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FAMENNIAN (LATE DEVONIAN) CONODONTS FROM THE PIZZUL WEST SECTION (CARNIC ALPS, ITALY)

CONODONTI DEL FAMENNIANO (DEVONIANO SUPERIORE) DALLA SEZIONE MONTE PIZZUL OVEST (ALPI CARNICHE, ITALIA)

Riassunto breve - Vengono illustrati conodonti dalla sezione Pizzul Ovest, situata nell'area del Passo del Cason di Lanza/ Monte Zermula nelle Alpi Carniche centrali. La sezione, potente circa 24 metri, è costituita da calcari del Devoniano Superiore. L'associazione comprende 41 taxa di conodonti, che permettono di riconoscere sette biozone del Frasniano e del Famenniano: Upper *rhenana*, Upper *crepida*, Uppermost *crepida*, Lower *rhomboidea*, Upper *rhomboidea*, Lower *marginifera* e Lower *expansa*.
Parole chiave: Conodonti, Biostratigrafia, Devoniano Superiore, Alpi Carniche.

Abstract - *Conodonts from the Pizzul West section are presented. The section is located in the Cason di Lanza/Mt. Zermula area of the central Carnic Alps and it exposes about twenty-four metres of Upper Devonian limestone. The forty-one taxa documented allow the discrimination of seven biozones of Frasnian and Famennian: Upper* rhenana*, Upper* crepida*, Uppermost* crepida*, Lower* rhomboidea*, Upper* rhomboidea*, Lower* marginifera *and Lower* expansa.
Key-words: *Conodonts, Biostratigraphy, Upper Devonian, Carnic Alps.*

Introduction

The Clymeniae limestones have been extensively investigated for biostratigraphic purposes in the Carnic Alps in the last decades. The unit crops out widely along the Carnic Alps, but most of the research have been concentrated in the central-western part of the chain, mainly in Wolayer, Passo di Monte Croce Carnico, Timau-Pramosio areas. From the central-eastern part of the Carnic Alps data available are by far less abundant, probably because of the less spectacular outcrops, and/ or more difficult accessibility of some areas.

In this paper we present the conodont fauna and biostratigraphy from a section located in the Clymeniae Limestone on the western flank of Mt. Pizzul, in the central part of the Carnic Alps, just south of Passo del Cason di Lanza (Fig. 1). From these area only Manzoni (1966) figured a few latest Devonian-early Carboniferous conodonts from some spot localities along the crest of Mt. Zermula massif.

The Pizzul West (PZW) section is located in a First World War trench on the western flank of Mt Pizzul at q. 1905, at coordinates 46° 33' 21,67" N, 13° 18' 18,16" E (Fig. 1). About 24 meters of Clymeniae limestones are exposed, even if some tectonic elisions and repetitions affected the section. Beside the thirteen samples collected along the section, one more (PZW Z) have been picked several meters to the south, and its relationship with the section is not clear. The sample came from an irregular bed just below the Carboniferous sediments of the Hochwipfel Formation, very distinct in the field, being constituted by irregular gravels and cobbles scattered in a grey micritic cement.

Geological settings

The succession of the Mt. Pizzul area ranges from Ordovician to Carboniferous (Corradini et al. 2012, 2013; Pondrelli et al. 2011). The rocks here exposed belong to the Variscan sequences of the Carnic Palaeozoic, that were affected by the Variscan orogeny during the Westphalian and Alpine tectonics, including both extensional and compressional phases, that involved the whole Carnic area starting from the Cenozoic (Venturini 1990a; Venturini et al. 2009).

The oldest unit cropping in the area is represented by the Upper Ordovician "Uqua shales", consisting of highly fossiliferous shales, siltstones, sandstones and rare conglomerates. The sequence continues with few meters of nodular limestone ("Uqua limestones"), and calcareous sandstones (Plöcken Formation). Silurian

Fig. 1 - Location map.
- *Ubicazione della sezione.*

rocks are poorly exposed and are represented only by a few meters of "*Orthoceras* limestones" (Alticola Formation) of Pridoli age.

Compared to the older terms of the sequence, Devonian rocks are largely more abundant and differentiated. The oldest unit is the Rauchkofel Fm., constituted by dark cephalopod limestone with black shales interbedded, followed by the middle-upper Lochkovian La Valute Fm: a light grey-ochre nodular limestone. The sequence continues with the Findenig Fm., which consists of nodular purple red mudstones and wackestones with marly millimetric thick intercalations.

Starting from around the Lower-Middle Devonian boundary, the basin started to differentiate: in the shallower parts a thick reefal sequence started to build up, represented in the area by the white cliffs of Mt. Zermula. In the deeper parts of the basin, now represented by the units cropping out in Mt. Pizzul - Forca di Lanza area, gravitative driven deposits from the reef, intecalated with narrow pelagic levels, were deposited. These sediments belongs to the Vinz and Hohe Trieb formations.

During the Frasnian the Carnic basin underwent extensional tectonic pulses and the reefal facies collapsed and drowned (Venturini et al. 2009 and reference therein). The Upper Devonian is almost exclusively represented by "Clymeniae limestones": pelagic massive and/or nodular limestones, cropping out at Forca di Lanza and on the western flank of Mt. Pizzul.

The sequence of Mt. Pizzul area ends with the Hochwipfel Fm: gravitative driven accumulation of breccias, conglomerates, sandstones and pelites originated by the Lower Carboniferous transtensional to transpressional tectonics (Spalletta et al. 1980).

For a more detailed description of the geology of the Cason di Lanza - Mt. Pizzul area refer to Corradini et al. (2012, 2013).

The "Clymeniae limestones"

The "Clymeniae limestones" crops out widely in the Carnic Alps, and have been extensively studied by several authors. This informal unit of Frasnian-Tournaisian age is indicated in literature with various names, according to the different authors: Pal Fm., Gross Pal Fm., Calcari di Pramosio, etc.

It consists of grey massive limestone, grey to moderate pink and red very thin to thin (rarely medium) bedded nodular mudstone to wackestone. In the lower part of the units a few levels of breccia occur in some localities. The depositional environment is interpreted as pelagic (e.g., Schönlaub 1992) with local gravitative-driven deposits near the base of the unit.

The fossil content is represented by trilobites, ostracodes, radiolarians and conodonts, and less abundant echinoderms, molluscs, bivalves, brachiopods and fish teeth (Schönlaub 1992).

A detailed biostratigraphy of the unit have been provided by several authors on the basis of the rich conodont associations (for a summary see Perri & Spalletta 1998a).

The Pizzul West section

The Pizzul West section (Fig. 2) exposes about 24 meters of pelagic mudstones-wackestones of the Clymeniae limestones (Fig. 4). The lower and central part of the section (below sample PZW 1) is tectonically disturbed and is affected by folds and/or faults, as confirmed by conodont data (see below for discussion).

Three different facies can be distinguished in the section: a light grey massive micritic limestone, a dark red nodular limestone and a grey-ochre nodular limestone (Fig. 4). In general massive grey limestone are more abundant in the lower part, whereas the red nodular limestone prevails in the upper part. A few thin pelitic levels are present in the section between sample PZW 1 and sample PZW 4.

The microfacies of the grey limestone consists of a wackestone with a light grey color and few fossils remains scattered in the matrix (mostly ostracods and shells); some stylolite structures are also evident (Fig. 3).

The red nodular facies consists of a wackstone-packstone with nodules up to 1 cm of diameter, probably due to a synsedimentary diagenesis, with haematite precipitations (Fig. 3).

The fossil contents is higher and includes trilobites, small shells (brachiopods or bivalves), ostracods, a few cephalopods and sponge spiculae.

The grey-ochre nodular limestone consists of a wackstone-packstone similar to the red one, but without the haematite precipitations that most probably give the red color to the former unit (Fig. 3).

Beside the samples collected along the section, one more sample (PZW Z) has been picked several meters to the south, and its relationship with the section is not clear. The sample came from an irregular bed just below the Carboniferous sediments of the Hochwipfel Formation, very distinct in the field, being constituted by irregular gravels and cobbles scattered in a grey-brownish micritic cement (Fig. 3).

Fig. 2 - Views of the Pizzul West section. a) Panoramic view of Mt. Pizzul with indicated in red the position of section; b) general view of the section in the First World War trench; c) the undisturbed part of the section, with location of samples; d) detail of the reddish nodular limestone; e) the irregular level constituted by gravels and cobbles scattered in a grey micritic cement (sample PZW Z).

- *Vedute della sezione Pizzul Ovest. a) veduta panoramica di M. Pizzul con la sezione indicata in rosso; b) veduta generale della sezione nella trincea della Prima Guerra Mondiale; c) la parte indisturbata della sezione, con ubicazione dei campioni; d) dettaglio del calcare nodulare rosso; e) livello irregolare con litici immersi in un cemento micritico (campione PZW Z).*

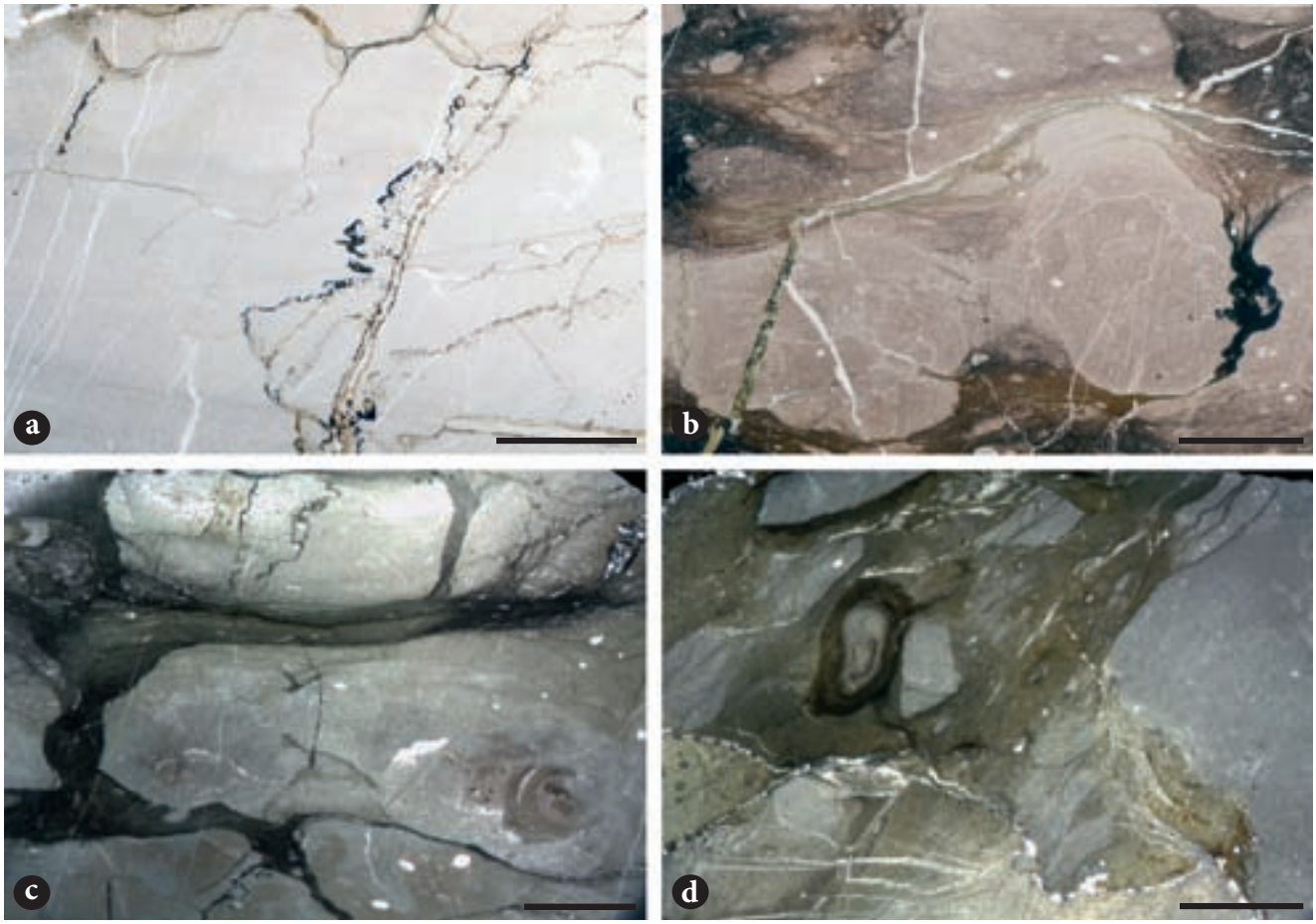


Fig. 3 - Microfacies of the Pizzul West section (scale bar 0,5 cm). a) Grey massive limestone with some stylolite structures from the sample PZW 1; b) Red nodular limestone with haematite precipitations and nodules (Sample PZW 5); c) grey-ochre nodular facies of the sample PZW 5A; d) fine-grained breccia of sample PZW Z.
- *Microfacies della sezione Pizzul Ovest (scala 0,5 cm). a) Calcare grigio massivo con strutture stilolitiche del campione PZW 1; b) precipitazioni di ematite e noduli millimetrici nella facies nodulare rossa (campione PZW 5); c) facies grigio-ocracea nodulare del campione PZW 5A; d) breccia fine del campione PZW Z.*

Conodont data

Fourteen samples (Fig. 4), weighting from 1.2 to 2.6 kg, have been collected from the Pizzul West section (PZW), for a total amount of about 24 Kg of limestone.

