Conodont faunas from Portugal and southwestern Spain

Part 7. A Frasnian conodont fauna near the Estação de Cabrela (Portugal)

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A Frasnian conodont fauna is described. The possible composition of the multi-element conodont apparatus of *Polygnathus decorosus* Stauffer, 1938 is discussed.

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Introduction

In the area near the Estaçao (station) of Cabrela on the railroad from Beja to Vendas Novas several lense-like limestone outcrops occur amidst the Palaeozoic shales and slates of the Evora Massif. Samples from six of these limestone bodies were collected by the Serviços Geologicos de Portugal and sent to me for investigation. One of them - a black limestone - yielded a well preserved conodont fau-

na of Frasnian age. The others proved to be devoid of conodonts. The area still being subject to investigation by the Portugese Geological Survey no definite details upon the stratigraphy are available yet.

Note added in proof – In March 1983 Dr A. Ribeiro (University of Lisbon) sent me - for which I am grateful - a preprint of his paper: Relaçoes entre formaçoes do Devónico superior e o Maciço de Évora na regiao de Cabrela (Vendas Novas), which will be published in the Communicaçoes dos Serviços Geologicos de Portugal. In this paper Ribeiro describes the Cabrela Formation as consisting of an alternation of pelites, siltstones and middle- to fine-grained graywackes, with intercalations of limestones and keratophyres and some rare intraformational conglomerates.

Acknowledgements

Thanks are due to G. Klapper for his comments on some of my identifications.

Age of the limestone

Palmatolepis punctata and *P. gigas* only occur together in the Lower *gigas* Zone (Klapper & Ziegler, 1979). *Ancyrognathus triangularis* becomes extinct in the lowest part of the Upper *gigas* Zone (Ziegler, 1962). Consequently we may assume that the Cabrela fauna belongs to the Lower *gigas* Zone, thus being of Late Frasnian age.

Conodont biofacies

In the Cabrela fauna even the very delicate forms are well preserved. This indicates deposition in an environment of very low energy well below wave base.

Schumacher (1976) in his study of conodont biofacies in Middle to Upper Devonian beds in central Missouri found a narrow-*Polygnathus* biofacies to occur in shallow to deep subtidal facies although of the latter the depth was still close to wave base. *Ancyrodella* sp. and *Polygnatus asymmetricus* occurred in deeper subtidal facies.

Palmatolepis sp. occurs according to Sandberg (1976) in deeper water. It apparently occupied the same ecological niche as its ancestor *Polygnathus asymmetricus*.

Our fauna is dominated by a narrow-*Polygnathus, Polygnathus decorosus* (63.2% of the P elements). *Palmatolepis* + *Ancyrodella* form 34.3% of the P elements, *Icriodus* only 2.5% . Although species of *Icriodus* generally indicate very shallow water, some species apparently do not. Schumacher (1976) reports that *Icriodus brevis* was found in deep subtidal deposits and rare or absent in contemporaneous shallow subtidal deposits.

Considering the composition of the Cabrela fauna we must conclude in comparison with the results of Schumacher (1976) and Sandberg (1976) that

our fauna was deposited in a deep to moderately deep subtidal marine environment. This is in agreement with our assumption stated above that the energy was very low as evidenced by the good preservation of the most delicate elements.

Palaeontology

A limestone sample of 7 kg has been dissolved with formic acid and the residue was found to contain more than 2000 conodonts. They are listed in Table 1. Van den Boogaard & Kuhry (1979) have put Linnean terms for separate elements (form species) between quotation marks, a custom which is continued in this paper. The specimens are stored in the Rijksmuseum van Geologie en Mineralogie, Leiden, with registration numbers RGM 296 798 - 296 849.

Ancyrodella nodosa Ulrich & Bassler, 1926
Pl. 1, figs. 3, 5.

1926 *Ancyrodella nodosa* n. sp. – Ulrich & Bassler, p. 48, pl. 1, figs. 10-13.
1968 *Ancyrodella nodosa* Ulrich & Bassler – Huddle, p. 6-7, pl. 13, figs. 1-4, 7-10.

