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Conodonts of Middle Moscovian Age from the Kongul Formation (Bolkardağ Unit), Northwest of Hadim, Central Taurus, Turkey

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Key words: Conodonts, Kongul Formation, Bolkardağ Unit, Atokan, Moscovian, Taurus, Turkey.

Abstract

A rich shallow water conodont fauna with *Idiognathodus incurvus* DUNN, *I.* cf. *suberectus* (DUNN), *Idioprioniodus* sp., and *Neognathodus columbiensis* STIBANE was found in the lower part of the Kongul Formation of the Bolkardağ Unit, about 12 km NW of Hadim town, central Taurus, Turkey. The conodonts indicate a middle to late Atokan age (on the American scale) for this part of the formation. On the Russian scale, the fauna corresponds to the middle Moscovian. According to previous correlations between the Russian and North American scales, a (middle) late Atokan (middle Moscovian age) is assumed for this fauna.

Variscan deep-water sequences are not present in the study area.

1. INTRODUCTION

Few conodont data have previously been published from Palaeozoic rocks of Turkey but recent investigations have shown that Palaeozoic conodonts are very common in Turkey and provide very important new data for the stratigraphy, palaeogeography and tectonic evolution of Turkey (e.g., KOZUR, 1997a, b, 1998; GÖNCÜOĞLU & KOZUR, 1998a, b). No conodonts have previously been reported from the Bolkardağ Unit of the Tauride-Anatolide Composite Terrane, but GÖNCÜOĞLU & KOZUR (1998a, b) dated a deep-sea turbidite-olistostrome unit within the Bolkardağ Unit (formerly assumed to be a Variscan Lower Carboniferous sequence - ÖZCAN et al., 1990) as Late Silurian to earliest Devonian from conodont and muellerisphaerid evidence.

The development of the Carboniferous in the Bolkardağ Unit is not yet clear. ÖZCAN et al. (1990) reported a Carboniferous deep-water sequence (Variscan development), but re-study of all known localities of this "Variscan" flysch by GÖNCÜOĞLU & KOZUR (1998a, b) did not confirm a Variscan age for these rocks (see above). ÖZGÜL (1997) assumed a Middle Devonian to Viséan-Serpukhovian age for the Hocalar and lower Kongul formations, and a Bashkirian to Moscovian age for the upper Kongul Formation, with no unconformity in the shallow-water deposits of this Middle Devonian to Moscovian time interval. This would exclude the existence of any Variscan oceanic unit and of Variscan movements.

Shallow-water pre-Permian deposits of the Bolkardağ Unit from the Hadim-Bozkir area in the central Taurides have been studied here, and Pennsylvanian (Moscovian) conodonts were discovered. As beds of this age could be either a shallow-water molasse (after the closure of a Variscan ocean) or shallow-water platform carbonates in an area without Variscan orogeny, further investigations of the underlying deposits (Hocalar Formation, Fig. 2) are necessary.

2. GEOLOGICAL SETTING AND PREVIOUS WORK

The first detailed research on the geology of the Central Taurus was carried out by BLUMENTHAL (1944, 1956), who recognized the presence of Permo-Carboniferous or Permian limestone and of Devonian(?) schists in the Hadim Region, and defined in 1956 a tectonic unit for Palaeozoic rocks that was later named the Bolkardağ Unit.

Comprehensive studies of this region were undertaken by ÖZGÜL (1969, 1976, 1984, 1997), ÖZGÜL & GEDIK (1973), GEDIK (1977) and MONOD (1977). ÖZGÜL (1984) subdivided the Taurus belt into six main tectonic units, the Geyikdağ Autochthon and the Antalya, Alanya, Aladağ, Bolkardağ and Bozkir units in nappe position.

The Bolkardağ Unit is, according to ÖZGÜL (1984), a rootless nappe over the Lutetian flysch of the Geyikdağ Unit. It was subdivided by ÖZGÜL (1997) into seven formations that range from the Middle Devonian to Upper Cretaceous. According to ÖZGÜL (1984), the Middle Devonian to pre-Turonian Cretaceous rocks are shallow-water deposits, and deep-water conditions started in the Turonian.