The samples have been solved with conventional formic acid technique. All the samples were productive, yielding more than 900 conodonts. The state of preservation is good, even if some specimens are broken. Conodonts color is black (CAI = 5-5.5). The abundance is very variable, from a maximum of 154 conodonts/kg in sample PZW 5 to a minimum of 0.59 conodonts/kg in sample PZW C; the average abundance is 25.85 conodont/kg. Sample PZW Z, collected few meters from the section, has a high abundance of about 154 conodont/kg (Tab. I).

Fourty-one taxa, between species and subspecies, belonging to six genera (*Ancyrodella, Bispathodus, Icriodus, Palmatolepis, Pseudopolygnathus, Polygnathus*) have been recognized (Fig. 4).

Palmatolepis is the predominant genus, so the whole Famennian part of the section belongs to the *palmatolepid-bispathodid* biofacies of Sandberg (1976).

Biostratigraphy

The conodont zonation scheme followed in this paper is the scheme proposed by Corradini (2008), that is a rielaboration of the Late Devonian Standard Conodont Zonation (Ziegler & Sandberg 1990) and the Late Devonian-Early Carboniferous Zonation of Sandberg et al. (1978).

Seven Biozones have been recognized:

- The Upper *rhenana* Zone (sample PZW D) has been discriminated thanks to the joint occurrence of *Icriodus alternatus alternatus*, *Palmatolepis rotunda*, *Ancyrodella lobata*, *Palmatolepis jamiae* and *Palmatolepis lyaiolensis.* In fact the first two taxa have their first occurrence, while the others became extinct

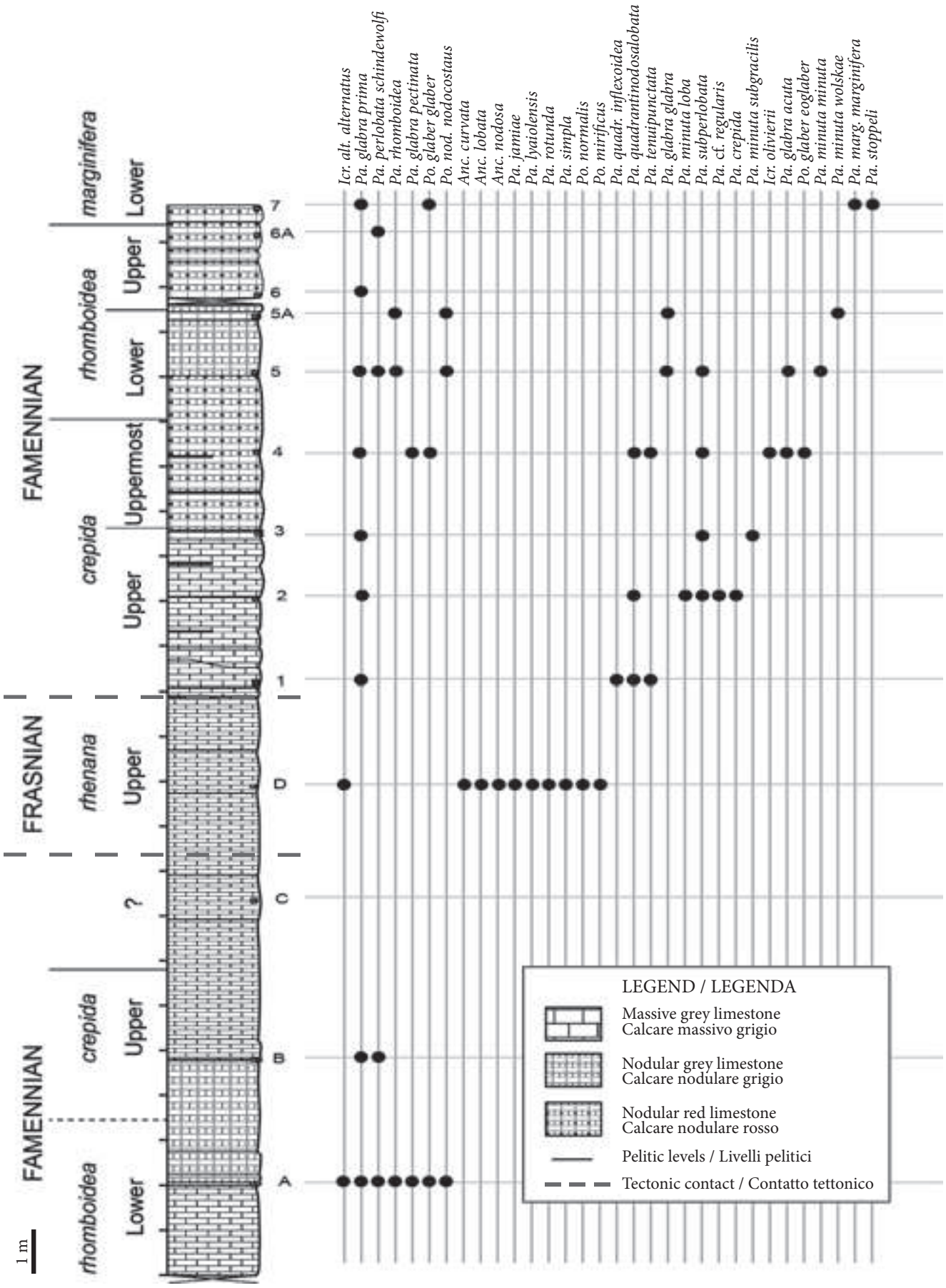


Fig. 4 - Stratigraphic log of the Pizzul West section and conodont distribution.
- *Colonna stratigrafica e distribuzione dei conodonti nella sezione Pizzul Ovest.*

PIZZUL WEST SECTION															
Stage	FAMENNIAN			FRASNIAN	FAMENNIAN										TOTAL
Conodont biozone	Lower *rhomboidea*	Upper *crepida*	?	Upper *rhenana*	Upper *crepida*			Uppermost *crepida*	Lower *rhomboidea*		Upper *rhomboidea*		Lower *marginifera*	Lower *expansa*	
Sample	*A*	*B*	*C*	*D*	*1*	*2*	*3*	*4*	*5*	*5A*	*6*	*6A*	*7*	*Z*	
Ancyrodella curvata				1											1
Ancyrodella lobata				4											4
Ancyrodella nodosa				4											4
Bispathodus stabilis														22	22
Icriodus alternatus alternatus	1			8											9
Icriodus olivierii								6							6
Palmatolepis crepida						1									1
Palmatolepis glabra acuta								2	3						5
Palmatolepis glabra glabra						1			23	5					29
Palmatolepis glabra pectinata	4							3							7
Palmatolepis glabra prima	4	3			1		1	23	26		1		4		63
Palmatolepis gracilis gracilis							1							20	21
Palmatolepis gracilis sigmoidalis														5	5
Palmatolepis jamiae				5											5
Palmatolepis lyaiolensis				4											4
Palmatolepis m. marginifera													1		1
Palmatolepis minuta minuta									7						7
Palmatolepis minuta loba						1									1
Palmatolepis minuta wolskae										2					2
Palmatolepis p. schindewolfi	4	1							3			2		26	36
Palmatolepis perlobata postera														2	2
Palmatolepis regularis						1									1
Palmatolepis rhomboidea	3								3	5					11
Palmatolepis rotunda				1											1
Palmatolepis rugosa rugosa														2	2
Palmatolepis simpla				2											2
Palmatolepis stoppeli													1		1
Palmatolepis subperlobata						1	1	4	11						17
Palmatolepis tenuipunctata					3			2							5
Pseudopolygnathus controversus														5	5
Pseudopolygnathus irregularis														2	2
Pseudopolygnathus m. marburgensis														2	2
Pseudopolygnathus micropunctatus														2	2
Polygnathus glaber eoglaber								2							2
Polygnathus glaber glaber	6							1	8				1		16
Polygnathus marginvolutus														8	8
Polygnathus mirificus				1											1
Polygnathus n. nodocostatus	3									1				4	8
Polygnathus normalis				1											1
Polygnathus obliquicostatus														7	7
Polygnathus styriacus														50	50
Ramiforms		1		7	2			1	34	4	2	5		127	183
Ancyrodella sp.				5											5
Icriodus sp.				2	2	1		5							10
Palmatolepis sp.	18		1		12	1	1	1		15			5		54
Polygnathus sp.				7					1						8
Pb elements									3						3
Unidentified	21			58			4	42		23		6	4	117	275
Total	**64**	**5**	**1**	**110**	**20**	**7**	**8**	**92**	**122**	**55**	**3**	**13**	**16**	**401**	**917**
Weight	1,9	1,8	1,7	1,9	2,2	1,7	1,4	1,2	1,2	2,1	2,4	1,9	1,9	2,6	25,9
Abundance	33,7	2,8	0,6	57,9	9,1	4,1	5,9	74,8	100,0	26,2	1,3	6,8	8,4	154,2	485,8

Tab. I - Conodont distribution chart of the Pizzul West section.
- *Tabella di distribuzione dei conodonti nella sezione Pizzul Ovest.*

within this zone (Ziegler & Sandberg 1990; Ji & Ziegler 1993; Ovnatanova & Kononova 2008).
- The Upper *crepida* Zone has been discriminated in samples PZW 1-3, thanks of the first occurrence of the marker *Palmatolepis glabra prima*, and of *Palmatolepis glabra lepta* and *Palmatolepis minuta subgracilis*. The absence of taxa having a younger first occurrence suggests that also sample PZW B may belong to this biozone.
- The Uppermost *crepida* Zone is recognized in sample PZW 4 by the joint occurrence of the marker *Palmatolepis glabra pectinata* and of *Palmatolepis tenuipunctata*, that has its last appearance datum within this zone (Ji & Ziegler 1993). Also, *Icriodus olivierii* enters here at the base of its known range (Corradini 2008).
- The Lower *rhomboidea* Zone is discriminated in samples PZW 5-5A by the presence of the marker *Palmatolepis rhomboidea*, and of *Palmatolepis minuta wolskae* and *Palmatolepis subperlobata* that have their last occurrence within this Zone (Ji & Ziegler 1993).
- The Upper *rhomboidea* Zone (Samples PZW 6, 6A) is here recognized by the extinction of *Palmatolepis minuta wolskae*.
- The Lower *marginifera* Zone (Sample PZW 7) is recognized by the first occurrence of the marker *Palmatolepis marginifera marginifera*. The presence of *Palmatolepis stoppeli*, which became extinct within this Zone (Ji & Ziegler 1993) confirms the attribution of PZW 7.
- The Lower *expansa* Zone (Sample Z) is discriminated by the joint occurrence of *Palmatolepis rugosa rugosa*, *Polygnathus nodocostatus nodocostatus* and *Polygnathus styriacus*. The first one make its first occurrence in this Zone, while the other two became extinct (Ji & Ziegler 1993).

Sistematic Palaeontology

Synonymy lists are limited to main captions and to reports from the Carnic Alps. The whole conodont collection is housed in the Museum of Palaeontology "Domenico Lovisato" of Cagliari University (MDLCA); catalog numbers of figured specimens (Figs 5-6) can be obtained from the figure captions.

Family Spathognathodontidae Hass, 1959

Genus *Ancyrodella* Ulrich & Bassler, 1926

Ancyrodella curvata Branson & Mehl, 1934
(Fig. 5.3)

1934 *Ancyrodella curvata* n. sp. - Branson & Mehl, p. 241, pl. 19, figs 6, 11.
1966 *Ancyrodella curvata* Branson & Mehl - Glenister & Klapper, p. 798, pl. 86, figs 13-15.
1993 *Ancyrodella curvata* Branson & Mehl - Ji & Ziegler, p. 96, pl. 2, figs 4-5.
1998 *Ancyrodella curvata* Branson & Mehl - Spalletta & Perri, p. 204, pl. 2.2.1, fig. 1.

Remarks: *Ancyrodella curvata* is characterized by a strongly pronounced latero-posterior lobe which can bear a secondary carina and a secondary keel. The anterior lobes are well developed. The carina goes all along the element and is bounded by two row of nodes, one on each side of the carina. The platform is covered by nodes. It is distinguished from *Ancyrodella lobata* by a secondary carina on the latero-posterior lobe and a secondary keel.

Range: From within the Lower *hassi* Zone to the end of the *linguiformis* Zone (Ji & Ziegler 1993).

Studied material: 1 specimen from sample PZW D.

Ancyrodella lobata Branson & Mehl, 1934
(Fig. 5.2)

1934 *Ancyrodella lobata* n. sp. - Branson & Mehl, p. 239-240, pl. 19, fig. 14, pl. 21, figs 22-23.
1971 *Ancyrodella lobata* Branson & Mehl - Szulczewski, p. 13, pl. 3, figs 1-4 only.
1985 *Ancyrodella lobata* Branson & Mehl - Klapper & Lane, p. 923-924, pl. 14, fig. 12, 13, 16, 17.
1989 *Ancyrodella lobata* Branson & Mehl - Ji, pl. 3, fig. 3.
1993 *Ancyrodella curvata* (Branson & Mehl) - Ji & Ziegler, p. 96, pl. 2, figs 6-10.