Remarks – The specimens conform to the description given by Huddle. Although the specimen of Pl. 1, fig. 3 shows some tendency to form a lobate extension of the outer margin as in *A. lobata* it misses the corresponding keel at the aboral side. The figured specimen also seems to have some more denticles than typical *A. nodosa*. However, it has less than *A. buckeyensis* and does not show the ridges normal to the platform margin. According to Druce (1975) it is difficult to make a good separation between *A. nodosa* and *A. buckeyensis* but he considers a sigmoidal platform outline on both sides as a feature of *A. nodosa* and a triangular platform outline typical for *A. buckeyensis*. Because the outline of the present specimens is more of the sigmoidal type they are assigned to *A. nodosa*.

The fauna only contains a few adult specimens. Juvenile specimens (Pl. 1, fig. 5) are more frequent, difficult to identify on specific level and are only provisionally assigned to *A. nodosa*.

A. nodosa is reported to range from the base of the *Anc. triangularis* Zone into the Upper *gigas* Zone (Klapper & Ziegler, 1979).

Ancyrognathus triangularis Youngquist, 1945

Remarks – The two specimens in our fauna conform to the descriptions of Youngquist (1945) and Ziegler (1958). A picture could not be given because the only good specimen was demolished during scanning operations.

Ancyrognathus triangularis is reported to range from the base of the *Anc. triangularis* Zone into the lower part of the Upper *gigas* Zone (Klapper & Ziegler, 1979).

'Belodella resima' (Philip, 1965)
Pl. 1, fig. 1.

1965 *Belodus resimus* sp.nov. – Philip, p. 98-99, pl. 8, figs. 15-17, 19, textfigs. 2e-f.
1966 *Belodella resima* (Philip) – Philip, p. 444, pl. 1, figs. 14-17.

Remarks – The specimens conform to the descriptions given by Philip. The deep basal cavity is narrowly triangular in cross section and the junctions of the anterior and lateral faces are marked by costae. The denticles of the posterior edge are numerous and partly fused.

Philip's 1965 and 1966 material was Lower Devonian. In the Canning Basin the species was found to occur in Frasnian limestones by Seddon (1970) and even to range into the lower Famennian (Middle *crepida* Zone) by Druce (1975). Orchard (1978) reported specimens of this species from the Middle *varcus* Zone in southwest England.

Icriodus sp. cf. *I. brevis* Stauffer, 1940
Pl. 2, figs. 1-8.

Diagnosis – A small slender species of *Icriodus* with the median row of nodes of the I element extended posteriorly of the lateral rows of nodes. The extended part consists of three fused denticles of about the same height. Anterior of the lateral rows the median row has only one denticle.

Description – Adult I elements of this species show the following features: Posterior of the lateral rows the median row consists of three denticles which are grown into a crest. The median denticles anterior of this crest are clearly separated and erect. The anteriormost sometimes are somewhat proclined. The lateral denticles are inclined outward and upward. The anteriormost lateral pair always is preceded by only one denticle in the median row. The tips of all denticles are at the same level.

In juvenile specimens the denticles of the lateral rows alternate with those of the median row. In adult specimens the denticles of lateral rows and median row stand in a more chevron-like arrangement. The margins of the basal cavity diverge regularly backward. The element is straight to slightly bend.

The I elements grow by adding denticles at the anterior end. The most juvenile I element in the fauna is a *Pelekysgnathus*-like form with four partly fused denticles (Pl. 2, fig. 1). In the next growth stage it has added a pair of lateral denticles between the third and fourth median denticle reckoned from the posterior end (Pl. 2, fig. 2). At the same time the platform is extended forward. In subsequent growth stages denticles are added at the anterior end, each time one in the median row and a pair of lateral ones (Pl. 2, figs. 3-5). At the same time the older denticles are covered by new lamellae in such a way that they become progressively less sharply separated from each other. Especially the three posteriormost of the median row become almost completely fused into a crest. Simultaneously the sides are extended downwards and outwards thus enlarging the basal cavity.

Nicoll (1977) published a form of *Icriodus brevis* which differs from our species in that in his specimens the denticle length more strongly increases in posterior direction. As a result of this the level of the tips of the denticles of his specimens is much less parallel with the plane of the aboral side as in our specimens. Besides the I element Nicoll also found S_2 and M elements, simple cones the upper part of which is striated. In our fauna one very small simple cone was found which may represent the S_2 element of our species (Pl. 1, fig. 6).