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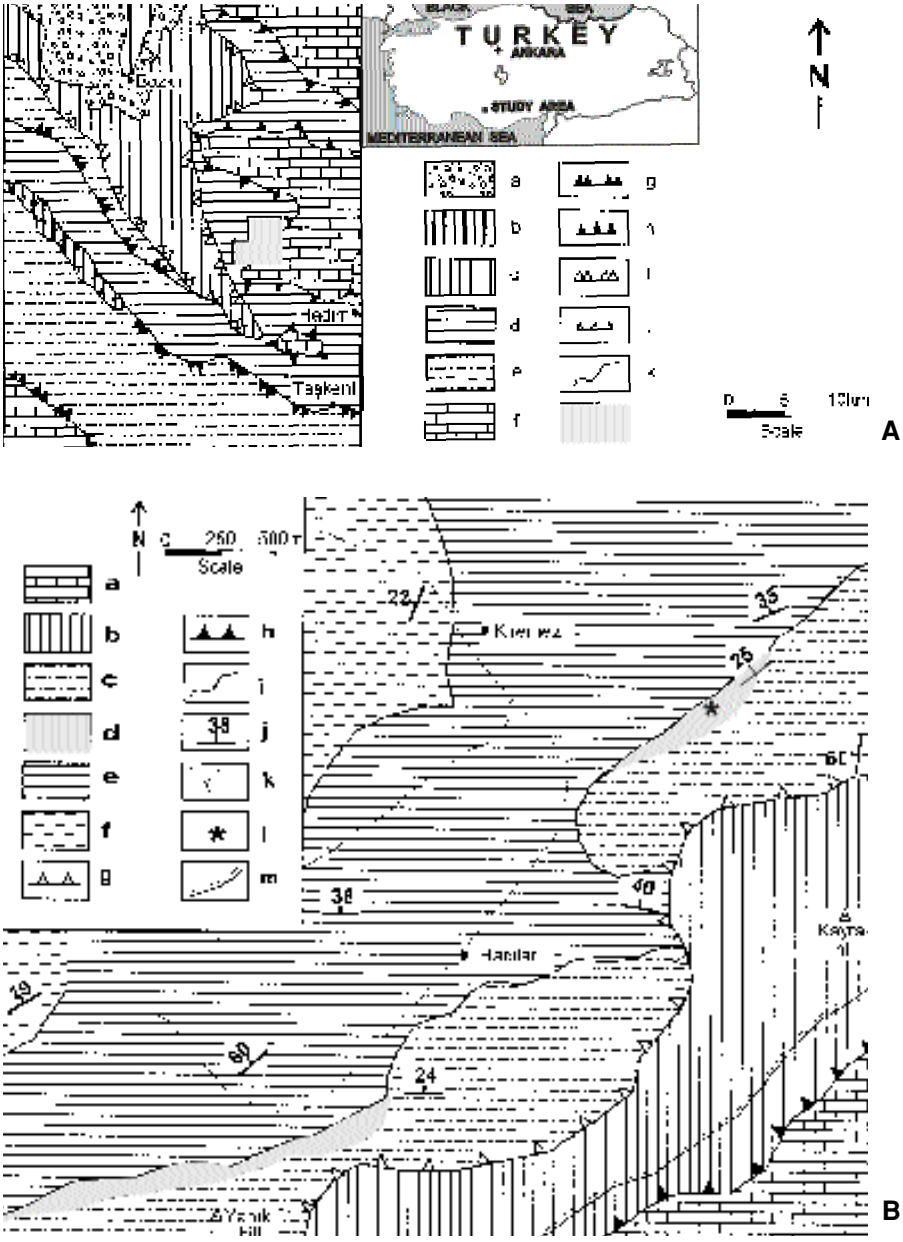

Fig. 1 Geological map. A) Generalized geological map of the Hadim-Bozkir area. Legend: a) Post-Mesozoic cover rocks; b) Dipsizgöl Ophiolite; c) Bozkir Unit; d) Bolkardağ Unit; e) Aladağ Unit (Hadim Unit); f) Geyikdağ Autochthon (Anamas-Akseki Autochthon); g) Hadim overthrust; h) Bolkardağ overthrust; i) Bozkir overthrust; j) ophiolite overthrust; k) normal contact; l) study area. B) Geological map of the study area and sample location. Legend: a) Palaeogene of the Anamas-Akseki Autochthon; b) Cretaceous siliciclastic sediments and volcanic rocks (Polat Fm.) of the Aladağ Unit; c-f) Bolkardağ Unit: c) pre-Moskovian Hocalar Fm., d) Moscovian Kongul Fm., e) Permian Kinikyayla Fm., f) Triassic Ekinlikyayla Fm; g) Bolkardağ Unit overthrust; h) Polat Fm. overthrust; i) normal contact; j) dip-strike; k) drainage system; l) sample location; m) stabilized road. Modified after OZGÜL (1969).

