Bollettino della Società Paleontologica Italiana, 52 (2), 2013, 113-121. Modena

First finding of upper Silurian and Lower Devonian conodonts from the Peloritani Mountains (NE Sicily, southern Italy)

Rosario Rodríguez-Cañero, Pilar Navas-Parejo, Roberta Somma, Agustín Martín-Algarra & Vincenzo Perrone

R. Rodríguez-Cañero, Departamento de Estratigrafía y Paleontología, Universidad de Granada, Campus de Fuentenueva, E-18071 Granada, Spain; charorc@ugr.es

P. Navas-Parejo, Departamento de Estratigrafía y Paleontología, Universidad de Granada, Campus de Fuentenueva, E-18071 Granada, Spain; png@ugr.es

R. Somma, Dipartimento di Scienze dell'Ambiente, della Sicurezza, del Territorio, degli Alimenti e della Salute (S.A.S.T.A.S.), Università di Messina, Salita Sperone 31, Contrada Papardo, Sant'Agata di Messina, I-98166 Messina, Italy; rsomma@unime.it; corresponding author

A. Martín-Algarra, Departamento de Estratigrafía y Paleontología, Universidad de Granada, Campus de Fuentenueva, E-18071 Granada, Spain; agustin@ugr.es

V. Perrone, Dipartimento di Scienze della Terra, della Vita e dell'Ambiente, Campus Scientifico Località Crocicchia, I-61029 Urbino, Italy; vincenzo.perrone@uniurb.it

KEY WORDS - Conodonts, biostratigraphy, upper Silurian, Lower Devonian, Silurian/Devonian boundary, Peloritani Mountains, Sicily.

ABSTRACT - In the Peloritani Mountains (NE Sicily), the Favoscuro west section (near Pizzo Leo, between Floresta and Roccella Valdemone, Messina Province) cross-cuts the Variscan basement of the Longi-Taormina Unit. This section, in the less deformed part, shows a mildly metamorphosed continuous 50-m-thick Palaeozoic succession of metamarls and calc-schists with a bed of nodular metalimestones occurring at the base and of calc-schists at the top. The basal bed yielded a conodont fauna consisting of several fragments of Pa elements of Ancoradella *cf.* A. ploeckensis *Walliser, 1964 (Ludlow,* Ancoradella ploeckensis - Polygnathoides siluricus *zones). The topmost bed yielded one fragment of a Pa element of* Polygnatus *cf.* P. kitabicus *Yolkin, Weddige, Izokh & Erina, 1994 (early Emsian,* Polygnathus kitabicus - Polygnathus excavatus *zones). This conodont fauna, although not well preserved due to greenschist facies metamorphism and deformation, for the first time enables the recognition of upper Silurian and Lower Devonian rocks in the Peloritani Mountains. The Favoscuro west section studied herein is of important stratigraphic significance as it encompasses the Silurian/Devonian boundary.*

RIASSUNTO - [Primo ritrovamento di conodonti del Siluriano superiore e Devoniano Inferiore nei Monti Peloritani (Sicilia nord-orientale; Italia meridionale)] - *In Sicilia, i migliori affioramenti di terreni paleozoici si ritrovano nell'Unità di Longi-Taormina dei Monti Peloritani (Sicilia nord-orientale). La sezione Favoscuro ovest (nei pressi di Pizzo Leo, tra Floresta e Roccella Valdemone; provincia di Messina) attraversa il basamento varisico dell'Unità di Longi-Taormina. In particolare, in essa, nella parte meno deformata, è rappresentata una successione continua paleozoica, potente circa 50 m, formata da metamarne e calcescisti con un livello di metacalcari nodulari e uno di calcescisti, rispettivamente alla base e al tetto della sezione. Il livello basale ha fornito una fauna a conodonti formata da diversi frammenti di elementi Pa di* Ancoradella *cf.* A. ploeckensis *Walliser, 1964 (Ludlow, biozone* Ancoradella ploeckensis - Polygnathoides siluricus*). Il livello superiore ha fornito un elemento Pa di* Polygnatus *cf.* P. kitabicus *Yolkin, Weddige, Izokh & Erina, 1994 (Emsiano inferiore, biozone* Polygnathus kitabicus - Polygnathus excavatus*). La fauna a conodonti individuata, sebbene mal preservata a causa del metamorfismo in facies scisti verdi, consente di riconoscere per la prima volta la presenza del Siluriano superiore e del Devoniano Inferiore nei Monti Peloritani. In conclusione, la sezione Favoscuro ovest risulta molto importante da un punto di vista stratigrafico poiché comprende il limite Siluriano/Devoniano.*

INTRODUCTION

In the Peloritani Mountains (Calabria-Peloritani Arc; Fig. 1), the only Variscan basement preserving Palaeozoic remnants of original sedimentary-volcanic protoliths and fossils belongs to the Longi-Taormina Unit (Bonardi et al., 1976; Somma et al., 2005b, 2012; Somma, 2006). In this unit, the main Palaeozoic fossils thus far found are related to Cambrian-Ordovician acritarchs (Bouillin et al., 1987), Devonian dacryoconarids (Lardeux & Truillet, 1971), and Upper Devonian-Lower Carboniferous conodonts (Majesté-Menjoulas et al., 1986; Bouillin et al., 1987).

The aim of this paper is to illustrate the preliminary results of a biostratigraphic analysis on a conodont fauna found in some beds of nodular metalimestones and calc-schists of the Longi-Taormina Unit exposed west of Pizzo Leo (between Floresta and Roccella Valdemone, in the Messina Province, Fig. 1).

The recognized fauna differs from that previously reported by the French authors, indicating that older carbonate beds, presumably late Silurian and Early Devonian in age, are also present in this sector of the Calabria-Peloritani Arc.

