

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

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(Manuscript received December 16, 2011; accepted in revised form March 13, 2012)

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 *rhomboides*? 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 (Abdüselamoğlu 1963; Haas 1968; Kaya 1973; Göncüoğlu 1997; Gedik & Önalın 2001; Gedik et al. 2005), stratigraphy and sedimentology (Önalın 1987/1988, Yalçın & Yılmaz 2010), tectonics and global tectonics (Göncüoğlu & Kozur 1998, 1999; Yanev et al. 2006), conodonts (Çapkinoğlu 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 & Sieverters 1932; Paeckelmann 1938; Nazik et al. 2007), Thuringian (Dojen et al. 2004), beyrichioideans and entomozoaceans (Yalçın et al. 2007; Nazik & Groos-Uffendorde 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).

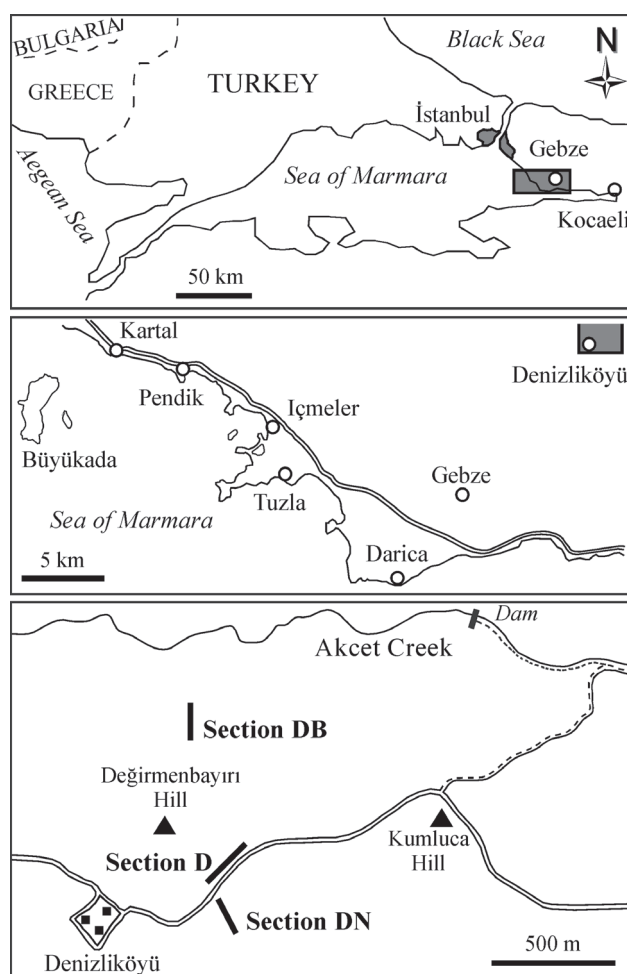


Fig. 1. Locality maps showing location of the studied sections (D, DN and DB) and adjacent areas (modified from Çapkinoğlu 2000).