The Carboniferous of the Bolkardağ Unit is represented by the Kongul Formation which was subdivided by OZGÜL (1997) into the Zindancik Member of presumed Viséan-Serpukhovian age and the Mantarbeleni Member of presumed Bashkirian to Moscovian age. According to ÖZGÜL (1997), the Zidancik Member concordantly overlies the presumed Middle to Upper Devonian Hocalar Formation despite the fact that he could not date any Tournaisian rocks. The Zidancik Member consists mainly of dark shales, sandstones and limestones, while the Mantarbeleni Member consists of shallow-water, partly oolitic or dolomitic limestones. In the study area, the Kongul Formation lies unconformably on the Hocalar Formation, and begins with middle Moscovian limestones and shales, overlain by recrystallized limestone.

A new tectonic view to the Bolkardağ Unit was presented by ÖZCAN et al. (1990). They assigned a siliciclastic deep-water flysch to the Lower Carboniferous assuming a Variscan orogeny. Subsequently, GÖNCÜOĞLU & KOZUR (1998a, b) re-investigated three outcrops of these siliciclastic deep-sea flysch sequences and underlying ribbon cherts. In two sections, limestone and lydite olistoliths from the turbidite-olistostrome unit yielded Upper Silurian to Pragian conodonts. In a third outcrop, black ribbon cherts from a distal turbiditic shale-chert sequence with several benthonitic layers (altered felsic to intermediate tuffs) yielded Wenlock to Upper Silurian Muellerisphaerida. From these results, the existence of a Caledonian-time oceanic sequence was proven. This Karaburun-Bolkardağ Ocean (KOZUR, 1997a, b, 1998) separated for example, Ordovician Baltic warm-water faunas with connections to Siberian and North American warm-water faunas, from a typical Perigondwana Ordovician cold-water association (DEAN & MARTIN, 1992; MARTIN, 1996; GÖNCÜOĞ-