Our species differs from *Icriodus brevis* Stauffer, 1940 in that the latter has more median row denticles (4 to 5) posterior of the lateral rows, denticles which moreover seem to be less fused (Klapper, in Ziegler, 1975, *Icriodus* Plate 3, figs. 1-3; Ziegler et al., 1976, Pl. 1, figs. 10-16).

Our species also seems to have much in common with forms found by Lys and Serre (1957) in Frasnian strata of the Montagne Noire, described by them as *Icriodus cymbiformis* Branson & Mehl. The main differences to judge from Lys and Serre's description are the form of the basal cavity which is more expanded in the posterior part and the fact that only the two posteriormost denticles of the median row are fused. The name *Icriodus cymbiformis* or *I.* sp. cf. *cymbiformis* cannot be applied to our specimens as the name has to be considered a nomen nudum (G. Klapper, personal communication) because the types are lost (Klapper, in Ziegler, 1975) and the original description is too little specific.

Genus *Palmatolepis* Ulrich & Bassler, 1926
Pl. 3, figs. 1-9.

Only a few adult P skeletal elements are present of the species *Palmatolepis gigas* (Pl. 3, fig. 5), *P. subrecta* (Pl. 3, fig. 8) and *P. punctata* (Pl. 3, fig. 9). The specimens ascribed to The latter species originally have been assigned by me to the species *P. hassi*, but according to G. Klapper they are still within the variability of *P. punctata*. Most specimens of the P elements are juvenile and therefore difficult to assign to either *P. subrecta* or *P. punctata* and when part of the lateral lobe is broken off to *P. gigas* also. Three types of the O element ('*Nothognathella*' spp.) are present: one with only a small platform at the inner side (Pl. 3, fig. 6), one with a broad platform at the inner side and a small one at the outer side (Pl. 3, fig. 4) and one with broad platforms at both sides (Pl. 3, fig. 7). In this fauna with its many not fully grown P skeletal elements of *Palmatolepis* it is difficult to assign any of the O elements to a particular species. The first two mentioned resemble the O elements respectively assigned to *P. gigas* and *P. subrecta* by van den Boogaard & Kuhry (1979). The third (broadest) one was not encountered by van den Boogaard & Kuhry. May be this broad nothognathellan element belongs to *P. punctata*, a species not discussed by van den Boogaard & Kuhry. The fauna furthermore contains the N_1, N_2, A_1, A_2 and A_3 elements of *Palmatolepis*. From Table 1 it is evident that they are strongly underrepresented. This may be due to the fact that sieve fractions smaller than 0.18 mm have not been investigated.

P. subrecta ranges from the Upper *asymmetricus* Zone upto or into the *P. triangularis* Zone, *P. punctata* from the Middle *asymmetricus* Zone into the Lower *gigas* Zone, *P. gigas* from the base of the *gigas* Zone upto or somewhat into the *P. triangularis* Zone (Klapper & Ziegler, 1979).

Table 1. Natural species and form ('. . .') species present in the sample from Cabrela.

	Number of specimens*
Ancyrodella nodosa Ulrich & Bassler, 1926: P element	21
Ancyrognathus triangularis Youngquist, 1945: P element	2
'Belodella resima' (Philip, 1965)	27
Icriodus sp. cf. *I. brevis* Stauffer, 1940 : I element	30
: S_2 element ?	1
Palmatolepis (Manticolepis) punctata (Hinde, 1879): P element	
Palmatolepis (Manticolepis) gigas Miller & Youngquist, 1947: P element	386
Palmatolepis (Manticolepis) subrecta Miller & Youngquist, 1947: P element	
Palmatolepis (Manticolepis) spp. : O element	29
: N_1 element	16
: N_2 element	14
: A_1 element	3
: A_2 element	4
: A_3 element	4
Palmatolepis sp.: P element	2
Polygnathus decorosus Stauffer, 1938 : P element	769
: O element	170
: N element	69
: A_1 element	171
: A_2 element	135
'Avignathus' sp. cf. *'A. orthoptera'* Ziegler, 1958	34
Polygnathus sp.: P element	7
'Hibbardella' sp.	15
'Diplododella' sp.	5
Other non-platform elements	150

* Number of specimens in the sieve fractions > 0.18 mm.

