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Conodonts from the Variscan Basement of the Eastern Kopet Dagh Range (NE-Iran)

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With 2 Plates

NE-Iran
Kopet Dagh Range
Aghdarband
Upper Devonian
Conodonts

Contents

Zusammenfassung

Innerhalb des Erosionsfensters von Aghdarband (östliches Kopet Dagh-Gebirge, Nordiran) besteht der Nordrahmen einer stark deformierten Trias-Schichtfolge aus einer dicken Sequenz älterer Gesteine, für die bisher Altersangaben weitgehend fehlten. Es handelt sich um mehrere 100 m mächtige schwach metamorphe Schiefer mit Einlagerungen von Breccien, Konglomeraten und lokal Diabasen. In ihren nördlichen und südlichen Randbereichen treten darin auch geringmächtige Kalklagen auf, die oberdevonische Conodonten führen. Sie gehören im Norden in die *Palmatolepis triangularis*-Zone des älteren Famenne, im Süden hingegen sind sie geringfügig jünger und im Gegensatz zur älteren Fauna sehr schlecht erhalten und beträchtlich metamorph. Die Farb- und texturellen Änderungen gehen auf regional-metamorphe Überprägungen zurück, wobei auf eine Temperaturbeeinflussung zwischen 360 und 550° zu schließen ist. Die Conodontengemeinschaft spiegelt ein küstenfernes pelagisches Milieu am Rande eines Kontinents wieder. Dieses Bild stimmt mit paläogeographischen Modellvorstellungen für dieses Gebiet gut überein.

Abstract

In the erosional window of Aghdarband (Northern Iran) basement rocks of the eastern Kopet Dagh Range are well exposed; they consist mainly of a deformed Triassic rock sequence which is framed to the north – and probably also to the south – by older rocks. In the pre-Triassic of the so-called "Northern Frame" a thick sequence of clastic rocks is assigned to the Late Devonian by conodonts. They were recovered from thin limestone beds which were found to the north and south of various shales, breccias, conglomerates and volcanics. The northern conodont localities belong to the *Palmatolepis triangularis* Zone of the Earliest Famennian, the southern samples are slightly younger. In contrast to the older fauna the younger one is significantly altered. Its CAI and the surface texture indicates a temperature range between 360 and 550°. The most likely source for all alterations is regional metamorphism which affected all basement rocks with varying strength. The small conodont fauna is assigned to an offshore open marine environment at the continental margin. This setting is consistent with paleogeographic reconstructions for this area.

1. Introduction

This report on conodonts from the Variscan basement of the Eastern Kopet Dagh Range of Northern Iran is based on 6 small limestone samples which have been collected by A. RUTTNER in 1975 and 1976. During the first year he collected two samples at the localities 41 and 44 and in the following field season he designated his samples with the numbers 76a, 76b, 54 and 84. With the exception of the two latter localities the other four are indicated in the geological map published by A. RUTTNER in this volume. Four samples, i. e.

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nos. 41, 44, 76a and 84 yielded conodonts. This contribution deals with their age, their preservation and biofacial implications derived from the small fauna.

All conodont samples the weight of which was less than 0.5 kg for each, were derived from the so-called "Northern Frame" which accompanies the Triassic of Aghdarband to the north within the erosional window of Aghdarband (RUTTNER, 1984 and this vol.). It consists partly of an up to 700 m thick E–W-directed volcaniclastic sequence of mainly coarse sandstones and fine grained breccias with interbedded slates. At the base and on top of this formation calcareous beds of varying thicknesses occur. They are associated in the north with black shales and "diabases" (see A. RUTTNER, this vol., chapter 3.2.). From this lithology the conodont bearing samples 41 and 44 are derived. In the south impure limestones also occur. Similarily to the north they are intercalated in greenish-yellowish slates; vulcanics, however, are missing there. These rocks have a thickness between 0 and more than 50 m depending on local tectonics between the clastic sequence and the succeeding "Marble-Formation". Within this impure limestone the two samples 76a and 84 were collected, the latter, however, was found outside the published map.

