *Tricornina (Bohemina) paragracilis* Blumenstengel, 1965 are common species in this section and found from 5 to 7 ostracod zones of Blumenstengel, 1965. In addition, *Beckerhealdia circumreptata* Blumenstengel, 1994 and *Clinacratia clinata* Blumenstengel, 1965 are found in the upper part of this section. Higher samples after the sample DN7a have also been assigned to the *postera* Zone due to the lack of any taxa typical of younger zones by Çapkınoğlu (2005a). *Clinacratia clinata* is the characteristic species for the ostracod 6–7 zones. Also, *Beckerhealdia circumreptata* Blumenstengel, 1994 is a key fossil for the ostracod 7 Zone. Therefore, these fossils indicate that the upper part of this section is younger than the *postera* Zone.

Section DB. This section, 31.50 meters thick, was measured on the north side of Değirmenbayırı Hill (Fig. 1). The conodont fauna points to the Lower and Middle *expansa* Zones. The range of determined ostracods in this section is shown in the Fig. 4. According to *Beckerhealdia circumreptata* Blumenstengel, 1994, *Ceratacratia cerata* Blumenstengel, 1965, *Clinacratia clinata* Blumenstengel, 1965 and *Rectonaria inclinata* Gründel, 1961, this section can be correlated with the ostracod 6 to 7 zones of Blumenstengel (1965).

Regional distribution and faunal relationship of the ostracod assemblage

In general, Thuringian ostracods are known from the Devonian to Early Carboniferous. These faunas are known in Thuringia/Germany (Gründel 1961, 1962; Blumenstengel 1965, 1993, 1994, 1995), Rhenish Massif/Germany (Becker 1988, 1999; Becker et al. 1993), Cantabrian Mountains/Spain (Becker 1982), Pyrenees/Spain (Sanchez de Posada et al. 2008), Montagne Noire/France (Lethiers & Feist 1991), Holy Cross Mountains/Poland (Olempska 1979, 1997), Algeria, Morocco/N Africa (Becker 1987) and China (1988).

The common species of this study can be correlated with the above mentioned works in alphabetic order (Table 1).