Polygnathus decorosus Stauffer, 1938
Pl. 4, figs. 1-10.

Diagnosis – P skeletal element is the form species *'Polygnathus decorosus'* Stauffer, O skeletal element is ozarkodinan, N is synprioniodinan, A_1 is hindeodellan, A_2 is angulodontan, A_3 is uncertain, either diplododellan or *'Avignathus'* sp.

Description – The specimens of the P skeletal element conform to the descriptions given by Klapper et al. (1970) and Klapper (in Ziegler, 1973). They do show the long free blade, and have the basal cavity at the anterior end of the platform or just posterior of that position in very large specimens. The platform is adorned with nodes or short ridges normal to the rim. The outline of the platform is sagitate. The anterior margins of the platform often are somewhat upturned but do not form a well-developed rostrum as in *Polygnathus dubius* Hinde, 1879.

Table 2. Composition of some faunas containing '*Avignathus*' sp.

	15-9-5 Steinbruch Schmidt near Wildungen, Germany; Upper *gigas* Zone.	15-9-4 Steinbruch Schmidt near Wildungen, Germany; Upper *gigas* Zone.	F3082 Road from Löhnberg to Weilburg, Germany; Lower Kellwasserkalk, Lower *gigas* Zone.	Estaçao de Cabrela
Icriodus spp.	56	61	15	30
Ancyrodella spp.	31	29	2	21
Ancyrognathus spp.	30	8	-	2
'*Spathognathodus*' spp.	6	3	4	-
Polygnathus spp. non *decorosus*	92	31	10	7
Symmetrical element a	4	12	6	15
Symmetrical element b	5	8	2	5
Symmetrical element c	6	8	1	-
Symmetrical element d	8	-	-	-
Polygnathus decorosus P element	543	196	84	769
P. decorosus ozarkodinan element	48	47	8	170
P. decorosus synprioniodinan element	37	23	8	69
P. decorosus hindeodellan element	51	48	10	171
P. decorosus angulodontan element	30	31	7	135
'*Avignathus*' sp.	15	15	5	34
Palmatolepis spp. P element	1702	1371	230	388
Palmatolepis spp. O element	124	60	9	29
Palmatolepis spp. N_1 element	121	62	7	16
Palmatolepis spp. N_2 element	116	44	4	14
Palmatolepis spp. A_1 element	49	44	3	3
Palmatolepis spp. A_2 element	55	33	-	4
Palmatolepis spp. A_3 element	21	12	1	4

The O, N, A_1, and A_2 skeletal elements of the apparatus (see Pl. 4, figs. 1-4) seem to be identical or nearly so to the elements of *P. dubius* Hinde as figured by Klapper & Philip (1971, fig. 12). I have no doubt that they belong to the apparatus of *Polygnathus decorosus* because in the fauna each of the form species representing these O, N, A_1, and A_2 elements is the dominant form of its respective form genus, '*Ozarkodina*', '*Synprioniodina*', '*Hindeodella*', and '*Angulodus*'. The few remaining forms of these form genera probably belong to other apparatuses, i.a. that of *Ancyrodella nodosa*.

Concerning the symmetrical A_3 element I feel uncertain. The fauna contains some fifteen hibbardellan elements (Pl. 1, fig. 4) which resemble much

