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Early Devonian transgression in the Eastern Antalya Nappes: conodont data from the Tahtalidag Nappe, north of Alanya, southern Turkey

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Abstract – The second carbonate level in the Güneyyaka Formation of the Ovacik and Gündogmus slivers of the Tahtalidag Nappe (eastern Antalya nappes, southern Turkey) have been dated by conodonts as late early to middle Lochkovian (Early Devonian). Previous interpretations where the Güneyyaka Formation begins in the Late Silurian and represents continuous deposition through to the Middle Devonian, are not confirmed. An earliest Devonian transgression post-dating a pronounced Silurian-Devonian boundary hiatus is also recorded in the Tahtalidag Nappe. There is little thermal alteration of sediments deposited in the Karaburun-Boikardag Ocean on the Perigondwanan shelf to the south during the Caledonian time interval.

INTRODUCTION

The Devonian successions of southern Turkey were poorly understood prior to the 1970s. The pioneering stratigraphic studies of Özgül *et al.* (1973) and Demirtaşli (1973) in conjunction with Gedik's (1977) studies of conodont biostratigraphy advanced our understanding of Devonian stratigraphy and distribution in the Taurides. In particular, these studies have shown that Early Devonian rocks are restricted to the Antalya nappes in the southern Taurides. Gedik (1988) briefly summarized the rock-types and suggested that Devonian deposition in the central Taurides was concentrated in two distinct basins separated by an intervening high, the Hadim-Suetandag Uplift. The southern basin, from where the Antalya nappes are assumed to be originated, is interpreted as a restricted and/or closed basin representing the proto-Pamphylian basin sensu Dumont *et al.* (Dumont *et al.* 1972 in Gedik 1988). Cambrian and Triassic data, however, suggest that the Antalya nappes were transported from the north rather than the south. Instead, the Antalya nappes would have originated immediately north of the Hadim-Sultandag Uplift and not be part of a restricted southern basin as indicated by faunas and facies.

A recent and extensive study of the Early Palaeozoic evolution of Turkey (Göncüoglu 1997) aimed to clarify the previously assumed differences between the southern and northern areas in the Taurides during the Devonian and to incorporate them into a geodynamic scenario of the region. Preliminary results indicate the presence of a large Caledonian-time ocean to the north of the Taurides, the Karaburun-Bolkardag Ocean (Göncüoglu and Kozur 1998).

In this study, we have re-examined unpublished conodont findings (of the first author) from the Antalya nappes in the area to the northeast of Antalya (Alanya- Gündogmuş area) in order to determine the original position of the units within these nappes and to collect additional data pertinent to Palaeozoic palaeogeography. This is the first Early Devonian conodont data from the Antalya nappes.

TECTONIC FRAMEWORK OF THE ANTALYA NAPPES

The Antalya nappes are mainly restricted to the interior of the Isparta Angle in southwest Anatolia (Figure 1). It is commonly accepted that they are polyphased thrust-sheets on the Bey Daglari Carbonate Platform (Bey Daglari Autochthon) in the western part of the Isparta Angle and on the Anamas-Akseki Carbonate Platform in the east. They include slices with highly variable sequences suggesting different palaeogeographic settings. There is still no consensus about their original position with respect to the Mesozoic carbonate platforms (e.g. Ricou *et al.* 1974; Robertson and Woodcock 1980; Özgül 1984; Şenel *et al.* 1992) despite the broad consensus outlined above.

The subdivision of the nappes has been mainly based on differences in successions, major unconformities and tectonic style. The Antalya nappes were classified as Lower, Middle and Upper nappes (Brunn *et al.* (1971). Şenel *et al.* (1992) redefined them as the Çataltepe, Alakirçay and Tahtalidag nappes. Each were further subdivided into thrust sheets. The position of the "haut-fond taurique" represented by the Palaeozoic platform