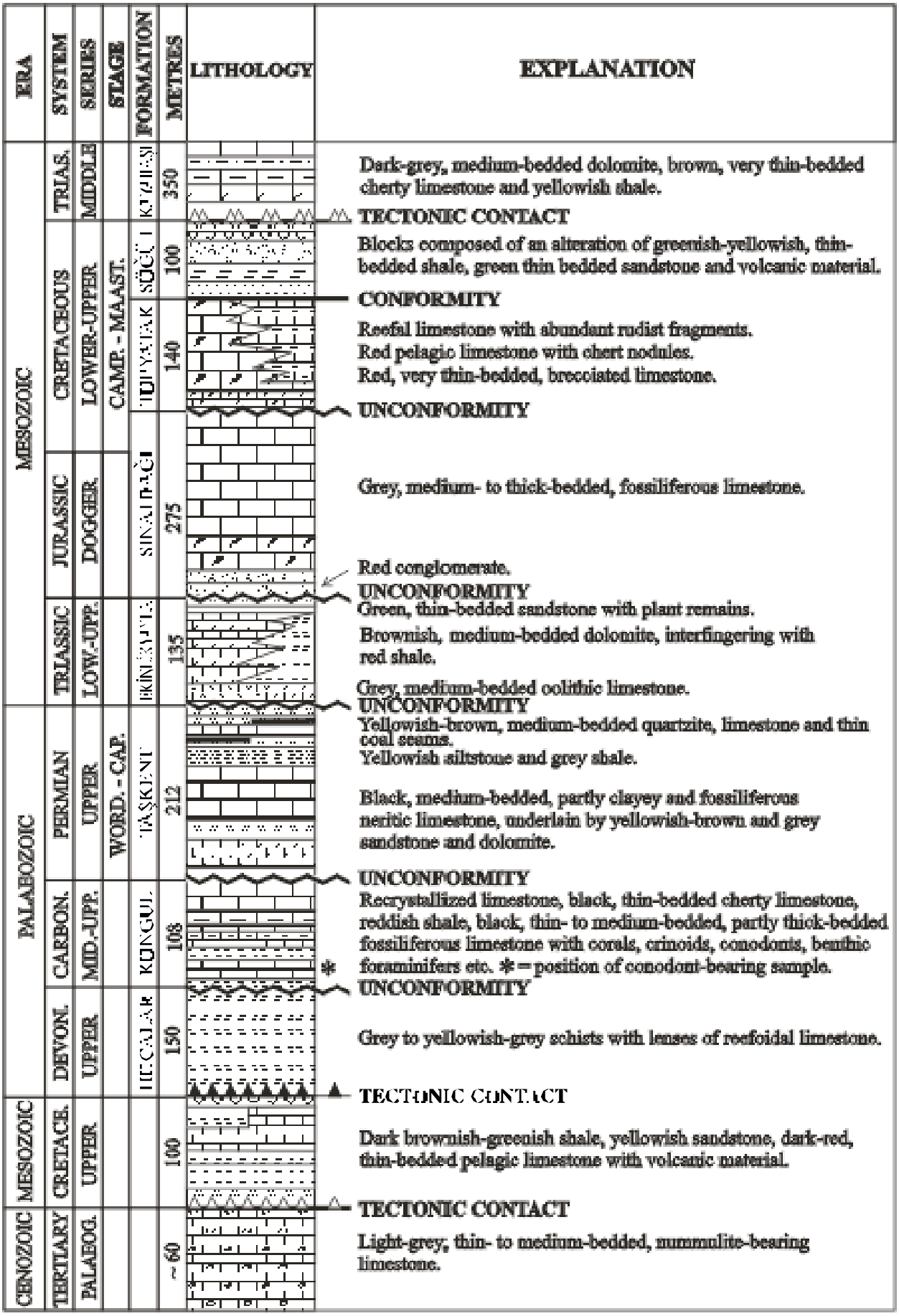

Fig. 2 Generalized columnar section of the Bolkardağ Unit (Hocalar to Söğüt formations) in the study area (after ÖZGÜL, 1997).

LU & KOZUR, 1998a, b). As in the Karaburun Zone both Upper Silurian-Pragian and upper Famennian to middle Viséan oceanic sequences are present, this may be also assumed for the Bolkardağ Unit, although the Triassic in this unit indicates a somewhat more southern palaeogeographic location than that for the Triassic of the Karaburun Zone. However, until now no Variscan deep-sea sequence was found in the Bolkardağ Unit.

3. LOCALITY DATA

The conodont-bearing sample from the lower part of the Kongul Formation (Bolkardağ Unit) was obtained from a road cut 2 km southeast of Kiremez village, about 12 km NW of Hadim (Fig. 1). The exposed Carboniferous Kongul Formation consists of recrystallized limestone, black, thin-bedded cherty limestone, reddish shale and black, thin- to medium-, partly thick-bedded fossiliferous limestone. The conodonts were obtained from sample AL 95/740 L that was taken from a fossiliferous limestone in the lower part of the Kongul Formation at this locality (Fig. 2).

4. AGE OF THE CONODONT FAUNA FROM THE LOWER KONGUL FORMATION

The following conodonts were determined from sample AL 95/740 L: *Idiognathodus incurvus* DUNN, 1966, *I.* ? cf. *suberectus* (DUNN, 1966), *Idioprioniodus* sp., and *Neognathodus columbiensis* (STIBANE, 1967).

Within the idiognathodid plexus *I. sinuosus* ELLISON & GRAVES - *I. incurvus* DUNN - *I. obliquus* KOSENKO & KOSITSKAYA forms with an inwardly curved and deflected downward posterior platform, continuous and equally spaced transverse ridges on the platform, a better developed and ornamented inner platform lobe and a well developed and flared inner serrate adcarinal ridge, as in our *I. incurvus* material, are, according to Dr. R.G. STAMM, Reston, and Dr. B.R. WARDLAW, Reston (pers. comm.), most typical of middle and late Atokan age. Such forms also occur in the late early and middle Moscovian of Russia. A similar age is indicated by *N. columbiensis* that occurs in the middle to late Atokan and in the Moscovian, except the latest Moscovian.

A similar *Idiognathodus* fauna and *N. columbiensis* is also present in the middle Moscovian of the Bükk Mts. in northern Hungary (KOZUR, 1984).

