Introduction

The Clymeniae limestone 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 fissiliferous shales, siltstones, sandstones and rare conglomerates. The sequence continues with few meters of nodular limestone (“Uqua limestones”), and calcareous sandstones (Plöcken Formation). Silurian
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, intercalated 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 Hochwipf Fm.: gravitative driven accumulation of breccias, conglomerates, sandstones and pebbles originated by the Lower Carboniferous transtensional to transpressional tectonics (SPALLETTA et al. 1980).


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 PEK & 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. 3). 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. 3). 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. 4).

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. 4).

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. 4).

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. 4).
Fig. 3 - Stratigraphic log of the Pizzul West section and conodont distribution - Colonna stratigrafica e distribuzione dei conodonti nella sezione Pizzul Ovest.

LEGEND

- Massive grey limestone
- Nodular grey limestone
- Nodular red limestone
- Pelitic levels
- Tectonic contact

Ir. alt. alternatus
Pa. glabra prima
Pa. perlobata schindewolfii
Pa. rhomboidea
Pa. glabra pectinata
Pa. glaber glaber
Pa. nod. nodocostatus
Anc. curvata
Anc. lobata
Anc. nodosa
Pa. jamiae
Pa. jasoleinis
Pa. rotunda
Pa. simpla
Pa. normalis
Po. mirificus
Pa. quadr. inflexoidea
Pa. quadrant. nodosalebata
Pa. temiupunctata
Pa. glabra glabra
Pa. minuta lobata
Pa. subperlobata
Pa. cl. regularis
Pa. crepida
Pa. minuta subgracilis
Ir. olivierii
Pa. glabra acuta
Po. glaber eoglaber
Pa. minuta minuta
Pa. minuta wolskiae
Pa. marg. marginifera
Pa. stoppell
Conodont data

Fourteen samples (Fig. 3), weighing 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).

Forty-one taxa, between species and subspecies, belonging to six genera (Ancyrodella, Bispathodus, Icriodus, Palmatolepis, Pseudopolygnathus, Polygnathus) have been recognized (Fig. 3).

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 has been recognized:
- The Upper rhena 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
### 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; Ovhatanova & Konono 2008).

- The Upper crepida Zone has been discriminated in samples PZW 1-3, thanks of the first occurrence of the marker Palnatolesgi glabra prima, and of Palnatolesgi glabra lepta and Palnatolesgi minuta subagracilis. 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 Palnatolesgi glabra pectinata and of Palnatolesgi 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 (Corradiini 2008).

- The Lower rhomboidea Zone is discriminated in samples PZW 5-5A by the presence of the marker Palnatolesgi rhomboidea, and of Palnatolesgi minuta wolske and Palnatolesgi 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 Palnatolesgi minuta wolske.

- The Lower marginifera Zone (Sample PZW 7) is recognized by the first occurrence of the marker Palnatolesgi marginifera marginifera. The presence of Palnatolesgi stoppeii, 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 Palnatolesgi rugosa rugosa, Polygnathus nodocostatus nodocostatus and Polygnathus styriacus. The first one makes 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.

Genus Anycyrodela Ulrich & Bassler, 1926

Anycyrodela curvata Branson & Mehl, 1934

(Fig. 5.3)

1934 Anycyrodela curvata n. sp. - Branson & Mehl, p. 241, pl. 19, figs 6, 11.


1993 Anycyrodela curvata Branson & Mehl - Ji & Ziegler, p. 96, pl. 2, figs 4-5.

1998 Anycyrodela curvata Branson & Mehl - Sfaleletta & Perri, p. 204, pl. 2.2.1, fig. 1.

Remarks: Anycyrodela curvata is characterized by a strongly pronounced lateo-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 Anycyrodela 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 linguisticis Zone (Ji & Ziegler 1993).

Studied material: 1 specimen from sample PZW D.