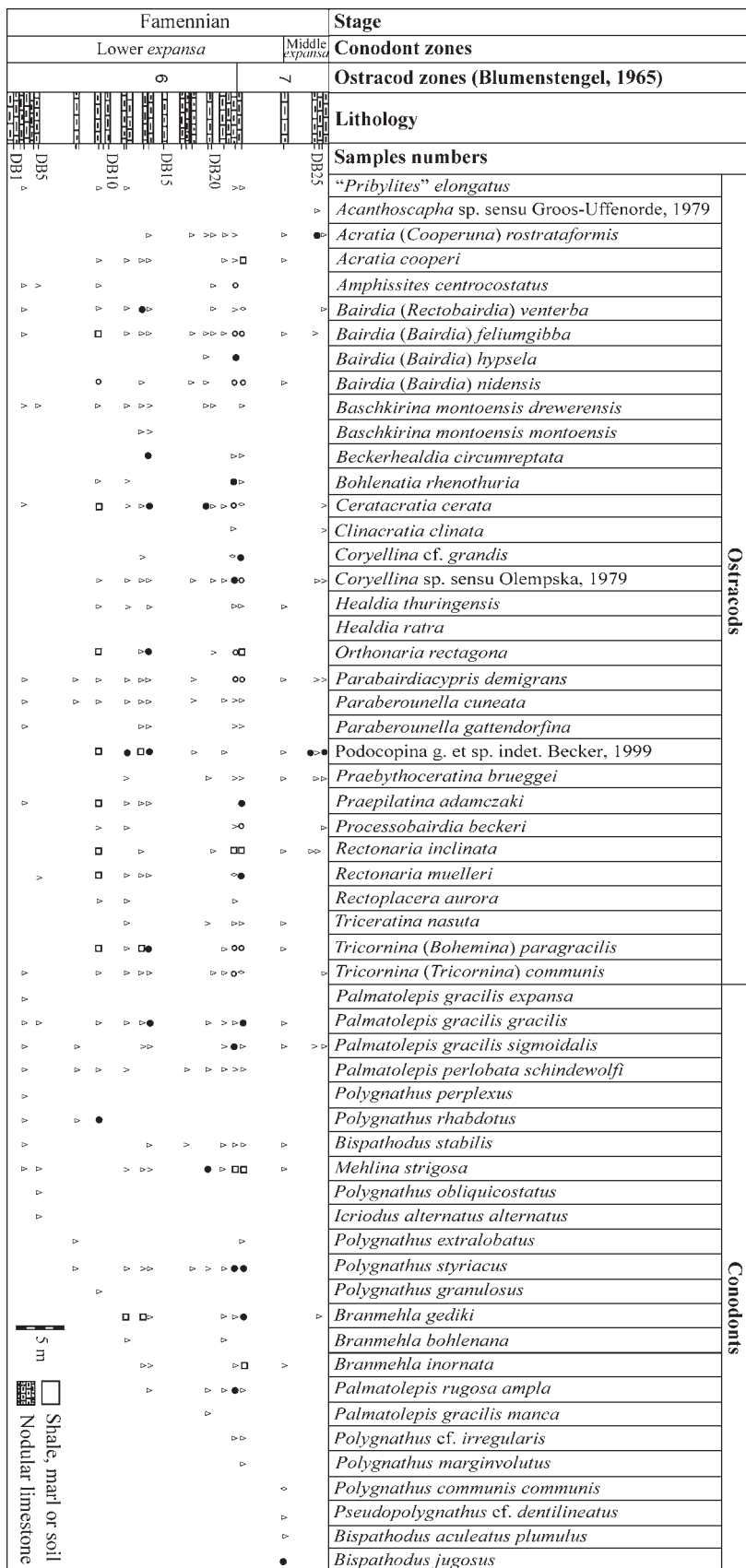


Fig. 4. Stratigraphical distribution of the Famennian ostracod and conodont species in the DB section.

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 Çapkinoglu (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).