Only the presence of *Idiognathodus* ? cf. *suberectus* is problematical for age determination. This species was previously classified as *Streptognathodus*. However, it lacks a true platform trough and the anterior platform lobes are not reduced to absent as characteristic of true streptognathodids. Thus, this species is more closely related to *Idiognathodus* than to *Streptognathodus*. However, the missing uninterrupted transverse ribs in most of the platform makes this species an atypical *Idiognathodus*. It may represent a new genus. This species was previously described from the middle Morrovian (DUNN, 1966) which corresponds to the lower Bashkirian, an age that strongly conflicts with the age given by the common *I. incurvus* of the above mentioned morphotype and *N. columbiensis.* However, according to Dr. R.G. STAMM and Dr. B.R. WARDLAW (pers. comm.), *I.* ? *suberectus* is also known to occur sporadically through the late Morrowan and Atokan. This fits well with our material, in which *I.* ? cf. *suberectus* is very rare, whereas *I. incurvus* and *N. columbiensis* are common. *Idioprioniodus* sp. gives no age, but is indicative of shallow-water conditions.

5. CONCLUSIONS

The Kongul Formation in the study area unconformably overlies the Hocalar Formation. The age of the lower Kongul Formation in the study area is middle to late Atokan on the North American scale and late early Moscovian to middle Moscovian in the international (Russian) scale. This corresponds to the upper Duckmantian to earliest Westfalian D of the Western European scale (Fig. 3). Tethyan conodonts of this age were previously described from the Bükk Mountains of Hungary (KOZUR, 1984) where they represent the oldest shallow-water deposits above Lower Carboniferous to Bashkirian flyschoid deposits.

Neither Variscan deep-water sediments (ÖCZAN et al., 1990) nor Lower Carboniferous shallow-water deposits (ÖZGÜL, 1997) were found in the Bolkardağ Unit of the study area. TheVariscan orogeny cannot be proven in the study area.

The presence of a Silurian to Lower Devonian oceanic sequence (known from other parts of the Bolkardağ Zone - GÖNCÜOĞLU & KOZUR, 1998a, b) can neither be proven nor excluded for the Bolkardağ Unit of the study area, because the lower thrust boundary of the Bolkardağ Unit is not older than Middle Devonian (ÖZGÜL, 1997).

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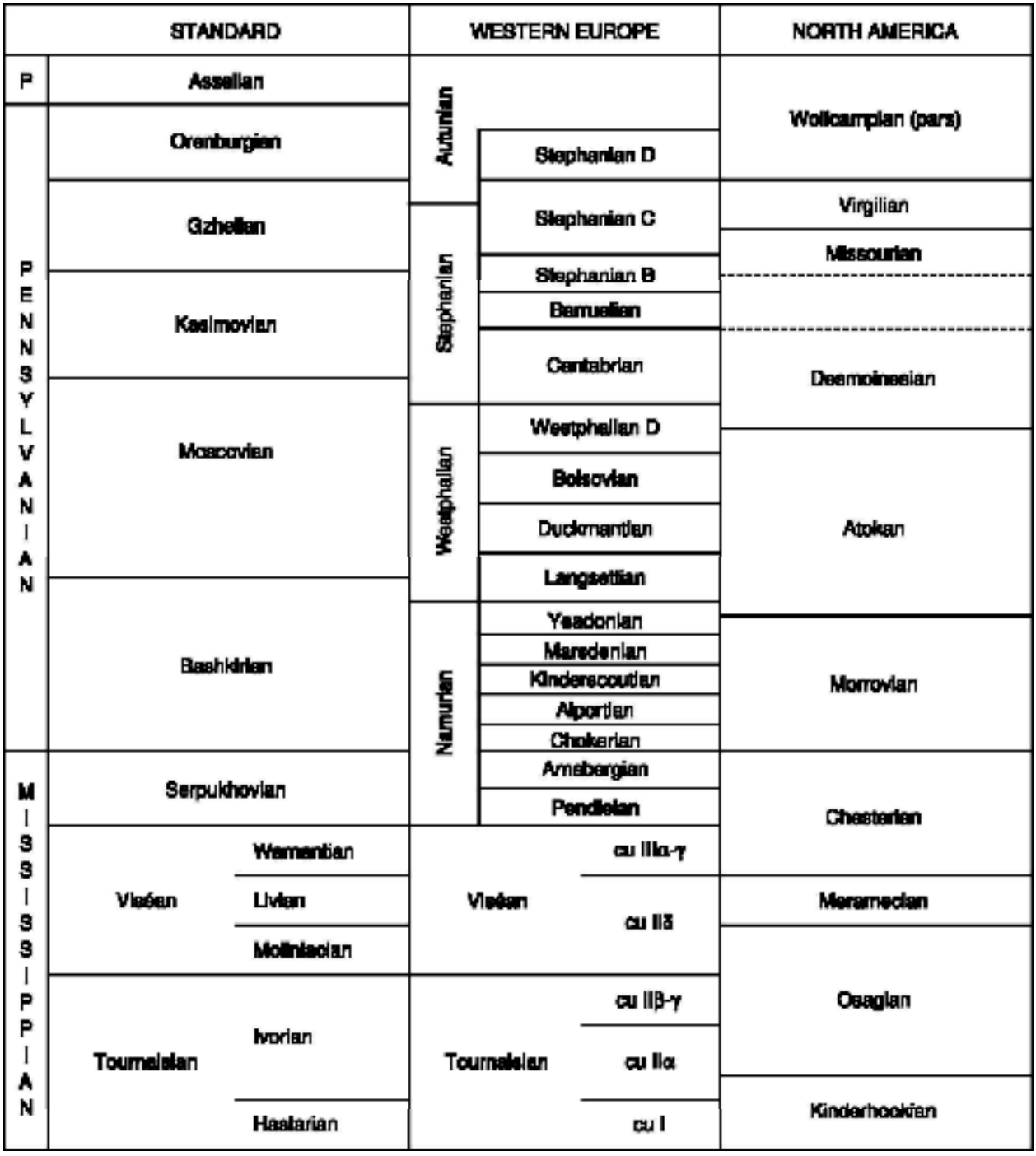

