Turkish Journal of Earth Sciences

Volume 12 | Number 2 Article 3

1-1-2003

First Records of Conodonts from "the Permo-Carboniferous of Demirözü" (Bayburt), Eastern Pontides, NE Turkey

ŞENOL ÇAPKINOĞLU

Turkish Journal of Earth Sciences (Turkish J. Earth Sci.), **Vol. 12**, 2003, pp. 199-207. *Copyright ©TÜBİTAK*

First Records of Conodonts from "the Permo-Carboniferous of Demirözü" (Bayburt), Eastern Pontides, NE Turkey

ŞENOL ÇAPKINOĞLU

Karadeniz Teknik Üniversitesi, Jeoloji Mühendisliği Bölümü, TR-61080 Trabzon - Turkey
(e-mail: capkin@risc01.ktu.edu.tr)

Abstract: Permo-Carboniferous sedimentary rocks, which belong to the pre-Jurassic basement of the Eastern Pontides, occur in the Cebre relative autochthon and the Hamurkesen thrust sheet in the Demirözü area, Bayburt, NE Turkey, and consist of the Çatalçeşme and Hardişi formations, respectively. Some limestone beds of the Çatalçeşme Formation in the village of Çatalçeşme produced the first conodont faunas encountered in Palaeozoic sediments of the Eastern Pontides. A rich conodont fauna with abundant *Neognathodus bassleri* (HARRIS & HOLLINGSWORTH), less *Idiognathodus* sp. and *Streptognathodus elegantulus* STAUFFER & PLUMMER, and rare *Gondolella* sp. were obtained from a densely-packed bioclastic packstone bed on the west side of the Deliklitaş Hill, about 2 km south of the village of Çatalçeşme (Demirözü, Bayburt). This fauna indicates a late Middle Pennsylvanian age (Desmoinesian on the North American scale; late Moscovian on the Russian scale). Furthermore, Pa elements of *Streptognathodus elongatus* GUNNELL, a long-ranging form, were obtained from two samples of the Çatalçeşme-Cebre road cut section, about 1250 m west of the village of Çatalçeşme.

The conodonts of the Çatalçeşme Formation are geographically widespread forms, and do not show any provinciality.

Key Words: conodonts, Desmoinesian, Çatalçeşme Formation, Demirözü (Bayburt), Eastern Pontides

"Demirözü (Bayburt) Permo-Karbonifer'inden" Konodontların İlk Kayıtları, Doğu Pontidler, KD Türkiye

Özet: Doğu Pontidler'in Jura öncesi temeline ait olan Permo-Karbonifer yaşlı tortul kayalar, Demirözü bölgesi (Bayburt, KD Türkiye) Cebre göreli otoktonu'nda ve Hamurkesen itki dilimi'nde bulunur ve sırasıyla, Çatalçeşme ve Hardişi formasyonlarından oluşur. Çatalçeşme Formasyonu'ndan alınan kireçtaşı örneklerinden bazıları, Doğu Pontidlerin Paleozoyik tortularında rastlanan ilk konodont faunalarını üretmiştir. Çatalçeşme Köyü'nün (Demirözü, Bayburt) yaklaşık 2 km güneyindeki Deliklitaş Tepe'nin batı yamacından alınan yoğun istiflenmiş bir biyoklastik istiftaşı katmanından, bol *Neognathodus bassleri* (HARRIS & HOLLINGSWORTH), daha az *Idiognathodus* sp. ve *Streptognathodus elegantulus* HARRIS & HOLLINGSWORTH, ve nadir *Gondolella* sp. içeren zengin bir konodont faunası elde edilmiştir. Bu fauna, Orta Pensilvaniyen'in üst kısmına (Kuzey Amerika ölçeğine göre Desmonesiyen; Rus ölçeğine göre geç Moskoviyen) işaret eder. Ayrıca, Çatalçeşme Köyü'nün yaklaşık 1250 m batısındaki Çatalçeşme-Cebre yol yarması kesitine ait iki örnekten, uzun menzilli bir form olan *Streptognathodus elongatus* GUNNELL'a ait Pa öğeleri elde edilmiştir.

Çatalçeşme Formasyonu'ndan elde edilen konodontlar coğrafik olarak yaygın formlardır ve herhangi bir bölgesellik göstermezler.

Anahtar Sözcükler: konodontlar, Desmonesiyen, Çatalçeşme Formasyonu, Demirözü (Bayburt), Doğu Pontidler

Introduction

A Palaeozoic sedimentary sequence known as "the Permo-Carboniferous of Demirözü" is exposed near the town of Demirözü, approximately 30 km southwest of Bayburt, NE Turkey (Figures 1 & 2). The sequence is geologically very important as it is the only known Palaeozoic sedimentary series in the Eastern Pontides, and thus provides evidence about the Late Palaeozoic evolution of this region (Okay & Leven 1996). It has received considerable attention from some researchers because of its geological importance and coal content. Ketin (1951) is the first researcher who defined "the Permo-Carboniferous of Demirözü". In more recent years, the stratigraphy of the succession has been studied