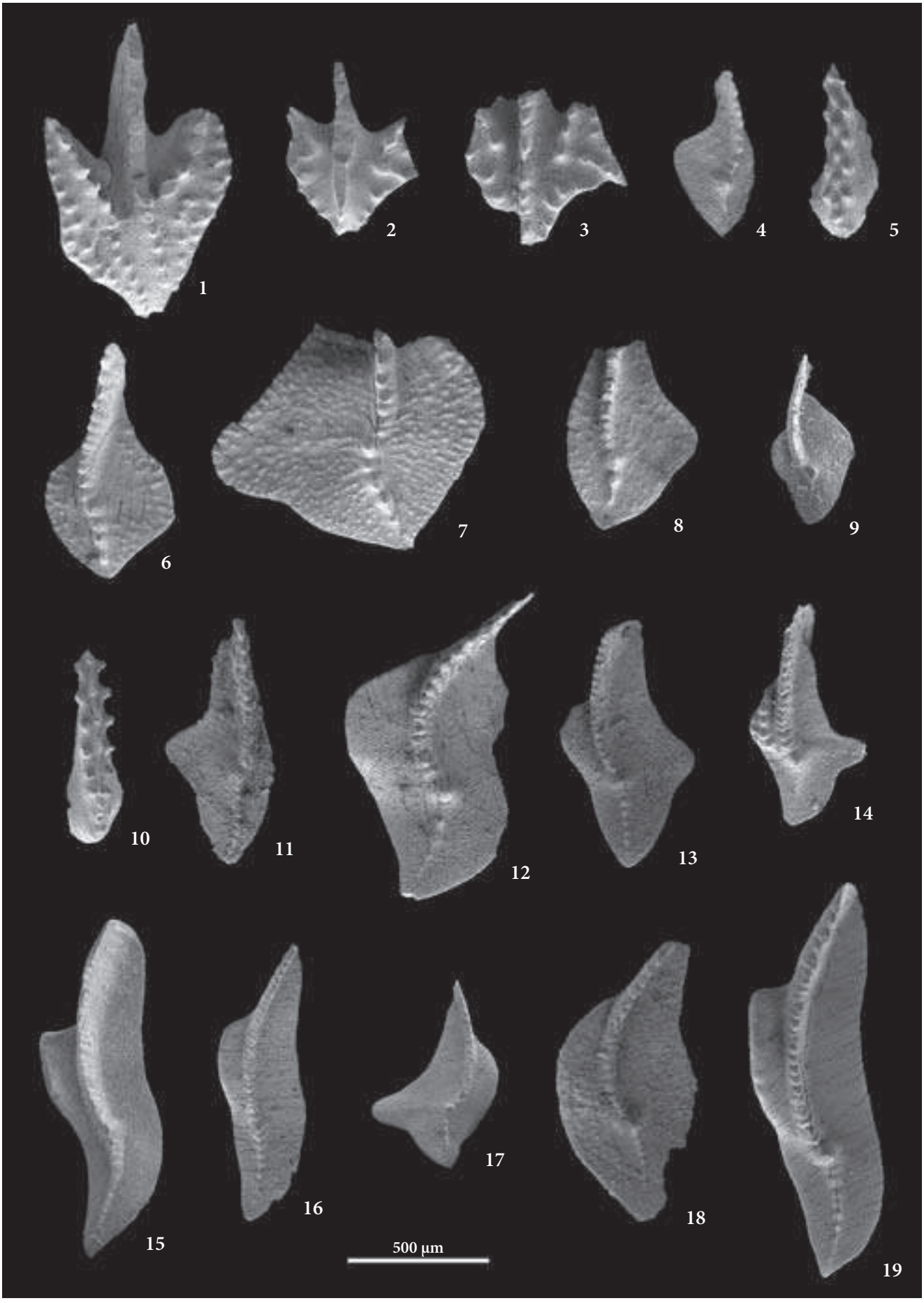
Remarks: *Ancyrodella lobata* is characterized by a platform covered with nodes, with two raws of big nodes on each side. The platform is bilaterally asymmetrical with a well-developed lobe-like protrusion on the outer side. The lobe is covered with random nodes and underneath is evident a secondary keel. It is distinguished by *Ancyrodella curvata* by a lobe-like protrusion, rather than a distinct latero-posterior lobe on the outer platform, and by the lack of the secondary carina on this lobe-like protrusion.

Range: Nearly from the start of the Lower *hassi* Zone into the Upper *rhenana* Zone (Ji & Ziegler 1993).

Studied material: 4 specimens from sample PZW D.

Ancyrodella nodosa Ulrich & Bassler, 1926
(Fig. 5.1)

1926 *Ancyrodella nodosa* n. sp. - Ulrich & Bassler, p. 48, pl. 1, figs 1-13.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500 µm

1958 *Ancyrodella nodosa* Ulrich & Bassler - Ziegler, p. 44, pl. 11, fig. 1.
1966 *Ancyrodella nodosa* Ulrich & Bassler - Glenister & Klapper, p. 798-799, pl. 86, figs 5-12.
1993 *Ancyrodella nodosa* Ulrich & Bassler - Ji & Ziegler, p. 96, pl. 2, figs 11-12; text-fig. 8, figs 8-9.
2008 *Ancyrodella nodosa* Ulrich & Bassler - Ovnatanova & Kononova, p. 1080-1081, pl. 26, figs 11-16.

Remarks: *Ancyrodella nodosa* is characterized by an alate platform with the surface covered by random nodes. The carina extends beyond the platform in the posterior part of the element, due to the constriction of the posterior margins of the platform. It is distinguished from *Ancyrodella lobata* by the absence of the lobe-like protrusion on the outer platform.

Range: Nearly from the start of the Upper *hassi* Zone to the end of the *linguiformis* Zone (Ji & Ziegler, 1993).

Studied material: 4 specimens from sample PZW D.

Family Icriodontidae Müller & Müller, 1957

Genus *Icriodus* Branson & Mehl, 1938

Icriodus alternatus Branson & Mehl, 1934
(Fig. 5.5)

1934 *Icriodus alternatus alternatus* n. sp. - Branson & Mehl, p. 225-226, pl. 13, figs 4-6.
1984 *Icriodus alternatus alternatus* Branson & Mehl - Sandberg & Dreesen, pl. 2, figs 5, 11.
1993 *Icriodus alternatus alternatus* Branson & Mehl - Ji & Ziegler, p. 55, pl. 5, figs 5-8; text-fig. 6, fig 2.
1998d *Icriodus alternatus alternatus* Branson & Mehl - Perri & Spalletta, p. 204, pl. 2.2.1, figs 4-5.
2003 *Icriodus alternatus alternatus* Branson & Mehl - Corradini, p. 92, pl. 2, figs 9-12.

Remarks: *Icriodus alternatus alternatus* is characterized by a thin and elongated platform. It has three rows of longitudinal nodes that covered the platform. The central row is located anterior to those of the lateral rows. The central raw has a cusp at the posterior end. The basal cavity is deep and narrow in the anterior half of the platform, wider in the posterior third. It is distinguished from *Icriodus alternatus helmsi,* which has the posterior cusp aligned with one of the lateral rows.

Range: Upper *rhenana* Zone to Uppermost *crepida* Zone (Schülke 1999).

Studied material: 9 specimens from samples PZW A, PZW D.

Icriodus olivierii Corradini, 1998
(Fig. 5.10)

1970 *Icriodus symmetricus* Branson & Mehl - Olivieri, pl. 14, fig. 9.
1998 *Icriodus olivierii* - Corradini, pl. 1.4.1, fig. 8.
2003 *Icriodus olivierii* Corradini - Corradini, p. 92-93, pl. 2, figs 14-21 (cum syn.).

Fig. 5 - Upper views of P1 elements from PZW section. 1. *Ancyrodella nodosa* Ulrich & Bassler, 1926 (Sample PZW D); 2. *Ancyrodella lobata* Branson & Mehl, 1934 (Sample PZW D); 3. *Ancyrodella curvata* Branson & Mehl, 1934 (Sample PZW D); 4. *Palmatolepis simpla* Ziegler & Sandberg, 1990 (Sample PZW D); 5. *Icriodus alternatus alternatus* Branson & Mehl, 1934 (Sample PZW D); 6. *Palmatolepis lyaiolensis* Khrustcheva & Kuzmin, 1996 (Sample PZW D); 7. *Palmatolepis rotunda* Ziegler & Sandberg, 1990 (Sample PZW D); 8. *Palmatolepis jamiae* Ziegler & Sandberg, 1990 (Sample PZW D); 9. *Palmatolepis rhomboidea* Sannemann, 1955 (Sample PZW 5); 10. *Icriodus olivierii* Corradini, 1998 (Sample PZW 4). 11. *Palmatolepis minuta loba* Helms, 1963 (Sample PZW 2); 12. *Palmatolepis regularis* Cooper, 1931 (Sample PZW 2); 13. *Palmatolepis tenuipunctata* Sannemann, 1955 (Sample PZW 1); 14. *Palmatolepis quadrantinodosalobata* Sannemann, 1955 (PZW 4); 15. *Palmatolepis glabra glabra* Ulrich & Bassler, 1926 (Sample PZW 5); 16. *Palmatolepis glabra prima* Ziegler & Huddle, 1969 (Sample PZW 5); 17. *Palmatolepis subperlobata* Branson & Mehl, 1934 (Sample PZW 4); 18. *Palmatolepis crepida* Sannemann, 1955 (Sample PZW 2); 19. *Palmatolepis glabra pectinata* Ziegler, 1962 (Sample PZW 4).

- *Veduta superiore di elementi P1 dalla sezione PZW. 1.* Ancyrodella nodosa *Ulrich & Bassler, 1926 (Campione PZW D); 2.* Ancyrodella lobata *Branson & Mehl, 1934 (Campione PZW D); 3.* Ancyrodella curvata *Branson & Mehl, 1934 (Campione PZW D); 4.* Palmatolepis simpla *Ziegler & Sandberg, 1990 (Campione PZW D); 5.* Icriodus alternatus alternatus *Branson & Mehl, 1934 (Campione PZW D); 6.* Palmatolepis lyaiolensis *Khrustcheva & Kuzmin, 1996 (Campione PZW D); 7.* Palmatolepis rotunda *Ziegler & Sandberg, 1990 (Campione PZW D); 8.* Palmatolepis jamiae *Ziegler & Sandberg, 1990 (Campione PZW D); 9.* Palmatolepis rhomboidea *Sannemann, 1955 (Campione PZW 5); 10.* Icriodus olivierii *Corradini, 1998 (Campione PZW 4). 11.* Palmatolepis minuta loba *Helms, 1963 (Campione PZW 2); 12.* Palmatolepis regularis *Cooper, 1931 (Campione PZW 2); 13.* Palmatolepis tenuipunctata *Sannemann, 1955 (Campione PZW 1); 14.* Palmatolepis quadrantinodosalobata *Sannemann, 1955 (PZW 4); 15.* Palmatolepis glabra glabra *Ulrich & Bassler, 1926 (Campione PZW 5); 16.* Palmatolepis glabra prima *Ziegler & Huddle, 1969 (Campione PZW 5); 17.* Palmatolepis subperlobata *Branson & Mehl, 1934 (Campione PZW 4); 18.* Palmatolepis crepida *Sannemann, 1955 (Campione PZW 2); 19.* Palmatolepis glabra pectinata *Ziegler, 1962 (Campione PZW 4).*

Remarks: This species is characterized by a platform thin and elongated, with the longitudinal axis straight or slightly curved. There are three rows of longitudinal nodes. The nodes of the middle row laterally compressed and longitudinally elongated, in some cases are almost joined together. The basal cavity is deep and narrow in the anterior half of the platform, wider in the posterior third.

Range: From the Upper *rhenana* Zone to the Uppermost *crepida* Zone (Corradini 2003).

Studied material: 6 specimens from sample PZW 4.

Family Palmatolepididdidae Bassler, 1926

Genus *Palmatolepis* Ulrich & Bassler, 1926

Palmatolepis crepida Sannemann, 1955
(Fig. 5.18)

1955 *Palmatolepis crepida* n. sp. - Sannemann, p. 134, pl. 6, fig. 21.
1962 *Palmatolepis crepida* crepida Sannemann - Ziegler, p. 55, pl. 6, figs 13-19 (no fig. 12).
1993 *Palmatolepis crepida* Sannemann - Ji & Ziegler, p. 59, pl. 22, figs 1-7; text-fig. 13, fig. 4.

Remarks: *Palmatolepis crepida* is characterized by having a drop-shape platform, with a shagreen surface. The inner anterior margin is convex, the outer margin is almost straight. The carina is strongly curved, the central node is situated in the second half of the element, and the posterior carina is weakly pronounced. It is distinguished by *Palmatolepis tenuipunctata* by the lack of the outer lobe.

Range: From the Lower *crepida* Zone to the Lower *rhomboidea* Zone (Ji & Ziegler 1993).

Studied material: 1 specimen from sample PZW 2.

Palmatolepis glabra acuta Helms, 1963

1963 *Palmatolepis* (*Panderolepis*) *serrata acuta* n. sp. - Helms, p. 468, pl. 3, fig. 1-4, 6.
1971 *Palmatolepis glabra acuta* Helms - Szulczewski, p. 33, pl. 14, figs 6, 7.
1990 *Palmatolepis glabra acuta* Helms - Perri & Spalletta, p. 60, pl. 1, figs 4a-b.
1993 *Palmatolepis glabra acuta* Helms - Ji & Ziegler; pl. 16, figs 11, text-fig. 17, fig. 5.

Remarks: This subspecies of *Palmatolepis glabra* is characterized by a parapet in the inner anterior margin of the platform, that ends with a thorn-like projection in the anterior ends. The carina is slightly sigmoidal. It is distinguished by *Palmatolepis glabra glabra* by the presence of the thorn-like projection on the inner anterior margin, and by *Palmatolepis glabra distorta* by the lack of the pronounced parapet.

Range: From the upper part of the Lower *rhomboidea* Zone to the base of the Upper *marginifera* Zone (Ji & Ziegler 1993).

Studied material: 5 specimens from samples PZW 4 and PZW 5.

Palmatolepis glabra glabra Ulrich & Bassler, 1926
(Fig. 5.15)

1926 *Palmatolepis glabra* n. sp. - Ulrich & Bassler, p. 51, pl. 9, fig. 20.
1993 *Palmatolepis glabra glabra* Ulrich & Bassler - Ji & Ziegler, p. 60-61, pl. 17, figs 13-15; text-fig. 17, fig. 4.
2003 *Palmatolepis glabra glabra* Ulrich & Bassler - Corradini, p. 79, pl. 4, figs 1-2.