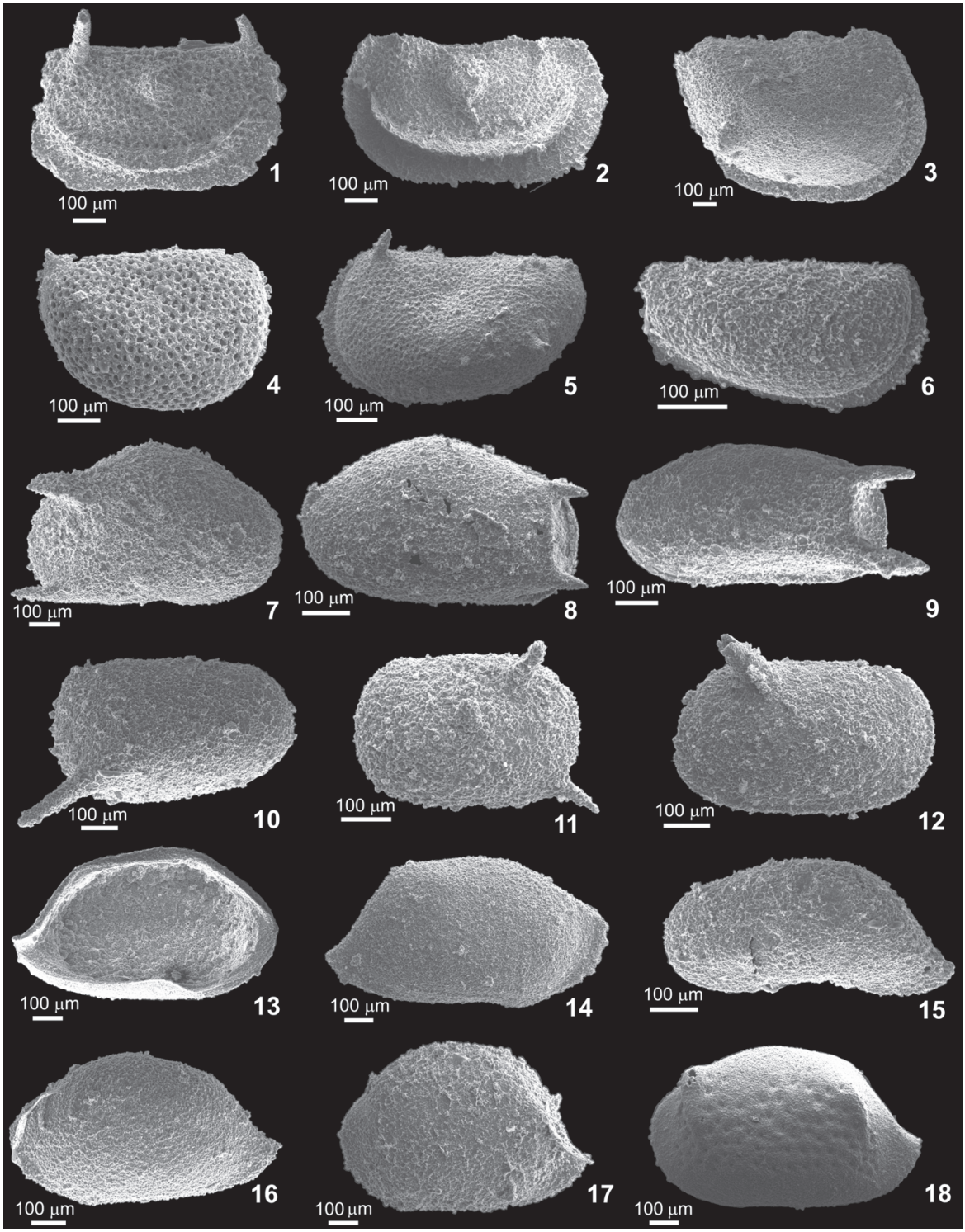


Fig. 5. 1 — *Amphissites bispinosus* Blumenstengel, 1965. Right valve, JB-O-D15/1. **2** — *Amphissites centrocostatus* Ulrich & Bassler, 1906. Left valve, JB-O-DB3/1. **3** — *"Selebratina"* aff. *angustocristata* Blumenstengel, 1965. Right valve, JB-O-DN3/1. **4** — *Coryellina* sp. sensu Olempska, 1979. Right valve, JB-O-DN1/1. **5** — *Coryellina* cf. *grandis* Robinson, 1978. Left valve, JB-O-DB22/1. **6** — *"Pribylites" elongatus* Blumenstengel, 1965. Right valve, JB-O-DB13/1. **7** — *Healdia thuringensis* Gründel, 1961. Right valve, JB-O-DN1/2. **8** — *Healdia ratra* Gründel, 1961. Left valve, JB-O-DB3/2. **9** — *Timorhealdia nitidula nitidula* (Reinh. Richter, 1869). Left valve, JB-O-DN1/3. **10** — *Rectoplacera aurora* Becker, 2000. Right valve, JB-O-DN1/4. **11–12** — *Rectonaria muelleri* Gründel, 1961; 11 — Left valve, JB-O-D6a/1, 12 — Right valve, JB-O-D6a/2. **13–14** — *Bairdia* (*Rectobairdia*) *venterba* Gründel, 1961; 13 — Left valve, inner view. JB-O-D13/2, 14 — Right valve, JB-O-DB3/3. **15** — *Bairdia* (*Bairdia*) *feliumgibba* Becker, 1982. Left valve, JB-O-D15/2. **16** — *Bairdia* (*Bairdia*) *nidensis* Olempska, 1979. Left valve, JB-O-D5/1. **17** — *Bairdia* (*Bairdia*) *hypsela* Rome, 1971. Left valve, JB-O-DB22/2. **18** — *Processobairdia beckeri* Olempska, 1979. Left valve, JB-O-DB23/1.