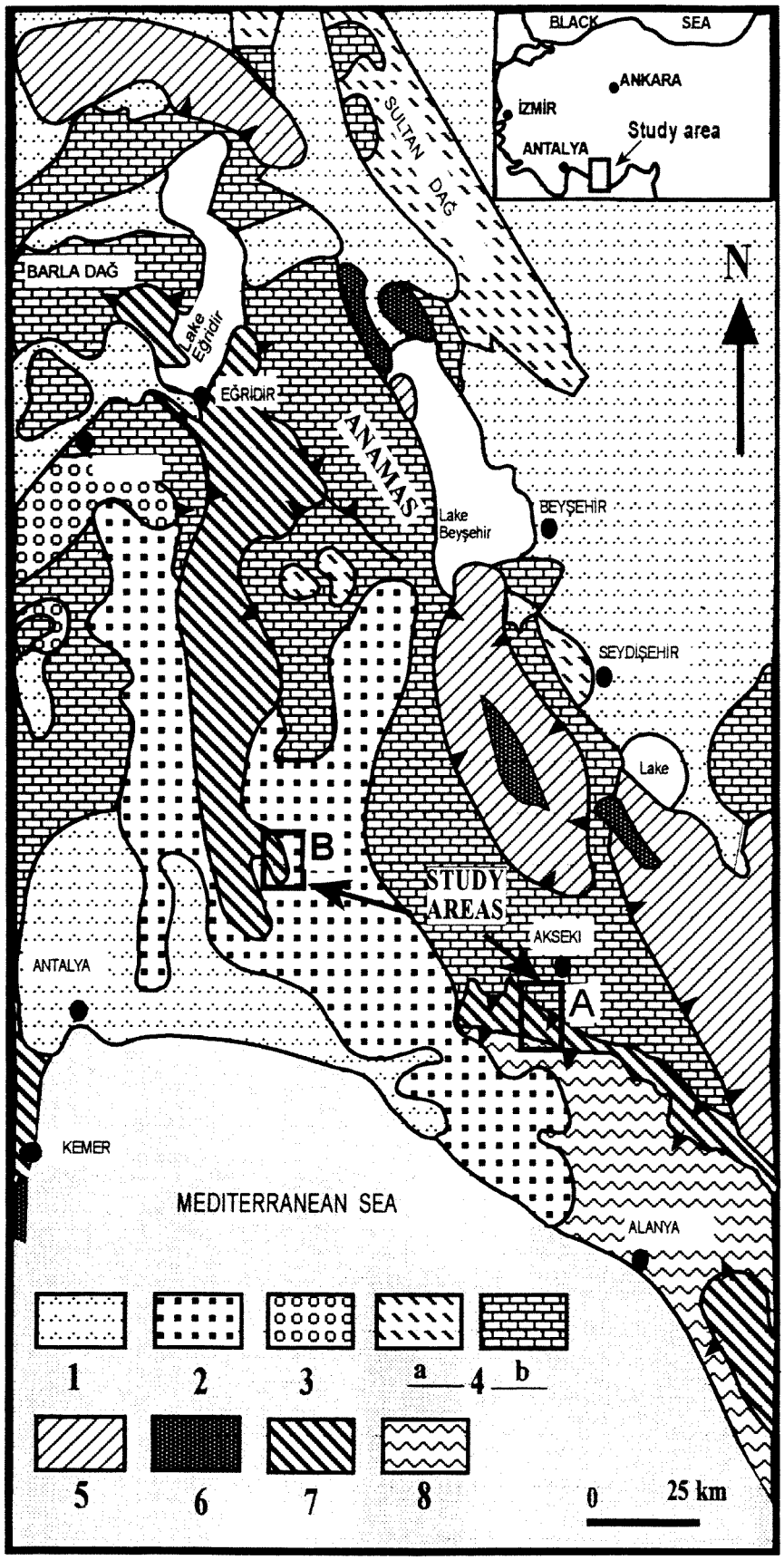


Figure 1 Structural map showing the tectonic units of the Isparta Angle, SW Anatolia (after Şenel 1984). 1- Alluvium; 2- Antalya Miocene Basin; 3- Lower-Middle Miocene cover of Bey Daglari Autochthon; 4- Geyikdag Unit: a: Palaeozoic units, b: Mesozoic platform carbonates; 5- Beysehir-Hoyran Nappes; 6- Ophiolite Nappes; 7- Antalya Nappes; 8- Alanya Unit (modified after Şenel 1984). A: Location of Gündogmuş sliver in Göksu Beleni (type section of Güneyyaka Formation); B: Location of Ovacik sliver in Burgaz Dere (reference section of Güneyyaka Formation).

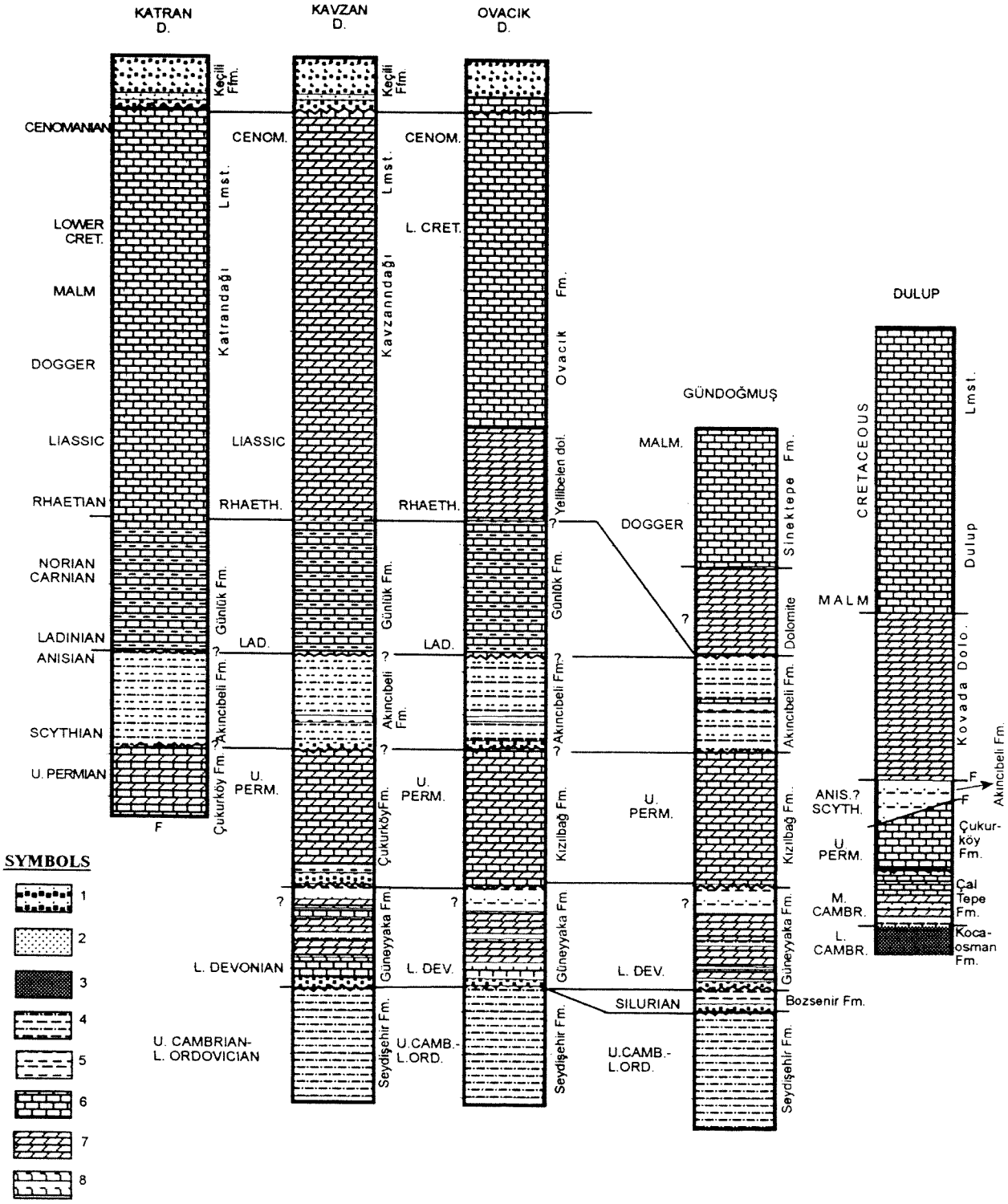


Figure 2 Generalized sections of Katran Dagi, Kavzan Dagi, Ovacik Dagi, Gündogmuş, and Dulup slivers of the Antalya nappes (after Şenel *et al.* 1992; not to scale). Explanations: 1- Conglomerate; 2- Sandstone; 3- Quartzite; 4- Siltstone; 5- Shale; 6- Limestone; 7- Dolomite; 8- Evaporite.