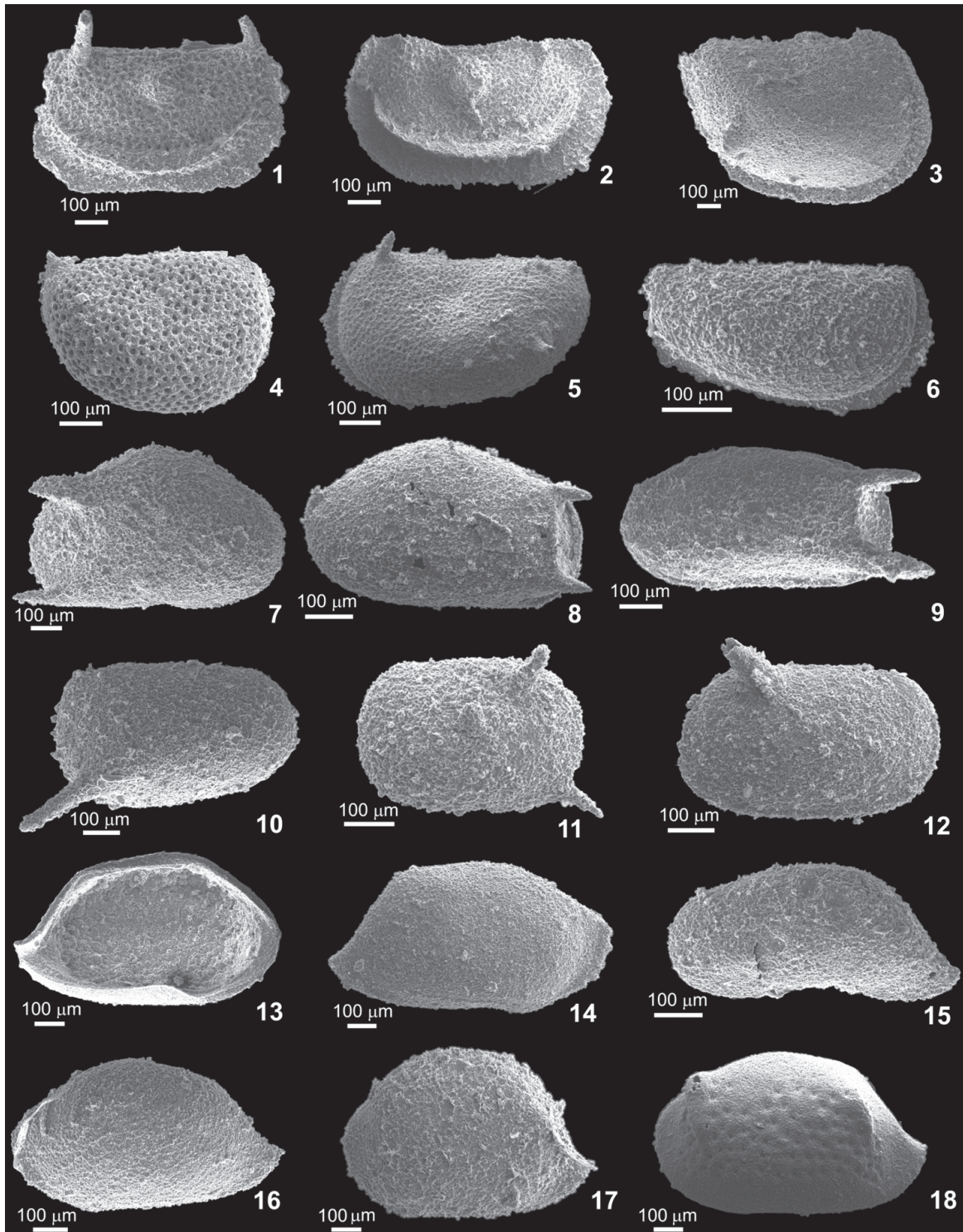


Fig. 5. 1 — *Amphissites bispinosus* Blumenstengel, 1965. Right valve, JB-O-D15/1. 2 — *Amphissites centrocostatus* Ulrich & Bassler, 1906. Left valve, JB-O-DB3/1. 3 — “*Selebratina*” aff. *angustocristata* Blumenstengel, 1965. Right valve, JB-O-DN3/1. 4 — *Coryellina* sp. sensu Olempska, 1979. Right 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.