those of the apparatuses of *Ancyrodella* and *Delotaxis* as pictured by Klapper & Philip (1971, 1972), and five diplododellan elements (Pl. 1, fig. 2) which somewhat resemble the A_3 element of *Polygnathus dubius*. The only other symmetrical element in our fauna which moreover occurs in a larger number than the other symmetrical elements together is *'Avignathus'* sp. cf. *'A. orthoptera'* Ziegler, 1958. I am tempted to assume that *'Avignathus'* is the symmetrical element of *Polygnathus decorosus*, however do have no definite data to prove so. I investigated three other samples with relatively large numbers of *P. decorosus* and found several specimens of *'Avignathus'* but the data are too few to be convincing (Table 2). Some other samples with smaller numbers of *P. decorosus* did not yield any specimens of *'Avignathus'* but this may be due to the fact that *'Avignathus'* is a very delicate form and often too poorly preserved to be recognised. This may explain why *'Avignathus'* is seldomly reported in literature and consequently it is not known whether *P. decorosus* and *'Avignathus'* do have the same stratigraphic range. At this moment I also can do nothing but suggest that this species of *'Avignathus'* may represent the A_3 element of *Polygnathus decorosus*. Subsequent research on very well preserved faunas will be needed to establish this and if eventually it might be the case than one has to consider if *P. decorosus* has to be assigned to a new subgenus.

The range of the species *P. decorosus* is *Ancyrognathus triangularis* Zone through uppermost *P. gigas* Zone (Klapper, in Ziegler, 1973).

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Plate 1

Fig. 1. *'Belodella resima'* (Philip, 1965), specimen RGM 296 842a, x 210.
Fig. 2. *'Diplododella'* sp., specimen RGM 296 844a, x 100.
Fig. 3. *Ancyrodella nodosa* Ulrich & Bassler, 1926, specimen RGM 296 844b, x 50.
Fig. 4. *'Hibbardella'* sp., specimen RGM 296 844c, x 100.
Fig. 5. *Ancyrodella nodosa* Ulrich & Bassler, 1926, specimen RGM 296 844d, x 100.
Fig. 6. Simple cone, S_2 element of *Icriodus*?, specimen RGM 296 848a, x 500.