Anycyrodela lobata Branson & Mehl, 1934

(Fig. 5.2)

1934 Anycyrodela lobata n. sp. - Branson & Mehl, p. 239-240, pl. 19, fig. 14, pl. 21, figs 22-23.

1971 Anycyrodela lobata Branson & Mehl - Szulczewski, p. 13, pl. 3, figs 1-4 only.

1985 Anycyrodela lobata Branson & Mehl - Klapper & Lane, p. 923-924, pl. 14, fig. 15, 16, 17.

1989 Anycyrodela lobata Branson & Mehl - Ji, pl. 3, fig. 3.

1993 Anycyrodela curvata (Branson & Mehl) - Ji & Ziegler, p. 96, pl. 2, figs 6-10.

Remarks: Anycyrodela lobata is characterized by a platform covered with nodes, with two rows 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 Anycyrodela 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.

Anycyrodela nodosa Ulrich & Bassler, 1926

(Fig. 5.1)

1926 Anycyrodela nodosa n. sp. - Ulrich & Bassler, p. 48, pl. 1, figs 1-13.

1958 Anycyrodela nodosa Ulrich & Bassler - Ziegler, p. 44, pl. 11, fig. 1.

1993 *Ancyrodella nodosa* Ulrich & Bassler - Ji & Ziegler, p. 96, pl. 2, figs 11-12; text-fig. 8, figs 8-9.


**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.

**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 - Perritt & 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 *crepa* Zone (Schülke 1999).

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

*Icriodus olivieri* Corradini, 1998

(Fig. 5.10)

1970 *Icriodus symmetricus* Branson & Mehl - Olivieri, pl. 14, fig. 9.

1998 *Icriodus olivieri* - Corradini, pl. 1.4.1, fig. 8.

2003 *Icriodus olivieri* Corradini - Corradini, p. 92-93, pl. 2, figs 14-21 (cum syn.).

**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.

Genus *Palmateopsis* Ulrich & Bassler, 1926

*Palmateopsis crepida* Sanemann, 1955

(Fig. 5.18)

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

Remarks: *Palmateopsis 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 *Palmateopsis 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.

*Palmateopsis glabra acuta* Helms, 1963

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

Remarks: This subspecies of *Palmateopsis 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 *Palmateopsis glabra glabra* by the presence of the thorn-like projection on the inner anterior margin, and by *Palmateopsis 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.

*Palmateopsis glabra glabra* Ulrich & Bassler, 1926

(Fig. 5.15)

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

Remarks: *Palmateopsis 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 *Palmateopsis glabra prima* because of the angle of the insertion of the inner anterior margin into the blade, and by *Palmateopsis 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.

*Palmateopsis glabra pectinata* Ziegler, 1962

(Fig. 5.19)

1962 *Palmateopsis glabra pectinata* n. sub. sp. - Ziegler, p. 398-399, pl. 2, figs 3-5.
1966 *Palmateopsis 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 *Palmateopsis glabra pectinata* Ziegler - Ji & Ziegler, p. 61, pl. 16, figs 5-10, pl. 17, figs 1-12; text-fig. 17, figs 7-8.
1998b *Palmateopsis glabra pectinata* Ziegler - Perri & Spalletta, p. 156, pl. 1.3.1, figs 1-2.

Remarks: This subspecies is distinguished from *Pa. glabra prima* and *Palmateopsis glabra glabra* having a long parapet that lies close and parallel to the carina, and from *Palmateopsis 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 species 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.

*Palmateopsis glabra prima* Ziegler & Huddie, 1969

(Fig. 5.16)
1969 *Palmatolespis glabra prima* - Ziegler & Huddle, p. 379 (cum syn).
1970 *Palmatolespis glabra prima* Ziegler & Huddle - Olivier, p. 100, pl.17, figs 1-4.
1977 *Palmatolespis glabra prima* Ziegler & Huddle - Ziegler in Ziegler (ed.), p. 309, pl. Palmatolespis-7, fig. 4-7 (cum syn.).
1990 *Palmatolespis glabra prima* Ziegler & Huddle - Perri & Spalletta, p. 61, pl. 2, figs.1a-b.
1993 *Palmatolespis glabra pectinata* Ziegler - Ji & Ziegler, p. 61, pl. 16, figs 12-17, pl. 17, text-fig 17, figs 2, 9, 17.
1998c *Palmatolespis glabra prima* Ziegler & Huddle - Perri & Spalletta, p. 156, pl. 1.3.1, figs. 3-4, 5.
2003 *Palmatolespis glabra prima* Ziegler & Huddle - Corradini, p. 79, pl. 4, figs 3-6.