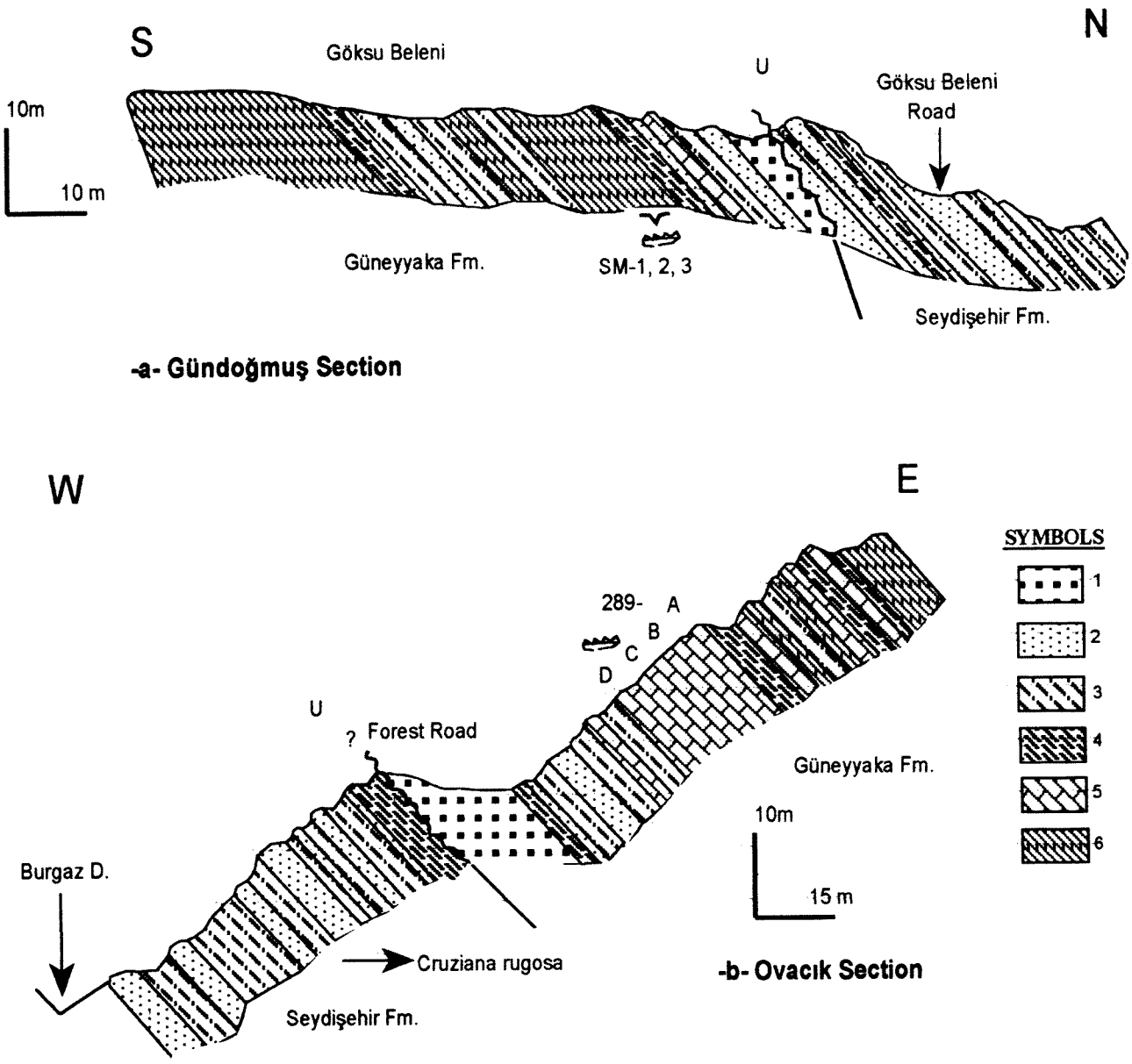


Figure 3 Cross-sections showing the locations of the conodont-bearing samples (a: type locality at Göksu Beleni; b: reference section at the Burgaz Dere) and the contact relations of Güneyyaka Formation (after Senel *et al.* 1992). Explanations: 1- Coarse clastics; 2- Sandstone; 3- Siltstone; 4- Shale; 5- Limestone; 6- Dolomite-dolomitic limestone.

basement rocks is one of the most important criteria for separating the thrust sheets according to their palaeogeographic settings with respect to the Mesozoic platforms.

STRUCTURAL SETTING AND STRATIGRAPHY

The Tahtalidag Nappe of Şenel *et al.* (1992), consisting of several thrust sheets, is equivalent to the Upper Nappe of Brunn *et al.* (1971). The Dulup Dagi, Katran Dagi, Gündogmuş, Ovacik Dagi and Kavzan Dagi units are characterized by the presence of Palaeozoic sequences. Slivers of these units are overthrust by metamorphics of the Alanya Unit.

In the Gündogmuş area, Ovacik Dagi, and Kavzan Dagi units the lowermost observable part of the succession consists of Late Cambrian to Arenig shales of the Seydişehir Formation. This formation is unconformably overlain by the Güneyyaka Formation initiated in the earliest Devonian. This unconformity is a regional event observed in most units of the Tahtalidag Nappe (Figure 2).

The Gündogmuş Unit differs from the others by the occurrence of an almost 30m thick Silurian succession, the Bozsenir Formation (Şenel *et al.* 1992). This formation unconformably overlies the Seydişehir Formation. The lower part of the Bozsenir Formation is dominated by medium to thickly bedded, yellow to red, coarse grained sandstones. These are overlain by alternating grey

