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WENLOCKIAN (SILURIAN) GRAPTOLITES FROM "LA VALUTE NORD" SECTION (MT. ZERMULA, CARNIC ALPS, NE ITALY)

GRAPTOLITI DEL WENLOCK (SILURIANO)
DALLA SEZIONE "LA VALUTE NORD"
(MONTE ZERMULA, ALPI CARNICHE, NE ITALIA)

Riassunto breve - Vengono descritti per la prima volta graptoliti siluriani provenienti dalla parte occidentale del massiccio del Monte Zermula (Alpi Carniche, Udine). La fauna è stata raccolta nella sezione de La Valute Nord (VALN) e comprende cinque specie; tra queste *Monograptus belophorus* e *Monoclimacis flumendosae* vengono descritti per la prima volta nelle Alpi Carniche. La fauna a graptoliti è riferibile alla Biozona a *belophorus* (Sheinwoodian, Wenlock).

Parole chiave: Graptoliti, Sistematica, Wenlock, Siluriano, Alpi Carniche.

Abstract - *Silurian graptolites from the western flank of Mt. Zermula massif (Carnic Alps, Udine) are here described for the first time. The fauna, collected from the La Valute Nord (VALN) section includes five species. Monograptus belophorus and Monoclimacis flumendosae are reported for the first time in the Carnic Alps. The graptolite fauna allows to date the section to the belophorus Zone (Sheinwoodian, Wenlock).*

Key words: Graptolites, Systematics, Wenlock, Silurian, Carnic Alps.

Introduction

The mountains north of Paularo, in the central part of the Carnic Alps, represent one of the better areas for researches on graptolites across the Italian-Austrian border: the first remains of graptolites from the Italian side of the Carnic Alps were collected from Rio dal Musch, in the Rio Cercevesa valley (TARAMELLI 1881), and other important localities are described close to Casera Meledis (VINASSA DE REGNY & GORTANI 1905; VINASSA DE REGNY 1906; GORTANI 1923c; PIRAS & SIMONETTO 2011). A few kilometers northward, some famous localities are exposed in the Austrian side of the chain, close to Gundesheimer Alm and Zollner Lake (JAEGER & SCHÖNLAUB 1977, 1980; STORCH & SCHÖNLAUB, 2012).

The occurrence of Silurian rocks in La Valute area, the northwestern flank of Mt. Zermula massif, a few kilometres south of the Meledis outcrops is known since long time (VINASSA DE REGNY & GORTANI 1905; GORTANI 1920; SELLI 1963; VENTURINI 1990; VENTURINI et al. 2002), but up to now the occurrence of graptolites have never been reported.

This paper is the first report on graptolites in La Valute area. More precisely a fauna of a few species of Wenlock age from the La Valute Nord section is described.

The La Valute Nord section

The La Valute Nord (VALN) section is located in the northern side of La Valute, the northwestern corner of Mt. Zermula massif. More precisely the section is measured at coordinates: base N 46°34'30", E 13°07'08" (figs 1, 2).

The La Valute Nord section consists of about 45 m of sediments belonging to the Nölbling Fm. (fig. 3). This unit is constituted by black shales with interbedded levels and lenses of limestone (JAEGER & SCHÖNLAUB 1977) and is relatively widespread only in the central part of the Carnic Alps (VENTURINI 2006). The lowermost part of the section is characterized by a relatively high limestone content in the first 2 m. Then, after a covered interval, probably represented by shales, 2 m of shales and limestones interbedded occur. The pelitic content increase in the central part of the section, where black shales are the only lithology present in an interval of almost 20 m. Limestone re-occur at m. 35 and became progressively more abundant in the upper part of the section.

Conodonts, ostracods, microbrachiopods, and rare nautiloid cephalopods and trilobites have been found in the limestones. Graptolites are the only fossils collected from the black shales.