Plate 1

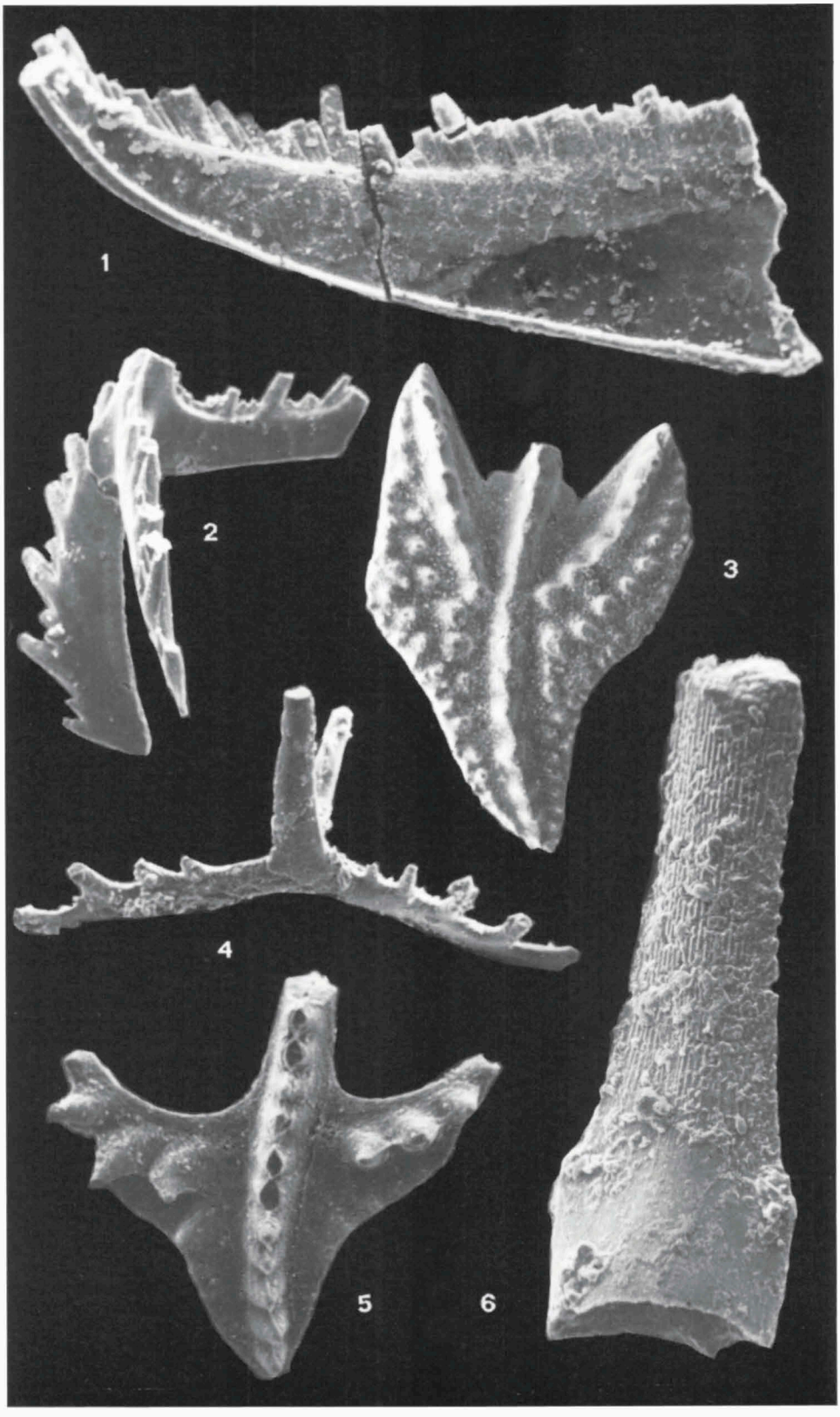

Plate 2

Icriodus sp. cf. *I. brevis* Stauffer, 1940, ontogenetic series.

Fig. 1. Earliest growth stage, *Pelekysgnathus*-like form, RGM 296 847a, x 200.
Fig. 2. Stage 2, one pair of lateral denticles, specimen RGM 296 848b, x 200.
Fig. 3. Stage 3, two pair of lateral denticles, specimen RGM 296 847b, x 200.
Fig. 4. Stage 4, three pair of lateral denticles, specimen RGM 296 847c, x 200.
Fig. 5. Stage 5, four pair of lateral denticles, specimen RGM 296 847d, x 200.
Fig. 6. Stage 6, five pair of lateral denticles, specimen RGM 296 847e, x 200.
Fig. 7. Stage 3, aboral side, specimen RGM 296 847f, x 200.
Fig. 8. Stage 5, aboral side, specimen RGM 296 847g, x 200.