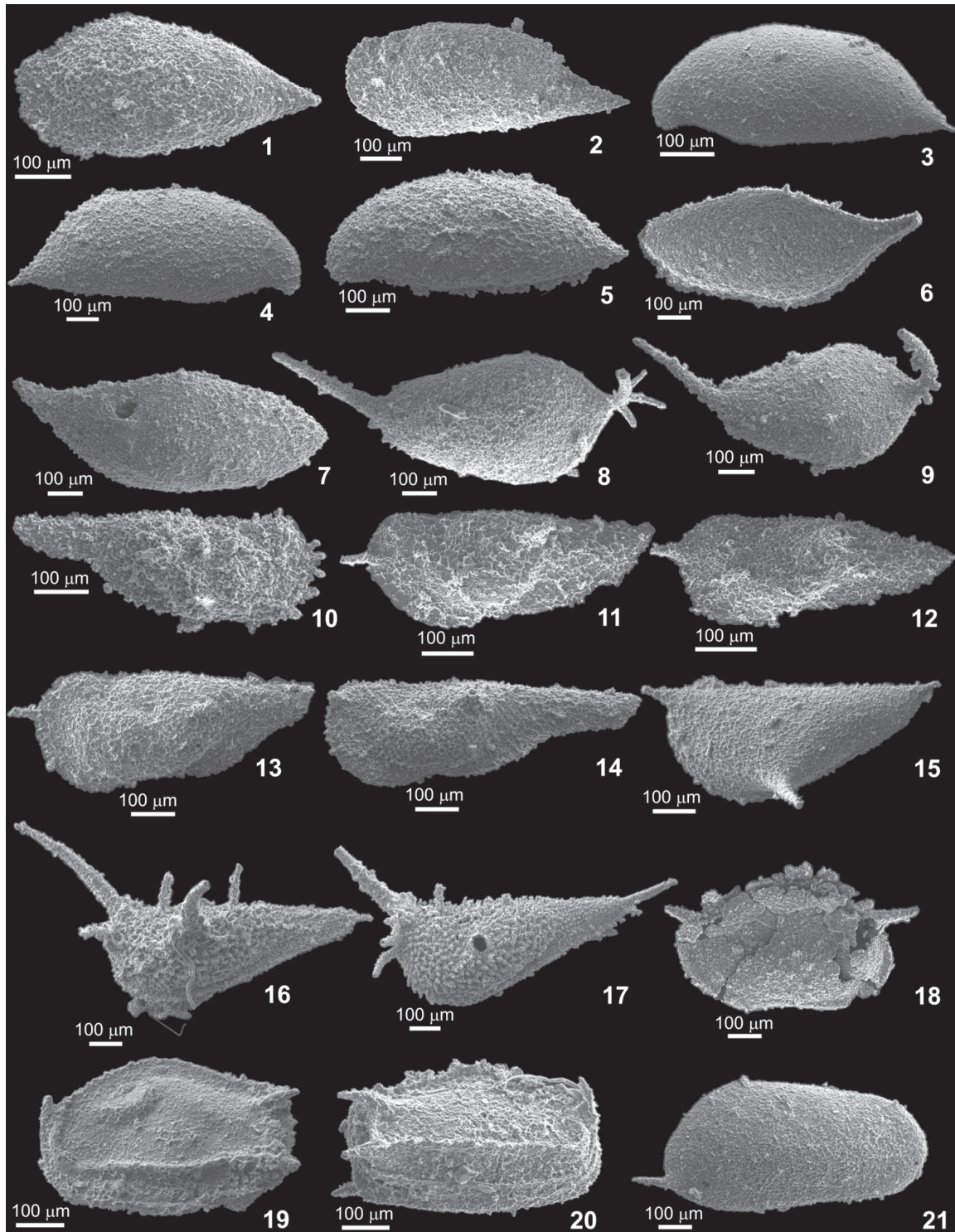


Fig. 6. 1–2 — *Bohlenatia rhenothuria* Becker, 1993; 1 — Left valve, JB-O-DB22/3, 2 — Left valve, JB-O-D16/1. 3–4 — *Acratia cooperi* Gründel, 1962; 3 — Left valve, JB-O-DB14/1, 4 — Right valve, JB-O-DB22/4. 5 — *Acratia (Cooperuna) rostrataformis* Shevtsov, 1964. Left valve, JB-O-DB22/5. 6–7 — *Clinacratia 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 brueggeri* 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 gattendorffina* 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.