Remarks: *Palmatolepis glabra glabra* is characterized by a narrow and elongated platform. The inner anterior margin joins the blade at a right angle. The carina is slightly sigmoidal. It is distinguished from *Palmatolepis glabra prima* because of the angle of the insertion of the inner anterior margin into the blade, and by *Palmatolepis glabra distorta* by the lack of a pronounced parapet.

Range: From the Lower *rhomboidea* Zone to the Lower *marginifera* Zone (Ji & Ziegler 2003).

Studied material: 23 specimens from samples PZW 5 and PZW 5A.

Palmatolepis glabra pectinata Ziegler, 1962
(Fig. 5.19)

1962 *Palmatolepis glabra pectinata* n. sub. sp. - Ziegler, p. 398-399, pl. 2, figs 3-5.
1966 *Palmatolepis glabra pectinata* Ziegler - Glenister & Klapper, p. 814, pl. 89, figs 1-3, 5, 9, 10; pl. 10, figs 4-5; pl. 91, figs 1, 3, 5.
1993 *Palmatolepis glabra pectinata* Ziegler - Ji & Ziegler, p. 61, pl. 16, figs 5-10, pl. 17, figs 1-12; text-fig 17, figs 7-8.
1998b *Palmatolepis glabra pectinata* Ziegler - Perri & Spalletta, p. 156, pl. 1.3.1, figs 1-2.

Remarks: This subpecies is distinguished from *Palmatolepis glabra prima* and *Palmatolepis glabra glabra* having a long parapet that lies close and parallel to the carina, and from *Palmatolepis glabra distorta* which is more sigmoidal and by the lack of the bulge in the posterior part of the outer platform. According to Ji & Ziegler (1993) there are two morphotypes of this specie that differs from the shape of the parapet.

Range: From the Uppermost *crepida* Zone to the Upper *marginifera* Zone (Ji & Ziegler 1993).

Studied material: 7 specimens from samples PZW A, PZW 4.

Palmatolepis glabra prima
Ziegler & Huddle, 1969
(Fig. 5.16)

1969 *Palmatolepis glabra prima* - Ziegler & Huddle, p. 379 (cum syn).
1970 *Palmatolepis glabra prima* Ziegler & Huddle - Olivieri, p.100, pl.17, figs 1-4.
1977 *Palmatolepis glabra prima* Ziegler & Huddle -Ziegler in Ziegler (ed.), p. 309, pl. *Palmatolepis*-7, fig. 4-7 (cum syn.).
1990 *Palmatolepis glabra prima* Ziegler & Huddle - Perri & Spalletta, p. 61, pl. 2, figs1a-b.
1993 *Palmatolepis glabra pectinata* Ziegler - Ji & Ziegler, p. 61, pl. 16, figs 12-17, pl. 17, text-fig 17, figs 2, 9, 17.
1998c *Palmatolepis glabra prima* Ziegler & Huddle - Perri & Spalletta, p. 156, pl. 1.3.1, figs 3-4, 5.
2003 *Palmatolepis glabra prima* Ziegler & Huddle - Corradini, p. 79, pl. 4, figs 3-6.

Remarks: *Palmatolepis glabra prima* is distinguished by the other subspecies of *Palmatolepis glabra* by the rounded, bulge-like parapet on the anterior inner platform, and by *Palmatolepis tenuipunctata* by the lack of the outer lobe.

Range: From the Upper *crepida* Zone to the Upper *marginifera* Zone (Ji & Ziegler 1993).

Studied material: 66 specimens from samples PZW B, PZW A, PZW 1, PZW 3, PZW 4, PZW 5, PZW 6, PZW 7.

Palmatolepis gracilis gracilis
Branson & Mehl, 1934
(Fig. 6.15-16)

1934 *Palmatolepis gracilis* - Branson & Mehl, p. 238, pl. 18, fig. 8.
1969 *Palmatolepis gracilis gracilis* Branson & Mehl - Pölser, p. 399, pl. 6, fig. 21.
1977 *Palmatolepis gracilis gracilis* Branson & Mehl - Ziegler in Ziegler (ed.), p. 315, pl. *Palmatolepis* -7, figs 8-10 (cum syn.).
1990 *Palmatolepis gracilis gracilis* Branson & Mehl - Perri & Spalletta, p. 61, pl. 2, fig. 2.
1991 *Palmatolepis gracilis gracilis* Branson & Mehl - Perri & Spalletta, p. 62, pl. 4, figs 3-4.
1993 *Palmatolepis gracilis gracilis* Branson & Mehl- Ji & Ziegler, p. 63, pl. 6, figs 4-7; text-fig. 14, fig. 2.
1998c *Palmatolepis gracilis gracilis* Branson & Mehl - Corradini, pl. 1.4.2, figs 16-17.

Remarks: *Palmatolepis gracilis gracilis* is characterized by a small, narrow platform with a raised margin rim. The element is curved, in some species almost at a right angle. The keel underneath the central node is twisted around the small basal cavity. It is distinguished from *Palmatolepis minuta minuta* by the characteristic twisted keel.

Range: From the Upper *rhomboidea* Zone to the Upper *praesulcata* Zone (Ji & Ziegler 1993).

Studied material: 20 specimens from sample PZW Z.

Palmatolepis gracilis sigmoidalis Ziegler, 1962
(Fig. 5.11)

1962 *Palmatolepis deflectens sigmoidalis* n. subsp. - Ziegler, p. 56 pl. 3, figs 24-28.
1969 *Palmatolepis gracilis sigmoidalis* Ziegler- Pölser, p. 399, pl. 6, fig. 22.
1979 *Palmatolepis gracilis sigmoidalis* Ziegler- Sandberg & Ziegler; p. 178, pl. 1, figs 3-5.
1991 *Palmatolepis gracilis sigmoidalis* Ziegler - Perri & Spalletta, p. 64, pl. 4, fig. 6.
1993 *Palmatolepis gracilis sigmoidalis* Zieglerr - Ji & Ziegler, pl. 5, figs 1-3; text-fig. 14, fig. 6.

Remarks: This subspecies differs from the other subspecies of *Palmatolepis gracilis* having a characteristic twisted platform and by the offset of the anterior carina.

Range: From within the Upper *trachytera* Zone to the Upper *praesulcata* Zone (Ji & Ziegler 1993).

Studied material: 5 specimens from sample PZW Z.

Palmatolepis jamiae Ziegler & Sandberg, 1990
(Fig. 5.8)

1990 *Palmatolepis jamiae* - Ziegler & Sandberg, p. 50-51, pl. 6, figs 1-3, 9, 10 (only).
1993 *Palmatolepis jamiae* Ziegler & Sandberg - Ji & Ziegler, pl. 27, figs 1-3.
2008 *Palmatolepis jamiae* Ziegler & Sandberg - Ovnatanova & Kononova, pl. 10, figs 16-18; pl. 11, figs 1-4, 5?, 6, 7?, 8, 9; pl. 14, fig. 10.

Remarks: *Palmatolepis jamiae* is characterized by a shagreen platform that tapers in the anterior part where the two margins join the blade more or less in the same position. A rounded well pronounced lobe is present just anteriorly of the central node. The inner posterior margin of the platform is concave. The carina is slightly sigmoidal, and well developed posterior of

the central node where is composed of three or four nodes. This species differ from *Palmatolepis foliacea* by having a well-developed lobe with two sinuses.

Range: From the start of the *jamiae* Zone to the Upper *rhenana* Zone (Ziegler & Sandberg 1990).

Studied material: 5 specimens from sample PZW D.

Palmatolepis lyaiolensis
Khrustcheva & Kuzmin, 1996
(Fig. 5.6)

1996 *Palmatolepis lyaiolensis* - Khrustcheva & Kuzmin, p. 93, pl. 11, figs 1-2.
2008 *Palmatolepis lyaiolensis* Khrustcheva & Kuzmin - Ovnatanova & Kononova, pl. 13, figs 4-11.

Remarks: This species is characterized by having a broad shagreen platform. The inner platform is rounded, while the outer platform is sub-triangular, because of the presence of a poorly differentiated lobe. The carina is slightly sigmoidal, and posterior of the central node is composed by one or two nodes. *Palmatolepis lyaiolensis* differs from *Palmatolepis hassi* in the poorly developed lobe, lacking well pronounced sinuses.

This species is here reported for the first time in Europe.

Range: From within the Lower *rhenana* Zone to the Upper *rhenana* Zone (Ovnatanova & Kononova 2008).

Studied material: 4 specimens from sample PZW D.

Palmatolepis marginifera marginifera
Helms, 1959
(Fig. 6.18)

1959 *Palmatolepis quarantinodosa marginifera* Ziegler (sic.) - Helms, p. 649, pl. 5, figs 22-23.
1973 *Palmatolepis marginifera marginifera* Helms - Sandberg & Ziegler; p. 104, pl. 3, figs 13-14.
1977 *Palmatolepis marginifera marginifera* Helms - Ziegler in Ziegler (ed.), p. 328, pl. *Palmatolepis* -7, fig. 17-18; pl. *Palmatolepis*-8, figs 1-2 (cum syn.).
1990 *Palmatolepis marginifera marginifera* Helms - Perri & Spalletta, p. 61, pl. 2, figs 3-4.
1993 *Palmatolepis marginifera marginifera* Helms - Ji & Ziegler, p. 64, pl. 13, figs 7-10; pl. 14, figs 1-6; text-fig. 17, fig. 14.
1998b *Palmatolepis marginifera marginifera* Helms - Perri & Spalletta, p. 156, pl. 1.3.1, fig. 6.
1998 *Palmatolepis marginifera marginifera* Helms - Corradini, pl. 1.4.1, fig. 14.
2013 *Palmatolepis marginifera marginifera* Helms - Mossoni et al., fig. 3.2.

Remarks: *Palmatolepis marginifera marginifera* is characterized by a rounded platform with a well-developed parapet parallel to the carina. The parapet starts in the inner anterior platform and it extends posterior the central node. It is distinguished from *Palmatolepis glabra distorta* by the length of the parapet and by the shape of the platform.

Range: From the base of the Lower *marginifera* Zone into the *velifer* Zone (Ji & Ziegler 1993).

Studied material: 1 specimen from sample PZW 7.

Palmatolepis minuta
Branson & Mehl, 1934
(Fig. 6.17)

1934 *Palmatolepis minuta minuta* - Branson & Mehl, p. 236, pl. 18, figs 1, 6-7.
1962 *Palmatolepis minuta minuta* Branson & Mehl -Ziegler; pl. 3, figs 1-10, text fig. 5 b-n.
1990 *Palmatolepis minuta minuta* Branson & Mehl - Perri & Spalletta, p. 62, pl. 3, figs 1, 7.
1993 *Palmatolepis minuta minuta* Branson & Mehl - Ji & Ziegler, pl. 7, figs 1-19; pl. 9, figs 8-18; text-fig. 13, figs 9, 15, 16.
1998b *Palmatolepis minuta minuta* Branson & Mehl - Perri & Spalletta, p. 156, pl. 1.3.1, fig. 8.
1998 *Palmatolepis minuta minuta* Branson & Mehl - Corradini, pl. 1.4.1, fig. 14.

Remarks: *Palmatolepis minuta minuta* is characterized by a lanceolate smooth platform. In some elements a weak outer lobe is present. The carina is straight or weakly curved. This species differ from *Palmatolepis rhomboidea* by the lacking of the bulge in the anterior part of the inner platform.

Range: From the Upper *triangularis* Zone to the Upper *trachytera* Zone (Ji & Ziegler, 1993).

Studied material: 7 specimens from sample PZW 5.

Palmatolepis minuta loba Helms, 1963
(Fig. 5.11)

1963 *Palmatolepis* (*Deflectolepis*) *minuta loba* - Helms, p. 470, pl. 2, figs 13-14; pl. 3 fig. 12; text fig. 2, fig. 39.
1970 *Palmatolepis minuta loba* Helms - Olivieri, p. 107, pl. 20, fig. 5.
1993 *Palmatolepis minuta loba* Helms - Ji & Ziegler, p. 64, pl. 10, figs 1-16, text-fig. 13, fig. 11-12.
2003 *Palmatolepis minuta loba* Helms - Corradini, p. 80, pl. 6, fig. 9.

Remarks: This species is characterized by a lanceolate platform with a pronounced lobe in the outer side. The anterior carina is straight and the posterior carina is not well developed. It is distinguished from *Palmatolepis minuta minuta* by the presence of the lobe.

Range: From the Lower *crepida* Zone to the Lower *rhomboidea* Zone (Ji & Ziegler 1993).

Studied material: 1 specimen from sample PZW 2.

Palmatolepis minuta subgracilis Bishoff, 1956

1956 *Palmatolepis minuta subgracilis* - Bishoff, p. 130, pl. 9, figs 9-12; pl. 10, fig. 13.
1977 *Palmatolepis minuta subgracilis* Bishoff - Ziegler in Ziegler (ed.), p. 343, pl. *Palmatolepis*-9, fig. 6 (cum syn).
2003 *Palmatolepis minuta subgracilis* Bishoff - Corradini; p. 80, pl. 6, fig. 21.

Remarks: *Palmatolepis minuta subgracilis* is characterized by a small and slender platform, with a small lobe. It is distinguished by the other subspecies of *Palmatolepis minuta* by the very small platform.

Range: From the Upper *crepida* Zone to the Lower *rhomboidea* Zone (Ziegler 1977).

Studied material: 1 specimens from sample PZW 2.