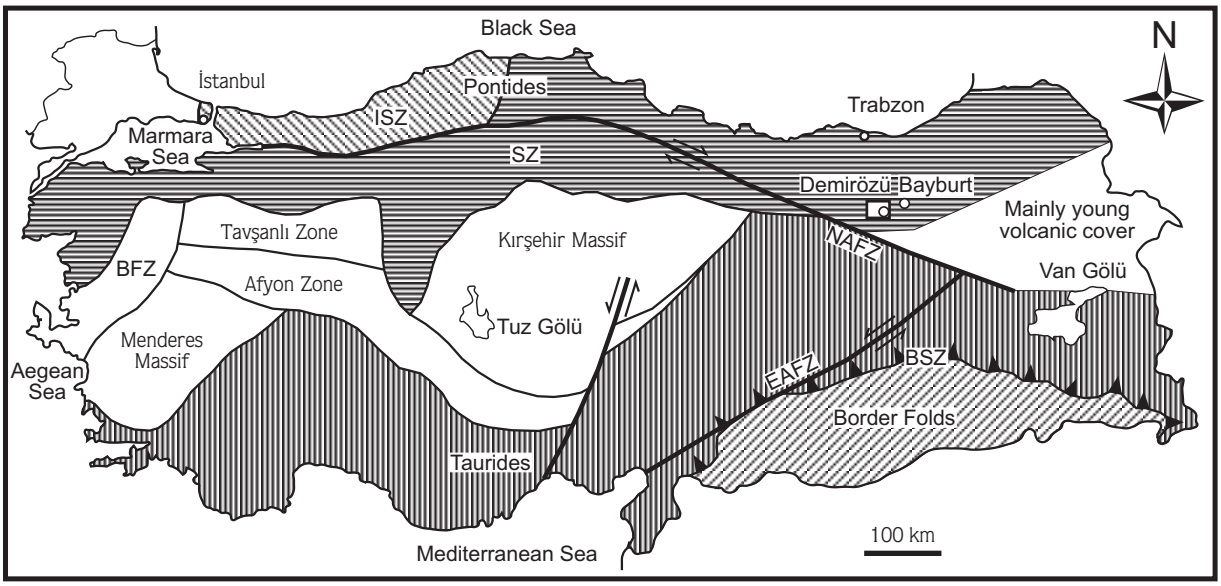

Figure 1. Tectonic map of Turkey (from Okay & Tüysüz 1999), and the location of the study area. Abbreviations: BFZ– Bornova Flysch Zone; BSZ– Bitlis Suture Zone; EAFZ– East Anatolian Fault Zone; ISZ– İstanbul Zone; NAFZ– North Anatolian Fault Zone; SZ– Sakarya Zone.