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

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

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

**Remarks:** *Palmatolespis 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 *Palmatolespis minuta minuta* by the characteristic twisted keel.

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

**Studied material:** 20 specimens from sample PZW Z.

*Palmatolespis gracilis sigmoidalis* Ziegler, 1962 (Fig. 5.11)

1969 *Palmatolespis gracilis sigmoidalis* Ziegler-Pölser, p. 399, pl. 6, fig. 22.
1979 *Palmatolespis gracilis sigmoidalis* Ziegler-Sandberg & Ziegler; p. 178, pl. 1, figs 3-5.
1991 *Palmatolespis gracilis sigmoidalis* Ziegler - Perri & Spalletta, p. 64, pl. 4, fig. 6.
1993 *Palmatolespis gracilis sigmoidalis* Ziegler - Ji & Ziegler, pl. 5, figs 1-3; text-fig. 14, fig. 6.

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

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

**Studied material:** 5 specimens from sample PZW Z.

*Palmatolespis jamae Ziegler & Sandberg, 1990* (Fig. 5.8)

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

**Remarks:** *Palmatolespis jamae* 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 *Palmatolespis foliacea* by having a well-developed lobe with two sinuses.

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

**Studied material:** 5 specimens from sample PZW D.

*Palmatolespis lyaiolensis* Khristcheva & Kuzmin, 1996 (Fig. 5.6)
1996 *Palmateopsis lyaiolensis* - Khrustcheva & Kuzmin, p. 93, pl. 11, figs 1-2.

2008 *Palmateopsis lyaiolensis Khrustcheva & Kuzmin* - Ovnatanoa & 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. *Palmateopsis lyaiolensis* differs from *Palmateopsis 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 (Ovnatanoa & Kononova 2008).

**Studied material**: 4 specimens from sample PZW D.

*Palmateopsis marginifera marginifera* Helms, 1959

(Fig. 6.18)


1990 *Palmateopsis marginifera marginifera* Helms - Perri & Spalletta, p. 61, pl. 2, figs 3-4.

1993 *Palmateopsis marginifera marginifera* Helms - Ji & Ziegler, p. 64, pl. 13, figs 7-10; pl. 14, figs 1-6; text-fig. 17, fig. 14.

1998b *Palmateopsis marginifera marginifera* Helms - Perri & Spalletta, p. 156, pl. 1.3.1, fig. 6.

1998 *Palmateopsis marginifera marginifera* Helms - Corradini, pl. 1.4.1, fig. 14.

2013 *Palmateopsis marginifera marginifera* Helms - Mossoni et al., fig. 3.2.

**Remarks**: *Palmateopsis 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 extend posterior the central node. It is distinguished from *Palmateopsis 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.

*Palmateopsis minuta* Branson & Mehl, 1934

(Fig. 6.17)

1934 *Palmateopsis minuta minuta* - Branson & Mehl, p. 236, pl. 18, figs 1, 6-7.

1962 *Palmateopsis minuta minuta* Branson & Mehl-Ziegler; pl. 3, figs 1-10, text fig. 5 b-n.

1990 *Palmateopsis minuta minuta* Branson & Mehl - Perri & Spalletta, p. 62, pl. 3, figs 1, 7.

1993 *Palmateopsis minuta minuta* Branson & Mehl - Ji & Ziegler, pl. 7, figs 1-19; pl. 9, figs 8-18; text-fig. 13, figs 9, 15, 16.

1998b *Palmateopsis minuta minuta* Branson & Mehl-Perri & Spalletta, p. 156, pl. 1.3.1, fig. 8.

1998 *Palmateopsis minuta minuta* Branson & Mehl - Corradini, pl. 1.4.1, fig. 14.

**Remarks**: *Palmateopsis 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 *Palmateopsis 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.

*Palmateopsis minuta loba* Helms, 1963

(Fig. 5.11)

1963 *Palmateopsis (Deflectolepis) minuta loba* - Helms, p. 470, pl. 2, figs 13-14; pl. 3 fig. 12; text fig. 2, fig. 39.

1970 *Palmateopsis minuta loba* Helms - Olivieri, p. 107, pl. 20, fig. 5.