Plate 2

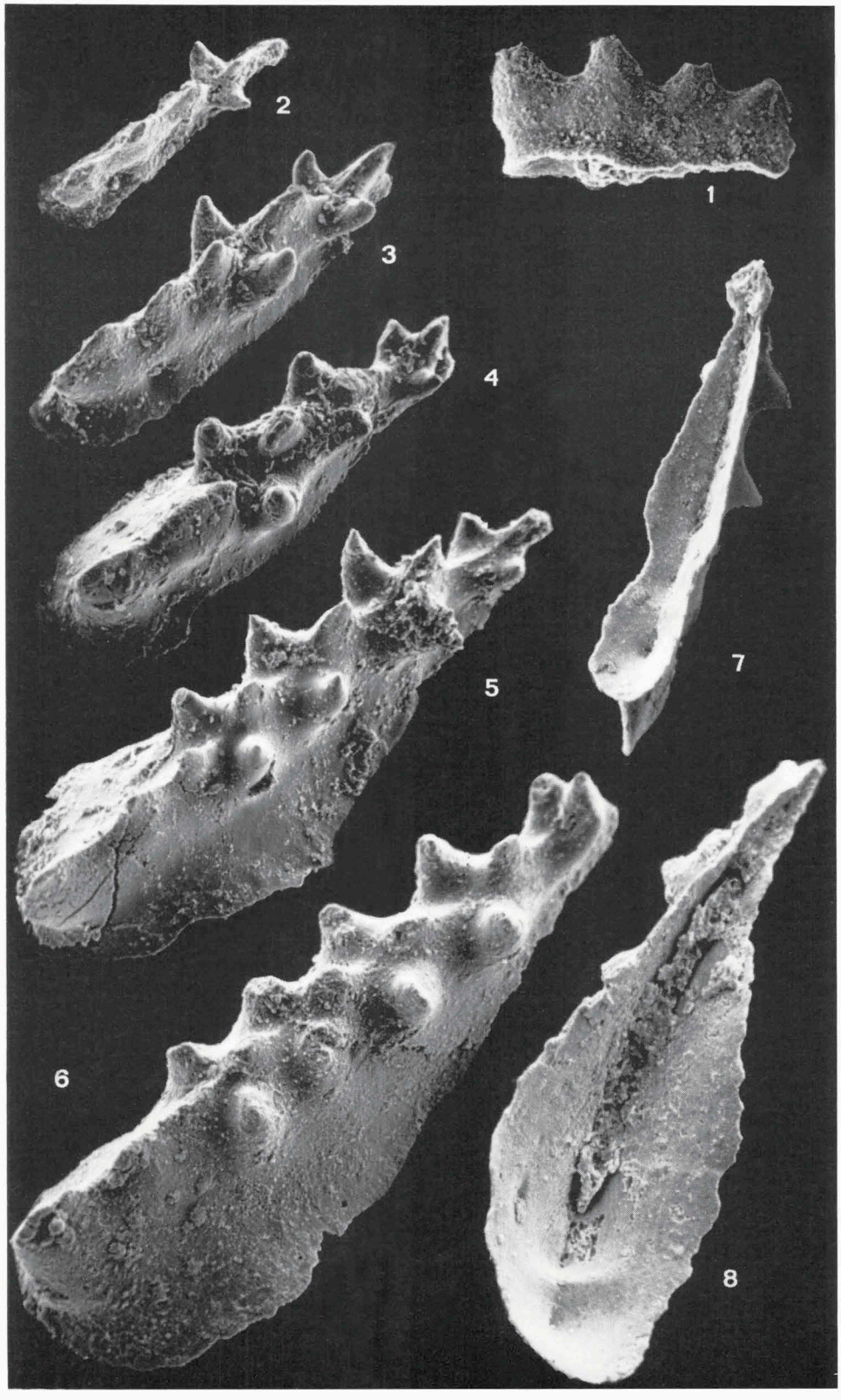

Plate 3

Fig. 1. *Palmatolepis* sp., N_2 element, specimen RGM 296 842b, x 78.
Fig. 2. *Palmatolepis* sp., A_3 element, specimen RGM 296 842c, x 78.
Fig. 3. *Palmatolepis* sp., N_1 element, specimen RGM 296 844e, x 75.
Fig. 4. '*Nothognathella*' sp., O element of *Palmatolepis subrecta* Miller & Youngquist, 1947, specimen RGM 296 843c, x 75.
Fig. 5. *Palmatolepis gigas* Miller & Youngquist, 1947, P element, specimen RGM 296 844f, x 75.
Fig. 6. '*Nothognathella*' sp., O element of *Palmatolepis gigas* Miller & Youngquist, 1947, specimen RGM 296 848c, x 75.
Fig. 7. '*Nothognathella*' sp., O element of *Palmatolepis punctata* (Hinde, 1879) ?, specimen RGM 296 848d, x 75.
Fig. 8. *Palmatolepis subrecta* Miller & Youngquist, 1947, P element, specimen RGM 296 844g, x 75.
Fig. 9. *Palmatolepis punctata* (Hinde, 1879), P element, specimen RGM 296 848e, x 75.