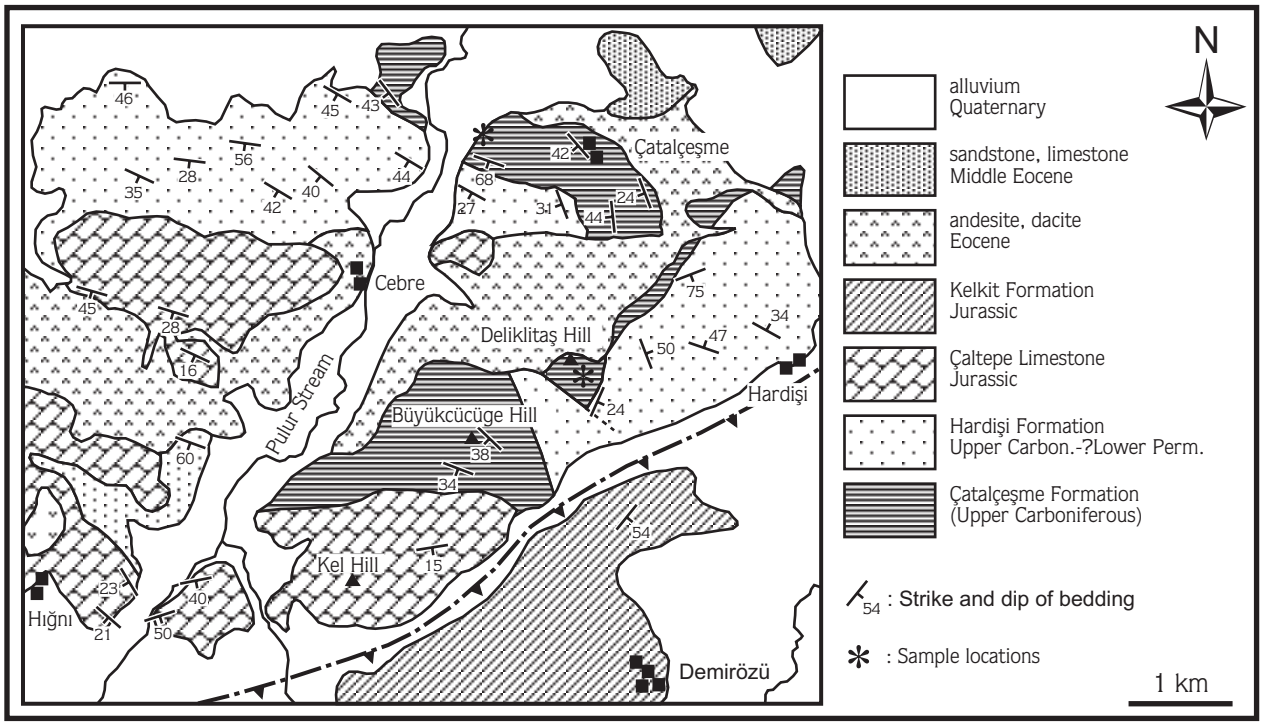

Figure 2. Geological map of the northwest of Demirözü, Bayburt (from Okay & Şahintürk 1997) showing the localities of the conodont-bearing samples. The locations of the samples containing conodonts are marked with a star.

in considerable detail (Ağar 1977; Keskin 1981; Akdeniz 1988; Robinson *et al.* 1995; Okay & Leven 1996; Okay *et al.* 1997; Okay & Şahintürk 1997). Okay & Leven (1996) revised the established stratigraphy and made important contributions to the better understanding of the Demirözü Palaeozoic sequence. They subdivided the sequence into two formations – Çatalçeşme and Hardişi formations, and studied fusulinids from the Çatalçeşme Formation.

The Demirözü Palaeozoic sequence has previously been investigated for its conodont fauna by Gedik (personal communication, 2002) and the author. However, none of these samples has produced conodont fauna. About 30 limestone samples were collected from three localities and processed for conodonts in the present study. Only three of them yielded the first conodont faunas encountered in the Permo-Carboniferous sediments of the Eastern Pontides. The purposes of the present study are therefore: (1) to describe this fauna and (2) to discuss its provinciality.

Stratigraphy

The geology of the Eastern Pontides is characterized by a complexly deformed and partly metamorphosed composite pre-Liassic basement – Carboniferous high-grade and Permo-Triassic low-grade metamorphic rocks – Lower Carboniferous granitoids, and Upper Carboniferous–? Lower Permian shallow marine to terrigeneous sedimentary rocks (Figure 1) (Okay & Şahintürk 1997; Topuz *et al.* 2001). A relative autochthon (Cebre) and three north-vergent thrust sheets (Hamurkesen, Aşutka, and İmalıdağ) are differentiated in the region (Okay *et al.* 1997). Palaeozoic sedimentary rocks occur in the Cebre relative autochthon and the overlying Hamurkesen thrust sheet (Okay & Leven 1996; Okay *et al.* 1997), and are exposed in the villages of Çatalçeşme (Figure 2) and Çamdere of the Demirözü area, Bayburt. The Çatalçeşme Palaeozoic sequence, the subject of this paper, occurs in the Cebre relative autochthon, and forms its base. It is divided into two formations (Okay & Şahintürk 1997; Okay & Leven 1996). The lower part, the Çatalçeşme Formation, consists of conglomerate, sandstone, limestone, quartzite, siltstone, and shale with scarce thin coal seams. Based on the fusulinids, the age of the formaton is Late Carboniferous (late Kasimovian–early Gzhelian on the Russian scale; late Missourian–early Virgilian on the North American scale; see Figure 3) (Okay & Leven 1996). Limestones, some of which contain conodont, are medium to thickly bedded, generally dark grey to black, locally rich in brachiopods, corals, bryozoa, gastropods, algae, and fusulinids. The lower contact of the Çatalçeşme Formation is covered by alluvium and intruded by Eocene volcanic rocks (Figure 2). The contact with the overlying Hardişi Formation is conformable and gradational. The continental Hardişi Formation is made up of unfossiliferous, terrigenous reddish sandstones and conglomerates, and is accepted as latest Carboniferous and possibly earliest Permian in age according to its stratigraphic position. Jurassic neritic limestones unconformably overlie the Hardişi Formation (Figure 2). More detailed descriptions of both units have been given in previous papers (Akdeniz 1988; Okay & Leven 1996; Okay *et al.* 1997).

<table>
<tr><th colspan="2">TIME</th><th>RUSSIA</th><th>NORTH AMERICA</th></tr>
<tr><td rowspan="8">CARBONIFEROUS</td><td rowspan="4">Pennsylvanian</td><td>Gzhelian</td><td>Virgilian</td></tr>
<tr><td>Kasimovian</td><td>Missourian</td></tr>
<tr><td rowspan="2">Moscovian</td><td>Desmoinesian</td></tr>
<tr><td>Atokan</td></tr>
<tr><td>Bashkirian</td><td>Morrowan</td></tr>
<tr><td rowspan="4">Mississippian</td><td>Serpukhovian</td><td>Chesterian</td></tr>
<tr><td>Visean</td><td>Meramecian</td></tr>
<tr><td rowspan="2">Tournaisian</td><td>Osagean</td></tr>
<tr><td>Kinderhookian</td></tr>
</table>

Figure 3. Correlation of the Russian and North American ages of the Carboniferous Period (Salvador 1985).