Up to now the mutual stratigraphic relationship between the two limestone bearing slate units on either side of the clastic sequence was unknown. An open question was also the age of the thick clastic sequence in between which was assigned to various Paleozoic systems in the past.

2. Conodont Biostratigraphy

The conodont faunas from the localities 41 and 44 comprises the following taxa:

Ancyrodella sp. aff. A. *nodosa* ULRICH & BASSLER
Palmatolepis triangularis SANNEMANN
Palmatolepis minuta minuta BRANSON & MEHL
Palmatolepis delicatula delicatula BRANSON & MEHL
Polygnathus sp.
Nothognathella sp.

Age

Early Upper Devonian. Based on the final decision of the Subcommission on Devonian Stratigraphy in 1988 the palmatolepid association reflects an Early Famennian age. Moreover, the fauna list includes two different associations, the older one being characterized by the genera *Ancyrodella* and *Polygnathus* the latter one by representatives of the genus *Palmatolepis*. The first one is derived from locality 44, the latter from locality 41. They both represent slightly different ages. According to W. ZIEGLER (1971) and others the genus *Ancyrodella* does not extend beyond the *P. gigas* Zone (with the exception of *A. curvata* which, however, can be excluded in our fauna). The start of the younger fauna can be assumed in the Middle *P. triangularis* Zone. Thus, locality 44 has an age between do Iα and do Iδ (Frasnian) whereas locality 41 is slightly younger and may be post-do Iδ and more precisely basal Famennian depending if the base of the newly defined Famennian starts at the Lower or Middle *P. triangularis* Zone*).

Conodonts from the localities 76a and 84 comprise the following taxa:

Palmatolepis glabra pectinata ZIEGLER
Palmatolepis glabra prima ZIEGLER & HUDDLE
Palmatolepis gracilis gracilis BRANSON & MEHL
Palmatolepis glabra cf. *distorta* BRANSON & MEHL
Palmatolepis marginifera marginifera HELMS
Tripodellan element.

Age

Upper Devonian. Lower Famennian, Cheiloceras Stage (do IIβ). According to the current conodont zonation this fauna represents the *Palmatolepis quadrantinodosa* Zone.

3. Preservation and Metamorphism

The total conodont fauna consists of less than 100 isolated platform and ramiform elements most of which are poorly preserved, fractured, deformed, corroded, and recrystallized. Hence, only few elements permit specific identification. All conodonts were recovered from more or less dark grey to black and up to 1 m thick limestone beds intercalated in yellowish and greenish slates. The term "slate" indicates that the pre-Triassic northern frame of the Triassic of Aghdarband consists of metamorphosed rocks of greenschist facies grade. In fact, the small fauna shows a considerable color and textural alteration which correlates with an increase of temperature and thus metamorphism. Its grade and intensity, however, varies significantly between the sample groups 44/41 and 76/84, respectively.

Conodonts from the two localities 41 and 44 are equally well preserved. They have an almost smooth surface texture and are mostly complete and not deformed or fractured. The platform and the denticle surface of most elements is covered by a micro-ornamentation which is a reticulate pattern of numerous small polygonal or honeycomb-like pits well known and often described from unalterd conodonts. We have illustrated such features on our plates. As far as the color of these conodonts is concerned an alteration took place and can be observed very clearly. The original pale-yellow color changed to dark grey and black indicating carbonization of organic matter within a temperature range from 190° to 300° (EPSTEIN et al., 1977; REJEBIAN et al., 1987). According to these authors this value corresponds to color alteration index (CAI) 4, a standard derived from naturally occurring and experimentally induced color alteration. The color change did not affect the whole conodont: In contrast to the dark platform and the dark carina or blade the denticles are more or less unaltered and grey suggesting preservation of the original white matter in these areas.