Palmatolepis minuta wolskae Szulczewski, 1971

1971 *Palmatolepis minuta wolskae* - Szulczewski, p. 36, pl. 15, figs 2, 12-14.
1993 *Palmatolepis minuta wolskae* Szulczewski - Ji & Ziegler; p. 85 pl. 11, figs 1-11, text-fig. 13, figs 7-8.
2003 *Palmatolepis minuta wolskae* Szulczewski - Corradini; p. 80, pl. 6, figs 7-8.

Remarks: This species is characterized by a small ovoidal or subtriangular platform, with a small lobe in the outer platform. The posterior carina is absent. It is distinguished from *Palmatolepis minuta loba* by the absence of the posterior carina.

Range: From the Middle *crepida* Zone to the Lower *rhomboidea* Zone (Corradini 2003).

Studied material: 2 specimens from sample PZW 5A.

Palmatolepis perlobata postera Ziegler, 1960
(Fig. 6.2)

1960 *Palmatolepis perlobata postera* n. subsp. - Ziegler, p. 27, pl. 8, figs 22-31; pl. 9, fig. 33.
1979 *Palmatolepis perlobata postera* Ziegler - Sandberg & Ziegler, p. 180, pl. 2, figs 1-4.
1993 *Palmatolepis perlobata postera* Ziegler - Ji & Ziegler; text-fig 15, fig. 10.

Remarks: *Palmatolepis perlobata postera* is characterized by a broad curved platform covered by small nodes. It is distinguished by the other subspecies of *Palmatolepis perlobata* by the weak lobe on the outer part of the platform. This species was choosen as marker of the *postera* Zone by Ziegler & Sandberg (1984), however in North Gondwana is a very rare taxon (Corradini 2008).

Range: From the Lower *postera* Zone to the Upper *expansa* Zone (Ji & Ziegler 1993).

Studied material: 2 specimens from sample PZW Z.

Palmatolepis perlobata schindewolfi Müller, 1956
(Fig. 6.20)

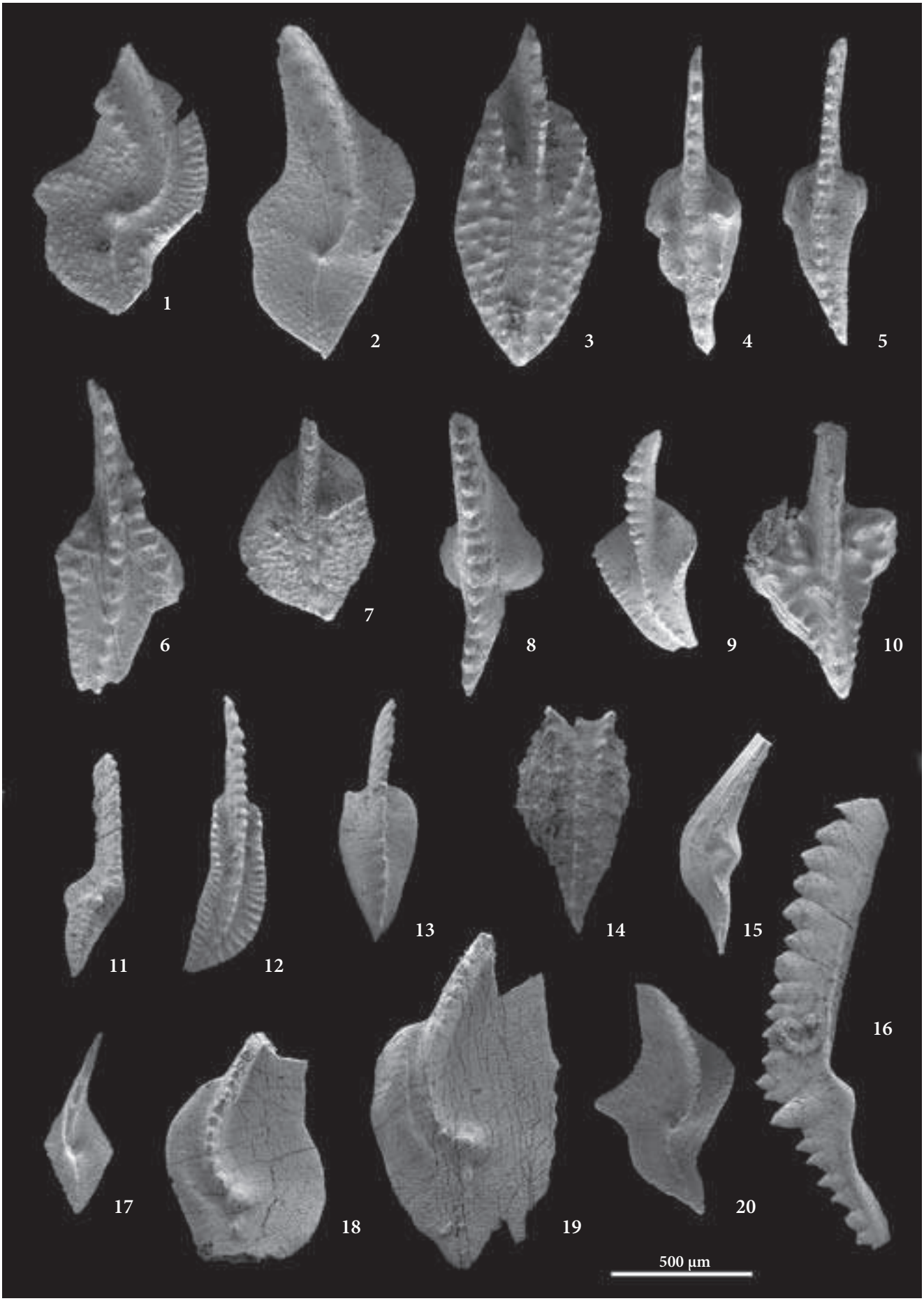
1956 *Palmatolepis perlobata schindewolfi* - Müller, p. 27, pl. 8, figs 22-31; pl. 9, fig. 33.
1969 *Palmatolepis perlobata schindewolfi* Müller - Pölser, p. 399, pl. 5, figs 1-2, 9.
1970 *Palmatolepis perlobata schindewolfi* Müller - Olivieri, p. 109, pl. 20, figs 11-14.
1977 *Palmatolepis perlobata schindewolfi* Müller - Ziegler in Ziegler (ed.), p. 361, pl. *Palmatolepis*-11, fig. 1-7 (cum syn.).
1990 *Palmatolepis perlobata schindewolfi* Müller - Perri & Spalletta, fig. 63, pl. 3, figs 4-5, 8.
1991 *Palmatolepis perlobata schindewolfi* Müller - Perri & Spalletta, fig. 66, pl. 4, fig. 7.
1993 *Palmatolepis perlobata schindewolfi* Müller - Ji & Ziegler; p. 67, pl. 18, figs 9-15; text-fig. 15, fig. 3.
2003 *Palmatolepis perlobata schindewolfi* Müller - Corradini, pl. 7, figs 1-5.

Remarks: *Palmatolepis perlobata schindewolfi* is characterized by an arc-shaped and elongated platform. There is a small lobe on the outer platform, and generally the posterior end is pointed downward. The surface is smooth or weakly ornamented. This species is distinguished from *Palmatolepis perlobata perlobata* by its slender shape, the small lobe and the weak ornamentation.

Range: From the Upper *crepida* Zone to the Upper *expansa* Zone (Ji & Ziegler 1993).

Studied material: 24 specimens from samples PZW A, PZW B, PZW 5 and PZW6A.

Palmatolepis quadrantinodosalobata Sannemann, 1955
(Fig. 5.14)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1955 *Palmatolepis quadrantinodosalobata* - Sannemann, p. 328, pl. 24, fig. 6.
1969 *Palmatolepis quadrantinodosalobata* Sannemann - Pölser, p. 399, pl. 6, figs 13-14.
1970 *Palmatolepis quadrantinodosalobata* Sannemann - Olivieri, p. 112, pl. 18, fig. 9-11.
1973 *Palmatolepis quadrantinodosalobata* Sannemann - Ziegler in Ziegler (ed.), p. 295, pl. *Palmatolepis*-4, figs 6-8 (cum syn.).
1993 *Palmatolepis quadrantinodosalobata* Sannemann - Ji & Ziegler, p. 69, pl. 23, fig. 5-7; text-fig. 12, fig. 3, 7-8.
2003 *Palmatolepis quadrantinodosalobata* Sannemann - Corradini, pl. 5, figs 7-9.

Remarks: *Palmatolepis quadrantinodosalobata* is distinguished by a well-developed rounded lobe in the outer part of the platform and the inner anterior part covered with aligned or randomly disposed nodes (Ji & Ziegler 1993). A few specimens may have a few small nodes on the outer anterior part of the platform. *Palmatolepis quadrantinodosalobata* is distinguished from *Palmatolepis subperlobata* by the presence of the ornamentation, and by *Palmatolepis sandbergi* that has the whole inner platform covered by nodes.

Range: From the base of the Lower *crepida* zone into the Lower *rhomboidea* Zone (Ji & Ziegler 1993).

Studied material: 10 specimens from samples PZW 1, PZW 2, PZW 4.

Palmatolepis regularis Cooper, 1931
(Fig. 5.12)

1931 *Palmatolepis regularis* n. sp. - Cooper, p. 242, pl. 28, fig. 36.
1962 *Palmatolepis* cf. *regularis* Cooper - Ziegler, p. 75-76, pl. 6, figs 20-24.
1969 *Palmatolepis* cf. *regularis* Cooper - Pölser, p. 399, pl. 5, figs 3-4.
1993 *Palmatolepis* cf. *regularis* Cooper - Ji & Ziegler, pl. 21, figs 6-10; text-fig. 16, figs 7, 9.

Remarks: This species is characterized by a sha-green, strongly sigmoidal platform lacking the outer lobe. Ji & Ziegler (1993) proposed two morphotypes that differ from the width of the platform. Morphotype 1 has a narrow and elongated platform, while morphotype 2 has a broader platform. The specimen from Pizzul West section belongs to morphotype 2. However, it should be pointed out that, since the range of the two morphotypes is the same and coincides with the range of the species, their utility is questionable. This species is distinguished by *Palmatolepis subperlobata* by the lack of the outer lobe.

Range: From the Upper *triangularis* Zone to the Lower *rhomboidea* Zone (Ji & Ziegler 1993).

Studied material: 1 specimen from sample PZW 2.

Palmatolepis rhomboidea Sannemann, 1955
(Fig. 5.9)

Fig. 6 - Upper views of P1 elements from PZW section, unless differently stated. 1. *Palmatolepis rugosa rugosa* Branson & Mehl, 1934 (Sample PZW Z); 2. *Palmatolepis perlobata postera* Ziegler, 1960 (Sample PZW Z); 3. *Polygnathus* cf. *nodocostatus* Branson & Mehl, 1934 (Sample PZW Z); 4. *Pseudopolygnathus irregularis* Traghelen & Hartenfels, 2011 (Sample PZW Z); 5. *Pseudopolygnathus micropunctatus* Bishoff & Ziegler, 1956 (Sample PZW Z); 6. *Pseudopolygnathus controversus* Sandberg & Ziegler, 1979 (Sample PZW Z); 7. *Polygnathus styriacus* Ziegler, 1957 (Sample PZW Z); 8. *Bispathodus stabilis* (Branson & Mehl, 1934) (PZW Z); 9. *Polygnathus marginvolutus* Gedik, 1969 (PZW Z); 10. *Pseudopolygnathus marburgensis marburgensis* Bishoff & Ziegler, 1956 (Sample PZW Z); 11. *Palmatolepis gracilis sigmoidalis* Ziegler, 1962 (Sample PZW Z); 12. *Polygnathus obliquicostatus* Ziegler, 1962 (Sample PZW Z); 13. *Polygnathus glaber glaber* Ulrich & Bassler, 1926 (Sample PZW 5); 14. *Polygnathus nodocostatus nodocostatus* Branson & Mehl, 1934 (Sample PZW 5); 15. *Palmatolepis gracilis gracilis* Branson & Mehl, 1934, lower view (Sample PZW Z); 16. *Palmatolepis gracilis gracilis* Branson & Mehl, 1934 (Sample PZW Z); 17. *Palmatolepis minuta minuta* Branson & Mehl, 1934 (Sample PZW 5A); 18. *Palmatolepis marginifera marginifera* Helms, 1959 (Sample PZW 7); 19. *Palmatolepis stoppeli* Sandberg & Ziegler, 1973 (Sample PZW 7); 20. *Palmatolepis perlobata schindewolfi* Muller, 1956 (Sample PZW 5).
- *Veduta superiore di elementi P1 dalla sezione PZW, a meno di indicazioni differenti nella didascalia. 1.* Palmatolepis rugosa rugosa *Branson & Mehl, 1934 (Campione PZW Z); 2.* Palmatolepis perlobata postera *Ziegler, 1960 (Campione PZW Z); 3.* Polygnathus *cf.* nodocostatus *Branson & Mehl, 1934 (Campione PZW Z); 4.* Pseudopolygnathus irregularis *Traghelen & Hartenfels, 2011 (Campione PZW Z); 5.* Pseudopolygnathus micropunctatus *Bishoff & Ziegler, 1956 (Campione PZW Z); 6.* Pseudopolygnathus controversus *Sandberg & Ziegler, 1979 (Campione PZW Z); 7.* Polygnathus styriacus *Ziegler, 1957 (Campione PZW Z); 8.* Bispathodus stabilis *(Branson & Mehl, 1934) (PZW Z); 9.* Polygnathus marginvolutus *Gedik, 1969 (PZW Z); 10.* Pseudopolygnathus marburgensis marburgensis *Bishoff & Ziegler, 1956 (Campione PZW Z); 11.* Palmatolepis gracilis sigmoidalis *Ziegler, 1962 (Campione PZW Z); 12.* Polygnathus obliquicostatus *Ziegler, 1962 (Campione PZW Z); 13.* Polygnathus glaber glaber *Ulrich & Bassler, 1926 (Campione PZW 5); 14.* Polygnathus nodocostatus nodocostatus *Branson & Mehl, 1934 (Campione PZW 5); 15.* Palmatolepis gracilis gracilis *Branson & Mehl, 1934, veduta inferiore (Campione PZW Z); 16.* Palmatolepis gracilis gracilis *Branson & Mehl, 1934 (Campione PZW Z); 17.* Palmatolepis minuta minuta *Branson & Mehl, 1934 (Campione PZW 5A); 18.* Palmatolepis marginifera marginifera *Helms, 1959 (Campione PZW 7); 19.* Palmatolepis stoppeli *Sandberg & Ziegler, 1973 (Campione PZW 7); 20.* Palmatolepis perlobata schindewolfi *Muller, 1956 (Campione PZW 5).*

1955a *Palmatolepis rhomboidea* - Sannemann, p. 329, pl. 24, fig. 14.
1970 *Palmatolepis rhomboidea* Sannemann - Olivieri, p. 114, pl. 16, figs 11-14.
1985 *Palmatolepis rhomboidea* Sannemann - Ziegler in Ziegler (ed.), p. 299, pl. *Palmatolepis*-1, fig. 6-7 (cum syn.).
2003 *Palmatolepis rhomboidea* Sannemann - Corradini, p. 83, pl. 3, figs 19-21.