1993 *Palmateopsis minuta loba* Helms - Ji & Ziegler, p. 64, pl. 10, figs 1-16, text-fig. 13, fig. 11-12.

2003 *Palmateopsis 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 *Palmateopsis 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.

*Palmateopsis minuta subgracilis* Bishoff, 1956

1956 *Palmateopsis minuta subgracilis* - Bishoff, p. 130, pl. 9, figs 9-12; pl. 10, fig. 13.
1977 *Palmatolespis minuta subgracilis* BISHOFF - ZIEGLER in ZIEGLER (ed.), p. 343, *Palmatolespis*-9, fig. 6 (cum syn.).

2003 *Palmatolespis minuta subgracilis* BISHOFF - CORRADINI; p. 80, pl. 6, fig. 21.

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

*Palmatolespis minuta wolskai* SZULCZEWSKI, 1971

1971 *Palmatolespis minuta wolskai* - SZULCZEWSKI, p. 36, pl. 15, figs 2, 12-14.
1993 *Palmatolespis minuta wolskai* SZULCZEWSKI - Ji & ZIEGLER; p. 85 pl. 11, figs 1-11, text-fig. 13, figs 7-8.
2003 *Palmatolespis minuta wolskai* 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 *Palmatolespis 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.

*Palmatolespis perlobata postera* ZIEGLER, 1960 (Fig. 6.2)

1960 *Palmatolespis perlobata postera* n. subsp. - ZIEGLER, p. 27, pl. 8, figs 22-31; pl. 9, fig. 33.
1993 *Palmatolespis perlobata postera* ZIEGLER - Ji & ZIEGLER; text-fig. 15, fig. 10.

**Remarks:** *Palmatolespis perlobata postera* is characterized by a broad curved platform covered by small nodes. It is distinguished by the other subspecies of *Palmatolespis perlobata* by the weak lobe on the outer part of the platform. This species was chosen 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.

*Palmatolespis perlobata schindewolfii* MÜLLER, 1956 (Fig. 6.20)

1956 *Palmatolespis perlobata schindewolfii* - MÜLLER, p. 27, pl. 8, figs 22-31; pl. 9, fig. 33.
1969 *Palmatolespis perlobata schindewolfii* MÜLLER - PÖLSER, p. 399, pl. 5, figs 1-2, 9.
1970 *Palmatolespis perlobata schindewolfii* MÜLLER - OLIVIERI, p. 109, pl. 20, figs 11-14.
1977 *Palmatolespis perlobata schindewolfii* MÜLLER - ZIEGLER in ZIEGLER (ed.), p. 361, *Palmatolespis*-11, fig. 1-7 (cum syn.).
1990 *Palmatolespis perlobata schindewolfii* MÜLLER - PERRI & SPALLETTA, fig. 63, pl. 3, figs 4-5, 8.
1991 *Palmatolespis perlobata schindewolfii* MÜLLER - PERRI & SPALLETTA, fig. 66, pl. 4, fig. 7.
1993 *Palmatolespis perlobata schindewolfii* MÜLLER - Ji & ZIEGLER; p. 67, pl. 18, figs 9-15; text-fig. 15, fig. 3.
2003 *Palmatolespis perlobata schindewolfii* MÜLLER - CORRADINI, pl. 7, figs 1-5.

**Remarks:** *Palmatolespis perlobata schindewolfii* 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 *Palmatolespis perlobata postera* 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.

*Palmatolespis quadrantisnodosalobata* SANNEMANN, 1955 (Fig. 5.14)

1955 *Palmatolespis quadrantisnodosalobata* - SANNEMANN, p. 328, pl. 24, fig. 6.
1969 *Palmatolespis quadrantisnodosalobata* SANNEMANN - PÖLSER, p. 399, pl. 6, figs 13-14.
1970 *Palmatolespis quadrantisnodosalobata* SANNEMANN - OLIVIERI, p. 112, pl. 18, fig. 9-11.
1993 *Palmatolespis quadrantisnodosalobata* SANNEMANN - Ji & ZIEGLER, p. 69, pl. 23, fig. 5-7; text-fig. 12, fig. 3, 7-8.
2003 *Palmatolespis quadrantisnodosalobata* SANNEMANN - CORRADINI, pl. 5, figs 7-9.
Remarks: Palmatolepis quadratinodosalobata 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 quadratinodosalobata 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 shagreen, strongly sigmoidal platform lacking the outer lobe. Ji & Ziegler (1993) proposed two morphotypes that differ from within 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)

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.).