Conodont Fauna, Localities and Sedimentological Features

Samples have been collected from three localities: the Deliklitaş Hill, the Büyükcücüge Hill, and the Çatalçeşme-Cebre road cut (Figure 2). However, conodonts have been recovered from one sample (DT3) of the Deliklitaş Hill section and two samples (CY1 and CY4) of the

Çatalçeşme-Cebre road cut section. They have been represented only by their Pa elements in the collections.

Sample DT3 of the Deliklitaş Hill section, about 2 km south of the village of Çatalçeşme, yielded a rich conodont fauna. This shallow water conodont fauna with *Neognathodus bassleri, Idiognathodus* sp., *Streptognathodus elegantulus,* and *Gondolella* sp. is obtained from a bioclastic limestone bed. The fauna is dominated by *Neognathodus bassleri* (about 90%) and, therefore, can be assigned to the *Neognathodus*-biofacies (Merrill & von Bitter 1976). *Neognathodus* probably preferred environments similar to those inhabited by *Idiognathodus*, namely slightly offshore, normal marine environments (Driese *et al.* 1984).

The limestone sample that yielded this conodont fauna is a thin-bedded bioclastic packstone with densely packed bioclasts, and rare quartz and rock fragments in a micritic matrix. It is also rich in haematite and limonite that causes its colour, light to medium grey when fresh, to weather to a rust colour. Bioclasts are shells of brachiopods, pelecypods, and echinoderms. This fauna indicates an originally high-energy biotope and later allochthonous deposition of these particles in a protected low-energy environment. It has an over-packed fabric characterized by sutured grain contacts with iron-oxide accumulations. The conodonts have also been adversely affected by this deformation, and have been broken, cracked and distorted. They are very dark greyish brown with a Conodont Alteration Index of 3, indicating a temperature of about 110–200 °C (cf. Epstein *et al.* 1977). Although the Çatalçeşme-Hardişi contact in the Deliklitaş Hill is covered by soil, it is interpreted as a probable fault because beds are generally deformed in this area.

Two limestone samples (CY1 and CY4) from the Çatalçeşme-Cebre road cut section, about 1250 m west of the village of Çatalçeşme, yielded a poor conodont fauna with a few Pa elements of *Streptognathodus elongatus* STAUFFER & PLUMMER.

The overlying Hardişi Formation, conformable and gradational with the Çatalçeşme Formation, consists of detrital rocks and is barren of fossils.

Systematic Palaeontology

Family Gondolellidae LINDSTRÖM, 1970

Genus *Gondolella* STAUFFER & PLUMMER, 1932

Type species *Gondolella elegantula* STAUFFER & PLUMMER, 1932

Gondolella sp.

Plate 1, Figure 14

Description – Pa element is straight longitudinally, and symmetrical with subparallel sides. Slightly upturned platform margins may be smooth or faintly sculptured. Carina, highest at anterior end, consists of denticles fused anteriorly and closely spaced posteriorly. Aboral surface has a strong keel with pronounced medial groove that extends from anterior tip into pit at posterior end of platform. Pit is bordered by a nearly circular loop, the outer margin of which is slightly wider than the inner.

Remarks – A single Pa element, poorly preserved, has been found. In this specimen, the features of the oral surface are obscured by matrix. Furthermore, the anterior tip of the platform and cusp is broken.

Locality, Sample and Material – Deliklitaş Hill (Figure 2), DT3, 1 Pa element.

Family Idiognathodontidae HARRIS & HOLLINGSWORTH, 1933

Genus *Idiognathodus* GUNNELL, 1931

Type species *Idiognathodus claviformis* GUNNELL, 1931

Idiognathodus sp.

Plate 1, Figures 1-3

Diagnosis – Platform is slender and usually pointed at its posterior end. Free blade is attached to the platform in a median position. The short carina, posterior extension of the free blade, is generally restricted on the anterior one-third to one-fourth of the platform, and is flanked on the right side by one to two parallel ridges and on the left side by one parallel ridge. The posterior platform is ornamented with straight and parallel transverse ridges.

These parallel ridges are more subdued than usual and some abrasion may have modified them. The ridges are perpendicular or slightly diagonal to platform margins. One or both anterolateral margins of the platform may be occupied by nodose accessory lobes. Basal cavity is large and asymmetrical.

Remarks – Some Pa elements are close to *Idiognathodus delicatus* GUNNELL.

Locality, Sample and Material – Deliklitaş Hill (Figure 2), DT3, 28 Pa elements.

Genus *Neognathodus* DUNN, 1970

Type species *Polygnathus bassleri* HARRIS & HOLLINGSWORTH, 1933

Neognathodus bassleri

(HARRIS & HOLLINGSWORTH, 1933)

Plate 1, Figures 10-13

Polygnathus bassleri HARRIS & HOLLINGSWORTH, 1933, p. 198-199, Pl. 1, figs. 13a-e.