Remarks: *Palmatolepis rhomboidea* is characterized by a small rhomboidal platform with an evident bulge in the outer anterior part. It is distinguished by *Palmatolepis minuta minuta* by the bulge in the inner anterior platform and the shorter free blade.

Range: From the Lower *rhomboidea* Zone to the lower part of the Upper *marginifera* Zone (Corradini 2003).

Studied material: 11 specimens from samples PZW A, PZW 5, PZW 5A.

Palmatolepis rotunda Ziegler & Sandberg, 1990
(Fig. 5.7)

1990 *Palmatolepis rotunda* n. sp. - Ziegler & Sandberg, p. 62, pl. 10, figs 1-5.
1998 *Palmatolepis rotunda* Ziegler & Sandberg - Spalletta & Perri, p. 204, pl. 2.2.1, fig. 12.

Remarks: *Palmatolepis rotunda* is characterized by a broad rounded inner posterior platform. There is a well developed rounded lobe in the outer platform, with two evident sinuses. The anterior carina is strongly curved, while the posterior carina is not well pronounced.

Range: From the start of the Upper *rhenana* Zone to the top of the *linguiformis* Zone (Ziegler & Sandberg 1990).

Studied material: 1 specimen from sample PZW D.

Palmatolepis rugosa rugosa
Branson & Mehl, 1934
(Fig. 6.1)

1934 *Palmatolepis rugosa* n.sp. - Branson & Mehl, p. 236, pl. 18, figs 15, 16, 18, 19.
1979 *Palmatolepis rugosa rugosa* Branson & Mehl - Sandberg & Ziegler, p. 180, pl. 2, figs 1-4.
1991 *Palmatolepis rugosa rugosa* Branson & Mehl - Perri & Spalletta, p. 66, pl. 4, figs 8-9.
1993 *Palmatolepis rugosa rugosa* Branson & Mehl - Ji & Ziegler; text-fig 15, fig. 12.

Remarks: This species is characterized by a broad strongly ornamented platform, with a very pronounced outer lobe. The carina is strongly curved anterior the central node. It is distinguished from the other subspecies of *Palmatolepis rugosa* by the pattern of the ornamentation, that shows a ridge-type nodes in the inner parapet and a series of coarse nodes in the anterior part of the outer platform.

Range: From the Lower *expansa* Zone to the Upper *expansa* Zone (Ji & Ziegler, 1993).

Studied material: 2 specimens from sample PZW Z.

Palmatolepis simpla Ziegler & Sandberg, 1990
(Fig. 5.4)

1990 *Palmatolepis simpla* n. sp. - Ziegler & Sandberg, p. 47-48, pl. 4, figs 9-12.

Remarks: *Palmatolepis simpla* is characterized by a broad platform, almost rounded in the posterior part, while in the anterior part became narrow. There is a rounded lobe in the outer part of the anterior platform. The anterior outer platform margin is concave. It is distinguished from *Palmatolepis proversa* by the weaker marginal fortification and for the less pronounced lobe.

This species is here reported for the first time from the Carnic Alps.

Range: From the Upper *hassi* Zone to the Upper *rhenana* Zone (Ziegler & Sandberg 1990).

Studied material: 2 specimens from sample PZW D.

Palmatolepis stoppeli Sandberg & Ziegler, 1973
(Fig. 6.19)

1960 *Palmatolepis* sp. - Ziegler pl. 7 figs 12-13.
1977 *Palmatolepis stoppeli* n. sp. - Sandberg & Ziegler, p. 106-107, pl. 3 figs 1-11, pl. 5, fig. 13.
1993 *Palmatolepis stoppeli* Sandberg & Ziegler - Ji & Ziegler, p. 71, pl. 14, figs 7-12, text-fig. 17, fig. 12.
1998 *Palmatolepis stoppeli* Sandberg & Ziegler - Corradini, pl. 1.4.2, fig. 19.

Remarks: This species is characterized by a broad sub-ovoidal platform with an evident ramp in the upper part of the inner platform. It is distinguished from *Palmatolepis quadrantinodosa inflexa* by the lack of ornamentation on the surface of the platform and from *Palmatolepis rhomboidea* because the latter have in the inner platform a small bulge instead of an evident ramp.

Range: Upper *rhomboidea* Zone to Lower *marginifera* Zone (Ji & Ziegler 1993).

Studied material: 1 specimen from sample PZW 7.

Palmatolepis subperlobata Branson & Mehl, 1934
(Fig. 5.17)

1934 *Palmatolepis subperlobata* n. sp. - Branson & Mehl, p. 235, pl. 18, figs 11, 21.
1971 *Palmatolepis subperlobata* Branson & Mehl - Szulczewski, p. 40-41, pl. 13, fig. 12.
1993 *Palmatolepis subperlobata* Branson & Mehl - Ji & Ziegler, pl. 20, figs 3-9; pl. 21, figs 11-12; text-fig. 16, figs 5, 6, 8.
2003 *Palmatolepis subperlobata* Branson & Mehl - Corradini, pl. 3, figs 1-4.

Remarks: *Palmatolepis subperlobata* is characterized by a shagreen platform with a well-developed lobe on the outer platform. The carina is strongly sigmoidal. This species is distinguished from *Palmatolepis tenuipunctata* which has a relatively narrow, elongated platform and a small outer lobe.

Range: From the base of the Lower *triangularis* Zone to the Upper *marginifera* Zone (Corradini 2003).

Studied material: 15 specimens from samples PZW 2, PZW 3, PZW 4 and PZW 5.

Palmatolepis tenuipunctata Sannemann, 1955
(Fig. 5.13)

1955b *Palmatolepis tenuipunctata* - Sannemann, p. 136, pl. 6, fig. 22.
1969 *Palmatolepis tenuipunctata* Sannemann - Pölser, p. 399, pl. 5, fig. 21.
1970 *Palmatolepis tenuipunctata* Sannemann - Olivieri, p. 117, pl. 18, figs 1-2.
1993 *Palmatolepis tenuipunctata* Sannemann - Ji & Ziegler, p. 72, pl. 19, fig. 1-6; text-fig.16, fig. 2.
2003 *Palmatolepis tenuipunctata* Sannemann - Corradini, pl. 3, figs 11-13.

Remarks: *Palmatolepis tenuipunctata* is characterized by an elongated platform, with a small lobe in the outer part. The blade-carina is slightly sigmoidal. Underneath the element there is a thin keel that goes all along the platform. It is distinguished from *Palmatolepis subperlobata* by the less developed lobe and from *Palmatolepis glabra prima* by the presence of the lobe.

Range: From the Upper *triangularis* Zone to the Uppermost *crepida* Zone (Ji & Ziegler, 1993).

Studied material: 5 specimens from samples PZW 1 and PZW 4.

Family Polygnatidae Bassler, 1926

Genus *Bispathodus* Müller, 1962

Bispathodus stabilis (Branson & Mehl), 1934
(Fig. 6.8)

1934 *Spathodus stabilis* - Branson & Mehl, p. 188, pl. 17, fig. 20.
1962 *Spathognathodus stabilis* (Branson & Mehl) - Ziegler, p. 110, pl. 13, figs 4-5, 9-10.
1969b *Spathognathodus stabilis* (Branson & Mehl) - Schönlaub, p. 321, pl. 3, figs 14-15.
1969 *Spathognathodus stabilis* (Branson & Mehl) - Pölser, p. 399, pl. 5, figs 15-16.
1974 *Bispathodus stabilis* (Branson & Mehl) M1 - Ziegler, Sandberg & Austin, p. 103, pl. 3, figs 1-3.
1974 *Bispathodus stabilis* (Branson & Mehl) M2 - Ziegler, Sandberg & Austin, p. 103, pl. 3, fig. 2.
1990 *Bispathodus stabilis* (Branson & Mehl) M1 - Perri & Spalletta, p. 60, pl. 1, fig. 2.
1998c *Bispathodus stabilis* (Branson & Mehl) M1 - Perri & Spalletta, p. 177, pl. 1.5.1, figs 5-6.
2003 *Bispathodus stabilis* (Branson & Mehl) M1 - Corradini, p. 95, pl. 1, figs 1-2.

Remarks: This element is characterized by a thin and nearly straight blade, bearing discrete denticles. Close to the posterior end, the denticles are less heigh. There are two morphotypes of *Bispathodus stabilis*, differing by the shape of the basal cavity: in M1 is small and do not reaches the posterior end, while in M2 is wide, slightly asymmetrical, and reaches the posterior end of the element. In our material both the morphotypes are present.

Range: From the Upper *marginifera* Zone through the Lower Carboniferous (Ziegler, Sandberg & Austin 1974).

Studied material: 22 specimens from sample PZW Z.

Genus *Polygnathus*, Hinde, 1879

Polygnathus glaber eoglaber Ji & Ziegler, 1993

1993 *Polygnathus eoglaber* - Ji & Ziegler, p. 78, pl. 36, figs 10-15; text-fig 21, fig. 10.
2003 *Polygnathus glaber eoglaber* Ji & Ziegler - Corradini, pl. 8, fig. 2.

Remarks: This species is characterized by a small smooth platform, and by the prolongation of the carina slightly after the posterior end of the platform, almost to form a small free blade.

Range: From the Upper *triangularis* Zone to the Upper *rhomboidea* Zone (Ji & Ziegler 1993).

Studied material: 2 specimen from sample PZW 4.

Polygnathus glaber glaber Ulrich & Bassler, 1926
(Fig. 6.13)

1926 *Polygnathus glaber* - Ulrich & Bassler, p. 46, pl. 7, fig. 13.
1969a *Polygnathus glabra glabra* Ulrich & Bassler - Schönlaub, p. 295, pl. 2, fig. 14.
1998c *Polygnathus glaber glaber* Ulrich & Bassler - Corradini, pl. 1.4.1, fig. 5.
2003 *Polygnathus glaber glaber* Ulrich & Bassler - Corradini, pl. 8, figs 3-5.

Remarks: *Polygnathus glaber glaber* is characterized by a small, ovate shagreen platform; a few specimen present slightly raised lateral margins. It is different from *Polygnathus glaber eoglaber* by the lack of the posterior free blade.

Range: From the base of the Lower *rhomboidea* Zone into the Lower *trachytera* Zone (Corradini, 2003).

Studied material 17 specimens from samples PZW A, PZW 4, PZW 5, PZW 7.

Polygnathus marginvolutus Gedik, 1969
(Fig. 6.9)

1969 *Polygnathus marginvolutus* - Gedik, pl. 237, pl. 5, figs 2-8.
1991 *Polygnathus marginvolutus* Gedik - Perri & Spalletta, p. 237, pl. 6, figs 1-2.
1998d *Polygnathus marginvolutus* Gedik - Perri & Spalletta, p. 179, pl. 1.5.2, fig. 7.

Remarks: This species is characterized by a subtriangular or heart-shape platform with upturned margins. The anterior margins are often scalloped. The posterior part of the platform bear weak ridges which don't reach the carina, while the anterior part is smooth.

Range: From within the Upper *trachytera* Zone to the Upper *expansa* Zone (Perri & Spalletta 1991).

Studied material: 8 specimen from sample PZW Z.

Polygnathus mirificus Ji & Ziegler, 1993

1993 *Polygnathus mirificus* n. sp. - Ji & Ziegler, pl. 37, figs 16-21.

Remarks: *Polygnathus mirificus* is characterized by an asymmetrical and lanceolate platform ornamented with transverse ridges. The anterior margin of the platform bears small denticles. The carina, generally extended to the posterior tip of the platform, is low and composed of fused denticles. *Polygnathus mirificus* is distinguished from *Polygnathus alatus*, *Polygnathus webbi* and *Polygnathus normalis* by having an asymmetrical platform with strong denticulate outer margin.

This species is here reported for the first time from the Carnic Alps.

Range: From within the Upper *rhenana* Zone to the *linguiformis* Zone (Ji & Ziegler 1993).

Studied material: 1 specimen from sample PZW D.