GEOLOGICAL SETTING

The crystalline basements of the Peloritani Mountains (Amodio-Morelli et al., 1976; Bonardi et al., 1976; Messina et al., 2004; Somma et al., 2005a, b; Somma, 2006; Di Paolo et al., 2010; Aldega et al., 2011; De Capoa et al., 2013; Fig. 1) are formed by Palaeozoic (and older) protoliths metamorphosed during the Variscan event under thermo-baric conditions ranging from subgreenschist to granulite facies (Messina et al., 2004). Among the different Peloritani basements, the best-preserved Palaeozoic succession belongs to the Longi-

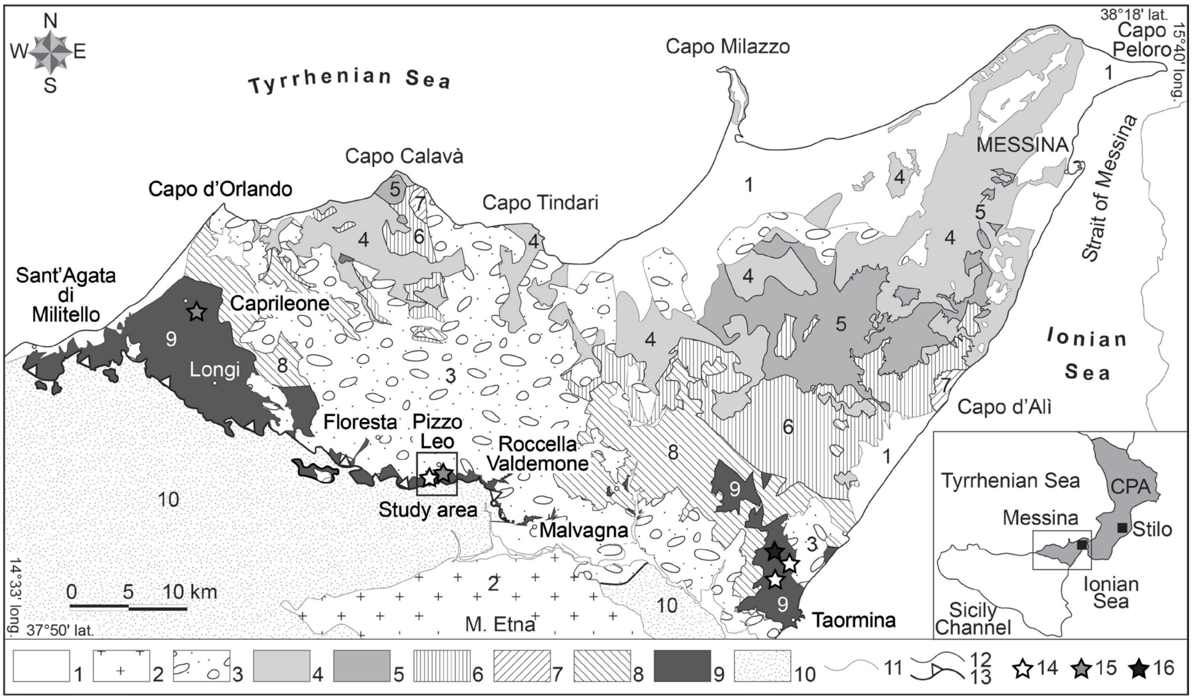


Fig. 1 - Geological sketch map of the Peloritani Mountains with the study area (Pizzo Leo) and main Palaeozoic fossiliferous sites (modified after Somma, 2006; Aldega et al., 2011; Somma et al., 2013). The Calabria-Peloritani Arc (CPA) is represented in the insert at bottom-right. Key: 1: Upper Miocene to Holocene covers. 2: Etna volcanics. 3: Calcareniti di Floresta (Serravallian-Langhian), "Antisicilide Variegated Clays" (Upper Cretaceous-Palaeogene), and Stilo-Capo d'Orlando Fm (Burdigalian). 4: Aspromonte Unit (Variscan medium-high grade metamorphics with Pre-Variscan granulitic relics, intruded by Late-Variscan plutonic rocks and with local medium- to low-grade Alpine metamorphic overprint). 5: Mela Unit (Variscan medium-grade metamorphics with Eo-Variscan eclogitic relics). 6: Mandanici-Piraino Unit (Variscan low- to medium-grade basement and Mesozoic cover affected by low-grade Alpine metamorphism). 7: Alì-Montagnareale Unit (Permian?-Mesozoic succession affected by Alpine very low-grade metamorphism). 8: Fondachelli Unit (Variscan low-grade basement and Mesozoic cover). 9: Longi-Taormina Unit (Variscan very low- to low-grade basement and Mesozoic-Cenozoic sedimentary cover). 10: Maghrebian Flysch Basin Units (Upper Jurassic-lower Miocene). 11: Stratigraphic contact. 12: Tectonic contact. 13: Peloritani basal thrust (Taormina Line; triangle on the hanging wall). 14: Conodonts (Majesté-Menjoulas et al., 1986). 15: Dacryoconarids (Pizzo Leo: Lardeux & Truillet, 1971; Caprileone: Acquafredda et al., 1991). 16: Acritarchs (Majesté-Menjoulas et al., 1986; Bouillin et al., 1987).

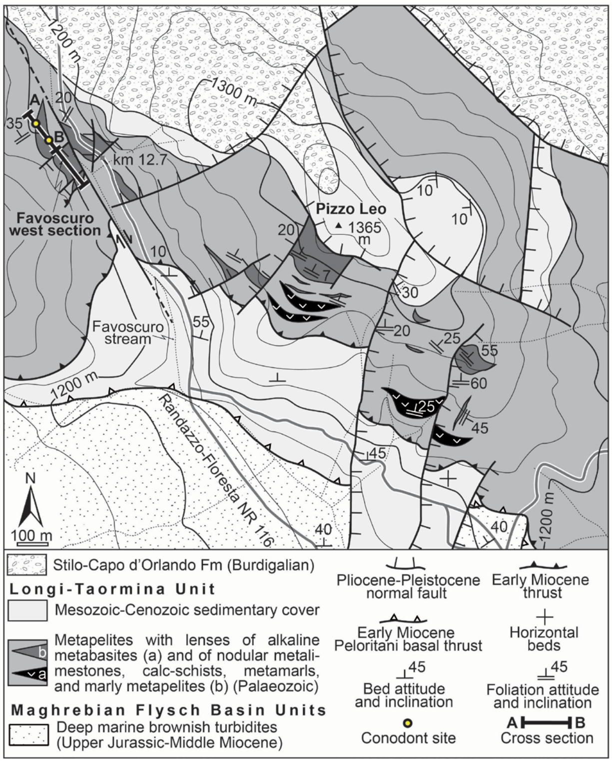


Fig. 2 - Geological sketch map of the Pizzo Leo area with location of the Favoscuro west section and the investigated conodont sites.