AGE	FAMENNIAN				
Chronology of Thuringian	Hemberg			Dasberg	
	doIII		doIV	doV	
Ostracod zones	5		6	7	
Conodonts zones	Lower marginifera	Upper & Uppermost marginifera	trachytera	postera	expansa
The Studied Sections	D			DB	
	DN				
<i>Beckerhealdia circumreptata</i>	[Stratigraphic range bar]				
<i>Ceratacratia cerata</i>	[Stratigraphic range bar]				
<i>Clinacratia clinata</i>	[Stratigraphic range bar]				
<i>Healdia thuringensis</i>	[Stratigraphic range bar]				
<i>Paraberounella cuneata</i>	[Stratigraphic range bar]				
<i>Praebythoceratina brueggei</i>	[Stratigraphic range bar]				
<i>Rectonaria inclinata</i>	[Stratigraphic range bar]				
<i>Rectonaria muelleri</i>	[Stratigraphic range bar]				
<i>Tricornina (Tricornina) communis</i>	[Stratigraphic range bar]				
<i>Tricornina (Tricornina) paragracilis</i>	[Stratigraphic range bar]				
<i>Triplacera triquetra</i>	[Stratigraphic range bar]				

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)
<i>Beckerhealdia circumreptata</i>	x						
<i>Ceratacratia cerata</i>	x	x	x		x	x	x
<i>Clinacratia clinata</i>	x	x					x
<i>Healdia thuringensis</i>	x	x		x	x		
<i>Praebythoceratina brueggei</i>	x	x				x	
<i>Rectonaria inclinata</i>	x	x		x	x	x	x
<i>Rectonaria muelleri</i>	x	x	x	x	x	x	x
<i>Tricornina (Tricornina) communis</i>	x	x				x	x
<i>Tricornina (Tricornina) paragracilis</i>	x	x	x			x	
<i>Paraberounella cuneata</i>	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, Morocco) 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 *rhomboides?* 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.

Acknowledgments: The study was supported by Çukurova University Project Grant MMF2009YL56 and partly Adiyaman University Project Grant MTEFBAP2008-0002. The first author is grateful to Prof. Luis C. Sanchez de Posada (Oviedo University/Spain) for the discussion dealing with Thuringian ostracods. We are greatly indebted to the editors of this journal and two reviewers. Their suggestions and comments have improved the manuscript.