Neognathodus bassleri (HARRIS & HOLLINGSWORTH). SWEET in ZIEGLER (ed), 1975, p. 197–200, *Neognathodus*-Pl. 1, figs. 3a–b (see synonymy); GRAYSON, MERRILL & LAMBERT, 1990, p. 378–379, Pl. 3, figs. 36–37 (Pa elements), Pl. 3, fig. 41 (Pb element), Pl. 3, figs. 29, 30, 35 (M elements), Pl. 3, figs. 28, 33-34 (Sa elements), Pl. 3, fig. 42 (Sb element), Pl. 3, figs. 32, 38–40 (Sc elements), Pl. 3, fig. 31 (Sd element).

Description – The Pa elements of *Neognathodus bassleri* are defined by a carina that does not extend to the posterior end of the platform, and by two nodose parapets flanking the carina and meeting posteriorly. Unit is straight or slightly curved longitudinally. The platform with a pointed to acutely rounded posterior end varies from distinctly asymmetrical to almost symmetrical. The carina consists of denticles fused anteriorly and closely spaced posteriorly. Asymmetrical basal cavity is widely expanded.

Remarks – The present Pa elements can be divided into two morphotypes: a narrow morphotype (Pl. 1, fig. 12) with nearly parallel sides, and a wide morphotype (Pl. 1, fig. 13), one margin of which is nearly straight and the other distinctly convex.

Locality, Sample and Material – Deliklitaş Hill (Figure 2), DT3, at least 350 Pa elements mostly broken.

Genus *Streptognathodus*

STAUFFER & PLUMMER, 1932

Type species *Streptognathodus excelsus* STAUFFER & PLUMMER, 1932

Streptognathodus elegantulus

STAUFFER & PLUMMER, 1932

Plate 1, Figures 4-6

Streptognathodus elegantulus STAUFFER & PLUMMER, 1932, p. 47, Pl. 5, figs. 6, 7, 22, 27; ELLISON, 1941, p. 127–128, Pl. 22, figs. 1–6, 10; HUI & SHILU, 1990, Pl. 1, figs. 6, 19.

Polygnathus pawhuskensis HARRIS & HOLLINGSWORTH, 1933, p. 199–200, Pl. 1, figs. 12a-b.

Description – A medial to submedial deep median trough bisecting the posterior platform, and a carina restricted into anterior half to one-third of the platform consisting of a row of nodes or a fused ridge are the most distinctive features of the Pa element. Oral surface of the platform is ornamented with transverse ridges ending in a U-shaped median trough. Some Pa elements have an incipient accessory lobe bearing one or more discrete or fused nodes.

Remarks – Similar Pa elements reported from the Desmoinesian of British Columbia have been defined as *Idiognathodus-Streptognathodus plexus*, and three subgroups based on the characteristics of Pa elements are distinguished (Orchard & Struik 1985). The present Pa elements correspond to the subgroup 3 from these. Brown *et al.* (1993) has assigned similar specimens with