Taormina Unit (Bonardi et al., 1976), as mildly deformed and metamorphosed under subgreenschist to greenschist (chlorite zone) facies conditions (T ~ 350°C and P ≤ 0.2 GPa; Atzori et al., 1984). Notwithstanding Variscan metamorphism and deformation, responsible for two foliations crossing the original bedding at different angles (S_{v1} and S_{v2}; Somma, 2006), pre-Permian siliciclastics and minor carbonates crossed by volcanic rocks (Ferla & Azzaro, 1978; Cirrincione et al., 2005) are still clearly observable (Somma et al., 2012).

In the Longi-Taormina Unit, the main outcrops of Palaeozoic rocks are exposed in the eastern (Taormina area), central (Pizzo Leo area), and western (Caprileone area) sector of the Taormina Line (sensu Bonardi & Giunta, 1982; Fig. 1). Particularly, in the central sector of the Taormina Line (Pizzo Leo area), one of the best preserved Palaeozoic successions crops out. The geological survey made in this area (Fig. 2) indicates that the Variscan basement, up to 300 m thick, consists mainly of a Palaeozoic siliciclastic and carbonate monoclinal succession, primarily N-dipping. The lower part of the succession is formed by siliciclastic beds, composed

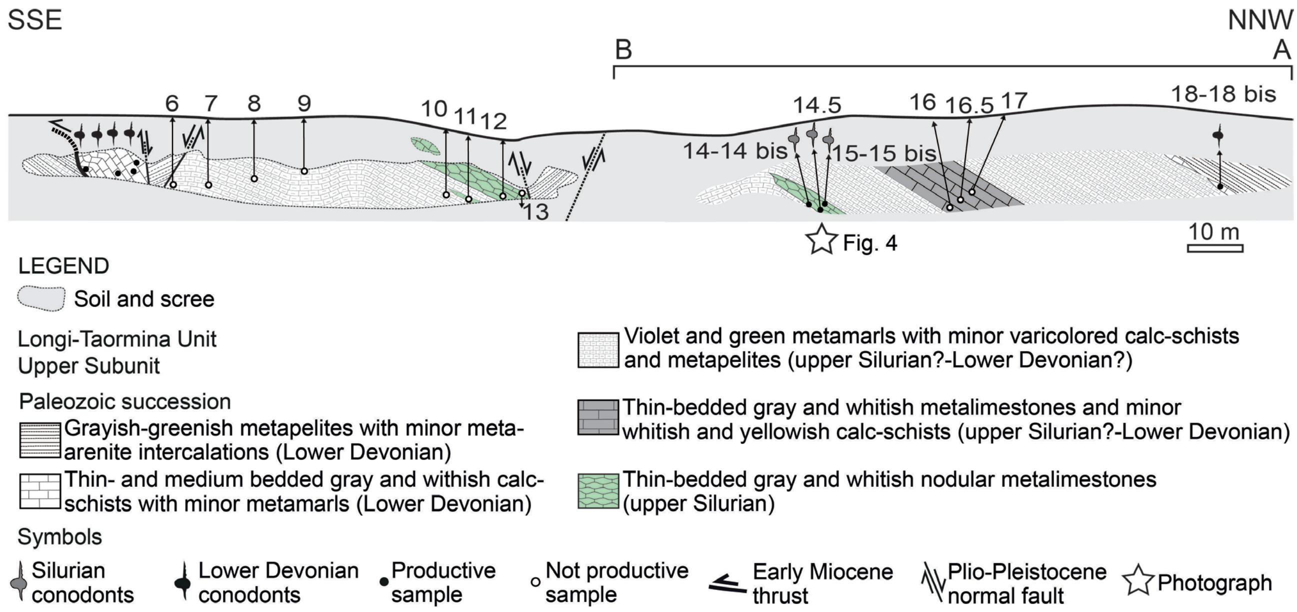


Fig. 3 - Favoscuro west section: section A-B (see location of the section in Fig. 2). The conodonts in the southernmost carbonate block are Emsian in age (Somma et al., 2012).

mainly of metapelites hosting several-metre-thick lenses of alkaline metavolcanic rocks (in the lower part) and decimetre-thick lenses of nodular metalimestones (at the top). The upper part of the succession is made up mainly of metacarbonates. These are represented, at the base, by thick-bedded metalimestones, laterally evolving to metamarls with lenses of nodular metalimestones, followed by medium-bedded metalimestones and calc-schists, with metapelite interbeds, at the top.

THE FAVOSCURO WEST SECTION: FIELD AND BIOSTRATIGRAPHIC DATA

West of Pizzo Leo, along a path on the western slope of the Favoscuro stream, the section designated Favoscuro west was measured and sampled for conodonts. Only the most continuous part of the section (A-B; Figs 2-3) was studied, avoiding the southern part, displaced by several Pliocene-Pleistocene normal faults and an early Miocene thrust (Fig. 3). The section A-B is precisely located at an elevation of about 1200 m at coordinates (WGS84): top (A) 37°57'23.37"N - 14°57'13.54"E, and base (B) 37°57'22.35"N - 14°57'14.68"E (Figs 2-3). This is formed mainly by a succession of violet and greenish metamarls (alternated with minor metapelites) showing a 10-metre-thick interbed of calc-schists. A lens of nodular metalimestones (Fig. 4) and thin beds of calc-schists appear at the base and top of the section, respectively. The overall thickness of the section A-B does not exceed 50 m.