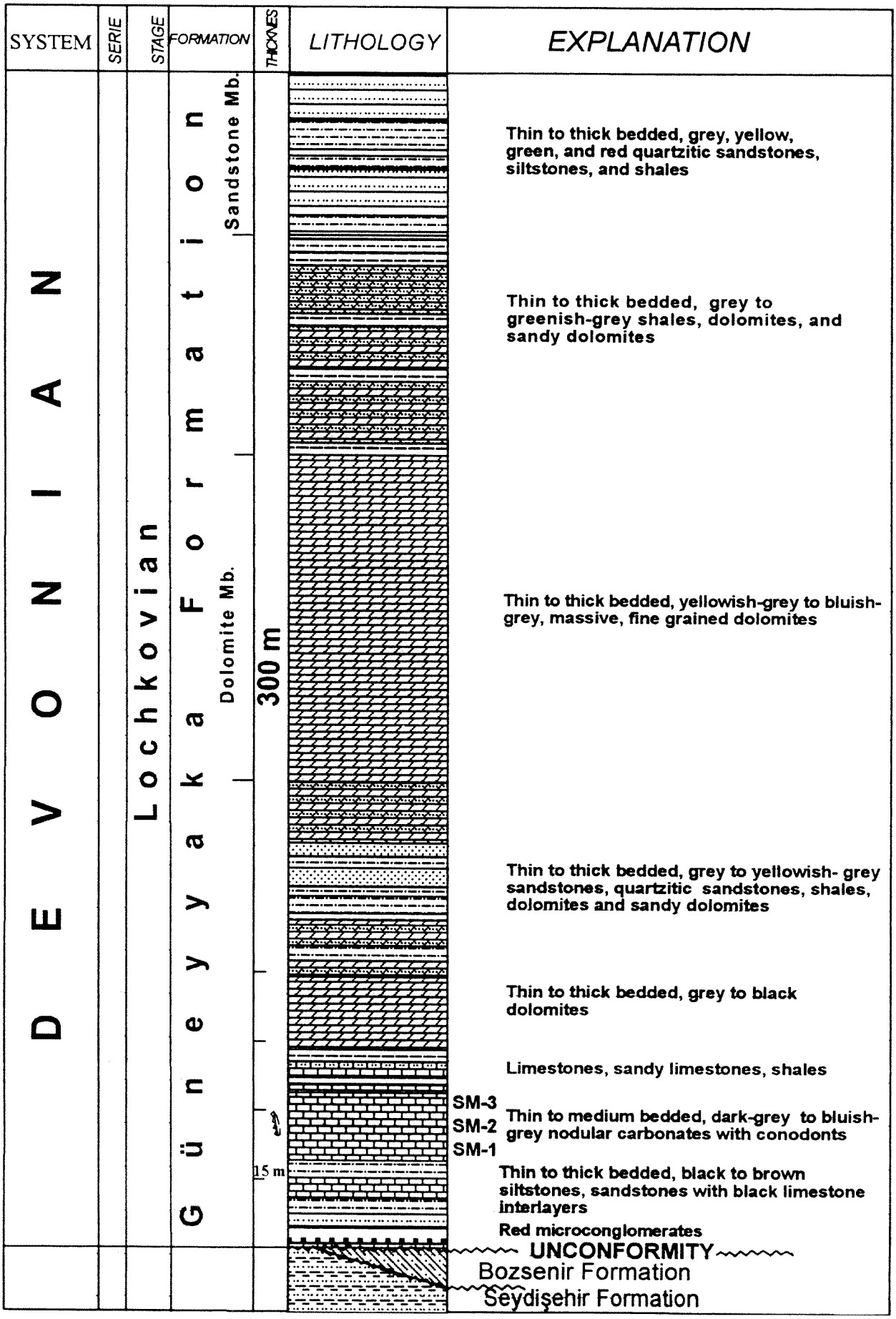
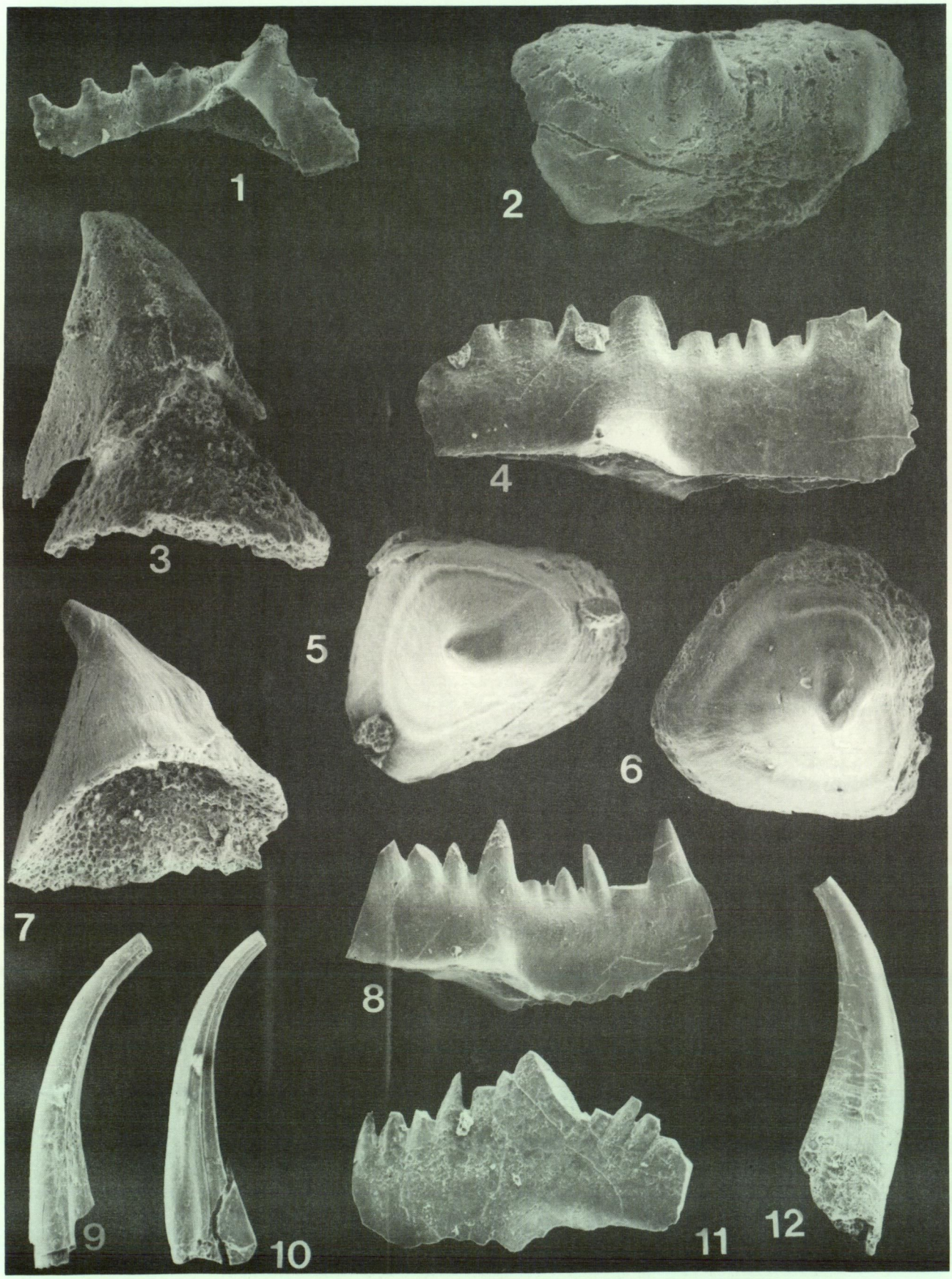


Figure 4 Generalized section of Güneyyaka Formation in its type locality (after Şenel *et al.* 1992).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sandstones and shales that grade upwards into *Monograptus*-bearing black shales. The black shales were dated as ?Early Silurian by Demirtaşli (1987). Recent conodont data from the western Antalya nappes in the Kemer area (Göncüoglu and Kozur, this volume) has corroborated this by indicating a early late Llandoverian (early Telychian) age. In the same tectonic unit, a few kilometers to the southeast of the type-locality (Kaş Yaylasi and Beldibi Yaylasi) Gedik (1977) found the conodonts "*Spathognathodus steinhornensis eosteinhornensis, Plectospathodus extensus* and *Lonchodina* sp." (Gedik 1977; original determinations) in a carbonate sliver almost 20 m thick, indicating an Late Silurian age.

The Güneyyaka Formation unconformably overlies both the Seydişehir and Bozsenir formations. The type locality of the Güneyyaka Formation is NNW of Alanya at Göksu Beleni (1:25.000 scaled topographic map No: 027-b4). The reference section is in Burgaz Dere to the south of Ovacik Dagi (N26-d1) (Figure 3). A generalized section of the Güneyyaka Formation is given in Figure 4.