Plate 3

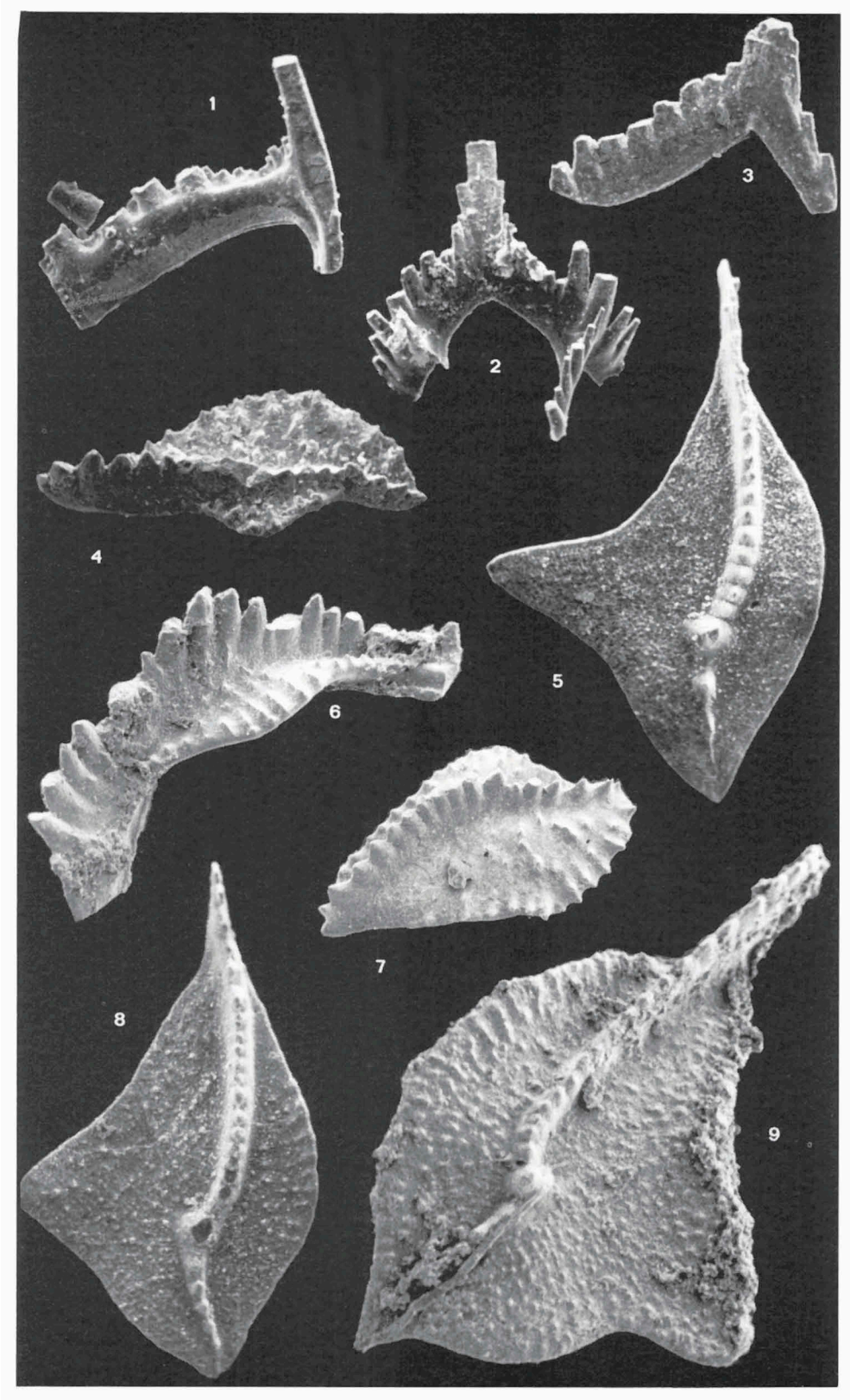

Plate 4

Polygnathus decorosus Stauffer, 1938.

Fig. 1. '*Synprioniodina*' sp., N element of *P. decorosus*, specimen RGM 296 843a, x 87.
Fig. 2. '*Ozarkodina*' sp., O element of *P. decorosus*, specimen RGM 296 847h, x 87.
Fig. 3. '*Hindeodella*' sp., A_1 element of *P. decorosus*, specimen RGM 296 847i, x 87.
Fig. 4. '*Angulodus*' sp., A_2 element of *P. decorosus*, specimen RGM 296 843b, x 87.
Fig. 5. P element, oral view, specimen RGM 296 849a, x 87.
Fig. 6. P element, oral view, specimen RGM 296 849b, x 87.
Fig. 7. P element, oral view, specimen RGM 296 849c, x 87.
Fig. 8. P element, aboral view, specimen RGM 296 845a, x 91.
Fig. 9. '*Avignathus*' sp., A_3 element ? of *P. decorosus*, specimen RGM 296 847j, x 87.
Fig. 10. P element, lateral view, specimen RGM 296 842d, x 91.

Plate 4