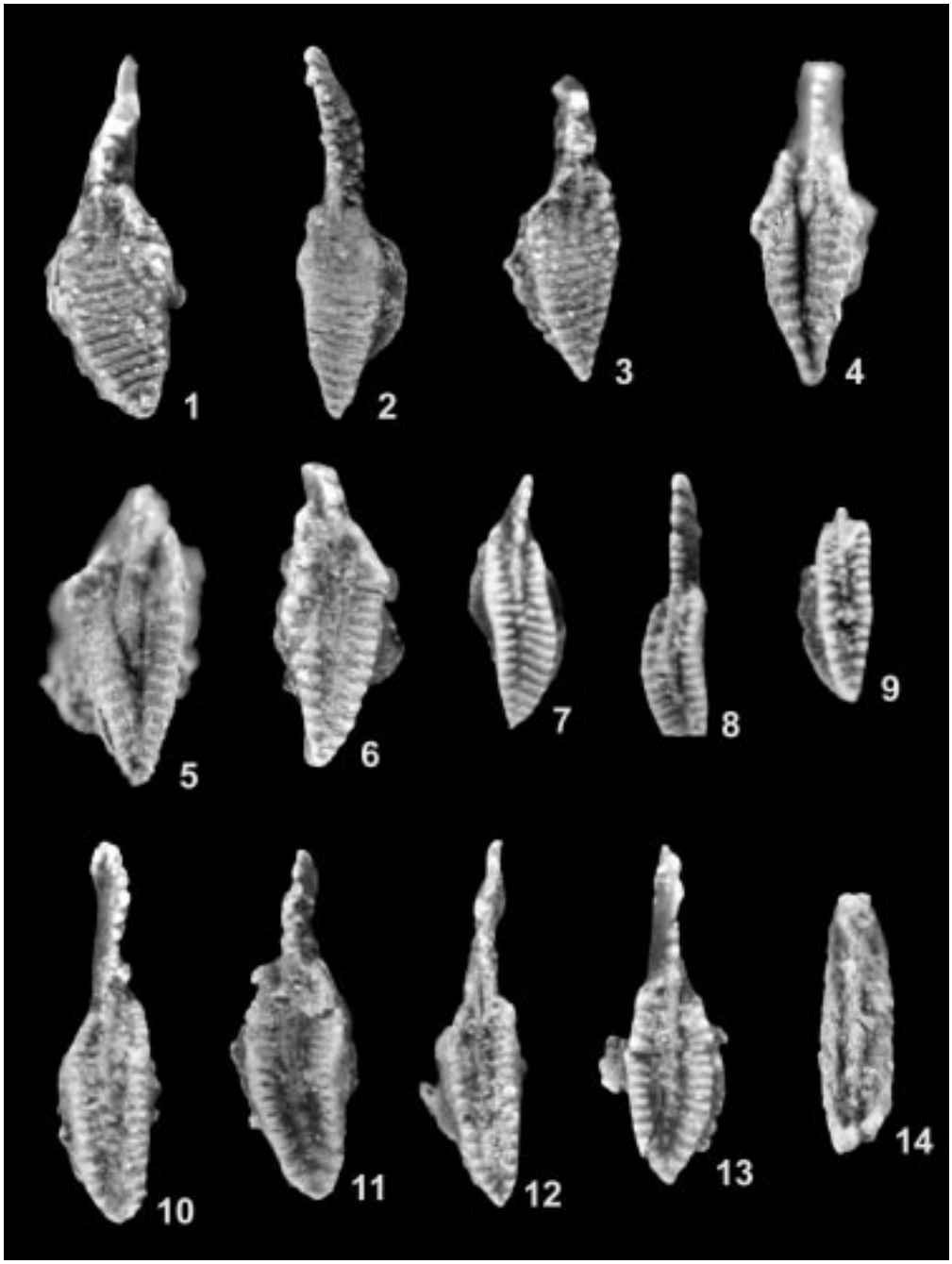

PLATE 1 Late Carboniferous conodonts from the Çatalçeşme Formation of the Demirözü Palaeozoic sequence. All specimens present the upper views of Pa elements. Specimens are reposited in KTÜ, Department of Geology, Trabzon.

Figures 1-3. *Idiognathodus* sp., Deliklitaş Hill, sample DT3. 1. x33, 2. x32, 3. x38.

Figures 4-6. *Streptognathodus elegantulus* STAUFFER & PLUMMER, 1932, Deliklitaş Hill, sample DT3. 4. x27, 5. x26, 6. x29.

Figures 7-9. *Streptognathodus elongatus* GUNNELL, 1933, The Çatalceşme-Cebre road cut, 7. Sample CY4, x40, 8. Sample CY1, x41, 9. Sample CY4, x47.

Figures 10-13. *Neognathodus bassleri* (HARRIS & HOLLINGSWORTH, 1933), Deliklitaş Hill, sample DT3, 10. x34, 11. x35, 12. x34, 13. x30.

Figure 14. *Gondolella* sp., Deliklitaş Hill, sample DT3, x40.

a trough on the platform to *Streptognathodus,* and placed all of them in *Streptognathodus elegantulus*.

Locality, Sample and Material – Deliklitaş Hill (Figure 2), DT3, 5 Pa elements.

Streptognathodus elongatus GUNNELL, 1933

Plate 1, Figures 7-9

Streptognathodus elongatus GUNNELL, 1933, p. 283–284, Pl. 33, fig. 30; ELLISON, 1941, p. 130–131, Pl. 22, fig. 9; HUI & SHILU, 1990, Pl. 1, figs. 1–2.

Streptognathodus simplex GUNNELL, 1933, p. 285–286, pl. 33, fig. 40.

Description – A short carina restricted to anterior half of the platform and a V-shaped median trough extending to posterior end of the platform are the most characteristic features of the Pa element of *Streptognathodus elongatus*. Unit is slightly flexed laterally. Platform with nearly parallel sides in anterior part tapers after about posterior one-third and terminates with a pointed posterior tip. Oral surface is ornamented with transverse ridges ending in the median trough. Wide flaring basal cavity occupies the entire lower surface of the platform.

Remarks – The Pa elements of *Streptognathodus elongatus* differ from those of *Streptognathodus elengantulus* by having a more slender platform and a median trough with a V-shaped transverse section as indicated by Ellison (1941). In the latter, the median trough is U-shaped in transverse section.

Locality, Sample and Material – The Çatalceşme-Cebre road cut (Figure 2), CY1 and CY4, 8 Pa elements.

Discussion and Conclusions

This investigation shows that conodonts are present but not common in the Demirözü Permo-Carboniferous sequence. They were recovered from limestone strata in the Çatalçeşme Formation exposed in the village of Çatalçeşme, Demirözü, Bayburt (Figure 2). A conodont fauna with abundant *Neognathodus bassleri* (HARRIS & HOLLINGSWORTH), less *Idiognathodus* sp. and *Streptognathodus elegantulus* STAUFFER & PLUMMER and scarce *Gondolellla* sp. were found in sample DT3 of the Çatalçeşme Formation (Figure 2). Although the conodont assemblage consists mainly of long-ranging forms, it indicates the Desmoinesian (late Moscovian on Russian scale) for this part of the formation (Figure 3), which is based on the co-occurrence of *Neognathodus bassleri* (HARRIS & HOLLINGSWORTH), *Streptognathodus elegantulus* STAUFFER & PLUMMER and *Gondolella* sp. In the Desmoinesian, *Neognathodus bassleri* has its last occurrence, and *Streptognathodus elegantulus* and genus *Gondolella* their first occurrences (Sweet 1973, 1975).