In contrast to the fairly good preserved older group of conodonts the second and also younger association in the samples 76 and 84 is significantly altered. The alteration concerns the color and the surface texture. According to REJEBIAN et al. (1987) these conodonts re-

*) In 1988 the Subcommission on Devonian Stratigraphy agreed to define the base of the Famennian Stage to be the base of the lower *Palmatolepis triangularis* conodont zone.

present the "Color Alteration Index" 6 indicating a temperature range between 360° and 550°. Most of these conodonts are irregularly spotted grey and light grey. They are often fractured and corroded. Deformation along microfissures is very common, recrystallisation, however, is rare. All conodonts are more or less overcrusted by light grey quartz aggregates. In some specimens of the genus *Palmatolepis* the platform is very thin and fragile, its color almost white. These forms are extremely corroded and have a smooth surface texture. In others the reticulated surface pattern is originally preserved. All variations can occur in one sample (see Pl. 1, Figs. 1,2,6).

The question which type of metamorphism can be held responsible for these naturally altered conodonts depends on the degree of color and textural alteration. According to REJEBIAN et al. (1987) CAI values of 5 and above are characteristic of regionally metamorphosed, contact metamorphosed, and hydrothermally altered rocks. Each thermal event can be recognized by specific alterations.

Contact metamorphism produces conodonts that have been subjected to short-term heating events. In this case they are texturally mainly unaltered and better preserved than those from regionally metamorphosed rocks. However, they can be significantly altered if they were subjected to hydrothermal solutions. Generally such conodonts are very corroded and may be recrystallized. Their CAI values within one sample have generally wide ranges indicating very different temperatures during hydrothermal activity.

Field data do not support the assumption that the whole area or part of it was affected by either contact or hydrothermal contact metamorphism. This conclusion can also be outruled by the quality of conodont preservation. Hence, regional metamorphism is the most likely source for the bad preservation of our conodont fauna. This metamorphism, however, varies due to a certain degree, as far as its grade within the greenschist facies (chlorite grade) is concerned: In the northern area charactrized by the samples 41 and 44 the grade of metamorphism is significantly lower than that at the southern edge of the northern frame from which the sample 76 was recovered. This sample also shows chlorite grade metamorphism but it represents the CAI 6 instead of CAI 4 from the other samples. In our opinion these conodonts are just recognizable although most of them tend to break into unidentifiable fragments. Fragmentation is also attested by the close neighbourhood to a major vertical ESE directed fault zone, i.e. the tectonic boundary between the Triassic Aghdarband Group and its northern Paleozoic frame. Originally, the rocks of this frame formed the Hercynian basement of the Triassic sequence of Aghdarband.

4. Paleogeographic implications

In the Western United States C. A. SANDBERG (1976) recognised 5 conodont biofacies based on the abundance ratios of platform genera of Famennian age. They occupy linear belts parallel to the former coastline. In a shoreward direction he established a pelagic offshore palmatolepid-bispathodid biofacies and a palmatolepid-polygnathid biofacies followed in a more nearshore setting on the shallow-water shelf margin and even shallower coastal habitats by the polygnathid-"icriodid" and several other biofacies. Up to now 9 biofacies were recognised for the late Upper Devonian and seven for the Lower Carboniferous (C.A. SANDBERG & W. ZIEGLER, 1979; R. DREESEN et al., 1986, C.A. SANDBERG & R.C. GUTSCHICK, 1979, 1985; R.C. GUTSCHICK & C.A. SANDBERG, 1984). They were named after individual conodont platform genera that form the bulk of faunas in each paleotectonic setting.

Studies of the Frasnian to early Famennian foreslope mud mound tracts of Belgium and of the partly coeval Kellwasser Limestone of Germany provided evidence of close association of nearshore and pelagic biofacies for that time. The concept of lateral segregation can thus also be applied for the Frasnian although splitting of conodont faunas into different habitats seems to be less pronounced in the Frasnian than in the Famennian. For this faunal realm the newly established nearshore conodont zonation based on the ranges of species of *Icriodus, Pelekysgnathus* and *"Icriodus"*, and *Antognathus* was tested and combined with the *Palmatolepis*-based standard pelagic conodont zonation. Stragglers between both major habitats were used to integrate both schemes.