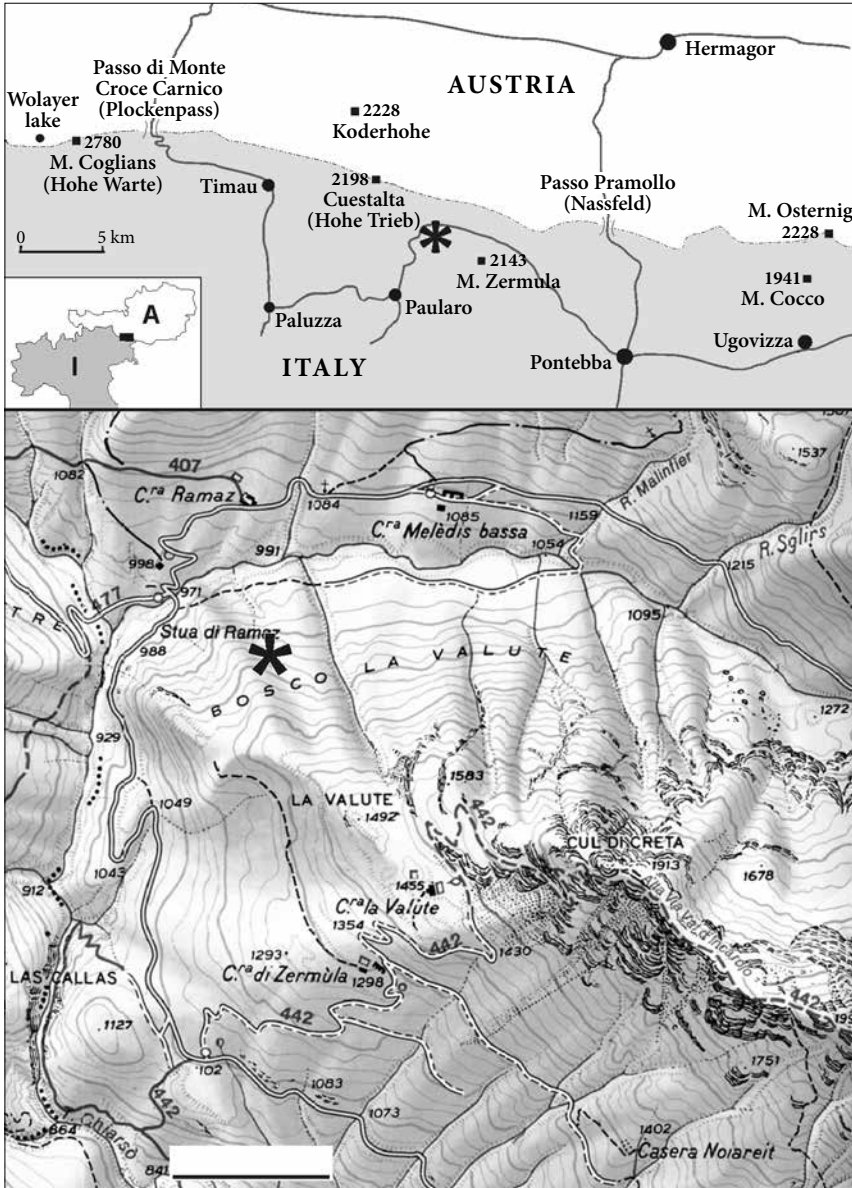


Fig. 1 - Location map of "La Valute Nord" section.
 - Ubicazione della sezione "La Valute Nord".



Fig. 2 - Outcrop of Silurian black shales in "La Valute Nord" section (white circle).
 - L'affioramento di scisti neri del Siluriano lungo la sezione "La Valute Nord" (cerchio bianco).

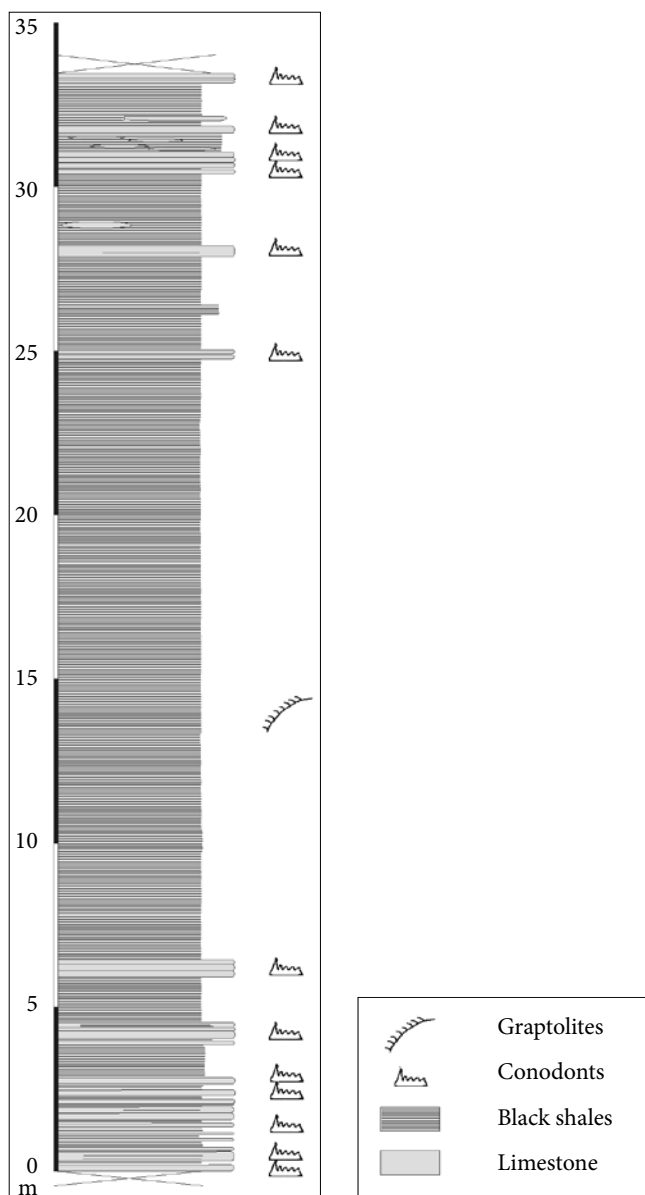


Fig. 3 - Stratigraphic log of "La Valute Nord" section, with the presence of graptolites and conodonts.
- Colonna stratigrafica della sezione "La Valute Nord", con la presenza di graptoliti e conodonti.

Conodont data

Sixteen conodont samples have been collected from the limestones along the section. In general the abundance is very scarce (less than 1 element/Kg), and some samples are barren. Only in sample VALN 15, at the top of the section the abundance is very high. The association includes ten taxa belonging to seven genera: *Belodella*, *Dapsilodus*, *Oulodus*, *Ozarkodina*, *Panderodus*, *Pseudooneotodus* and *Wurmiella*.

In general the section can be dated to the Wenlock (*rhenana* and *sagitta* Zone) on the basis of the occurrence of the markers *Ozarkodina sagitta rhenana* (sample VALN 1) and *Oz. s. sagitta* in several samples along the section.