At the type locality of the Güneyyaka Formation, the overturned succession commences locally with 4–5 m of red microconglomerate, massive, red and green to dark-grey and black sandstones, siltstones and mudstones. These clastics are overlain by of grey to black thin and medium to thick bedded limestones with rare shale interlayers. A second carbonate horizon consists of 15 m of thin to medium bedded, dark-grey, bluish-grey to black and partly nodular limestone containing a rich and diverse fauna of brachiopods, corals, crinoids and a few conodonts. Towards the top, alternating thin to thick-bedded, green to greenish-grey and brown sandy limestones, shales, and siltstones occur. The overlying dark-grey to black dolomites with interlayered sandstones, quartzitic sandstones, and sandy dolomites represent transitional layers to the main sequence of overlying dolomites. These are more than 200 m thick, very compact, and consist of thin to thick bedded, grey, blueish to greenish-grey, finegrained dolomitic lithologies. The dolomites contain fine bands of sandy dolomites and shales high in the sequence. The uppermost portion of the formation, separated as a proper "Sandstone Member" by Şenel *et al.* (1992), consists of grey, green and red sandstones, siltstones and shales. The lowermost shales of the sequence yielded *Heliolites porosus* Goldfuss, *Alveolites* sp. and *Thamnopora* sp. (Senel *et al.* 1992).

Samples SM-1, SM-2 and SM-3 from the second carbonate level of the lower Güneyyaka Formation in its type-locality, characterized by nodular interlayers, yielded a poor conodont fauna.

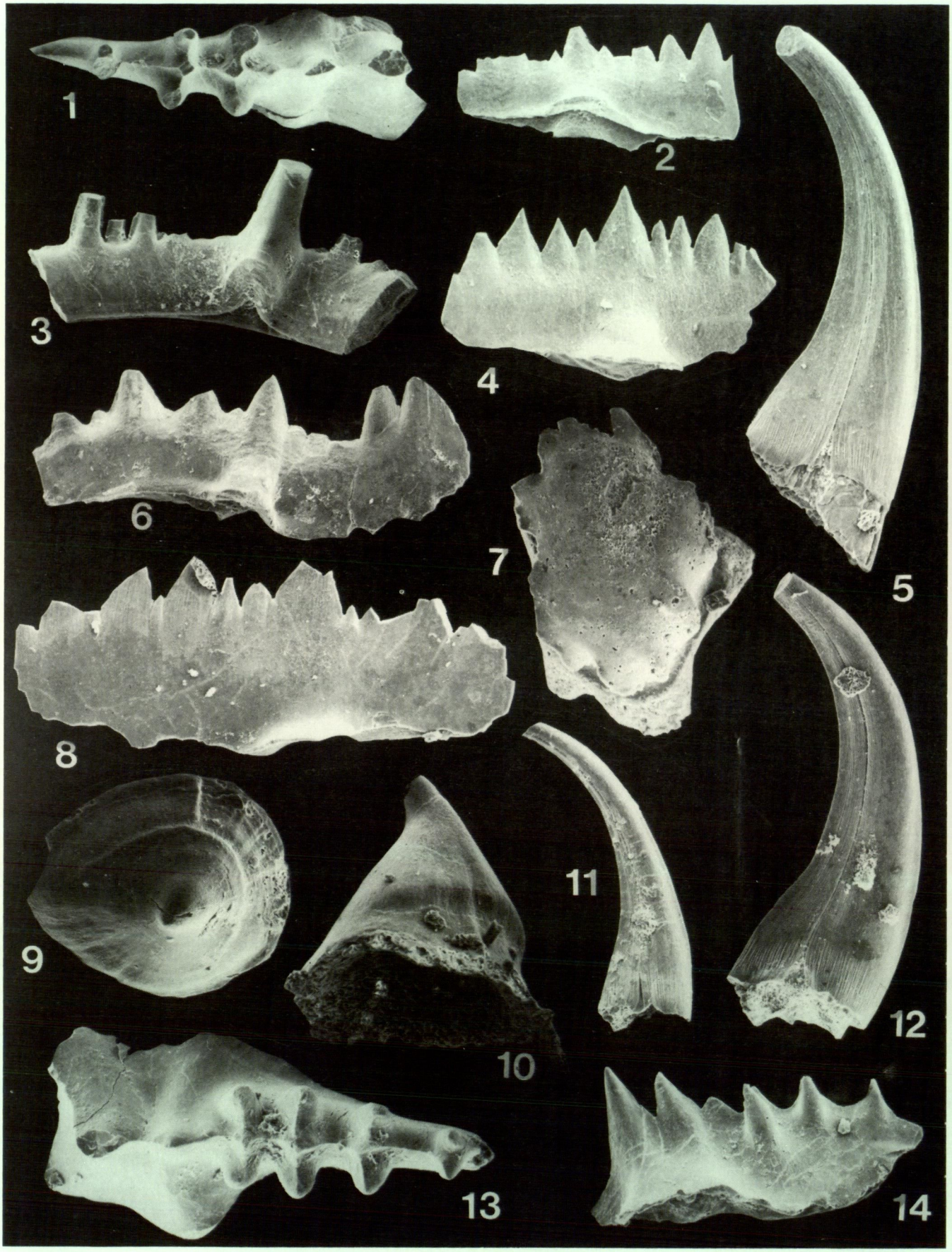
Samples 289-A, B, C and D are from a reference section in the Burgaz Dere to the east of Ovacik Dagi. Here, the Güneyyaka Formation unconformably overlies the Seydişehir Formation. The basal part consists of medium-thick bedded red, green and grey microconglomerates, sandstones and siltstones. These are overlain by grey, and dark grey, partly nodular, limestones with rare shale interlayers. The second carbonate level from the base has a rich and diverse brachiopod, coral and crinoid fauna. The samples 298 A, B, C and D (see Figure 3) contain a well-preserved conodont fauna. The thick dolomite sequence towards top (making up the main body of the formation) has not yielded any fossils, its age is therefore unclear.

The Güneyyaka Formation is unconformably overlain by Middle to Late Permian dolomites and limestones (Kizilbag Formation) in the Gündogmus and Ovacik Dagi units. In the Kavzan Unit, however, the lower part of the Middle Permian, the Wordian, Çukurköy Formation is characterized by coal seams. The upper part of the Kizildag Formation is represented - in contrast to the former two tectonostratigraphic units – by black limestones identified as "Bellerophon Kalke" by Nebert (1963).