Fig. 3 Correlation of the Carboniferous standard subdivision with the Western European and North American subdivisions (after KOZUR, 1984, and WAGNER & WINKLER PRINS, 1997). Vertical distances not time-related. P = Permian.

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6. REFERENCES

BLUMENTHAL, M. (1944): Schichtenfolge und Bau der Taurusketten im Hinterland von Bozkir.- Rev. Fak. Sci. Univ. Istanbul, B 9/2, 15-125, Istanbul.

BLUMENTHAL, M., (1956): Yüksek Bolkardağinin Kuzey Kenar Bölgelerinin ve Bati Uzantilarinin Jeolojisi (The Geology of the Northern Border of the High Bolkardağ and western extensions).- MTA Yayỳn Seri D, 7, Ankara.

DEAN, W.T. & MARTIN, F. (1992): Ordovician biostratigraphic correlation in southern Turkey.- In: WEBBY, B.D. & LAURIE, J.R. (eds.): Global Perspectives on Ordovician Geology. 195-203.

DUNN, D.L. (1966): New Pennsylvanian platform con-

odonts from southwestern United States.- J. Paleont., 40/6, 1294-1303.

GEDIK, I. (1977): Conodont biostratigraphy in the Middle Taurus.- Bull. Geol. Soc. Turkey, 20, 35-48, Ankara.

GÖNCÜOĞLU, C. & KOZUR, H. (1998a): Remarks to the pre-Variscan development in Turkey.- In: LINNEMANN, U., HEUSE, T., FATKA, O., KRAFT, P., BROCKE, R. & ERDTMANN, B.-D. (eds.): Pre-Variscan Terrane Analysis of "Gondwanan Europe". Schr. Staatl. Mus. Min. Geol. Dresden, 9, 137-138, Dresden.

GÖNCÜOĞLU, C. & KOZUR, H. (1998b): Facial development and thermal alteration of the Silurian of Turkey and its importance for the reconstruction of the Hercynian and pre-Hercynian development in Turkey.- In: GUTIEREZ-MARCO, J.C. & RABANO, I. (eds.): Proceedings of the 1998 Field Meeting, IUGS Subcommission on Silurian Stratigraphy. Temas Geologico-Mineros ITGE, 23, 87-90, Madrid.

KOZUR, H. (1984): Biostratigraphic evaluation of the Upper Paleozoic conodonts, ostracods and holothurian sclerites of the Bükk Mts. Part I: Carboniferous conodonts and holothurian sclerites.- Acta Geol. Hungar., 27/1-2, 143-162.

KOZUR, H. (1997a): New stratigraphic results on the Paleozoic of the western parts of the Karaburun peninsula, western Turkey.- In: PIŞKIN, Ö., ERGÜN, M., SAVAŞÇIN, M.Y. & TARCAN, G. (eds.): Proc. International Earth Sciences Colloquium on the Aegean region, IESCA 1995, 1, 289-307, Izmir.