Graptolite data

Graptolites have been collected from two narrow levels in the central part of the section (fig. 3), a few tens of centimeters far each other, between conodont samples VALN 8 and VALN 9. Preservation of graptolites is generally bad, being the rhabdosomes flattened and tectonically deformed; they are often observable only wet, under contrast of a thin layer of water.

More than seventy specimens are referred to five genera (*Cyrtograptus*, *Monoclimacis*, *Monograptus*, *Pristiograptus*, *Streptograptus*). Monograptidae are by long the most represented family, whilst only a few specimens belong to family Cyrtograptidae. *Monograptus belophorus* (MENEGHINI) and *Monoclimacis flumendosae* (GORTANI) are reported for the first time in the Carnic Alps.

The association allows to demonstrate the occurrence of the *belophorus* Zone for the first time in the black shales the Carnic Alps.

Systematic section

All graptolites have been collected from the central part of La Valute Nord (VALN) section, northwestern flank of Mt. Zermula massif, Paularo (Ud).

All the described specimens are stored in the Geo-Paleontological collection of the Museo Friulano di Storia Naturale of Udine, under catalog numbers MFSNgp 42420-42495.

Class Graptolithina BRONN, 1846
Order Graptoloidea LAPWORTH, 1875
Suborder Glossograptina JAANUSSON, 1960
Family Cyrtograptidae BOUCEK, 1933

Genus *Cyrtograptus* CARRUTHERS, 1867

Cyrtograptus sp.
(figs 5.2, 5.3)

Material: 1 rhabdosome in bad condition of preservation (MFSNgp 42423).

Description: slender and spiraled rhabdosome, with hooked techae. The rhabdosome diameter is about 25 mm, the width is about 3.5 mm. The sicula is not visible. The thecae are triangular, and the aperture have slender lappets. The thecal inclination to the rhabdosome axis is 25°, and the overlapping between thecae is 1/3 of their length. The 2TRD distally measured is about of 2.8 mm (measured in a fragment of the rhabdosome).

Discussion: the single specimen of *Cyrtograptus* from VALN section is very badly preserved and is not possible any attribution at specific level.

Suborder Monograptina LAPWORTH, 1880
Family Monograptidae LAPWORTH, 1873

Genus *Monoclimacis* FRECH, 1897

Monoclimacis flumendosae (GORTANI, 1923)
(fig. 4.3)

- 1923a *Monograptus linnarsoni* var. *flumendosae* GORTANI, p. 51, pl. 9 figs 1-6, pl. 12 figs 4A, 6C, pl. 13 fig. 4B.
- 1923b *Monograptus linnarsoni* var. *flumendosae* GORTANI, p. 91, 101, pl. 16 figs 1-3, pl. 17 figs 17-19, pl. 19 fig. 6A.
- 1968 *Monoclimacis flumendosae* (GORTANI) - COCKS & RICKARDS, pl. 10 figs e-f.
- 1975 *Monoclimacis flumendosae* (GORTANI) - BERRY & MURPHY, p. 68, pl. 4 figs 2-3, fig. 20b.
- 1995 *Monoclimacis flumendosae* (GORTANI) - RICKARDS et al., p. 45, figs 24N-Q, 25E-G.
- 2001 *Monoclimacis flumendosae* (GORTANI) - LENZ & KOZŁOWSKA-DAWIDZIUK, p. 10, pl. 2 figs 16, 19, 20.
- 2007 *Monoclimacis flumendosae* (GORTANI) - PIRAS, SIMONETTO & CORRADINI, p. 21, fig. 4d, pl. 1 figs 4b, 5.

Material: 7 rhabdosomes (MFSN_{gp} 42429; 42463; 42465; 42473a; 42473c; 42473d; 42476).

Description: slender and straight rhabdosome, slightly dorsally curved in the proximal part. The maximum length observed is 28 mm, the width of the rhabdosome is about 0.52 mm at the 1st theca, 0.6 at the 3rd theca, 0.88-1.1 mm in the distal part of the rhabdosome. The sicula is slender and straight 1.7-1.9 mm long, with a small aperture of about 0.24 mm; the apex achieve to the level of the first theca. The thecae are geniculated, with a tiny aperture; the thecal inclination to the axis of the rhabdosome is 25°, and the overlap between thecae is about 1/2 of their length. The 2TRD2 is about 1.8 mm, the 2TRD5 is about 2.5 mm, in the distal part of the rhabdosome is about 2.7 mm; the thecal count is 7-8 in 10 mm.

Discussion: the material from the Goni section (Sardinia, Italy) described by GORTANI (1923a, 1923b) and PIRAS et al. (2007), is similar to that collected in the VALN section. The specimens of *Monoclimacis flumendosae* figured by COCKS & RICKARDS (1968) and ZALASIEWICZ & WILLIAMS (1999) from United Kingdom, and those described by BERRY & MURPHY (1975) from Nevada (USA), and by RICKARDS et al. (1995) from Australia have similar shape and measure of our graptolites and are comparable with our samples. The three-dimensional samples described by LENZ & KOZŁOWSKA-DAWIDZIUK (2001) from Canada, are similar to our samples, but have a longer sicula.

Monoclimacis flumendosae is here reported for the first time from the Carnic Alps.