References

- Abdüsselamoğlu Ş. 1963: Nouvelles observations stratigraphiques et paléontologiques sur les terrains Paléozoïques affleurant à l'est du Bosphore. *MTA Bull.* 60, 1-6 (in Turkish).
- Becker G. 1977: Thuringian ostracods from the Famennian of the Cantabrian Mountains. In: Löffler H. & Danielopol D. (Eds.): Aspects of ecology and zoogeography of recent and fossil Ostracoda. *Kluwer Academic Publishers*, 459-474.
- Becker G. 1982: Ostracoda aus Cephalopoden-Führendem Oberdevon im Kantabrischen Gebirge (N-Spanien). 2. Bairdiacea, Cytheracea und Entomozoacea. *Palaeontographica A* 178, 109-182.
- Becker G. 1987: Ostracoda des Thüringer Ökotyps aus dem Grenzbereich Devon/Karbon N-Afrikas (Marokko, Algerien). *Palaeontographica A* 200, 45-104.
- Becker G. 1988: Tricorninidae (Ostracoda) aus der Wocklum-Stufe (hohes Oberdevon; Rechtsrheinisches Schiefergebirge). *Geol. Jb. Hessen* 116, 5-18.
- Becker G. 1999: Verkieselte Ostracoden vom Thüringer Ökotyp aus den Devon/Karbon-Grenzschieferungen (Top Wocklumer Kalk und Basis Hangenberg-Kalk) im Steinbruch Drewer (Rheinisches Schiefergebirge). *Cour. Forsch.-Inst. Senckenberg* 218, 1-159.
- Becker G., Clausen C.-D. & Leuteritz K. 1993: Verkieselte Ostracoden vom Thüringer Ökotyp aus dem Grenzbereich Devon/Karbon des Steinbruchs Drewer (Rheinisches Schiefergebirge). *Cour. Forsch.-Inst. Senckenberg* 160, 1-130.
- Blumenstengel H. 1965: Zur Taxonomie und Biostratigraphie verkieselter Ostracoden aus dem Thüringer Oberdevon. *Freib. Forsch.-H.* C183, 1-127.
- Blumenstengel H. 1979: Die Ostrakodenfauna der Wocklumena-Stufe (Oberdevon) bei Saalfeld im Thüringer Schiefergebirge. *Z. Geol. Wiss.* 7, 521-557.
- Blumenstengel H. 1993: Ostracodes from the Devonian-Carboniferous boundary beds in Thuringia (Germany). *Ann. Soc. Géol. Belg.* 115, 483-489.
- Blumenstengel H. 1994: *Beckerhealdia*, eine neue Ostrakodengattung des Thüringer Ökotyps aus den oberen Clymenienschichten von Saalfeld (Oberdevon, Thüringer Schiefergebirge). *Neu. Jb. Geol. Paläont. Mh.* 12, 733-740.
- Blumenstengel H. 1995: Zur Ostracodenfauna der Oberen Clymenien-Schichten von Saalfeld (höchstes Famennium, Thüringer Schiefergebirge). *Ber. Geol. Thüringen, N.F.* 2, 3-27.
- Çapkinoğlu Ş. 1997: Conodont fauna and biostratigraphy of the Famennian of Büyükdada, İstanbul, Northwestern Turkey. *Boll. Soc. Paleont. Ital.* 35, 165-185.
- Çapkinoğlu Ş. 2000: Late Devonian (Famennian) Conodonts from Denizliköyü, Gebze, Kocaeli, Northwestern Turkey. *Turkish J. Earth Sci.* 9, 91-112.
- Çapkinoğlu Ş. 2005a: Famennian conodonts from the Ayineburnu Formation of the İstanbul Zone, NW Turkey. *Geol. Carpathica* 56, 2, 113-122.
- Çapkinoğlu Ş. 2005b: Upper Devonian (upper Frasnian-lower Famennian) conodont biostratigraphy of the Ayineburnu Formation, İstanbul, NW Turkey. *Geol. Carpathica* 56, 3, 223-236.
- Dojen C., Özgül N., Göncüoğlu Y. & Göncüoğlu C. 2004: Early Devonian ostracodes of Thuringian ecotype from NW Anatolia (Turkey). *Neu. Jb. Geol. Paleont., Mh.* 12, 733-748.
- Gedik I. & Önal M. 2001: A new approach to the Paleozoic stratigraphy of the Çamdağ (Sakarya province). [Çamdağ (Sakarya İli) Paleozoik stratigrafisine ait yeni gözlemler.] *İstanbul Univ. Engineering Fac. Earth Sci. Rev.* 14, 61-76 (in Turkish).