MATERIAL AND METHODS

Ten samples (MAJ-14, MAJ-14bis, MAJ-14.5, MAJ-15, MAJ-15bis, MAJ-16, MAJ-16.5, MAJ-17, MAJ-18, and MAJ-18bis) were collected from the interbeds of limestone in the section A-B (Fig. 3). Also, eight samples (MAJ-6, MAJ-7, MAJ-8, MAJ-9, MAJ-10, MAJ-11, MAJ-12, and MAJ-13) were collected from the metamarls and interbeds of limestone in the intermediate part of the Favoscuro west section (Fig. 3). In total, more than 90 kg of limestone were processed for conodont studies using standard dissolution (Jeppsson et al., 1999) and concentration (Anderson et al., 1995) methods. Only six of these samples were productive and 16 poorly preserved fragments of conodont elements were found in the nodular metalimestones and calc-schists, respectively, at the base and at the top of section A-B. Due to the Variscan metamorphism and deformation, the conodont elements found are broken and deformed, and their original texture is altered. Consequently, the studied conodont elements present tiny parallel fractures filled by recrystallized minerals, and their Colour Alteration Index (CAI) is around 6-6.5 (sensu Rejebian et al., 1987).

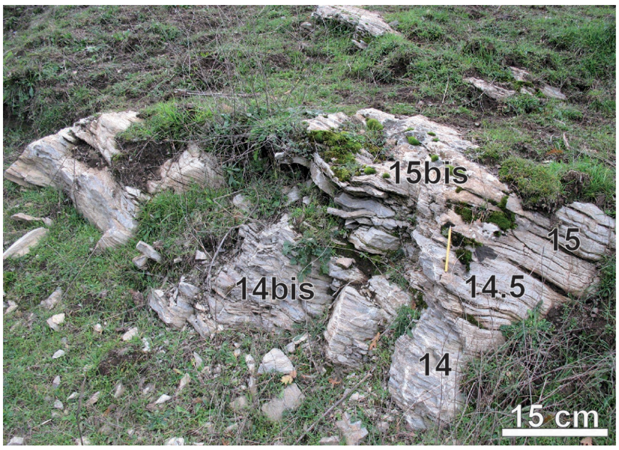


Fig. 4 - Basal whitish nodular metalimestones with location of conodont samples.

SYSTEMATIC PALAEONTOLOGY

The suprageneric classification proposed by Sweet (1988) was followed. Specimens are housed in the Departamento de Estratigrafía y Paleontología of the University of Granada (Spain). Catalogue numbers of figured specimens are given in the explanation of Plate 1.

Phylum Chordata Bateson, 1886
Class Conodonti Branson, 1938
Order Ozarkodinida Dzik, 1976
Family Kockelellidae Klapper, 1981

Genus *Ancoradella* Walliser, 1964

Type species - *Ancoradella ploeckensis* Walliser, 1964

Ancoradella cf. *A. ploeckensis* Walliser, 1964
(Pl. 1, figs 1-5)

cf. 1964 *Ancoradella ploeckensis* n. gen., n. sp. - Walliser, pp. 28-29, pl. 7, fig. 10; pl. 16, figs 16-21.
cf. 1995 *Ancoradella ploeckensis* Walliser - Simpson & Talent, pp. 131-135, pl. 5, figs 1-10.
cf. 1997 *Ancoradella ploeckensis* Walliser - Männik & Malkowski, p. 146, pl. 2, fig. 14.
cf. 2001 *Ancoradella ploeckensis* Walliser - Corradini et al., p. 319, pl. 1, fig. 21.
cf. 2001 *Ancoradella ploeckensis* Walliser - Johnson et al., p. 958, fig. 5.

Remarks - All the elements found are poorly preserved, all being fragmented and even fractured. Nevertheless, these fragments are not excavated in lower view, they possess shallow and narrow basal cavities surrounded by a broad zone of recessive basal margin (MAJ-14-3, MAJ-14 bis-15, and MAJ-15bis-3), wide stellate platform (MAJ-14-3 and MAJ-15bis-3) and rows of low wide denticles on the processes (MAJ-14-3, MAJ-14 bis-15, MAJ-15bis-3, and MAJ-14-1). Such features fit well with those of the stelliplanate Pa element of *Ancoradella ploeckensis* Walliser, 1964.

Walliser (1964) established this species taking into account only the Pa element, and until now no reliable reconstruction of the apparatus of *Ancoradella ploeckensis* has been published. Only one M element has been proposed by Uyeno (1981) and Fordham (1991); one Sc? element has been suggested by Simpson & Talent (1995); and one Sc, one Sa, and one Pb are included by Männik & Malkowski (1997, pl. 2). The fauna here described offers no contribution to this subject. However, further study would be helpful if a larger amount of each sample will be processed in order to investigate this species, which is not very common in general, but appears to be relatively abundant in this section.

EXPLANATION OF PLATE 1

Upper Silurian and Lower Devonian conodonts from Pizzo Leo.

Figs 1-5 - *Ancoradella* cf. *A. ploeckensis* Walliser, 1964.
- 1a - MAJ-14-3; upper/oral view of Pa element (fragment); sample MAJ-14.
- 1b - MAJ-14-3; lower/aboral view of Pa element (fragment); sample MAJ-14.
- 2a - MAJ-15bis-3; lower/aboral view of Pa element (fragment); sample MAJ-15bis.
- 2b - MAJ-15bis-3; upper/oral view of Pa element (fragment); sample MAJ-15bis.
- 3a - MAJ-14-1; lateral view of Pa element (fragment); sample MAJ-14.
- 3b - MAJ-14-1; upper/oral view of Pa element (fragment); sample MAJ-14.
- 3c - MAJ-14-1; lower/aboral view of Pa element (fragment); sample MAJ-14.
- 4a - MAJ-14bis-15; lower/aboral view of Pa element (fragment); sample MAJ-14bis.
- 4b - MAJ-14bis-15; upper/oral view of Pa element (fragment); sample MAJ-14bis.
- 5a - MAJ-14-2; lateral view of Pa element (fragment); sample MAJ-14.
- 5b - MAJ-14-2; upper/oral view of Pa element (fragment); sample MAJ-14.