Genus *Monograptus* GEINITZ, 1852

Monograptus belophorus (MENEHINI, 1857)
(figs 5.1, 5.4a, 5.5a)

- 1857 *Graptolithus (Monograptus) belophorus* MENEHINI, p. 166, pl. B, fig. I, no 4b. fig. II nos 4, 4a.
- 1923a *Monograptus belophorus* (MENEHINI) - GORTANI, p. 57, pl. 10 figs 9-15, pl. 12 figs 3B, 14, pl. 13 fig. 1.
- 1923b *Monograptus belophorus* var. *laxus* (MENEHINI) - GORTANI, p. 94, pl. 16 figs 7, 8, pl. 18 fig. 12A, pl. 19 fig. 4.
- 1965 *Monograptus flexilis belophorus* (MENEHINI) - RICKARDS, p. 44, figs. 3f-g, pl. 29 figs 8, 9.

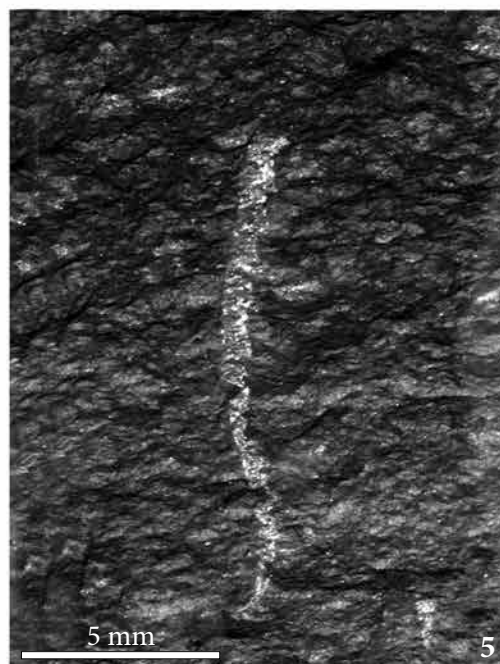
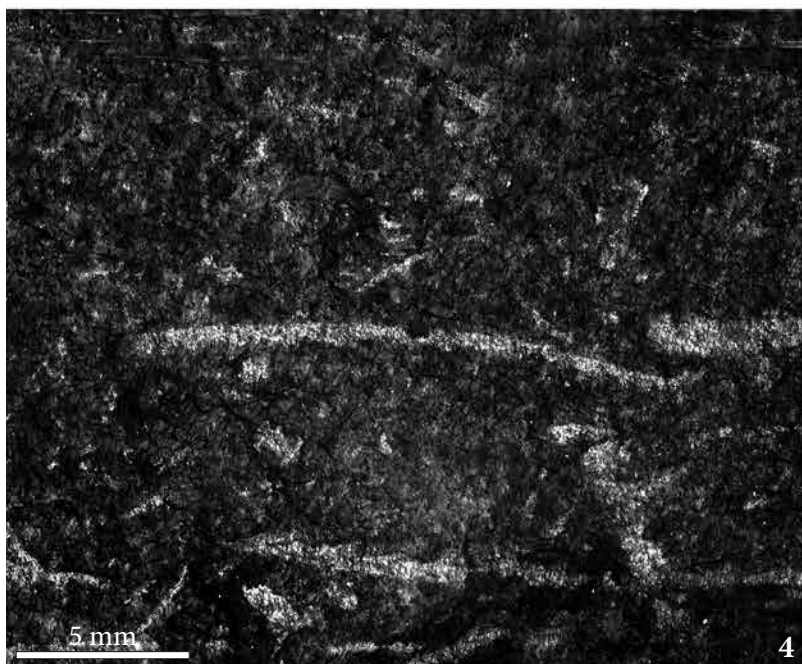
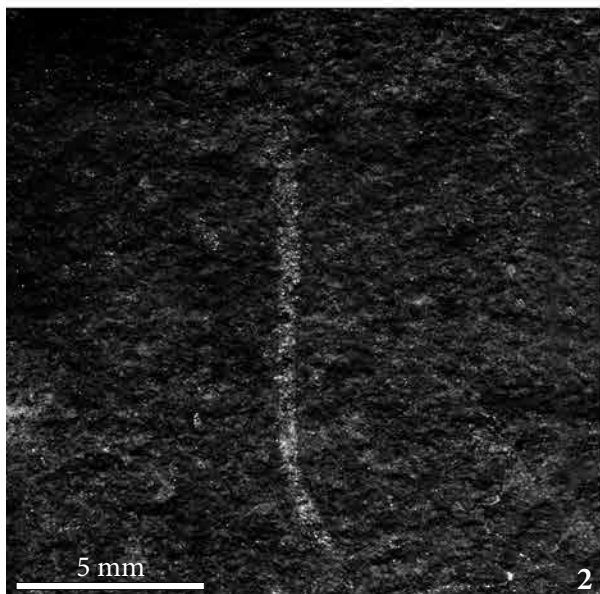
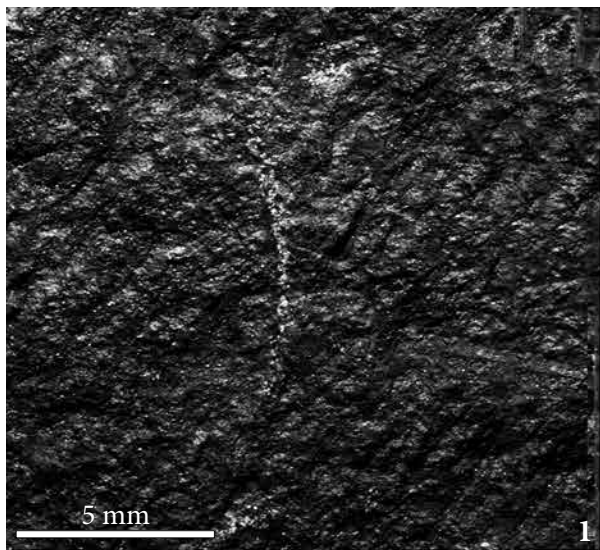
Material: 14 rhabdosomes (MFSN_{gp} 42421; 42437; 42439; 42443; 42456; 42460; 42464; 42467; 42468; 42469; 42483; 42487; 42488; 42494).