The other two limestone samples (CY1 and CY4) obtained from the Çatalçeşme-Cebre road cut section (Figure 2) produced a few Pa elements of *Streptognathodus elongatus* GUNNELL. This species is a stratigraphically long-ranging form, and extends from the ?mid-Pennsylvanian (Missourian) or the late Pennsylvanian (Virgilian) to the Early Permian (Wolfcampian) (Sweet 1975).

By fusulinids, the age of the Çatalçeşme Formation has previously been determined as the late Kasimovian–early Gzhelian (late Missourian–early Virgilian on the North American scale) (Okay & Leven 1996). According to combined fusulinid and conodont data, it belongs to an interval extending from the Desmoinesian to the early Virgilian (late Moscovian to early Gzhelian on the Russian scale) (Figure 3).

Furthermore, a rich fossil flora has been obtained from dark grey shale beds of the Çatalçeşme Formation. These specimens (unpublished) consist of forms similar to those of Ağar (1977). Based on its fossil flora, "the Permo-Carboniferous of Demirözü" has previously been referred to as Gondwana by Akdeniz (1988), and Euramerica by Şengör (1990).

Conodonts show strong provinciality three times during the Palaeozoic: Ordovician, Early Devonian, and Pennsylvanian–Permian (Charpentier 1984). Two faunal provinces called the American Province and Tethyan Province have been distinguished in Pennsylvanian conodonts. However, the conodont faunas of this study consist of geographically widespread forms, and do not show any provinciality.

From Turkey, a conodont fauna of the middle to late Atokan (middle Moscovian) age including different species of *Idiognathodus, Neognathodus* and *Idioprioniodus* has been described previously from the Kongul Formation of the Bolkardağ Unit, Central Taurus (Ekmekçi & Kozur 1999).

Acknowledgements

Professor Heinz Kozur and an anonymous reviewer are thanked for their comments and constructive reviews that improved an earlier draft of the paper. İsmet Gedik is also thanked for fruitful discussions. Steven K. Mittwede and Russel Fraser helped with English.

References

AĞAR, Ü. 1977. *Geology of the Demirözü (Bayburt) and Köse (Kelkit) Region*. PhD thesis, University of İstanbul, Turkey [in Turkish with English abstract, unpublished].

AKDENİZ, N. 1988. Permian and Carboniferous of Demirözü and their significance in the regional structure. *Geological Society of Turkey Bulletin* **31**, 71–80 [in Turkish with English abstract].

BROWN, L.M., REXROAD, C.B. & LIEURANCE, S. 1993. Conodont palaeontology of the Riverview Limestone Member of the Bond Formation (Pennsylvanian, Missourian) in Indiana. *Proceedings of the Indiana Academy of Science* **102**, 219–228.

CHARPENTIER, R.R. 1984. Conodonts through time and space: studies in conodont provincialism. *In*: CLARK, D.L. (ed), *Conodont Biofacies and Provincialism*. Geological Society of America Special Paper **196**, 11–32.

DRIESE, S.G., CARR, T.R. & CLARK, D.L. 1984. Quantitative analysis of Pennsylvanian shallow-water conodont biofacies, Utah and Colorado. *In*: CLARK, D.L. (ed), *Conodont Biofacies and Provincialism*. Geological Society of America Special Paper **196**, 233–250.

DUNN, D.L. 1970. Middle Carboniferous conodonts from the western United States and phylogeny of the platform group. *Journal of Paleontology* **44**, 312–342.

EKMEKÇİ, E & KOZUR, H.W. 1999. Conodonts of Middle Moscovian age from the Kongul Formation (Bolkardağ Unit), Northwest of Hadim, Central Taurus, Turkey. *Geologia Croatica* **52**, 1–8.

ELLISON, S.P.JR. 1941. Revision of the Pennsylvanian conodonts. *Journal of Paleontology* **15**, 107–143.

EPSTEIN, A.G., EPSTEIN, J.B. & HARRIS, L.D. 1977. Conodont color alteration – an index to organic metamorphism. *United States Geological Survey Professional Paper* **995**, 1–27.

GRAYSON, R.C.JR., MERRILL, G.K. & LAMBERT, L.L. 1990. Carboniferous Gnathodontid conodont apparatuses: evidence of a dual origin for Pennsylvanian taxa. *In*: ZIEGLER, W. (ed), *1st International Senckenberg Conference and 5th European Conodont Symposium (ECOS V), Contributions IV, Papers on Conodonts and Ordovician to Triassic Conodont Stratigraphy,* Courier Forschungsinstitut Senckenberg **118**, 353–396.