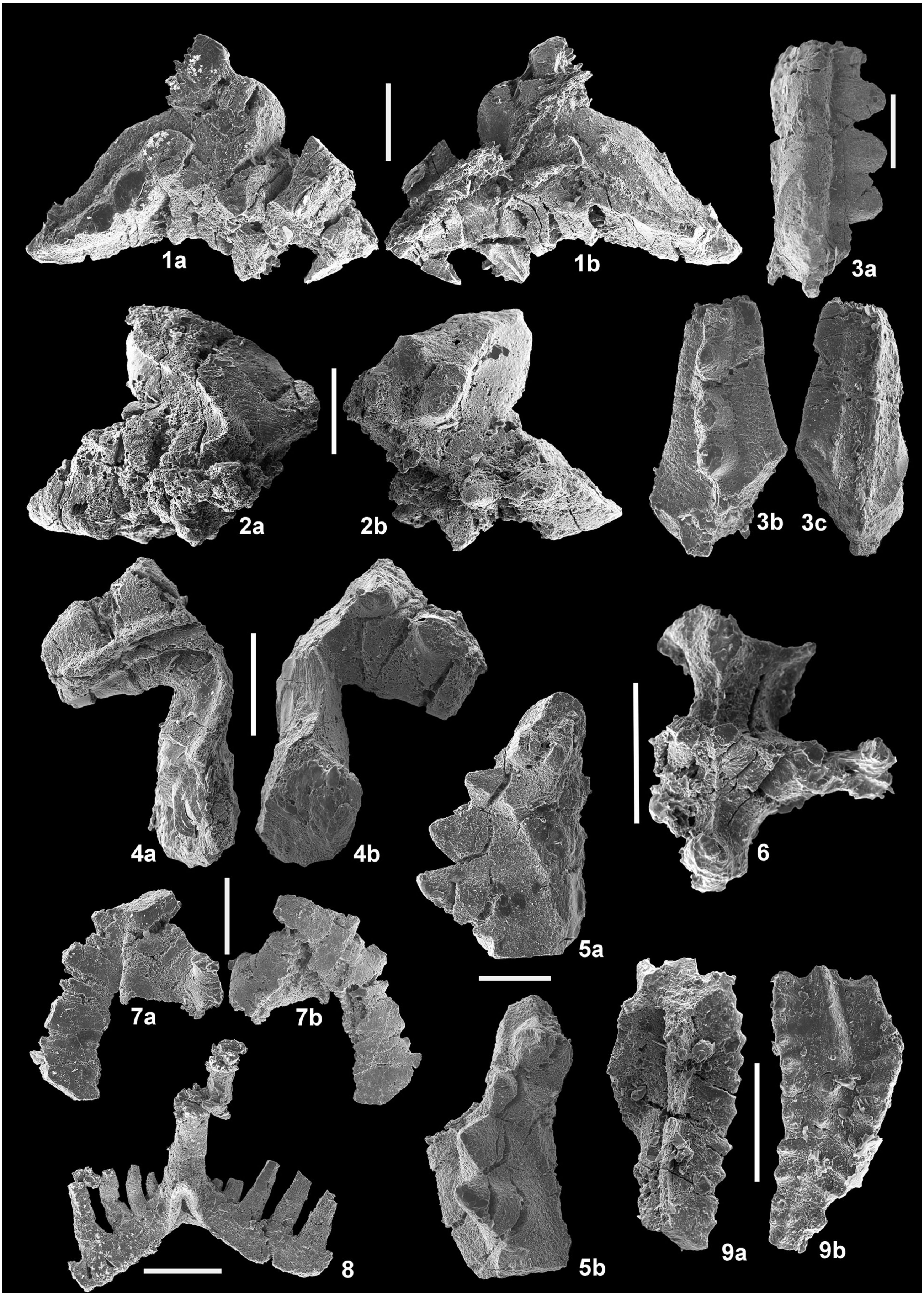
Fig. 6 - *Kockelella* cf. *K. variabilis* Walliser, 1957. MAJ-14.5-1; upper view of Pa element (fragment); sample MAJ-14.5.

Fig. 7 - Gen. et sp. indet. A.
- 7a - MAJ-15-3; anterior/rostral view of Sb element; sample MAJ-15.
- 7b - MAJ-15-3; posterior/caudal view of Sb element; sample MAJ-15.

Fig. 8 - Gen. et sp. indet. B. MAJ-15-1; posterior/caudal view of Sa element; sample MAJ-15.

Fig. 9 - *Polygnathus* cf. *P. kitabicus* Yolkin, Weddige, Izokh & Erina, 1994.
- 9a - MAJ-18bis; lower/aboral view of Pa element (fragment); sample MAJ-18bis.
- 9b - MAJ-18bis; upper/oral view of Pa element (fragment); sample MAJ-18bis.

Scale bars = 200 µm.


1a
1b
3a
2a
2b
3b
3c
4a
4b
6
5a
7a
7b
8
5b
9a
9b

Stratigraphic distribution - *Ancoradella ploeckensis* - *Polygnathoides siluricus* zones (late Gorstian-early Ludfordian; Walliser, 1964; Corradini & Serpagli, 1999).

Studied material - Twelve fragments of Pa elements from samples MAJ-14, MAJ-14bis, and MAJ-15bis.

Genus *Kockelella* Walliser, 1957

Type species - *Kockelella variabilis* Walliser, 1957

Kockelella cf. *K. variabilis* Walliser, 1957
(Pl. 1, fig. 6)

cf. 1957 *Kockelella variabilis* n. sp. - Walliser, pp. 35-36, Pl. 1, figs 3-10.
cf. 1999 *Kockelella variabilis variabilis* Walliser - Corradini & Serpagli, p. 288, Pl. 5, figs 1-13; Pl. 6, figs 1-9; Pl. 7, figs 1-7.
cf. 2001 *Kockelella variabilis variabilis* Walliser - Corradini et al., Pl. 1, fig. 15.

Remarks - The fragment found is small and fragile, breaking when we tried to turn it over. One of the most characteristic features of this fragment is a lateral outer (rostral) process bifurcated, with a round denticle on one branch and a small ridge on the other one. The inner (caudal) lateral process is not bifurcated and bears another round denticle. A narrow ridge connects the denticles of the two lateral processes through the carina. The expansions of basal cavity appear under the branched process. These features are very similar to some specimens of the *Kockelella variabilis* group.

Stratigraphic distribution - *K. variabilis* is Ludlow in age. The global range was assumed to be from the *Kockelella crassa* Zone up to the top of the *Ancoradella ploeckensis* Zone (Corradini & Serpagli, 1999), but in Bohemia it ranges high into the *Polygnathoides siluricus* Zone (Chlupáč et al., 1980; Slavík et al., 2010).