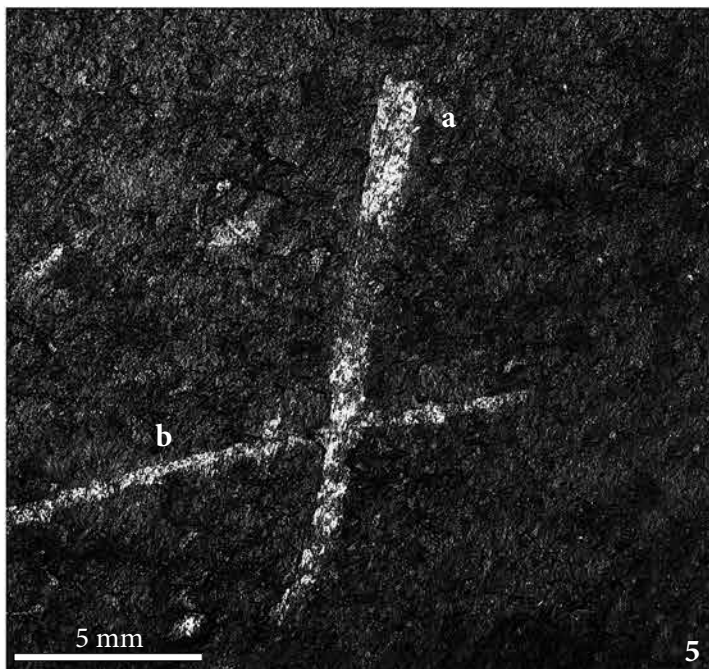
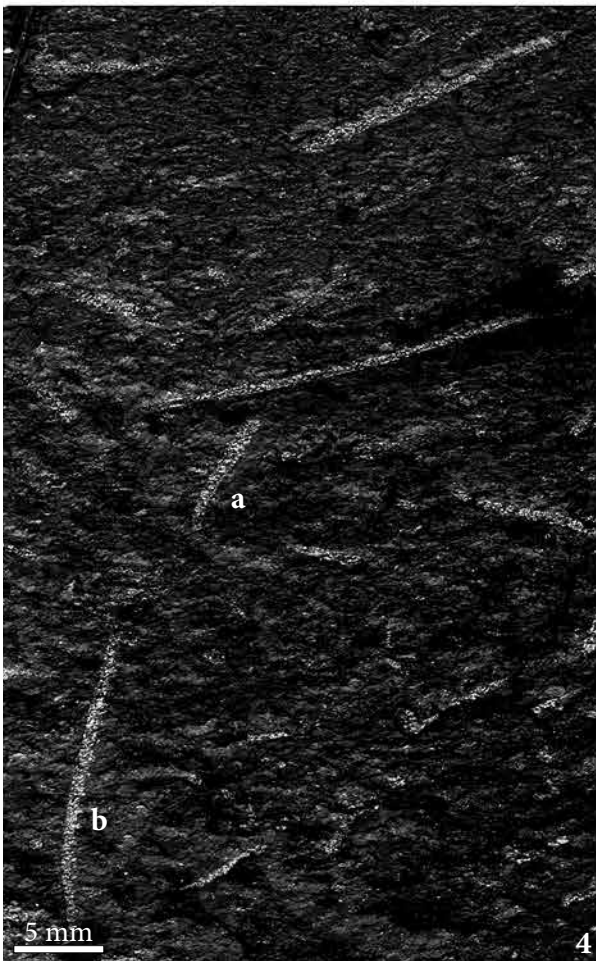
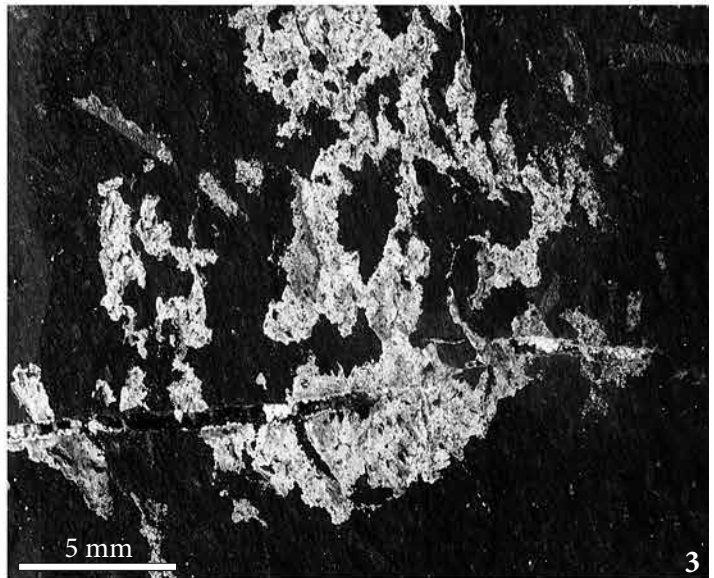
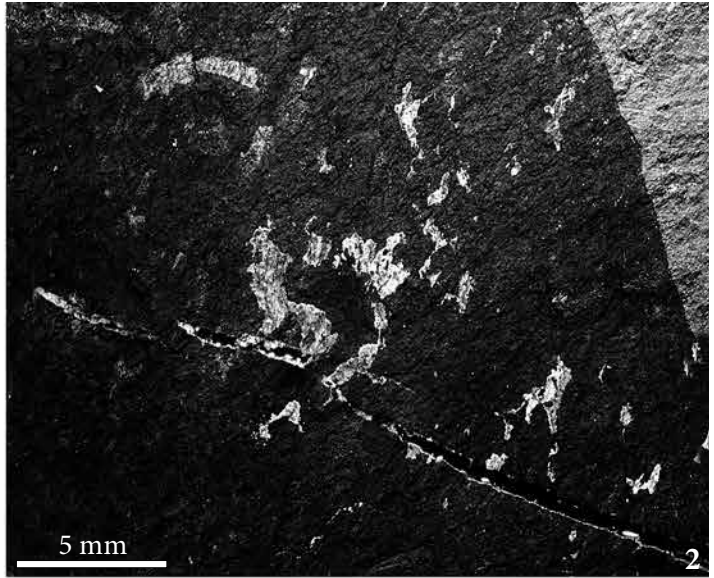
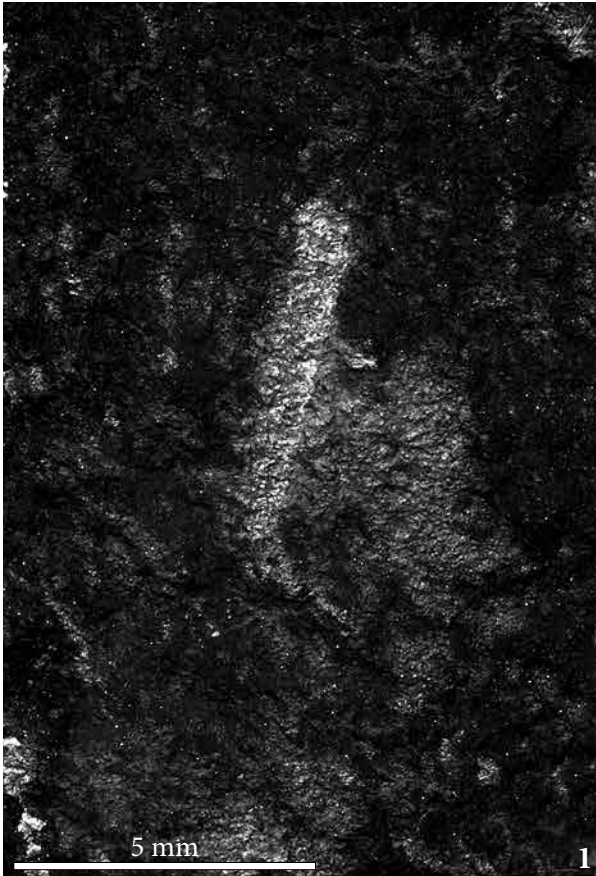
Description: robust rhabdosome, with a typical double S-shape curvature. The maximum length recorded in our specimens is 27 mm (in one incomplete graptolite); at the first theca the width is 0.5-0.7 mm, at the tenth theca 1-1.2 mm and the maximum width measured is 1.6 mm. The sicula is slender and curved with a long virgella, characteristic of this species; the length of the sicula is about 1.8 mm, the aperture measures about 0.4 mm, and the apex reach the level of the second theca. The thecae are hooked with the aperture bend downward; the thecal overlapping between thecae is about 3/4 of their length, and the thecae form an angle of 30° with the axis of the rhabdosome. The 2TRD2 is 1.2 mm, 2TRD in the distal part of the rhabdosome is 2-2.4 mm; the thecal count is 7-8 measured in the distal 10 millimeter of the rhabdosome.