- Gedik I., Pehlivan Ş., Timur E. & Duru M. 2005: Geological maps of Turkey, 1:50,000 scaled. No. 12, İstanbul F23d sheet. *MTA Publ.*, Ankara (in Turkish).
- Göncüoğlu M.C. 1997: Distribution of Lower Paleozoic rocks in the Alpine terranes of Turkey. In: Göncüoğlu M.C. & Derman A.S. (Eds.): Early Paleozoic in NW Gondwana. *Turkish Assoc. Petrol. Geol., Spec. Publ.* 3, 13-23.
- Göncüoğlu C. & Kozur H.W. 1998: Facial development and thermal alternation of Silurian rocks in Turkey. In: Guitierrez-Marco J.C. & Rabano I. (Eds.): Proceedings, 1998 Field-Meeting, IUGS Subcommission on Silurian Stratigraphy, Temas Geologico-Mineros ITGE 23, 87-90.
- Göncüoğlu C. & Kozur H.W. 1999: Remarks on the pre-Variscan development in Turkey. In: Linnemann U., Heuse T., Fatka O., Kraft P., Brocke R. & Erdtmann B.T. (Eds.): Prevariscan terrane analyses of "Gondwanan Europa". Proceedings, Schriften des Staatlichen Museums Mineralogie Geologie Dresden 9, 137-138.
- Göncüoğlu C., Boncheva I. & Göncüoğlu Y. 2004: First Discovery of Middle Tournaisian Conodonts in the Griotte-Type Nodular Pelagic Limestones, İstanbul Area, NW Turkey. *Rev. Ital. Paleont. Stratigr.* 10, 431-439.
- Gründel J. 1961: Zur Biostratigraphie und Fazies der Gattendorfia-Stufe in Mitteldeutschland unter besonderer Berücksichtigung der Ostracoden. *Freiberger Forsch.-H.* C111, 53-173.
- Gründel J. 1962: Zur Taxonomie der Ostracoden der Gattendorfia-Stufe Thüringens. *Freib. Forsch.-H.* C151, 51-105.
- Haas W. 1968: Das Alt-Paläozoikum von Bithynien (Nordwest Türkei). *Neu. Jb. Geol. Palaeont., Abh.* 131, 178-242.
- Kaya O. 1973: Paleozoic of İstanbul. *Ege Üniversitesi Fen Fakültesi Kitaplar Serisi* 40, 143.
- Lethiers F. & Feist R. 1991: Ostracodes, stratigraphie et bathymétrie du passage Dévonien-Carbonifère au Viséen inférieur en Montagne Noire (France). *Geobios* 24, 71-104.
- Nazik A., Groos-Uffendorde H. & Nalcioğlu G. 2007: Beyrichiacean Ostracodes from NW Turkey and their palaeogeographical relations. *19th International Senckenberg Conference, Europeans Ostracodologist's Meeting VI*, Abstract, 35.
- Nalcioğlu G., Nazik A. & Jansen U. 2009: Devonian Brachiopoda and ostracode assemblages in western Pontides and eastern Taurides and paleogeographic implications. [Batı Pontidler ve Doğu Toroslarda Devoniyen Brachiopod ve Ostrakod toplulukları paleocoğrafik yaklaşımlar.] *62. Türkiye Jeoloji Kurultayı Bildiri Özleri Kitabı*, Cilt II, 668-669.
- Nazik A. & Groos-Uffendorde H. 2008: Devonian ostracode assemblages from NW Anatolia (Turkey) and their paleogeographic implications. *IGCP 497 "The Rheic Ocean: Its Origin, Evolution and Correlatives" and IGCP 499 "Devonian Land-Sea Interactions: Evolution of Ecosystems and Climate" (DEVEC), 20th International Senckenberg Conference and 2nd Geinitz Conference: From Gondwana and Laurussia to Pangaea: Dynamics of Oceans and Supercontinents* Frankfurt, Germany, Abstract and Programme, 113.
- Nazik A. & Groos-Uffendorde H. 2009: First records of Frasnian (Late Devonian) entomozocean ostracodes in NW Turkey. [KB Türkiye'de Frasnien (Geç Devoniyen) Entomozocean ostrakodlarının ilk bulguları.] *62. Türkiye Jeoloji Kurultayı Bildiri Özleri Kitabı*, Cilt II, 666-667.