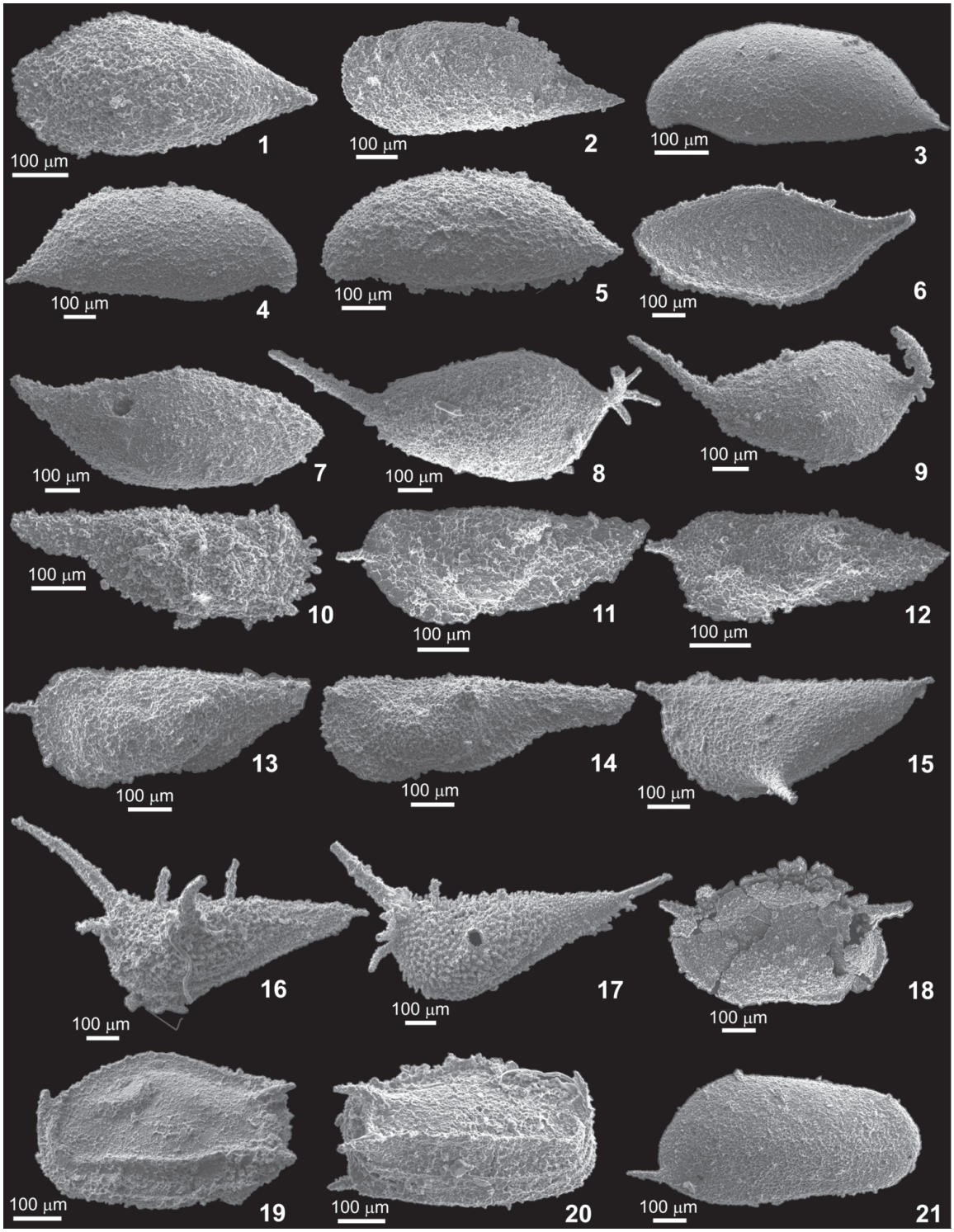


Fig. 6. 1–2 — *Bohlenatia rhenothuria* Becker, 1993; 1 — Left valve, JB-O-DB22/3, 2 — Left valve, JB-O-D16/1. **3–4** — *Acratia cooperi* Gründel, 1962; 3 — Left valve, JB-O-DB14/1, 4 — Right valve, JB-O-DB22/4. **5** — *Acratia* (*Cooperuna*) *rostrataformis* Shevtsov, 1964. Left valve, JB-O-DB22/5. **6–7** — *Clinacratia clinata* Blumenstengel, 1965; 6 — Right valve, JB-O-DB14/2, 7 — Right valve, inner view, JB-O-DB21/1. **8–9** — *Ceratacratia cerata* Blumenstengel, 1965; 8 — Right valve, JB-O-DN5/1. 9 — Right valve, JB-O-DB12/1. **10** — *Praebythoceratina brueggei* Gründel, 1973. Right valve, JB-O-DB21/2. **11–12** — *Paraberounella cuneata* Gründel, 1961; 11 — Left valve, JB-O-DB20/1, 12 — Left valve, JB-O-DB13/2. **13** — *Paraberounella gattendorfina* Gründel, 1973. Left valve, JB-O-DB13/3. **14** — *Triceratina