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.

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 perllobata postera Ziegler, 1960 (Sample PZW Z); 3. Polygnathus cf. nodocostatus Branson & Mehl, 1934 (Sample PZW Z); 4. Pseudopolygnathus irregularis Traghelein & 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. Bispadusotus stabilis (Branson & Mehl, 1934) (PZW Z); 9. Polygnathus marginulatus 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 obliquocostatus 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 stoppei Sandberg & Ziegler, 1973 (Sample PZW 7); 20. Palmatolepis perllobata schindewolf Müller, 1956 (Sample PZW 5).

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

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

*Palmatelepis rotunda* ZIEGLER & SANDBERG, 1990
(Fig. 5.7)

1990 *Palmatelepis rotunda* n. sp. - ZIEGLER & SANDBERG, p. 62, pl. 10, figs 1-5.
1998 *Palmatelepis rotunda* ZIEGLER & SANDBERG - SPALLET TA & PERRI, p. 204, pl. 2.2.1, fig. 12.

Remarks: *Palmatelepis 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.

*Palmatelepis rugosa rugosa* BRANSON & MEHL, 1934
(Fig. 6.1)

1934 *Palmatelepis rugosa* n.sp. - BRANSON & MEHL, p. 236, pl. 18, figs 15, 16, 18, 19.
1993 *Palmatelepis 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 *Palmatelepis 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.

*Palmatelepis simpla* ZIEGLER & SANDBERG, 1990
(Fig. 5.4)

1990 *Palmatelepis simpla* n. sp. - ZIEGLER & SANDBERG, p. 47-48, pl. 4, figs 9-12.

Remarks: *Palmatelepis 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 *Palmatelepis 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.

*Palmatelepis stoppeli* SANDBERG & ZIEGLER, 1973
(Fig. 6.19)

1960 *Palmatelepis* sp. - ZIEGLER pl. 7 figs 12-13
1977 *Palmatelepis stoppeli* n. sp. - SANDBERG & ZIEGLER, p. 106-107, pl. 3 figs 1-11, pl. 5, fig. 13.
1993 *Palmatelepis stoppeli* SANDBERG & ZIEGLER - JI & ZIEGLER, p. 71, pl. 14, figs 7-12, text-fig. 17, fig. 12.
1998 *Palmatelepis 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 *Palmatelepis quadratinodosa inflexa* by the lack of ornamentation on the surface of the platform and from *Palmatelepis 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.

*Palmatelepis subperlobata* BRANSON & MEHL, 1934
(Fig. 5.17)

1934 *Palmatelepis subperlobata* n. sp. - BRANSON & MEHL, p. 235, pl. 18, figs 11, 21.
1971 *Palmatelepis subperlobata* BRANSON & MEHL - SZULCZEW SKI, p. 40-41, pl. 13, fig. 12.
1993 *Palmatelepis subperlobata* BRANSON & MEHL - JI & ZIEGLER, pl. 20, figs 3-9; pl. 21, figs 11-12; text-fig. 16, figs 5, 6, 8.
2003 *Palmatelepis subperlobata* BRANSON & MEHL - CORRADINI, pl. 3, figs 1-4.

Remarks: *Palmatelepis subperlobata* is characterized by a shagreen platform with a well-developed lobe on the outer platform. The carina is strongly sigmoideal.
This species is distinguished from *Palmatelepis 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.

*Palmatelepis tenuipunctata* Sanemann, 1955  
(Fig. 5.13)

1955b *Palmatelepis tenuipunctata* - Sanemann, p. 136, pl. 6, fig. 22.

1969 *Palmatelepis tenuipunctata* Sanemann - Pölsler, p. 399, pl. 5, fig. 21.

1970 *Palmatelepis tenuipunctata* Sanemann - Oliveiri, p. 117, pl. 18, figs 1-2.

1993 *Palmatelepis tenuipunctata* Sanemann - Ji & Ziegler, p. 72, pl. 19, fig. 1-6; text-fig.16, fig. 2.