KOZUR, H. (1997b): First discovery of Muellerisphaerida (inc. sedis) and *Eoalbaillella* (Radiolaria) in Turkey and the age of the siliciclastic sequence (clastic series) in Karaburun Peninsula.- Freiberger Forsch.-H., C 466, 33-59.

KOZUR, H. (1998): The age of the siliciclastic series ("Karareis Formation") of the western Karaburun Peninsula, western Turkey.- In: SZANIAWSKI, H. (ed.): Proc. Sixth European Conodont Symposium (ECOS VI). Palaeont. Polonica, 58, 169-187, Warszawa.

MARTIN, F. (1996): Recognition of the acrtarch-based "*trifidum* flora" (Ordovician) in the absence of the eponymous species.- Bull. Inst. Royal. Sci. Natur. Belgique, 66, 5-13, Bruxelles.

MONOD, O. (1977): Recherces geologiques dans la Taurus occidentales au sud de Beyşehir (Turquie).- Unpublished PhD Thesis, Univ. Sud Orsay, 442 p., Paris.

PLATE I

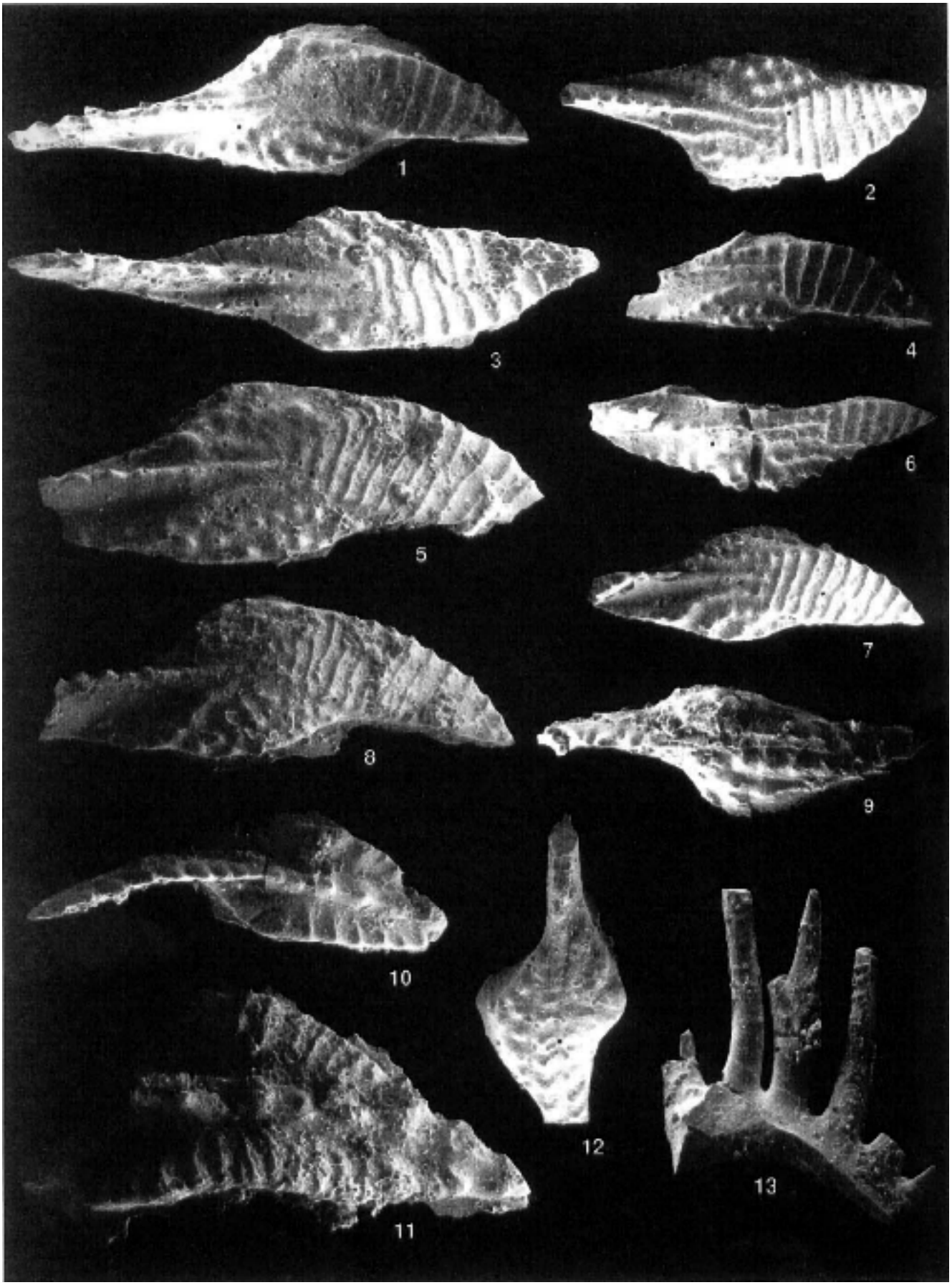
All illustrated specimens are from sample AL 95/740 L, lower Kongul Formation, middle Moscovian, Bolkardağ Unit, road cut 2 km southeast of Kiremez village, about 12 km NW of Hadim (for location see Fig. 1 in the text).