Discussion: the specimens of *Monograptus belophorus* from La Valute are similar to these described

Fig. 4 - 1. *Streptograptus antennularius* (MENEHINI), MFSN_{gp} 42461b. 2. *Streptograptus antennularius* (MENEHINI), MFSN_{gp} 42422. 3. *Monoclimacis flumendosae* (GORTANI), MFSN_{gp} 42473a. 4. *Streptograptus antennularius* (MENEHINI), MFSN_{gp} 42476a. 5. *Streptograptus antennularius* (MENEHINI), MFSN_{gp} 42457b. All the photos are taken under a thin level of water to increase the contrast.

- 1. *Streptograptus antennularius* (MENEHINI), MFSN_{gp} 42461b. 2. *Streptograptus antennularius* (MENEHINI), MFSN_{gp} 42422. 3. *Monoclimacis flumendosae* (GORTANI), MFSN_{gp} 42473a. 4. *Streptograptus antennularius* (MENEHINI), MFSN_{gp} 42476a. 5. *Streptograptus antennularius* (MENEHINI), MFSN_{gp} 42457b. Tutte le foto sono riprese sotto un leggero velo d'acqua per incrementare il contrasto.





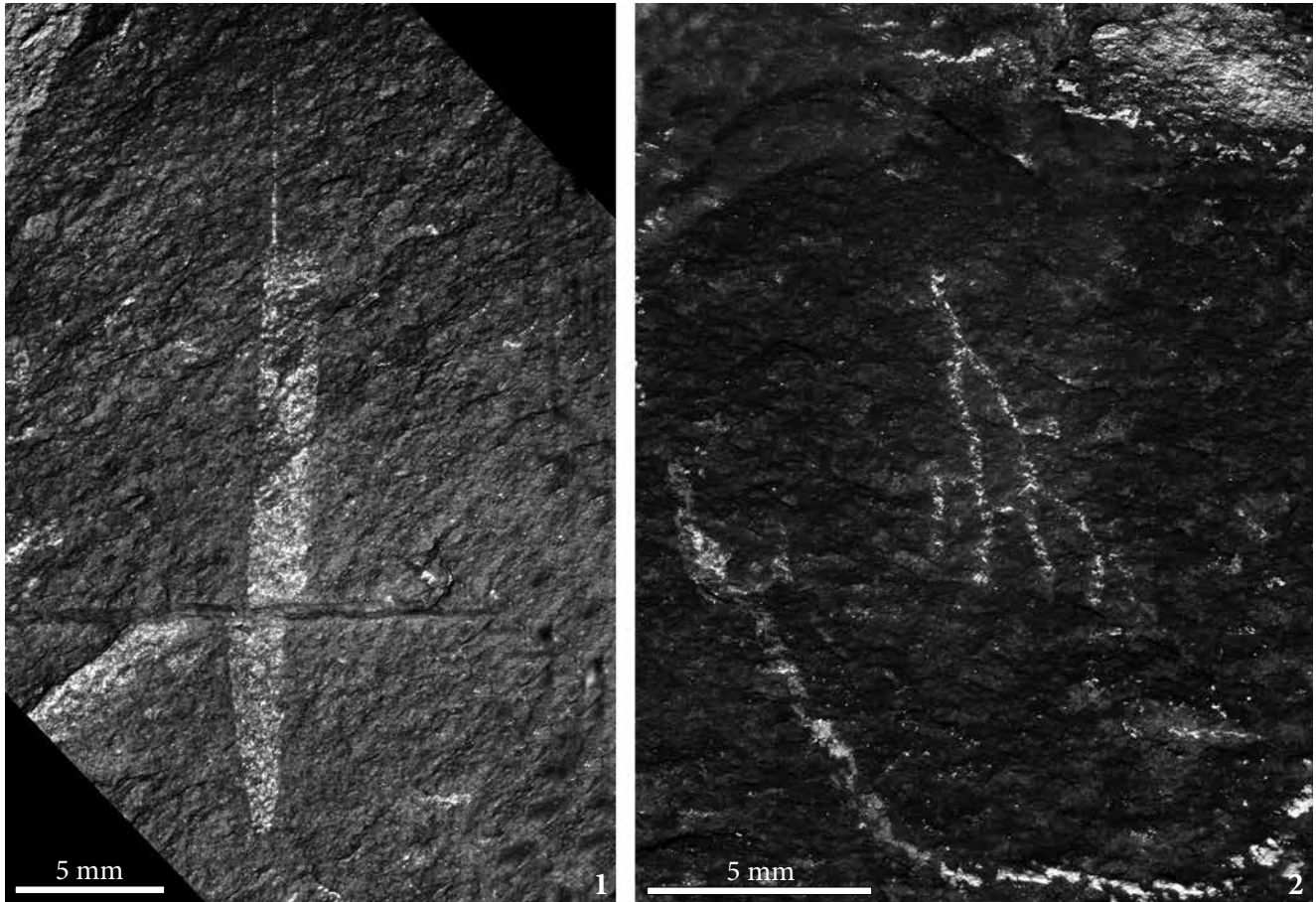


Fig. 6 - 1. *Pristiograptus* sp. MFSNgp 42420a. 2. Undetermined dendroid graptolite MFSNgp 42489. All the photos are taken under a thin level of water to increase the contrast.

- 1. *Pristiograptus* sp. MFSNgp 42420a. 2. *Graptolite dendroide non determinabile* MFSNgp 42489. Tutte le foto sono riprese sotto un leggero velo d'acqua per incrementare il contrasto.

by MENEGHINI (1857) and GORTANI (1923a, 1923b) from Sardinia, even if slightly smaller. Probably this could be because they represent incomplete specimens or juvenile forms. Also the specimens figured and described by RICKARDS (1965) from England, are very similar to that from Carnic Alps.

Monograptus belophorus, here documented for the first time in the Carnic Alps, is the marker of the *belophorus* Zone.

Genus *Pristiograptus* JAEKEL, 1889

Pristiograptus sp.
(fig. 6.1)

Material: 3 rhabdosomes (MFSNgp 42420; 42445; 42494).

Description: graptolite with a short and straight rhabdosome; the maximum length of this specimens is 20 mm. The width of the rhabdosome is 0.6-0.8 mm at the 1st theca, 1 mm at the 3rd, 1.6-1.9 mm in the distal part of the rhabdosome. The sicula is short, about 1.6 mm long, the aperture is 0.24 mm, the apex reaches the level of the first theca. The thecae are tubular, with a simple aperture. The overlapping between the thecae is about 1/2, and they form an angle of about 20° with the rhabdosome axis. The 2TRD at the 2nd theca is 1.2-1.3 mm, and it is about 2.24 mm in the distal part of the rhabdosome. In the distal part of the rhabdosome there are 10-12 thecae in 10 mm.