GUNNELL, F.H. 1931. Conodonts from the Fort Scott Limestone of Missouri. *Journal of Paleontology* **5**, 244–252.

GUNNEL, F.H. 1933. Conodonts and fish remains from the Cherokee, Kansas City, and Wabaunsee Groups of Missouri and Kansas. *Journal of Paleontology* **7**, 261–297.

HARRIS, R.W. & HOLLINGSWORTH, R.V. 1933. New Pennsylvanian conodonts from Oklahoma. *American Journal of Science* **225**, 193–204.

HUI, D. & SHILU, W. 1990. The Carboniferous-Permian conodont event-stratigraphy in the South of the North China Platform. *In*: ZIEGLER, W. (ed), *1st International Senckenberg Conference and 5th European Conodont Symposium (ECOS V), Contributions IV, Papers on Conodonts and Ordovician to Triassic Conodont Stratigraphy,* Courier Forschungsinstitut Senckenberg **118**, 131–155.

KESKİN, İ. 1981. A new evidence on the age of the Pulur Metamorphics. *General Directorate of Mineral Research and Exploration Bulletin* **107**, 171–174 [in Turkish with English abstract].

KETIN, İ. 1951. Über die Geologie der Gegend von Bayburt in Nordost Anatolien. *University of İstanbul, Faculty of Physical Science, Seri B* **16**, 113–127.

LINDSTRÖM, M. 1970. A suprageneric taxonomy of the conodonts. *Lethaia* **3**, 427–445.

MERRILL, G.K. & VON BITTER, P.H. 1976. Revision of conodont biofacies nomenclature and interpretations of environmental controls in Pennsylvanian rocks of Eastern and Central North America. *Life Sciences Contributions, Royal Ontario Museum* **108**, 1–46.

OKAY, A.İ. & LEVEN, E.Ja. 1996. Stratigraphy and Paleontology of the Upper Paleozoic Sequences in the Pulur (Bayburt) Region, Eastern Pontides. *Turkish Journal of Earth Sciences* **5**, 145–155.

OKAY, A.İ. & ŞAHİNTÜRK, Ö. 1997. Geology of the Eastern Pontides. *In*: ROBINSON, A.G. (ed), *Regional and Petroleum Geology of the Black Sea and Surrounding Region*. American Association of Petroleum Geologists, Memoir **68**, 291–311.

OKAY, A.İ. & TÜYSÜZ, O. 1999. Tethyan sutures of northern Turkey. *In*: DURAN, B., JOLIVET, L., HORVÁTH, F. & SÉRANNE, M. (eds), *The Mediterranean Basins: Tertiary Extension within the Alpine Orogen*. Geological Society, London, Special Publication **156**, 475–515.

OKAY, A.İ., ŞAHİNTÜRK, Ö. & YAKAR, H. 1997. Stratigraphy and tectonics of the Pulur (Bayburt) region in the Eastern Pontides. *General Directorate of Mineral Research and Exploration Bulletin* **119**, 1–24.

ORCHARD, M.J. & STRUIK, L.C. 1985. Conodonts and stratigraphy of upper Paleozoic limestones in Cariboo gold belt, east-central British Columbia. *Canadian Journal of Earth Sciences* **22**, 538–552.

ROBINSON, A.G., BANKS, C.J., RUTHERFORD, M.M. & HIRST, J.P.P. 1995. Stratigraphic and structural development of the Eastern Pontides, Turkey. *Journal of the Geological Society, London* **152**, 861–872.

SALVADOR, A. 1985. Chronostratigraphic and geochronometric scales in COSUNA stratigraphic nomenclature charts of the United States. *The American Association of Petroleum Geologists Bulletin* **69**, 182–184.

STAUFFER, C.R. & PLUMMER, H.J. 1932. Texas Pennsylvanian conodonts and their stratigraphic relations. *The University of Texas Bulletin* **3201**, 13–50.

SWEET, W.C. 1973. *Gondolella*. *In*: ZIEGLER, W. (ed), *Catalogue of Conodonts I.* E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 95–112.

SWEET, W.C. 1975. *Neognathodus*. *In*: ZIEGLER, W. (ed), *Catalogue of Conodonts I.* E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 201–234.

ŞENGÖR, A.M.C. 1990. A new model for the late Paleozoic-Mesozoic tectonic evolution of Iran and implications for Oman. *In*: ROBERTSON, A.H.F., SEARLES, M.P. & RIES, A.C. (eds), *The Geology and tectonics of the Oman Region*. Geological Society, London, Special Publications **49**, 797–831.

TOPUZ, G., ALTHERR, R., SATIR, M., SCHWARZ, W. & SADIKLAR, M.B. 2001. P-T path and cooling history of high-grade gneisses from the Pulur Massif (Eastern Pontides, NE Turkey). *In: Europrobe Neoproterozoic-Early Paleozoic Time-Slice Symposium:* Orogeny and Cratonic Response on the Margins of Baltica, Abstracts, Ankara, 88–90.

Received 07 August 2002; revised typescript accepted 09 March 2003