The Upper Devonian conodont faunas from the Northern Frame are assigned to the polygnathid-palmatolepid biofacies which represents an offshore open marine environment with predominant limestone sedimentation. Temporarily this kind of deposition changed to coarse sediments which were made up of a thick wedge of clastic sediments interpreted as cratonic derived coarse terrigenous sediments with minor contributions of volcanics at the edge or foreslope between a northern shelf margin and a southern basin. Supposedly these debris flows represent proximal channel fillings of flysch trough sediment at or near the end of the Variscan sedimentary cycle.

The conodont biofacies model that we conclude is in good accordance with paleogeographic considerations made by various authors. This model is based on the composition of the conodont fauna from four localities. The majority of identifiable conodonts belongs to the genus *Palmatolepis* and less to the genus *Polygnathus*. Representatives of the genus *Icriodus* are completely lacking. Consequently, we favor a setting further off the shore on the foreslope and platform-margin.

The Devonian rocks in the surroundings of Aghdarband represent a segment of the Hercynian basement that were deposited in the Middle and Upper Frasnian on the outer cratonic platform and on the continental shelf and slope, respectively. Rocks of this complex include various shales and slates with intercalations of dark limestone beds, sandstones, breccias and conglomerates. This thick clastic sequence forms the basement of the Kopet Dagh Range and is significantly different from time equivalent strata in central Iran. According to J. STÖCKLIN (1977, 1980) it represents the southern margin of the Turan Plate, i. e. Paleo-Asia, the "Northern Domain" which collided with the "Central Domain" during the early Cimmerian orogeny in the Late Triassic or Early Liassic. As the result of this collision the Indosinian foldbelt and, inter alia, the basement of Kopet Dagh, as exposed in the erosional window of Aghdarband was formed.

Plate 1

Conodonts from Pre-Triassic Limestones of ~~the~~ Aghdarband ~~Group~~.

Figs. 1–2: ***Palmatolepis glabra pectinata* ZIEGLER.**
Oral view of two Pa elements the posterior part of which is broken off. Surface is texturally almost unaltered.
Locality 76a.

Fig. 3: ***Palmatolepis marginifera marginifera* HELMS.**
Oral view of an almost complete Pa element cut by some microfractures.
Locality 76a.

Figs. 4–5: ***Palmatolepis glabra* cf. *distorta* BRANSON & MEHL.**
Oral view of two uncomplete und deformed Pa elements which are strongly altered (corroded and recrystallized) and fractured.
Localities: Fig. 4: 84; Fig. 5: 76a.

Fig. 6: ***Palmatolepis glabra prima* ZIEGLER & HUDDLE.**
Oral view of a complete but nevertheless strongly alterd Pa element. Specimen also resembles *P.* cf. *regularis* COOPER and *P. termini* SANNEMANN in outline. Anterior portion of the carina probably deformed.
Locality 76a.

Fig. 7: ***Palmatolepis gracilis gracilis* BRANSON & MEHL vel *Palmatolepis minuta minuta* BRANSON & MEHL.**
Single complete Pa element that most probably is a juvenile specimen.
Locality 76a.

Fig. 8: **Pb element of *Palmatolepis*.**
Fragment of a ozarkodiniform (Pb) element of the apparatus of *Palmatolepis*.
Locality 76a.

Fig. 9: ***Palmatolepis* sp.**
Undeterminable Pa element from the middle part of the platform. Strongly altered and partly corroded (or affected by boring). The element probably belongs to the *Palmatolepis glabra* group.
Locality 84.

Magnification × 108.