Studied material - 1 fragment of Pa element from sample MAJ-14.5.

Family Polygnathidae Bassler, 1925

Genus *Polygnathus* Hinde, 1879

Type species - *Polygnathus dubius* Miller, 1889

Polygnathus cf. *P. kitabicus* Yolkin, Weddige, Izokh & Erina, 1994
(Pl. 1, fig. 9)

1994 *Polygnathus kitabicus* n. sp. - Yolkin, Weddige, Izokh & Erina, pp. 149-150, Pl. 1, figs 1-4.
2012 *Polygnathus kitabicus* Yolkin et al., 1994 - Martínez Pérez, p. 86, Pl. 9, figs 1-12.

Remarks - The single Pa element found is broken, but it has a large and deep basal cavity reaching the posterior end totally open and without any inversion; the upper platform is flat in its posterior part and its adcarinal grooves are faintly developed. These features were established by Yolkin et al. (1994) as characteristic of *Polygnathus kitabicus*.

Stratigraphic distribution - *P. kitabicus* ranges from the base of the *Polygnathus kitabicus* Zone into the *Polygnathus excavatus* Zone (Yolkin et al., 1994). These zones are early Emsian (Early Devonian) in age.

Studied material - 1 fragmentary Pa element from sample MAJ-18bis.

Unassigned elements
(Pl. 1, figs 7-8)

Two ramiform elements were found in sample MAJ-15: one Sa element (MAJ-15-1) and one Sb element (MAJ-15-3). These elements may be included in apparatuses of several genera, among others *Oulodus* or *Kockelella*, and were therefore left in open nomenclature.

DISCUSSION AND CONCLUSIONS

The Favoscuro west section (Figs 2-3) yielded conodont faunas, notwithstanding the occurrence of the Variscan metamorphism under subgreenschist to greenschist facies (Atzori et al., 1984; Somma et al., 2005b). The lens of nodular metalimestones at the base of the section (samples MAJ-14, MAJ-14bis, MAJ-14.5, MAJ-15, and MAJ-15bis; Figs 3, 5a) has released several fragments attributed to Pa elements of *Ancoradella* cf. *A. ploeckensis* Walliser, 1964 (Pl. 1 and Fig. 5a), one fragment of Pa element attributed to *Kockelella* cf. *K. variabilis* Walliser, 1957 and two unassigned ramiform elements (Pl. 1). The presence of *Ancoradella* cf. *A. ploeckensis* suggests an attribution to the *Ancoradella ploeckensis* - *Polygnathoides siluricus* zones (Ludlow, late Silurian) (Walliser, 1964; Corradini & Serpagli, 1999). The topmost bed of calc-schists (sample MAJ-18bis, Figs 3, 5a) yielded a fragment of a Pa element of *Polygnathus* cf. *P. kitabicus* Yolkin et al., 1994 (Pl. 1 and Fig. 5a). This species ranges from the base of the *Polygnathus kitabicus* Zone into the *Polygnathus excavatus* Zone (early Emsian) (Yolkin et al., 1994). These fossil findings are relevant because they allow the first dating of possible upper Silurian and Lower Devonian rocks in Sicily.

The study section (Figs 3, 5a) apparently corresponds to that previously studied by Majesté-Menjoulas et al. (1986) (Fig. 5b), who found a bed of dacryoconarid-bearing grey limestones overlain by an almost 20-m-thick succession of violet metamarls and metapelites containing lenses of nodular limestones and calc-schists with conodonts. However, in the lower lens of grey nodular calc-schists (1 m thick), these authors found badly preserved fragments of conodonts ascribed to *Pseudopolygnathus* sp., *Bispathodus stabilis* (Branson & Mehl, 1933), and to *Bispathodus* sp., and assigned this lens to the upper Famennian (Fig. 5b). Finally, in the upper lens of calc-schists (5 m thick), these authors found undetermined