CONODONT DATA

Originally we intended to describe a new genus comprised of three new species, two in open nomenclature, and a new species of *Pseudooneotodus*. H.W. Kozur showed images of the new genus to M.A. Murphy and J.I. Valenzuela-Rios during

◀ **Figure 5** All illustrated specimens are from the Lochkovian lower Güneyyaka Formation of the Tahtalidag Nappe. Specimens **1–3** are from the type locality of the Güneyyaka Formation at Göksu Beleni. Specimens **4–12** are from the Burgaz Dere section to the east of Ovacik Dagi. Position of the samples in the sections is indicated in Figure 3. **1**, *Oulodus*? sp., Sb element, sample SM-1, Lochkovian, x 120, rep.-no. 27- 11/1-56. **2**, *Pseudooneotodus* n. sp., upper view, sample SM-3, Lochkovian, x 200, rep.-no. 27-11/1-49. **3**, *Pseudooneotodus beckmanni* (Bischoff and Sannemann), with preserved basal filling, lateral view, sample SM-3, Lochkovian, x 200, rep.-no. 27-11/1-48. **4, 8**, *Ozarkodina remscheidensis remscheidensis* (Ziegler). Pa element, sample 289D, late early Lochkovian, x 120; **4**, rep.-no. 27-11/11-45; **8**, rep.-no. 27-11/11-51. **5–7**, *Pseudooneotodus beckmanni* (Bischoff and Sannemann), sample 289 D, late early Lochkovian; **5**, upper view, x 120, rep.-no. 27-11/11-50; **6**, upper view, x 100, rep.-no. 27-11/11-46; **7**, lateral view, x150, rep.-no. 27-11/11-47. **9, 10, 12**, *Panderodus unicostatus* (Branson and Mehl), sample 289 D, late early Lochkovian; **9**, x 110, rep.-no. 27-11/11-53; **10**, x90, rep.-no. 27-11/11-48; **12**, x 90, rep.-no. 27-11/11-49. **11**, *Ozarkodina* sp. Pb element, sample 289 D, late early Lochkovian, x 150, rep.-no. 27-11/11-52.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biostratigraphic discussions at the ECOS VII Conference. They recognized forms of a new genus *Lanea* and identified one of our new species as *Lanea eoeleanorae*, a species they had identified from Nevada, Austria and Spain (Murphy and Valenzuela-Rios 1998, 1999 in press). Following the rules of prioroity, we use the genus *Lanea* Murphy and Valenzuela-Rios, and will describe a new species of *Lanea* and *Pseudooneotodus* in a subsequent paper. Relevant conodonts are illustrated in Figures 5–8.

Burgaz Dere Section

Samples 289-A, 289-B, 289-C and 289-D yielded 40, 25, 30 and 45 elements respectively. All specimens are kept in the repository of the Department of Geology, Mineral Research and Exploration General Directory, Ankara.

Sample 289-D

Icriodus angustoides bidentatus carls and gandl

Ozarkodina remscheidensis remscheidensis (Ziegler)

Panderodus unicostatus (Branson and Mehl)

Pseudooneotodus beckmanni (Bischoff and Sannemann)

Unassigned Sa and Pb element of *Ozarkodina* or closely related conodonts

Fish remains (placoid scales)

Icriodus angustoides bidentadus is characteristic of the early, but not earliest Lochkovian. Typical *0. remscheidensis remscheidensis* is characteristic of the middle and late early Lochkovian. A middle to late early Lochkovian is therefore indicated for sample 289-D. The CAI of the elements is 1.5.

Sample 289-C

Icriodus angustoides bidentatus carls and gandl

I. woschmidti Ziegler

Lanea n. sp.

Ozarkodina eladioi Valenzuela-Rios

Ozarkodina ex. gr. *remscheidensis* (Ziegler)

Ozarkodina (Ozarkodina) sp.

Panderodus sp.

Pseudooneotodus beckmanni (Bischoff and Sannemann)

The sample has the same age as the sample 289 D as indicated by the presence *I. angustoides bidentatus*. Furthermore, *Lanea* n. sp. appears to be the second oldest *Lanea* species of early Lochkovian age (P. Carls, M.A. Murphy and J.I. Valenzuela-Rios, pers. comm. 1998). *Ozarkodina eladioi* indicates an open sea environment and *Icriodus* generally indicates shallow-water conditions. The Antalya nappes were therefore probably part of a wide, but shallow Early Devonian shelf sea. The CAI of the elements is 1.5.

Sample 289-B

Lanea n. sp. A

Lanea eoeleanorae Murphy and Valenzuela-Rios

Lanea eoeleanorae is characteristic of the lower part of the middle Lochkovian (M.A. Murphy and J.I. Valenzuela-Rios, pers. comm. 1998). The CAI of the elements is 1.5.

Sample 289-A

Icriodus sp.

Lanea n. sp. B

Oulodus walliseri (Ziegler) (Pb Element)

Ozarkodina excavata (Branson and Mehl) group (only Sc element)

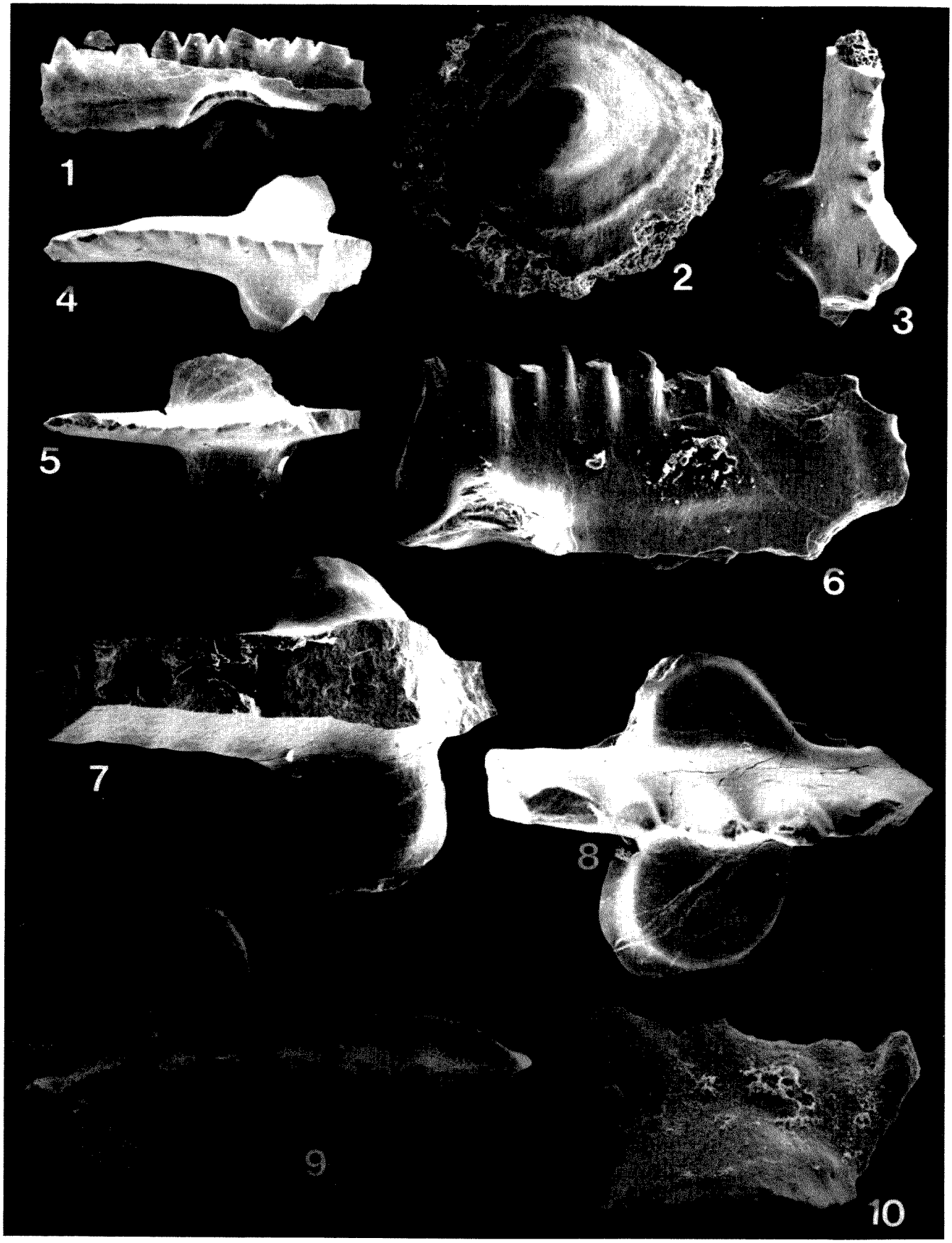
Panderodus sp.