**Remarks:** *Palmatelepis 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 *Palmatelepis subperlobata* by the less developed lobe and from *Palmatelepis 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.

**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.


1969 *Spathognathodus stabilis* (Branson & Mehl) - Pölsler, 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 height. 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.


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 marginovolutus* Gedik, 1969  
(Fig. 6.9)

1969 *Polygnathus marginovolutus* - Gedik, pl. 237, pl. 5, figs 2-8.
1991 *Polygnathus marginovolutus* Gedik - Perri & Spalletta, p. 237, pl. 6, figs 1-2.
1998d *Polygnathus marginovolutus* 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.

**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 posteria 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 praeasculata Zone (Corradini et al. 2003).

Studied material: 7 specimens from sample PZW Z.

Polygnathus styriacus Ziegler, 1957
(Fig. 6.7)

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.

Remarks: Pseudopolygnathus controversus is characterized by an asymmetrical lanceolate platform with an ornamented surface. The length 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
Tragelehn & Hartenfels, 2011
(Fig. 6.4)

2011 Pseudopolygnathus irregularis n. sp. - Tragelehn & Hartenfels, p. 8, pl. 2, fig. 16-23.
2013 Pseudopolygnathus irregularis Tragelehn & 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 (Tragelehn & 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*  
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 *Ps. marburgensis* differs from *Pseudopolygnathus 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**  
Bishoff & Ziegler, 1956  
(Fig. 6.5)

1956 *Pseudopolygnathus micropunctata* - Bishoff & Ziegler, p. 163, pl. 11, figs 7-8, 10.
1998f *Pseudopolygnathus micropunctatus* Bishoff & Ziegler - Perri & Spalletta, p. 226, pl. 2.5.1, fig. 12.
2011 *Pseudopolygnathus micropunctatus* Bishoff & Ziegler - Hartenfels, p. 510, pl. 63, figs 1-6, 8-10.
2013 *Pseudopolygnathus micropunctatus* Bishoff & 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. Forty-one conodont taxa, between species and subspecies, belonging to six genera (*Ancyrodella, Bispidathus, Icriodus, Palmatelepis, Pseudopolygnathus, Polygnathus*) have been recognized.
3. Seven conodont biozones, one from the Frasnian (Upper rhenana) and six from the Famennian (Upper crepida, Uppermost crepida, Lower rhomboida, Upper rhomboida, Lower marginifera, Lower expansa) have been discriminated.

**Acknowledgements**

Angelo Mossoni gratefully acknowledges Sardinia Regional Government for the financial support of his PhD scholarship (P.O.R. Sardegna F.S.E. “Operational Programme of the Autonomous Region of Sardinia, European Social Fund 2007-2013” - Axis IV Human Resources, Objective L3, Line of Activity L3.1). Nicola Carta, Luca Simonetto and Maria Corriga helped in the field work.

We are deeply grateful to Claudia Spalletta for critical revision of the manuscript. This study was supported by R.A.S. (grants LR7/07 - 2010, Resp. C. Corradini). This paper is a contribution to IGCP Project n. 596 “Mid Palaeozoic climate and biodiversity”.

**References**

FAMENNIAN CONODONTS FROM THE PIIZUL WEST SECTION (CARNIC ALPS, ITALY)


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


ZIEGLER, W., & J.W. HUDDLE. 1969. Die Palmatolepis glabra-Gruppe (Conodonta) nach der Revision der Typen von


Authors’ addresses - Indirizzi degli Autori:
- Angelo MOSSONI
  Dipartimento di Scienze Chimiche e Geologiche
  Università degli Studi di Cagliari
  Via Trentino 51, I-09127 CAGLIAI
  e-mail: ang.mosson1@studenti.unic.it
- Carlo CORRADINI
  Dipartimento di Scienze Chimiche e Geologiche
  Università degli Studi di Cagliari
  Via Trentino 51, I-09127 CAGLIAI
  e-mail: corradin@unic.it
- Monica PONDRELLI
  International Research School of Planetary Sciences,
  Dipartimento di Ingegneria e Geologia, Università D’Annunzio
  Via Pindaro 42, I-65217 PESCARA
  e-mail: monica@irsps.unich.it