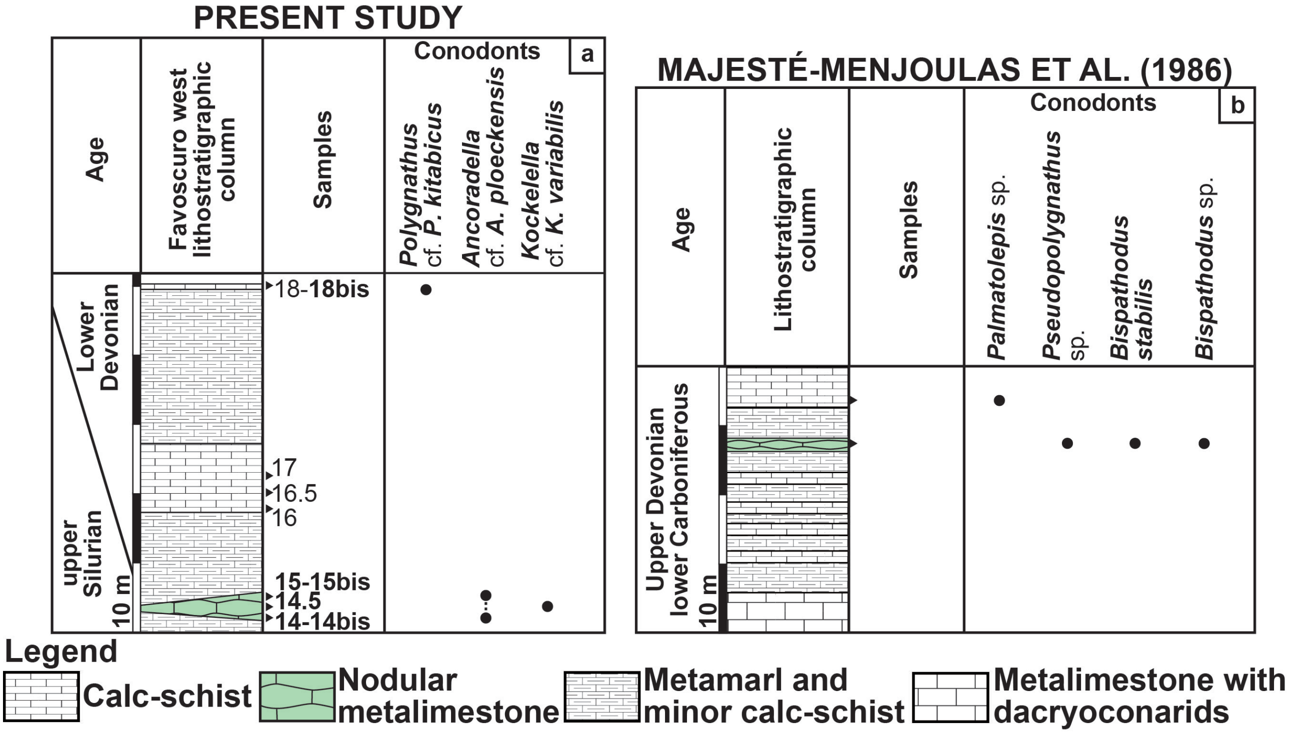


Fig. 5 - a) Stratigraphic column of the Favoscuro west section (Section A-B) showing occurrence of upper Silurian (Ludlow) and Lower Devonian (Emsian) conodonts. b) Stratigraphic column of the Favoscuro section and occurrence of conodonts by Majesté-Menjoulas et al. (1986). Productive samples are indicated in bold font.

fragments of conodonts which they attributed to *Palmatolepis* sp., and they assigned this lens to the upper Famennian-lower Carboniferous (Fig. 5b).

The pioneering research of Lardeux & Truillet (1971) reported badly preserved dacryoconarids in a bed of metamorphosed marly limestones exposed in the surrounding area along the eastern side of the Favoscuro stream (running close to the km 12 of the Randazzo-Floresta national road (N.R. 116). These authors also acknowledged their inability to determine the dacryoconarids because of the metamorphic recrystallization, proposing that most of the dacryoconarids could represent Styliolinidae (Pragian-Famennian) and that some rare specimens could, with caution, be attributed to *Viriatellina* sp. (Pragian to Givetian). Fortunately, in the same bed of metamorphosed marly limestones bearing dacryoconarids, we found Emsian conodonts (Somma et al., 2012) that could narrow the wide time lapse proposed by Lardeux & Truillet (1971). Finally, the occurrence of a Lochkovian conodont fauna in another section studied at the top of Pizzo Leo (Somma et al., 2012) suggests that the Favoscuro west section has important stratigraphic significance for the Sicilian Silurian-Devonian stratigraphy, as the investigated interval of metamarls and calc-schists between the Ludlow nodular metalimestones and the lower Emsian calc-schists encompasses the Silurian-Devonian boundary (Figs 3, 5a). Up to now, it has been impossible to locate the S/D boundary with precision in the study section, owing to the scarcity of conodont fauna and to the occurrence of deformation and metamorphism, so that further studies are needed for a more accurate location of the S/D boundary.

In conclusion, these new data confirm that, as in other areas of the Variscan Chain (the Calabrian sector of the Calabria-Peloritani Arc: Gelmini et al., 1978; Navas-Parejo et al., 2009a, b; Betic Cordillera: Rodríguez-Cañero et al., 1997; Pyrenees: Sanz-López, 2004; Carnic Alps: Histon & Schönlaub, 1999; Schönlaub & Histon, 2000; Corradini & Corriga, 2010; Corriga, 2010), and in Sardinia (Ferretti & Serpagli, 1996; Ferretti et al., 1998; Corradini & Serpagli, 1999; Corriga et al., 2009), Silurian and/or Lower Devonian conodont-bearing carbonates are present also in the Peloritani Mountains.

ACKNOWLEDGEMENTS

Financial support was provided by the MCI-DGICYT Project, CGL2012-32169, the RNM-208, and RNM-3715 research groups (Junta de Andalucía), and the Università di Messina research project (2008-2009). We greatly appreciate the reviewers Graciela Sarmiento, Peep Männik, Carlo Corradini and the Editor-in-Chief Annalisa Ferretti for their constructive reviews and suggestions thanks to which the manuscript has been strongly improved. We also thank the student Laura Russo for dissolving some samples.

REFERENCES

Acquafredda P., Lorenzoni S. & Zanettin-Lorenzoni E. (1991). The Devonian and Carboniferous volcanism of the Peloritan Mountains (Sicily) and the evolution of Paleozoic basins in the Calabrian Peloritan Arc. *Geological Journal*, 26: 145-156.

Aldega L., Corrado S., Di Paolo L., Somma R., Maniscalco R. & Balestrieri M.L. (2011). Shallow burial and exhumation of the Peloritani Mts. (NE Sicily, Italy): insight from paleo-thermal and structural indicators. *Geological Society of America Bulletin*, 123: 132-149.

Amodio-Morelli L., Bonardi G., Colonna V., Dietrich D., Giunta G., Ippolito F., Liguori V., Lorenzoni S., Paglionico A., Perrone V., Piccarreta G., Russo M., Scandone P., Zanetti-Lorenzoni E. & Zuppetta A. (1976). L'Arco Calabro-Peloritano nell'orogene appenninico-maghrebide. *Memorie della Società Geologica Italiana*, 17: 1-60.

Anderson M.A., Dargan G., Brock G.A., Talent J.A. & Mawson R. (1995). Maximising efficiency of conodont separations using sodium polytungstate solution. *Courier Forschungsinstitut Senckenberg*, 182: 515-521.

Atzori P., Ferla P., Paglionico A., Piccarreta G. & Rottura A. (1984). Remnants of the Hercynian orogen along the "Calabrian-Peloritan arc", southern Italy: a review. *Journal of the Geological Society*, 141: 137-145.

Bassler R.S. (1925). Classification and stratigraphic use of the conodonts. *Geological Society of America Bulletin*, 36: 218-220.

Bateson W. (1886). Anchestry of the Chordata. *Quarterly Journal of Microscopical Sciences*, 26: 535-571.

Bonardi G. & Giunta G. (1982). L'estremità nord-orientale della Sicilia nel quadro dell'evoluzione dell'Arco Calabro. *In* Catalano R. & D'Argenio B. (eds), Guida alla geologia della Sicilia Occidentale: 85-92. Società Geologica Italiana, Roma.