Pelekysgnathus sp.

Pseudooneotodus beckmanni (Bischoff and Sannemann)

Lanea n. sp. B is a middle Lochkovian species a little younger than the *Lanea* species of sample 289-

◀ **Figure 6** All illustrated specimens are from the Burgaz Dere section to the east of Ovacik Dagi, Lochkovian lower Güneyyaka Formation, Tahtalidag Nappe. Position of the samples in the section is indicated in Figure 3. **1**, *Icriodus angustoides bidentatus* Carls and Gandl, Pa element, upper view, sample 289 D, late early Lochkovian, x 120. rep.-no. 27-11/11-41. **2, 4, 8**, *Ozarkodina* ex gr. *remscheidensis* (ZIEGLER), Pa element, sample 289 D, late early Lochkovian. **2**, x 120, rep.-no. 27-11/11-31. **4**, x 150, rep.-no. 27-11/11-32. **8**, x200, rep.-no. 27-11/11-35. **3**, Sa element, sample 289 D, late early Lochkovian. x 120, rep.-no. 27-11/11-42. **5**, *Panderodus* sp., sample 289 C, late early Lochkovian, x 110, rep.-no. 27- 11/11-38. **6**, *Ozarkodina (Ozarkodina)* sp., Pa element, sample 289 C, late early Lochkovian, x 120, rep.-no. 27-11/11-34. **7** Placoid scale (Chondrichthyes), upper view, sample 289 D, late early Lochkovian, x 150, rep.-no. 27-11/11-44. **9, 10**, *Pseudooneotodus beckmanni* (Bischoff and Sannemann), sample 289 C, late early Lochkovian. **9**, upper view, x 120, rep.-no. 27- 11/11-24. **10**, lateral view, x 150, rep.-no. 27-11/11-26. **11, 12**, *Panderodus* spp., sample 289 C, late early Lochkovian. **11**, x 85, rep.-no. 27-11/11-40. **12**, x 120, x 150, rep.-no. 27-11/11-39. **13**, *Icriodus woschmidti* Ziegler, Pa element, upper view, sample 289 C, late early Lochkovian, x 120, rep.-no. 27-11/11-36. **14**, *Icriodus angustoides bidentatus* Carls and Gandl, Pa element, lateral view, sample 289 C, late early Lochkovian, x 110, rep.-no. 27-11/11-37.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B (M.A. Murphy and J.I. Valenzuela-Rios pers. comm. 1998). This is in accord with the stratigraphic position of samples from the section. The CAI of the elements is 1.5.

Göksu Beleni section

The following conodonts were found in the investigated samples (for positions in the stratigraphic sections see Figure 3). Samples SM-1 and SM-3 yielded 20 and 30 elements respectively. All specimens are kept in the repository of the Department of Geology, Mineral Research and Exploration General Directory, Ankara.

Sample SM-1

Lanea n. sp. (one broken specimen)

Ozarkodina excavata (Branson and Mehl)

Oulodus sp.

Sample SM-3

Pseudooneotodus beckmanni (Bischoff and Sannemann)

Pseudooneotodus n. sp.

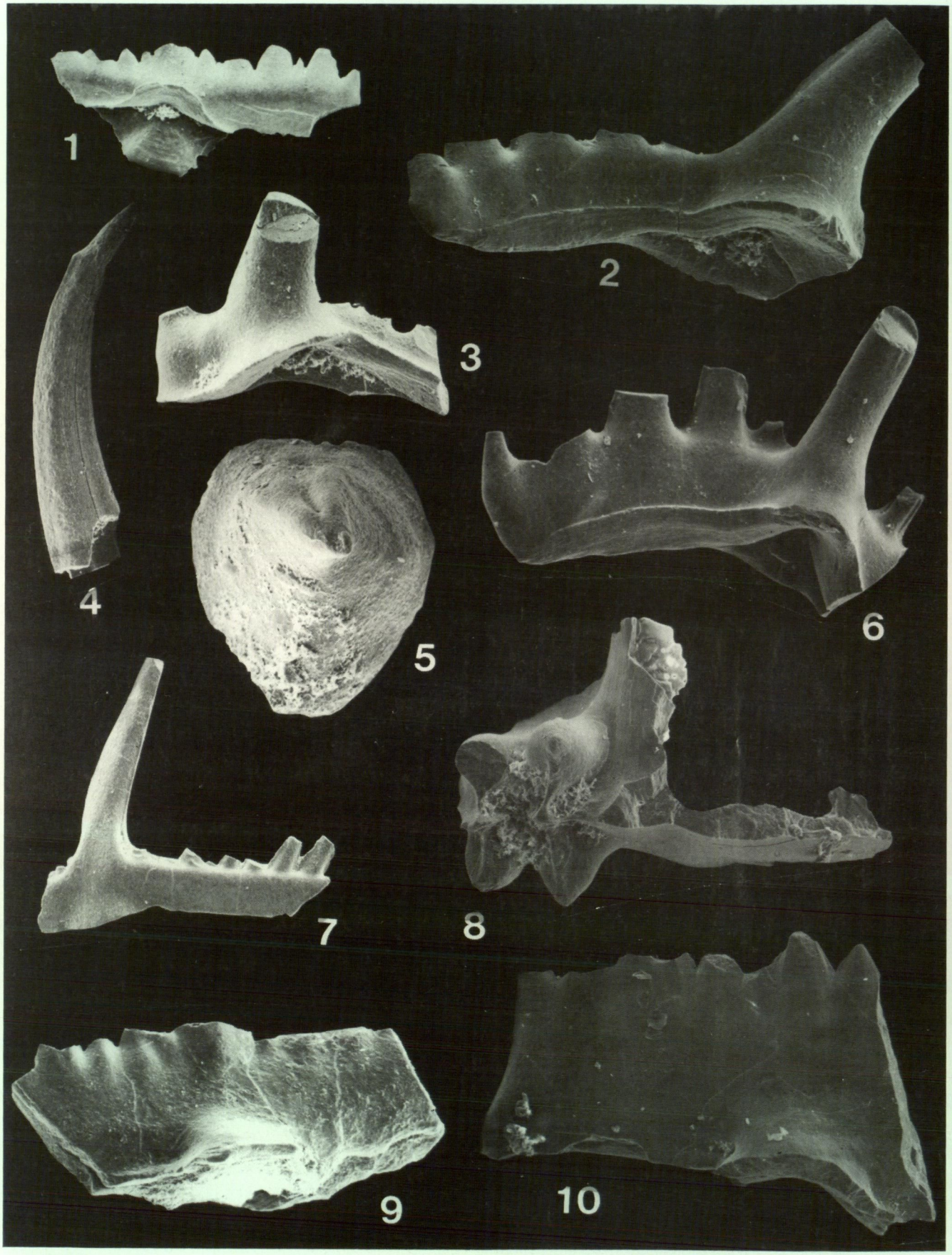
These samples from the Göksu Beleni section yielded mostly fragmentary specimens of long-ranging species and a broad age Silurian to early Early Devonian can be inferred. The fragmentary specimen of *Lanea* n. sp. however, indicates a Lochkovian age. Both sample sets were taken from the same horizon, the second carbonate level in both sections. The CAI is 1.5.