Polygnathus nodocostatus nodocostatus
Branson & Mehl, 1934
(Figs 6.3, 6.14)

1934 *Polygnathus nodocostata* - Branson & Mehl, p. 246, pl. 20, figs 9-13; pl. 21, fig. 15.
1969a *Polygnathus nodocostata nodocostata* Branson & Mehl - Schönlaub, p. 295, pl. 2, fig. 12.
1970 *Polygnathus nodocostatus nodocostatus* Branson & Mehl - Olivieri, p. 125, pl. 22, figs 1-5.
1993 *Polygnathus nodocostata nodocostata* Branson & Mehl - Ji & Ziegler, pl. 34, figs 13-15; text-fig. 20, fig. 1.
2003 *Polygnathus nodocostatus nodocostatus,* Branson & Mehl - Corradini, pl. 9, figs 1-2.pl. 9, figs 1-2.

Remarks: *Polygnathus nodocostatus nodocostatus* is characterized by a large platform, with a very variable outline. The platform is totally covered by rows of nodes parallel to the carina. It is distinguished by *Polygnathus perplexus* by the lack of the collar formed by two asymmetrically developed rostral ridges, and by *Polygnathus granulosus* because the latter has a randomly disposition of the nodes in the upper surface.

Range: From the Lower *crepida* Zone to the Lower *expansa* Zone (Ji & Ziegler 1993).

Studied material: 8 specimens from samples PZW A, PZW 5A and PZW Z.

Polygnathus normalis
Miller & Youngquist, 1947

1947 *Polygnathus normalis* n. sp. - Miller & Youngquist, p. 515, pl. 74, figs 4-5.
1966 *Polygnathus normalis* Miller & Youngquist - Glenister & Klapper, p. 829-830, pl. 95, figs 6, 21-22.
1993 *Polygnathus normalis* Miller & Youngquist - Ji & Ziegler, pl. 39, figs 9-15; text-fig. 18, fig.14.

Remarks: *Polygnathus normalis* is characterized by having an asymmetric platform with a posterior margin incurved and a slightly constricted anterior margin. The platform is covered by transversal

ridges. Some authors consider *Polygnathus normalis* as young synonym of *Polygnathus webbi*. However we believe that the two forms are different species because *Polygnathus webbi* has a strongly constricted anterior platform and a more expanded posterior outer platform.

Range: From within the Upper *rhenana* Zone to the Lower *postera* Zone (Ji & Ziegler, 1993).

Studied material: 1 specimen from sample PZW D.

Polygnathus obliquicostatus Ziegler, 1962
(Fig. 6.12)

1962 *Polygnathus obliquicostatus* n. sp. - Ziegler, p. 92, pl. 11, figs 8-12.
1970 *Polygnathus obliquicostatus* Ziegler - Olivieri, p. 128, pl. 23, figs 4-5.
1993 *Polygnathus obliquicostatus* Ziegler - Ji & Ziegler, text-fig. 19, fig. 5.
1998c *Polygnathus obliquicostatus* Ziegler - Perri & Spalletta, p. 166, pl. 1.4.2, figs 10a-b.
1998f *Polygnathus obliquicostatus* Ziegler - Perri & Spalletta, p. 226, pl. 2.5.1, fig. 6.
2003 *Polygnathus obliquicostatus* Ziegler - Corradini, p. 112, pl. 10, figs 3-5.

Remarks: *Polygnathus obliquicostatus* is characterized by a thin and elongated platform, with the posterior part turned downward. The platform bears oblique transverse ridges that forms an angle of about 45° with the carina, more evident posterior of the carina, where occupy the whole platform. It is distinguished by *Polygnathus semicostatus* because the latter has on the inner platform ridges perpendicular to the carina, and a generally more developed tongue; differs from *Polygnathus extralobatus* in the more thin and symmetrical platform.

Range: From the Lower *styriacus* Zone to the Lower *praesulcata* Zone (Corradini et al. 2003).

Studied material: 7 specimens from sample PZW Z.

Polygnathus styriacus Ziegler, 1957
(Fig. 6.7)

1957 *Polygnathus styriacus* - Ziegler, p. 47, pl. 1, figs 12-13.
1979 *Polygnathus styriacus* Ziegler - Sandberg & Ziegler, p. 186, pl. 4, figs 14-18.
1993 *Polygnathus styriacus* Ziegler - Ji & Ziegler, p. 84, pl. 34, fig. 6-10; text-fig. 20, fig. 12.
1998d *Polygnathus styriacus* Ziegler - Perri & Spalletta, p. 179, pl. 1.5.2, fig. 8.
1998f *Polygnathus styriacus* Ziegler - Perri & Spalletta, p. 226, pl. 2.5.1, fig. 8.
2003 *Polygnathus styriacus* Ziegler - Corradini, p. 110, pl. 9, fig. 10.
2011 *Polygnathus styriacus* Ziegler - Tragelehn & Hartenfels, p. 12, pl. 1, figs 10-19.
2011 *Polygnathus protostyriacus* Tragelehn & Hartenfels, p. 12, pl. 1, figs 3-9.

Remarks: *Polygnathus styriacus* is characterized by a small sub-triangular platform covered by weak nodes irregularly arranged in the posterior part; the anterior part of the platform is not ornamented and strongly deflected downward. Tragelehn & Hartenfels (2011) introduced a new species and two morphotypes, previously attributed to *Polygnathus styriacus*. In our opinion they represents variability within the population of *Polygnathus styriacus*.

Polygnathus styriacus is different from *Polygnathus vogesi* by the ornamentation pattern; differs from *Polygnathus granulosus* by the sub-triangular platform and the downward deflection of the anterior part of the platform.

Range: From the base of the Lower *styriacus* Zone (Lower *postera* Zone) to the Lower *expansa* Zone (Ji & Ziegler 1993).

Studied material: 50 specimens from sample PZW Z.

Genus *Pseudopolygnathus* Branson & Mehl, 1934

Pseudopolygnathus controversus
Sandberg & Ziegler, 1979
(Fig. 6.6)

1979 *Pseudopolygnathus controversus* n. sp. - Sandberg & Ziegler, p. 182, pl.3, figs 12-17.
1998f *Pseudopolygnathus controversus* Sandberg & Ziegler - Perri & Spalletta, p. 226, pl. 2.5.1, fig. 10.
2011 *Pseudopolygnathus controversus* Sandberg & Ziegler - Hartenfels p. 510, pl. 62, figs 10-11.

Remarks: *Pseudopolygnathus controversus* is characterized by an asymmetrical lanceolate platform with an ornamented surface. The lenght of the right side of the platform extends much farther anteriorly than the left side as a row of transverses ridges or nodes. It is distinguished from *Pseudopolygnathus brevipennatus* by the asymmetrical platform.

Range: From the Upper *styriacus* Zone to the Lower *expansa* Zone (Sandberg & Ziegler 1979).

Studied material: 5 specimens form sample PZW Z.

Pseudopolygnathus irregularis
Traghelen & Hartenfels, 2011
(Fig. 6.4)

2011 *Pseudopolygnathus irregularis* n. sp. - Traghelen & Hartenfels, p. 8, pl. 2, fig. 16-23.
2013 *Pseudopolygnathus irregularis* Traghelen & Hartenfels - Mossoni et al., p. 88, figs 3.10.

Remarks: This species has an asymmetric platform, which extends to the posterior tip of the element. The edges are slightly raised. The outline of the platform is irregular. The surface is covered with distinctive and irregular nodes. It is distinguished from the others species of *Pseudopolygnathus* by the irregular outline of the platform and by the ornamentation.

Range: From the Upper *styriacus* Zone to the Lower *expansa* Zone (Traghelen & Hartenfels 2011).

Studied material: 2 specimens form sample PZW Z.

Pseudopolygnathus marburgensis marburgensis
Bishoff & Ziegler, 1956
(Fig. 6.10)

1956 *Pseudopolygnathus marburgensis* n. sp. - Bishoff & Ziegler, p. 162-163, pl. 11, figs 9, 11-13.
1979 *Pseudopolygnathus marburgensis marburgensis* Bishoff & Ziegler - Sandberg & Ziegler, p. 182, pl. 3, figs 1-4.
1981 *Pseudopolygnathus marburgensis marburgensis* Bishoff & Ziegler - Klapper (in Ziegler) 381-382, *Pseudopolygnathus* - pl 1, figs 1-7.
2011 *Pseudopolygnathus marburgensis marburgensis* Bishoff & Ziegler - Hartenfels p. 512, pl. 64, fig. 5.

Remarks: This subspecies of *Pseudopolygnathus marburgensis* is characterized by a trilobate platform and a trilobate basal cavity. The upper surface of the platform is strongly ornamented, with some distinctive nodes in the anterior part of the platform. The outer lobe has a secondary carina that forms nearly a right angle with the main carina, the inner lobe bear large crowded nodes or a bifurcate pattern. This subspecies of *Pseudopolygnathus marburgensis* differs from *Ps. marburgensis trigonicus* because the latter has a cross-shape basal cavity instead, while *Pseudopolygnathus marburgensis marburgensis* has a broad basal cavity.

Range: From the Upper *styriacus* Zone to the Middle *expansa* Zone (Ziegler & Sandberg 1984).

Studied material: 2 specimens from sample PZW Z.

Pseudopolygnathus micropunctatus
Bischoff & Ziegler, 1956
(Fig. 6.5)

1956 *Pseudopolygnathus micropunctata* - Bischoff & Ziegler, p. 163, pl. 11, figs 7-8, 10.
1979 *Pseudopolygnathus* cf. *micropunctatus* Bischoff & Ziegler - Sandberg & Ziegler, p. 183, pl. 3, figs 5-7.
1998f *Pseudopolygnathus micropunctatus* Bischoff & Ziegler - Perri & Spalletta, p. 226, pl. 2.5.1, fig. 12.
2003 *Pseudopolygnathus micropunctatus* Bischoff & Ziegler - Corradini, p. 112, pl. 10, fig. 14.
2011 *Pseudopolygnathus micropunctatus* Bischoff & Ziegler - Hartenfels, p. 510, pl. 63, figs 1-6, 8-10.
2013 *Pseudopolygnathus micropunctatus* Bischoff & Ziegler - Mossoni, Corradini & Spalletta, p. 88, fig. 3.12.

Remarks: This species is characterized by a lanceolate platform with a shagreen surface. Some specimens show a weak lobe in the inner part of the platform, but it's not a distinctive character. The weak ornamentation distinguish *Pseudopolygnathus micropunctatus* among all the other representative of genus *Pseudopolygnathus*.

Range: From the Upper *trachytera* Zone to the - Upper *expansa* Zone (Corradini 2003).

Studied material: 2 specimens from sample PZW Z.

Conclusions

The main results of this study on the Clymeniae limestones in the Pizzul West section can be summarized as follows:

1. Fourty-one conodont taxa, between species and subspecies, belonging to six genera (*Ancyrodella, Bispathodus, Icriodus, Palmatolepis, Polygnathus, Pseudopolygnathus*) have been recognized.
2. The following species have been reported for the first time from the Carnic Alps: *Icriodus olivierii* Corradini, 2003, *Palmatolepis lyaiolensis* Ji & Ziegler, 1993, *Palmatolepis simpla* Ziegler & Sandberg, 1990, *Pseudopolygnathus irregularis* Traghelen & Hartenfels, 2011, *Polygnathus mirificus* Ji & Ziegler, 1993.
3. Seven conodont biozones, one from the Frasnian (Upper *rhenana*) and six from the Famennian (Upper *crepida*, Uppermost *crepida*, Lower *rhomboidea*, Upper *rhomboidea*, Lower *marginifera*, Lower *expansa*) have been discriminated.

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References

Bassler, R. 1925. Classification and stratigraphic use of the conodonts. *Bulletin of the Geological Society of America* 36: 218-20.

Bischoff, G. 1956. Oberdevonische Conodonten (to I ä) aus dem Rheinischen Schiefergebirge. *Notizblatt des Hessisches Landesamt für Bodenforschung* 84: 115-37.

Bischoff, G., & W. Ziegler. 1956. Das Alter der "Urfer Schishten" im Marburger Hinterland nach Conodonten. *Notizblatt des Hessisches Landesamt für Bodenforschung* 84: 138-69.

Branson, E.B., & M.G. Mehl. 1934a. Conodonts from the Bushberg sandstone and equivalent formations of Missouri. *Missouri University Studies* 8, n. 4: 265-300.

Branson, E.B., & M.G. Mehl. 1934b. Conodonts from the Grassy Creek shale of Missouri. *Missouri University Studies* 8 (3): 171-259.

Branson, E.B., & M.G. Mehl. 1938. Conodonts from the lower Mississippian of Missouri. In *Stratigraphy and palaeontology of the lower Mississippian of Missouri*, cur. E.B. Branson et al., Missouri University Studies, 13: 128-48.

Cooper, C.L. 1931. New conodonts from the Woodford Formation of Oklahoma. *Journal of Paleontology* 5, n. 3: 230-43.

Corradini, C. 1998. Famennian conodonts from two sections near Villasalto. *Giornale di Geologia* 60, special issue: 122-35.

Corradini, C. 2003. Late Devonian (Famennian) conodonts from the Corona Mizziu Sections near Villasalto (Sardinia Italy). *Palaeontographia Italica* 89: 65-116.

Corradini, C. 2008. Revision of Famennian-Tournaisian (Late Devonian-Early Carboniferous) conodont biostratigraphy of Sardinia, Italy. *Revue de micro-paléontologie* 51: 123-32.

Corradini, C., M.G. Corriga, E. Kido, G. Muscio, M. Pondrelli, T.J. Suttner, L. Simonetto & C. Spalletta. 2013. *Cason di Lanza - leggere il passato nelle rocce*. Le guide del Geoparco della Carnia 1: 48 pp.