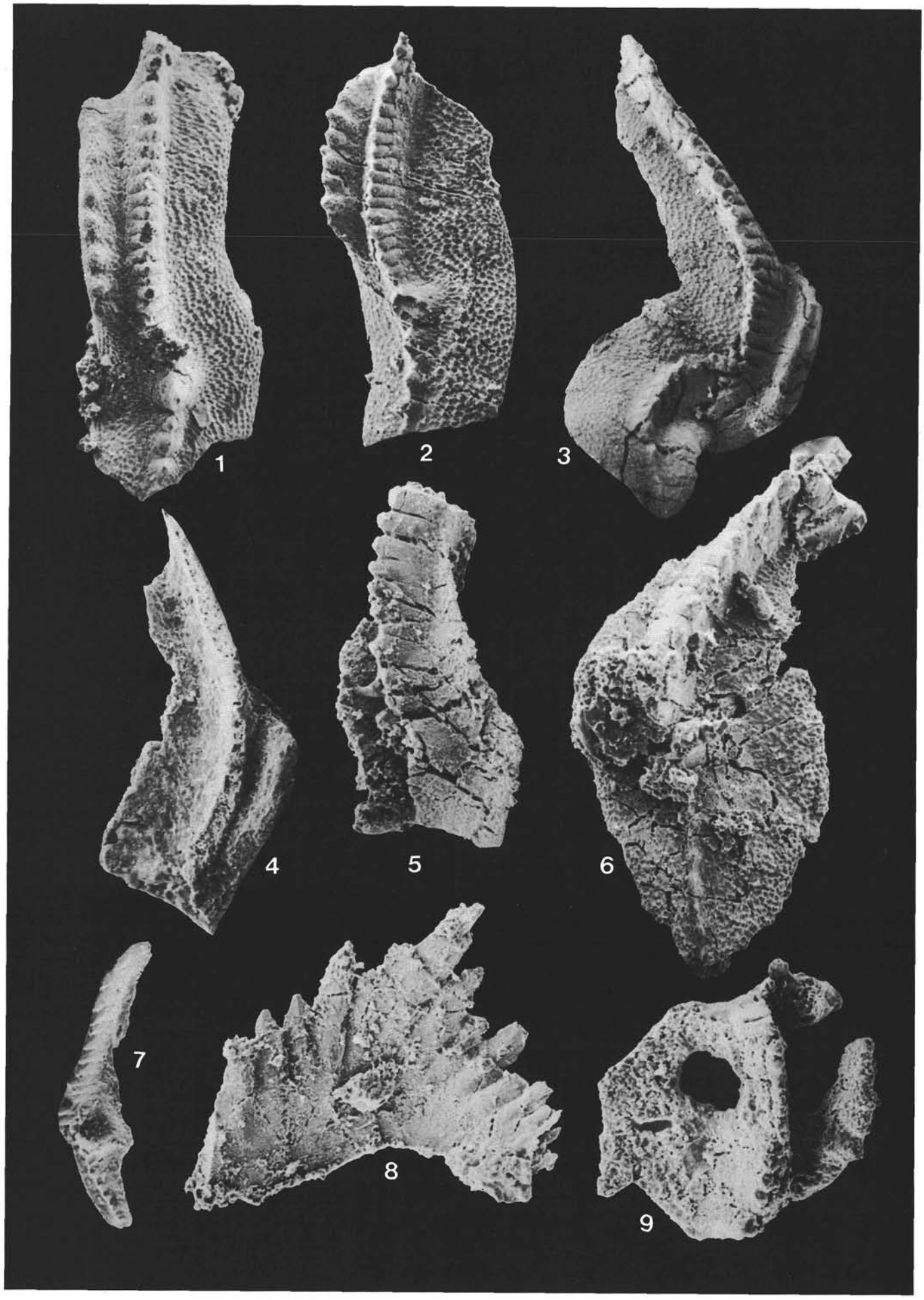


Plate 2

Conodonts from Pre-Triassic Limestones of ~~the~~ Aghdarband ~~Group~~.

Fig. 1: ***Palmatolepis triangularis*** **SANNEMANN.**
Locality 41.
× 90.