DISCUSSION AND CONCLUSIONS

Continuous deposition across the Silurian-Devonian boundary has been assumed by some authors (Şenel *et al.* 1992; Gül 1995) because of a late Silurian age interpretation for the base of the Güneyyaka Formation. Gedik (1977, 1988) also assumed continuous Late Silurian to Early Devonian deposition in an area NE of Alanya. Demirtaşli (1984, 1987) assumed continuous deposition of Late Silurian nautiloid limestone through to Early Devonian cross-laminated sandy to silty limestones with brachiopods and corals in the Silifke-Ovacik area. The shallowing was ascribed to a regression at the Silurian-Devonian boundary culminating in a very short gap close to the Silurian-Devonian boundary. The lowermost Devonian is transgressive. The exact level of this gap and the transgressive base of the Güneyyaka Formation, however, cannot be determined as yet because about 20 m of undated strata underlie the well-dated (middle early to middle middle Lochkovian) second carbonate level. The transgression started before or during middle early Lochkovian and, therefore, close to the base of the Devonian.

The conodont data also indicates a shallow-water, open sea environment. The diverse fauna contradicts the view that the Early Devonian of the Antalya Nappe was deposited in a restricted and/or closed basin. Alternatively it indicates the presence of a wide shallow-water shelf at the northern margin of Gondwana, to the south of the large Caledonian-time Karaburun-Bolkardag Ocean (Göncüoglu and Kozur 1998). This can be construed as evidence for the Antalya nappes originally being located north of the Hadim-Sultandag Uplift (and south of the Karaburun and Bolkardag zones). This would indicate that the Antalya nappes were thrust from north to south, with a root zone immediately north of the Sultandag Perigondwana autochthon. A similar conclusion can be drawn from the Late Cambrian. Late Cambrian rocks are well developed in the Antalya nappes (Göncüoglu and Kozur, in prep.), such as the Sultandag, but minimal or absent in all other southern Tauride units. A southwards thrust of the Antalya nappes can be also deduced from the Triassic fauna in the southern Geyikdag Autochthon (Gedik 1981). Around Seydisehir, *Pseudofumishius murcianus* is very common (Gedik 1981; Nicora 1981). This species is typical of epicontinental seas south of Tethys and of the southern marginal regions of Tethys (e.g., Jordan, Israel, Algeria, Spain, Sicily, Outer Dinarides; Gullo and Kozur 1991). This species is missing in the

◀ **Figure 7** All illustrated specimens are from the Burgaz Dere section to the east of Ovacik Dagi, Lochkovian lower Guneyyaka Formation, Tahtalidag Nappe. Position of the samples in the section is indicated in Figure 3. **1**, *Ozarkodina eladioi* Valenzuela-Rios, Pa element, sample 289 C, late early Lochkovian, x75, rep.-no. 27-11/11-29. **2**, *Pseudooneotodus beckmanni* (Bischoff and Sannemann). Upper view, sample 289 C, late early Lochkovian, x 120, rep.-no. 27-11/11-25. **3**, *Lanea* n. sp. A, Pa element, upper view, sample 289 B, early middle Lochkovian, x 120, rep.-no. 27-11/11-22. **4, 5**, *Lanea* n. sp., Pa element, upper view, sample 289 C, late early Lochkovian. **4**, x 80, rep.-no. 27-11/11-33. **5**, x 75, rep.-no. 27-11/11-30. **6**, *Lanea*? sp., Pa element, lateral view, sample 289 B, early middle Lochkovian, x 100, rep.-no. 27-11/11-21. **7, 8**, *Lanea eoeleanore* Murphy and Valenzuela-Rios. Pa element, upper view, sample 289 B, early middle Lochkovian. **7**, x 100, rep.-no. 27-11/11-20. **8**, x 120, rep.-no. 27-11/11-23. **9**, *Lanea* n. sp. B, Pa element, upper view, sample 289 A, middle middle Lochkovian, x220,rep.-no. 27-11/11-12. **10**, *Pelekysgnathus* sp., Pa element, lateral view, sample 289A, middle middle Lochkovian, x 110, rep.-no. 27-11/11-8.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Antalya nappes, indicating a root zone north of the Geyikdag Autochthon. The CAI is very low (1.5) indicating minimal thermal alteration in the Tahtalidag Nappe.

Conodont data provides precise age determinations for the Palaeozoic sequences within some Alpine nappes of Turkey.

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◀ **Figure 8** All illustrated specimens are from Sample 289 A in the Burgaz Dere section to the east of Ovacik Dagi, lower Güneyyaka Formation, Tahtalidag Nappe (Figure 3); mid Lochkovian. **1**, *Ozarkodina* ex gr. *O. remscheidensis* (Ziegler); Pa element, oblique lateral view, x 120, rep.-no. 27-11/11-17. **2, 3, 6**, *Oulodus walliseri* (Ziegler). **2**, Pb element, x 140, rep.-no. 27-11/11-13. **3**, Sb element, x 130, rep.-no. 27-11/11-15. **6**, Sa element, x 150, rep.-no. 27-11/11-14. **4**, *Panderodus* sp., x 120, rep.-no. 27-11/11-7. **5**, *Pseudooneotodus beckmanni* (Bischoff and Sannemann), upper view, x 200. rep.-no. 27-11/11-16. **7**, *Ozarkodina* ex gr. *excavata* (Branson and Mehl), Sc element, x 100, rep.-no. 27-11/11-18. **8**, *Icriodus* sp. indet, broken specimen, upper view, x 150, rep.-no. 27-11/11-11. **9**, *Ozarkodina* ex gr. *remscheidensis* (Ziegler), Pa element, lateral view, x 100, rep.-no. 27-11/11-19. **10**, *Ozarkodina* sp., broken Pa element, lateral view, x 100, rep.-no. 27-11/11-10.

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