Corradini, C., M. Pondrelli, M.G. Corriga, L. Simonetto, E. Kido, T.J. Suttner, C. Spalletta & N. Carta. 2012. Geology and stratigraphy of the Cason di Lanza area (Mount Zermula, Carnic Alps, Italy). *Berichte des Institutes für Erdwissenschaften, Karl-Franzens-Universität Graz* 17: 83-103.

Gedik, I. 1969. Karnik Alpler'den Alt Karbonifer'e ait conodont'lar. *The Mineral Research and Exploration Institut of Turkey, Bulletin* 70: 229-42.

Glenister, B.F., & G. Klapper. 1966. Upper Devonian conodonts from the Canning Basin, Western Australia. *Journal of Paleontology* 40, n. 4: 777-842.

Hartenfels, S. 2011. Die globalen Annulata-Events und die Dasberg-Krise (Famennium, Oberdevon) in Europa und Nord-Afrika: hochauflösende Conodonten-Stratigraphie, Karbonat-Mikrofazies, Paläoökologie und Paläodiversität. *Münstersche Forschungen zur Geologie und Paläontologie* 105: 17-527.

Helms, J. 1959. Conodonten aus dem Saalfelder Oberdevon (Thuringen). *Geologie* 8, n. 6: 634-77.

Helms, J. 1963. Zur "Phylogenese" und Taxionomie von *Palmatolepis* (Conodontida, Oberdevon). *Geologie* 12, n. 4: 449-85.

Hinde, G.J. 1879. On conodonts from the Chazy and Cincinnati group of the Cambro-Silurian and from the Hamilton and Genesee shale divisions of the Devonian in Canada and the United States. *Geological Society of London Quarterly Journal* 35, n. 3: 351-69.

Ji, Q. 1989. On the Frasnian conodont biostratigraphy in the Guilin Area of Guangxi, South Cina. *Courier Forschungs-Institut Senckenberg* 117: 303-19.

Ji, Q., & W. Ziegler. 1993. The Lali Section: an excellent Reference Section for Upper Devonian in South China. *Courier Forschungs-Institut Senckenberg* 157: 1-183.

Khrusheva, E.N., & A.V. Kuzmin. 1996. New late Frasnian conodonts of the Genus *Palmatolepis* from the Lyaiol'skaya Formation of southern Timan. *Palaeontologicheskyi Zhurnal* 3: 90-3.

Klapper, G., & H.R. Lane. 1985. Frasnian (Upper Devonian) Conodont sequence at Luscar Mountain and Mount Haultain, Alberta Rocky Mountains. *Canadian Society of Petroleum Geology* 3: 469-78.

Klapper, G., C. Sweet & W. Ziegler, cur. 1991. *Catalogue of Conodonts, volume 5*. Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 212 pp.

Manzoni, M. 1966. Conodonti neodevonici ed eocarboniferi al Monte Zermula (Alpi Carniche). *Giornale di Geologia* s. 2, 33: 461-88.

Miller, A.K., & W. Youngquist. 1947. Conodonts from the type section of the Sweetland Creek Shale in Iowa. *Journal of Paleontology* 21, n. 6: 501-17.

Mossoni, A., C. Corradini & C. Spalletta C. 2013. Conodonts from the Monte Taccu section (Famennian-Tournaisian, Sardinia, Italy). *Asociación Paleontológica Argentina, Publicación Especial* 13: 85-90.

Müller, K.J. 1956. Zur Kenntnis der Conodonten-Fauna des europaischen Devons, 1; Die Gattung *Palmatolepis*. *Abhandlunghen and Senckenbergischen Naturforschenden Gesellschaft* 494: 1-70.

Müller, K.J. 1962. Zur systematischen Einteilung der Conodontoporida. *Palaontologische Zeitschrift* 36: 109-17.

Olivieri, R. 1970. Conodonti e zonatura del Devoniano superiore e riconoscimento del Carbonifero inferiore nei calcari di Corona Mizziu (Gerrei, Sardegna). *Bollettino della Società Paleontologica Italiana* 8, n. 2: 63-152.

Ovnatanova, N.S., & L.I. Kononova. 2008. Frasnian conodonts from the Eastern Russian Platform. *Palaeontological Journal* 42, n. 10: 997-1166.

Perri, M.C., & C. Spalletta. 1990. Famennian conodonts from climenid pelagic limestone, Carnia Alps, Italy. *Palaeontographia Italica* 77: 55-83.

Perri, M.C., & C. Spalletta. 1991. Famennian conodonts from Cava Cantoniera and Malpasso sections, Carnic Alps, Italy. *Bollettino della Società Paleontologica Italiana* 30, n. 1: 47-78.

Perri, M.C., & C. Spalletta. 1998a. Updating of the conodont biostratigraphy in the Carnic Alps (Italy). In *Southern Alps Fiel Trip Guidebook, Ecos VII*, cur. M.C. Perri & C. Spalletta, 116-9. Giornale di Geologia, s. 3, 60, Spec. Issue.

Perri, M.C., & C. Spalletta. 1998b. The Upper *marginifera* Zone (Late Devonian) in the Casera Collinetta di Sotto C section (Carnic Alps, Italy). In *Southern Alps Fiel Trip Guidebook, Ecos VII*, cur. M.C. Perri & C. Spalletta, 150-7. Giornale di Geologia, s. 3, 60, Spec. Issue.

Perri, M.C., & C. Spalletta. 1998c. Late Famennian conodonts from the Casera Collinetta di Sotto B section (Carnic Alps, Italy). In *Southern Alps Fiel Trip Guidebook, Ecos VII*, cur. M.C. Perri & C. Spalletta, 158-67. Giornale di Geologia, s. 3, 60, Spec. Issue.

Perri, M.C., & C. Spalletta. 1998d. Latest Devonian and Early Carboniferous conodonts from the Casera Collinetta di Sotto A section (Carnic Alps, Italy). In *Southern Alps Fiel Trip Guidebook, Ecos VII*, cur. M.C. Perri & C. Spalletta, 168-81. Giornale di Geologia, s. 3, 60, Spec. Issue.

Perri, M.C., & C. Spalletta. 1998e. Middle Famennian conodonts of the Elios section (Carnic Alps, Italy). In *Southern Alps Fiel Trip Guidebook, Ecos VII*, cur. M.C. Perri & C. Spalletta, 205-13. Giornale di Geologia, s. 3, 60, Spec. Issue.

Perri, M.C., & C. Spalletta. 1998f. Late Famennian conodonts of the Malpasso section (Carnic Alps, Italy). In *Southern Alps Fiel Trip Guidebook, Ecos VII*, cur. M.C. Perri & C. Spalletta, 220-7. Giornale di Geologia, s. 3, 60, Spec. Issue.

Pölser, P. 1969. Conodonten aus dem Devon der Karnischen Alpen (Findenigkofel, Österreich). *Jahrbuch der Geologischen Bundesanstalt*, 112: 399-440.

Pondrelli, M., C. Corradini, M.G. Corriga, E. Kido, L. Simonetto, C. Spalletta, T.J. Suttner & N. Carta. 2011. Pragian to Famennian depositional evolution of the M. Pizzul area (Carnic Alps, Italy): preliminary results. In *IGCP 596 - Opening Meeting, Graz, 19-24th September 2011*, cur. T.J. Suttner, E. Kido, W.E. Piller & P. Könisghof, 78-9. Berichte des Institutes für Erdwissenschaften, Karl-Franzens-Universität Graz, 16.

Sandberg, C.A. 1976. Conodont biofacies of Late Devonian *Polygnathus styriacus* Zone in western United States. In *Conodont Palaeoecology*, cur. C.R. Barnes, 171-86. Geological Association of Canada, Special Paper 15.

Sandberg, C.A., & R. Dreesen. 1984. Late Devonian icriodontid biofacies models and alternate shallow-water conodont zonation. In *Conodont biofacies and provincialism*, cur. D.L. Clark, 143-78. Geological Society of America. Special Paper 196.

Sandberg, C.A., W. Ziegler, K. Leuteriz & S.M. Brill. 1978. Phylogeny, speciation and zonation of *Siphonodella* (Conodonta, Upper Devonian and Lower Carboniferous). *Newsletter on Stratigraphy* 7: 102-20.

Sandberg, C.A., & W. Ziegler. 1979. Taxonomy and biofacies of important conodonts of Late Devonian styriacus-Zone, United States and Germany. *Geologica et Palaeontologica* 13: 173-212.

Sannemann, D. 1955a. Beitrag zur Untergliederung des Oberdevons nach Conodonten. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen*, 100, n. 3: 324-31.

Sannemann, D. 1955b. Oberdevonische Conodonten (to II á). *Senckenbergiana Lethaea* 26 n. 1-2: 123-56.

Schönlaub, H.P. 1969a. Das Paläozoikum zwischen Bishofalm und Hohem Trieb (Zentrale Karnischen Alpen). *Jahrbuch der Geologischen Bundesanstalt* 112: 265-320.

Schönlaub, H.P. 1969b. Conodonten aus dem Oberdevon und Unterkarbon des Kronhofgrabens (Karnischen Alpen, Österreich). *Jahrbuch der Geologischen Bundesanstalt* 112: 321-54.

Schönlaub, H.P. 1992. Stratigraphy, Biogeography and Paleoclimatology of the Alpine Paleozoic and its implications for Plate movements. *Jahrbuch der Geologischen Bundesanstalt* 135: 381-418.

Schülke, I. 1999. Conodont multielement reconstruction from the Early Famennian (Late Devonian) of the Montagne Noire (Southern France). *Geologica et Palaeontologica*, SB 3: 1-123.

Spalletta, C., G.B. Vai & C. Venturini. 1980. II flysch ercinico nella geologia dei Monti Paularo e Dimon (Alpi Carniche). *Memorie della Società Geologica Italiana* 20: 243-65.

Spalletta, C., & M.C. Perri. 1998. The Frasnian-Famennian boundary at the Pramosio A section (Carnic Alps, Italy). In *Southern Alps Fiel Trip Guidebook, Ecos VII*, cur. M.C. Perri & C. Spalletta, 198-205. Giornale di Geologia, s. 3, 60, Spec. Issue.

Szulczewski, M. 1971. Upper Devonian conodonts, stratigraphy and facial development in the Holy Cross Mts.*Acta Geologica Polonica* 21, n. 1: 1-130.

Traghelen, H., & S. Hartenfels. 2011. Neue Conodont taxa aus dem höheren Famennium (Oberdevon) des Frankenwaldes. *Münstersche Forschungen zur Geologie and Paläontologie* 105: 1-15.

Ulrich, E.O., & R.S. Bassler. 1926. A classification of the toothlike fossils, conodonts, with descriptions of American Devonian and Mississippian species. *Proceedings of U.S. Natural History Museum* 68: 1-63.

Venturini, C. 1990a. *Geologia delle Alpi Carniche centro orientali*. Udine: Pubblicazioni del Museo Friulano di Storia Naturale 36: 220 pp.

Venturini, C., cur. 1990b. *Field Workshop on Carboniferous to Permian sequence of the Pramollo-Nassfeld Basin (Carnic Alps). Guidebook*. Udine: Arti Grafiche Friulane: 159 pp.

Venturini, C. (coord.), C. Spalletta, G.B. Vai, M. Pondrelli, C. Fontana, S. Delzotto, G. Longo Salvador & G.B. Carulli. 2009. *Note Illustrative al Foglio 031 Ampezzo, Carta geologica d'Italia alla scala 1:50.000.* Firenze: ISPRA, Servizio Geologico d'Italia: 232 pp.

Ziegler, W. 1958. Conodonten-feinstratigraphische Untersuchungen an der Grenze Mitteldevon/Oberdevon und in der Adorfstufe. *Notizblatt des Hessisches Landesamt für Bodenforschung* 87: 7-77.

Ziegler, W. 1960. Conodonten aus dem Rheinischen Untedevon (Gedinnium) des Remscheider sattels (Rheinisches Schiefergebirge). *Palaontologische Zeitschrift* 34, n. 2: 169-201.

Ziegler, W. 1962. Taxionomie und Phylogenie Oberdevonischer Conodonten und ihre stratigraphische Bedeutung. *Abhandlunghen des Hessisches Landesamt für Bodenforschung* 38: 166.

Ziegler, W. 1971. Conodont Stratigraphy of the European Devonian. *Geological Society of America Memoir* 127, 227-84.

Ziegler, W., cur. 1973. *Catalogue of Conodonts, volume 1*. Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 504 pp.

Ziegler, W., cur. 1975. *Catalogue of Conodonts, volume 2*. Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 404 pp.

Ziegler, W., cur. 1977. *Catalogue of Conodonts, volume 3*. Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 574 pp.

Ziegler, W., cur. 1981. *Catalogue of Conodonts, volume 4*. Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 445 pp.

Ziegler, W., & J.W. Huddle. 1969. Die *Palmatolepis glabra*-Gruppe (Conodonta) nach der Revision der Typen von Ulrich & Bassler durch J. W. Huddle. *Fortschritte in der Geologie der Rheinland und Westfalen* 16: 377-86.

Ziegler, W., & Sandberg, C.A. 1984. *Palmatolepis*-based revision of upper part of standard Late Devonian conodont zonation. In *Conodont biofacies and provincialism*, cur. D.L. Clark, Geological Society of America, Special Paper 196: 179-94.

Ziegler, W., & C.A. Sandberg. 1990. The Late Devonian Standard Conodont Zonation. *Courier Forschungs-Institut Senckenberg* 121: 1-115.

Ziegler, W., & C.A. Sandberg. 1994. Conodont Phylogenetic-Zone Concept. *Newsletter of Stratigraphy* 30: 105-23.

Ziegler, W., C.A. Sandberg & R.L. Austin. 1974. Revision of *Bispathodus* group (Conodonta) in the Upper Devonian and Lower Carboniferous. *Geologica et Palaeontologica* 8: 97-112.

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