nasuta* Gründel, 1961. Left valve, JB-O-DB21/3. **15** — *Tricornina* (*Tricornina*) *communis* Blumenstengel, 1965. Left valve, JB-O-DB22/6. **16–17** — *Tricornina* (*Bohemina*) *paragracilis* Blumenstengel, 1965; 16 — Left valve, JB-O-DB22/7, 17 — Left valve, JB-O-DB14/3. **18** — *Acanthoscapha* sp. sensu Groos-Uffenorde, 1979. Right valve, JB-O-DB26/1. **19–20** — *Beckerhealdia circumreptata* Blumenstengel, 1994; 19 — Left valve, JB-O-DB22/8, 20 — Right valve, JB-O-DB21/4. **21** — *Parabairdiacypris demigrans* Becker, 1982. Right valve, JB-O-DB8/1.

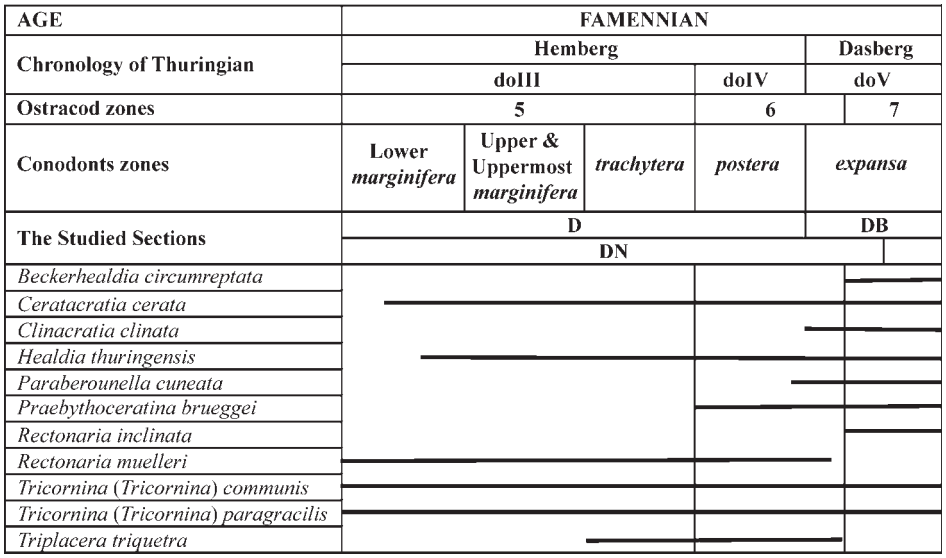


Fig. 7. Stratigraphic ranges of the common taxa from this study applicable for Blumenstengel's (1965 and 1994) assemblage zone determination.

Table 1: Paleogeographical correlation of the common species from this study with Europe, Africa and China.