Fig. 5 - 1. *Monograptus belophorus* (MENEGHINI), MFSNgp 42483b. 2. *Cyrtograptus* sp., MFSNgp 42423b. 3. fragments of *Cyrtograptus* sp. MFSNgp 42423a. 4a. *Monograptus belophorus* (MENEGHINI), MFSNgp 42472. 4b. *Streptograptus antennularius* (MENEGHINI), MFSNgp 42472. 5a. *Monograptus belophorus* (MENEGHINI), MFSNgp 42494a. 5b. *Streptograptus antennularius* (MENEGHINI), MFSNgp 42494a. All the photos are taken under a thin level of water to increase the contrast.

- 1. *Monograptus belophorus* (MENEGHINI), MFSNgp 42483b; 2. *Cyrtograptus* sp., MFSNgp 42423b. 3. frammenti di *Cyrtograptus* sp. MFSNgp 42423a. 4a. *Monograptus belophorus* (MENEGHINI), MFSNgp 42472. 4b. *Streptograptus antennularius* (MENEGHINI), MFSNgp 42472. 5a. *Monograptus belophorus* (MENEGHINI), MFSNgp 42494a. 5b. *Streptograptus antennularius* (MENEGHINI), MFSNgp 42494a. Tutte le foto sono riprese sotto un leggero velo d'acqua per incrementare il contrasto.

Discussion: the specimens studied and measured shown similar characteristic with graptolites of the *Pristiograptus dubius* group, but the nature of this samples (slightly twisted or fragmentary) do not allow a precise systematic attribution of these specimens at specific level.

Genus *Streptograptus* YIN, 1937

Streptograptus antennularius (MENEHINI, 1857)
(figs 4.1, 4.2, 4.4, 4.5, 5.4b, 5.5b)

- 1857 *Graptolithus antennularius* MENEHINI, p. 76, pl. B figs 1, 1a, 1b.
1923a *Monograptus antennularius* (MENEHINI) - GORTANI, p. 58, pl. 10 figs 16-20, pl. 13 figs 2A-A'.
1978 *Monograptus antennularius* (MENEHINI) - JAEGER, p. 96, fig. 1f, pl. 1 fig. 2.
1980 *Monograptus antennularius* (MENEHINI) - JAEGER & SCHÖNLAUB, p. 424, pl. 2 figs 1, 2.
2001 *Monograptus? antennularius* (MENEHINI) - LENZ & KOZŁOWSKA-DAWIDZIUK, p. 9, pl. 2 figs 6-8, 10, 14.
2007 *Monograptus? antennularius* (MENEHINI) - PIRAS, SIMONETTO & CORRADINI, p. 18, figs 4f-g, pl. 1 fig. 4a.

Material: 29 rhabdosomes (MFSN_{gp} 42421; 42422; 42425; 42426; 42428; 42430; 42432; 42434; 42441; 42442; 42446; 42447; 42451; 42455; 42457; 42458; 42461; 42462; 42466; 42470; 42471; 42472; 42478; 42480; 42486; 42490; 42492; 42493; 42495).

Description: the rhabdosome is slender and gently curved, sometimes with a sigmoidal shape. The maximum length observed is about 24 mm, the width of the rhabdosome is 0.8-1 mm. The sicula is small and straight, about 1.2-1.4 mm long with a small aperture (about 0.24 mm); the apex reaches the level of the first theca. The thecae are lobate, not well visible, with the aperture turned downward. The thecal overlapping is about 1/6 of their length, and the thecae form an angle of 15°-20° with the axis of the rhabdosome; the 2TRD2 is 1.5 mm, 2TRD in the distal part of the rhabdosome is 2.4-2.8 mm; the thecal count is 4-5 measured in the distal five millimeter of the rhabdosome.

Discussion: the species was described as *Monograptus antennularius* by MENEHINI (1857) from the Goni section (Sardinia, Italy). Our specimens are very similar with those described from the type-locality by MENEHINI (1857) and GORTANI (1923a, 1923b), with the only difference in the size: specimens from VALN section are smaller, as they probably represents younger forms. The specimens in the Gortani collection from Goni, described by PIRAS et al. (2007) fits well with ours *Streptograptus antennularius*. The specimens

figured by TELLER (1972) from Poland are proximal parts of *Streptograptus antennularius* well comparable with the samples here described. The specimens described by LENZ & KOZŁOWSKA-DAWIDZIUK (2001) from Canada, are very similar with the specimens from VALN section, with the only difference that our are bidimensional.

In the Carnic Alps *Streptograptus antennularius* was documented by JAEGER & SCHÖNLAUB (1980) in the Oberbuchach 1 section. Specimens similar to those from the Carnic Alps were found in the Northern Grauwackenzone of the Eastern Alps (JAEGER, 1978).

Conclusions

The main results of this papers can be summarized as follows:

- a graptolite fauna is described for the first time from La Valute area;
- *Monoclimacis flumendosae* (GORTANI) and *Monograptus belophorus* (MENEHINI) and are reported for the first time in the Carnic Alps.
- the association allows to date the section to the *belophorus* Zone (Wenlock). The datum is consistent with the conodonts collected from several limestone beds of the La Valute Nord section.
- the *belophorus* Zone is documented for the first time in the black shales of the Carnic Alps. The occurrence of this biozone could be previously only inferred on the basis of findings of older and younger graptolite associations in a thick black shale sequence at Nölblinggraben (JAEGER & SCHÖNLAUB, 1977).

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