1-8 *Idiognathodus incurvus* DUNN, upper view; Fig. 1: x70, rep.-no. 23-2-97/III-7; Fig. 2: subadult specimen, x80, rep.-no. 23-2-97/III-1; Fig. 3: x80, rep.-no. 23-2-97/III-2; Fig. 4: late juvenile specimen, x80, rep.-no. 23-2-97/III-5; Fig. 5: x100, rep.-no. 23-2-97/III-3; Fig. 6: juvenile specimen, x80; rep.-no. 23-2-97/III-4; Fig. 7: late juvenile specimen, x80, rep.-no. 23-2-97/III-8; Fig. 8: x80, rep.-no. 23-2-97/III-12.

9 and 12 *Idiognathodus* ? cf. *suberectus* (DUNN), upper view; Fig. 9: juvenile specimen, x100, rep.-no. 23-2-97/III-16; Fig. 12: x80, rep.-no. 23-2-97/III-9.

10 and 11 *Neognathodus columbiensis* (STIBANE), upper view; Fig. 10: juvenile specimen, x100, rep.-no. 23-2-97/III-10; Fig. 11: broken specimen, x100, rep.-no. 23-2-97/III-15.

13 *Idioprioniodus* sp., broken lateral process, x80, rep.-no. 23-2-97/III-6.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ÖZCAN, A., GÖNCÜOĞLU, M.C., TURHAN, N., UYSAL, Ş., ŞENTÜRK, K. & IŞIK, A. (1990): Late Paleozoic evolution of the Kütahya-Bolkardağ Belt.- METU Journal of Pure and Applied Sciences, Series A Geoscience, I, 21/1-3, 211-220, Ankara.

ÖZGÜL, N. (1969): 1/25.000 scale Geological Map of N29C3-C4.- Archive of Geological Research Departments, General Directorate of Mineral Research and Exploration (MTA) (unpublished).

ÖZGÜL, N. (1976): Toroslarin Bazi Temel Jeolojik Özellikleri (Some Geological aspects of the Taurus Orogenic Belt (Turkey)).- Bull. Geol. Soc. of Turkey, 19, 65-78, Ankara.

ÖZGÜL, N. (1984): Geology of the Central Taurides.- In: TEKELI, O. & GÖNCÜOĞLU, M.C. (eds.): Geology of Taurus Belt. Int. Symposium, 26-29 September 1983, 77-90, Ankara.

ÖZGÜL, N. (1997): Bozkir-Hadim-Taskent (Orta Toroslar'in Kuzey kesimi) dolayinda yer alan Tektonostratigrafik birliklerin stratigrafisi.- MTA Der., 119, 113-174, Ankara.

ÖZGÜL, N. & GEDIK, I. (1973): Orta Toroslarda Alt Paleozoyik yaşta Çaltepe Kireçtaşi ve Seydişehir formasyonunun Stratigrafisi ve Konodont Faunasi Hakkinda Yeni Bilgiler.- Bull. Geol. Soc. Turkey, 16, 39-52, Ankara.

STIBANE, F.R. (1967): Conodonten des Karbons aus den nördlichen Anden Südamerikas.- N. Jb. Geol. Paläont., Abh., 128, 329-340, Stuttgart.

WAGNER, R.H. & WINKLER PRINS, C.F. (1997): Carboniferous chronostratigraphy: Quo vadis?- In: PODEMSKI, M., DYBOVA-JACHOWICZ, S., JAWOROWSKI, K., JURECZKA, K. & WAGNER, R. (eds.): Proceedings of the XIII International Congress on the Carboniferous and Permian. Prace Pánstw. Inst. Geol., 157, 145-157, Warszawa.

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