- Nazik A. & Groos-Uffenorde H. 2011: First records of Late Devonian Entomozoacean Ostracodes in NW Turkey. *Turkish J. Earth Sci.* 20, 167–178.
- Noble P.J., Tekin U.K., Gedik İ. & Pehlivan Ş. 2008: Middle to Upper Tournasian Radiolaria of the Baltalimani Formation, İstanbul, Turkey. *J. Paleontology* 82, 1, 37–56.
- Olempska E. 1979: Middle to Upper Devonian Ostracoda from the southern Holy Cross Mountains, Poland. *Pal. Pol.* 40, 57–162.
- Olempska E. 1997: Changes in benthic ostracod assemblages across the Devonian Carboniferous boundary in the Holy Cross Mountains. *Acta Pal. Pol.* 42, 291–332.
- Önalın M. 1987/1988: Sedimentological properties of Devonian sequence in İstanbul. [İstanbul Devoniyen çökellerinin sedimenter özellikleri.] *İstanbul Univ. Engineering Fac. Earth Sci. Rev.* 6, 93–108.
- Paeckelmann W. 1938: Neue Beitræge zur Kenntnis der Geologie, Palaeontologie und Petrographie der Umgegend von Konstantinopel. 2. Geologie Thraziens, Bithyniens und der Prinzeninseln. *Abh. Preuss. Geol. LA, N.F.* 186, 1–202.
- Paeckelmann W. & Sieverts H. 1932: Neue Beiträge zur Kenntnis der Geologie, Paleontologie und Petrographie der Umgegend von Konstantinopel. 1. Obersilurische und devonische Faunen der Prinzeninseln, Bithyniens und Thraziens. *Abh. Preuss. Geol. LA, N.F.* 142, 1–79.
- Sanchez de Posada L.C., Sanz-Lopez J. & Gozalo R. 2008: Ostracod and conodont faunal changes across the Frasnian–Famennian (Devonian) boundary at Els Castells, Spanish central Pyrenees. *Rev. Micropaleont.* 5, 205–219.
- Şeker E. 2011: The biostratigraphy and paleogeographic features of Late Devonian Ostracodes in İstanbul (Northwest Turkey). *Çukurova University, Institute of Natural and Applied Sciences, MSc Thesis*, 1–107 (in Turkish).
- Şengör A.M.C., Yılmaz Y. & Sungurlu O. 1984: Tectonics of the Mediterranean Cimmerides: Nature and evolution of the western termination of Paleo-Tethys. In: Dixon J.E. & Robertson A.H.F. (Eds.): The geological evolution of the Eastern Mediterranean. *Geol. Soc. London, Spec. Publ.* 17, 77–112.
- Wang S.-Q. 1988: Ostracode faunas from the early Carboniferous Wangyou Formation in Nandan of Guangxi and their paleoecotype. *Mem. Nanjing Inst. Geol. Palaeont. Acad. Sinica.* 24, 269–315 (in Chinese).
- Yanev S., Göncüoğlu M.C., Gedik İ., Lakova I., Boncheva I., Sachanski V., Okuyucu C., Özgül N., Timur E., Maliakov Y. & Saydam G. 2006: Stratigraphy, correlations and palaeogeography of Paleozoic terranes in Bulgaria and NW Turkey: A review of recent data. In: Robertson A.H.F. & Mountrakis D. (Eds.): Tectonic development of the Eastern Mediterranean Region. *Geol. Soc. London, Spec. Publ.* 260, 51–67.
- Yalçın M.N. & Yılmaz İ. 2010: Devonian in Turkey — a review. *Geol. Carpathica* 61, 3, 235–253.
- Yalçın M.N., Bozdoğan N., Brocke R., Gedik İ., Janssen U., Karslıoğlu Ö., Köningshof P., Nazik A., Nalçioğlu G., Saydam G., Uguz M.F. & Yılmaz İ. 2007: Stratigraphy and facies development of the Devonian of northwestern Turkey. *Devonian land-sea interaction: evolution of “ecosystems and climate” field meeting IGCP 499*, 84–86.