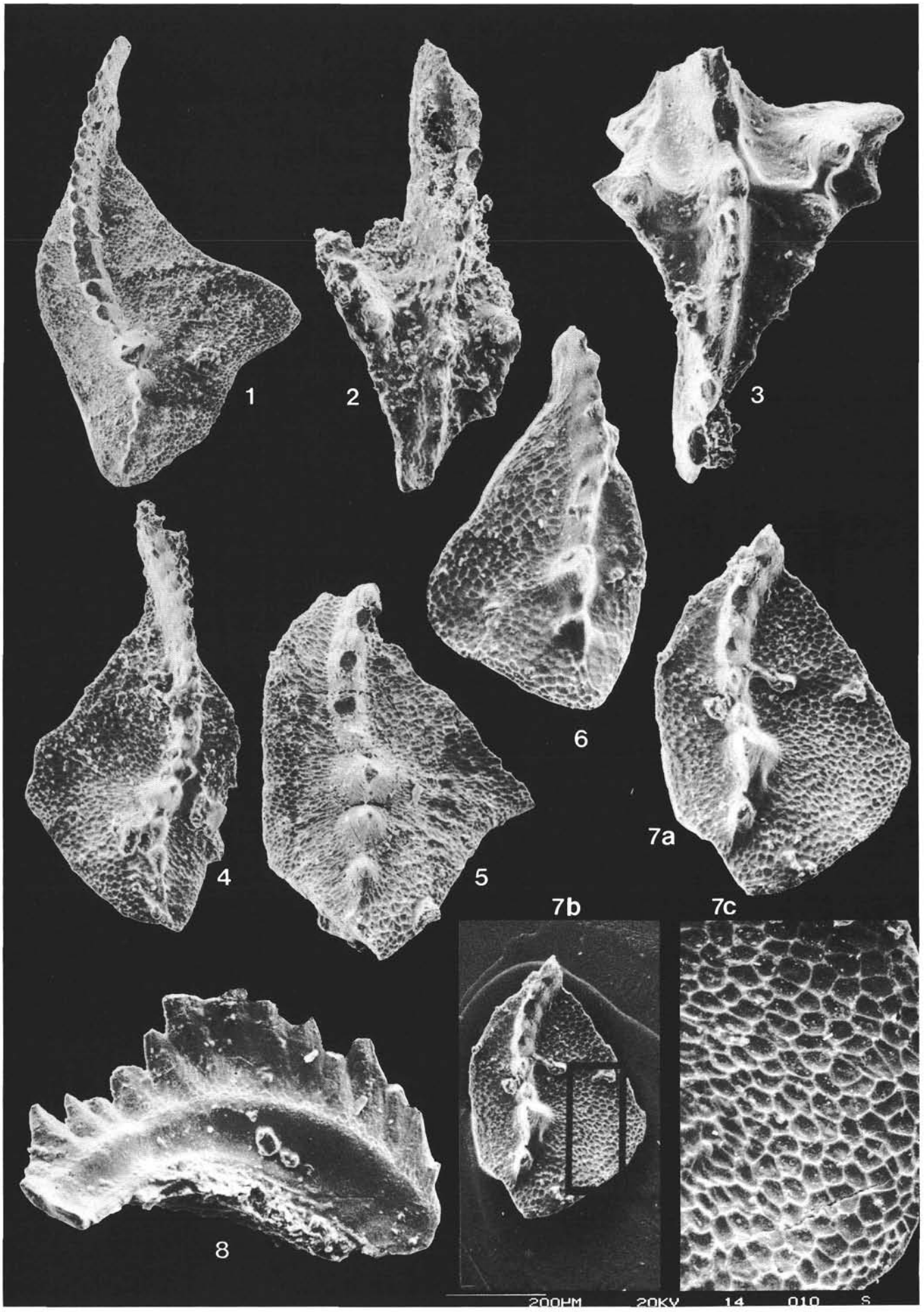
Figs. 2–3: ***Ancyrodella*** **sp. aff.** ***Ancyrodella nodosa*** **ULRICH & BASSLER.**
Locality 44.
Fig. 2: × 85.
Fig. 3: × 178.

Fig. 4: ***Palmatolepis minuta minuta*** **BRANSON & MEHL.**
Locality 41.
× 353.

Fig. 5: ***Palmatolepis*** **sp.**
Locality 41.
× 143.

Figs. 6–7: ***Palmatolepis delicatula delicatula*** **BRANSON & MEHL.**
Locality 41.
Fig. 6: × 170.
Figs. 7a,b: Oral view.
a: × 140.
b: × 96.
Fig. 7c: Detail of the reticulated platform surface. × 744.

Fig. 8: **Pb (ozarkodiniform) element of the genus** ***Palmatolepis*****.**
Locality 41.
× 187.



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