The Thuringian Ostracod Species	REGIONS							
	Thuringia	Rhenish Massif	Pyrenees	Montagne Noire / France	Holy Cross Mountains / Poland	Cantabrian Mountains	China (Guangxi)	N Africa
Beckerhealdia circumreptata	x							
Ceratacratia cerata	x	x	x		x	x		x
Clinacratia clinata	x	x						x
Healdia thuringensis	x	x		x	x			
Praebythoceratina brueggei	x	x				x		
Rectonaria inclinata	x	x		x	x	x	x	x
Rectonaria muelleri	x	x	x	x	x	x	x	x
Tricornina (Tricornina) communis	x	x				x	x	x
Tricornina (Tricornina) paragracilis	x	x	x			x		
Paraberounella cuneata	x	x		x		x	x	

Beckerhealdia circumreptata is described from the Upper Clymenia Beds (Upper Devonian) of Thuringia.

Ceratacratia cerata is found in Thuringia, the Rhenish Massif, Pyrenees, Cantabrian Mountains, Holy Cross Mountains, N Africa (Morocco) and ranges from doII to VI (Frasnian–Famennian).

Clinacratia clinata is known in Thuringia, the Rhenish Massif, N Africa (Algeria, Morocco) and its range is from doV to doVI (Famennian).

Healdia thuringensis is observed in Thuringia, Montagne Noire, the Rhenish Massif, Holy Cross Mountains. This species is known from doVI to cdII (Famennian–Early Carboniferous).

Paraberounella cuneata is known in Thuringian, the Rhenish Massif, Montagne Noire, Cantabrian Mountains, China (Guangxi). This species ranges from doI to cdI (Frasnian–Early Carboniferous).

Praebythoceratina brueggei is known in Thuringia, the Rhenish Massif and the Cantabrian Mountains from doIV to cdI (Famennian–Early Carboniferous).

Rectonaria inclinata is observed in Thuringia, the Rhenish Massif, Cantabrian Mountains, Holy Cross Mountains, Montagne Noire, N Africa (Algeria), China (Guangxi) and ranges from doV to cdI (Famennian–Early Carboniferous).

Rectonaria muelleri is one of the most characteristic species of the Thuringian Mega-Assemblage ostracods from Late Devonian to Early Carboniferous and known in Thuringia, Montagne Noire, the Cantabrian Mountains, Pyrenees, Rhenish Massif, Holy Cross Mountains, N Africa (Algeria, Morocco) and China (Guangxi).

Tricornina (Tricornina) communis is found in Thuringia, the Rhenish Massif, Cantabrian Mountains, N Africa (Morocco) and China (Guangxi). Its range is from doI to V (Frasnian–Famennian).

Tricornina (Tricornina) paragracilis is known in Thuringian, the Rhenish Massif, Pyrenees, Cantabrian Mountains and ranges from doI to V (Frasnian–Famennian).

Conclusion

Based on conodonts, the Ayineburnu Member ranges in age from Lower *rhenena* Zone to the *izosticha*-Upper *crenulata* Zone (Late Frasnian to Middle Tournasian) in previous works. The Thuringian Mega-Assemblage is described for the first time in the Famennian (Upper *rhomboidea*? or Lower *marginifera* Zone into the Middle *expansa* Zone) from the Ayineburnu Member in İstanbul Terrane Zone, NW Turkey. The studied ostracod faunas contain genera and species typical of the "Thuringian Mega-Assemblage". This assemblage shows similarities with ostracod zones 5 to 7 of Blumenstengel (1965, 1994). These species and genera are correlated from several part of the Europe, Africa and China. They show the closed affinities with the faunas of the Cantabrian Mountains (Spain), Thuringia and Rhenish Massif (Germany).

Conodonts of the palmatolepid-polygnathid biofacies and ostracods with spinous valves were recovered from the nodular limestone strata of the Ayineburnu Member. "The Thuringian Mega-Assemblage" was originally considered indicative of basinal and low-energy environments. The associated faunas and lithological features suggest a deposition in a relatively deep basin for the Ayineburnu Member.

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