Bonardi G., Giunta G., Liguori V., Perrone V., Russo M. & Zuppetta A. (1976). Schema geologico dei Monti Peloritani. *Bollettino della Società Geologica Italiana*, 95: 1-26.

Bouillin J.P., Majesté-Mejoulas C., Baudelot S., Cygan C. & Fournier-Vinas C.H. (1987). Les formations paleozoiques de l'Arc Calabro-Peloritain dans leur cadre structural. *Bollettino della Società Geologica Italiana*, 106: 683-698.

Branson E.B. (1938). Stratigraphy and paleontology of the Lower Mississipian of Missouri. *University of Missouri Studies*, 13: 1-208.

Branson E.B. & Mehl M.G. (1933). Conodonts studies number three: Conodonts from the Grassy Creek Shale of Missouri. *University of Missouri Studies*, 8: 172-259.

Chlupáč I., Kříž J. & Schönlaub H.P. (1980). Field Trip E. Silurian and Devonian conodonts of the Barrandian. *In* Schönlaub H.P. (ed.), Second European Conodont Symposium ECOS II. Guidebook - Abstracts. *Abhandlungen der Geologischen Bundesanstalt*, 35: 147-180.

Cirrincione R., Fiannacca P., Lo Giudice A. & Pezzino A. (2005). Evidence of Early Paleozoic rifting from mafic metavolcanics of Southern Peloritani Mountains (North-Eastern Sicily, Italy). *Ofioliti*, 30: 17-27.

Corradini C. & Corriga M.G. (2010). Silurian and lowermost Devonian conodonts from the Passo Volaia area (Carnic Alps, Italy). *Bollettino della Società Paleontologica Italiana,* 49: 237-253.

Corradini C., Leone F., Loi A. & Serpagli E. (2001). Conodont stratigraphy of a highly tectonised Silurian-Devonian section in the Basilio area (SE Sardinia, Italy*). Bollettino della Società Paleontologica Italiana*, 40: 315-323.

Corradini C. & Serpagli E. (1999). A Silurian conodont zonation from late Llandovery to end Pridoli in Sardinia. *Bollettino della Società Paleontologica Italiana*, 38: 255-273.

Corriga M.G. (2010). Biostratigrafia a conodonti attorno al limite Siluriano-Devoniano in alcune aree del Nord Gondwana. Unpublished Ph.D. thesis. 180 pp. Università di Cagliari.

Corriga M.G., Corradini C. & Ferretti A. (2009). Silurian conodonts from Sardinia: an overview. *Rendiconti della Società Paleontologica Italiana*, 3: 95-107.

De Capoa P., D'Errico M., Di Staso A., Perrone V., Somma R. & Zaghloul M.N. (2013). Biostratigraphic constraints for the palaeogeographic and tectonic evolution of the Alpine Central-Western Mediterranean orogenic belt (Betic, Maghrebian and Apenninic chains). *Rendiconti online Società Geologica Italiana*, 25: 43-63.

Di Paolo L., Aldega L., Corrado S., Somma R., Balestrieri M.L. & Maniscalco S. (2010). Paleo-thermal and structural indicators for unraveling burial/exhumation paths in the Peloritani Mts. (NE Sicily, Italy). Barcelona, 14-17 June 2010. *72nd EAGE Conference and Exhibition*. 5 pp.

Dzik J. (1976). Remarks on the evolution of Ordovician conodonts. *Acta Palaeontologica Polonica*, 21: 395-445.

Ferla P. & Azzaro E. (1978). Natura del vulcanismo precedente al metamorfismo ercinico nelle unità inferiori dei Monti Peloritani. *Bollettino della Società Geologica Italiana*, 97: 767-774.

Ferretti A., Corradini C. & Serpagli E. (1998). The Silurian and Devonian sequence in SW Sardinia. *Giornale di Geologia*, 60: 57-61.

Ferretti A. & Serpagli E. (1996). Geological outline, community sequence and paleoecology of the Silurian of Sardinia. *Rivista Italiana di Paleontologia e Stratigrafia*, 102: 353-362.

Fordham B.G. (1991). A Literature-Based Philogeny and classification of Silurian conodont. *Sonder-Abdruck aus Palaeontographica Beiträge zur Naturgeschichte der Vorzeit*, 217: 1-136.

Gelmini R., Lorenzoni S., Mastandrea A., Orsi G., Serpagli E., Vai G.B. & Zanettin Lorenzoni E. (1978). Rinvenimento di fossili devoniani nel cristallino dell'Aspromonte (Calabria). *Rendiconti della Società Geologica Italiana*, 1: 45-47.

Hinde G. (1879). On conodonts from the Chazy and Cincinnati Group of the Cambro-Silurian, and from Hamilton and Genesee-Shales division of the Devonian, in Canada and the United States. *The Quarterly Journal of the Geological Society of London*, 35: 351-369.

Histon K. & Schönlaub H.P. (1999). The Palaeozoic of the Southern Alps. *In* Histon K. (ed.), V International Symposium, Cephalopods - Present and Past, Carnic Alps Excursion Guidebook. *Berichte der Geologisches Bundesanstalt*, 47: 6-30.

Jeppsson L., Anehus R. & Fredholm D. (1999). The optimal acetate buffered acetic acid technique for extracting phosphatic fossils. *Journal of Paleontology,* 73: 964-972.

Johnson M.E., Rong J.Y., Wang C.Y. & Wang P. (2001). Continental island from the Upper Silurian (Ludfordian Stage) of Inner Mongolia: Implications for eustasy and paleogeography. *Geology*, 29: 955-958.

Klapper G. (1981). Family Kockelellidae. *In* Robinson R.A. (ed.), *Treatise on Invertebrate Paleontology*. 157 pp. Part W: Miscellanea, Supplement 2: Conodonta.

Lardeux H. & Truillet R. (1971). Découverte de Dévonien à Dacryoconarides (Tentaculites) dans le Monts Péloritains (Sicile). *Comptes Rendus sommaires de la Societé Géologique de France*: 122-123.

Majesté-Menjoulas C., Bouillin J.P., Cygan C. & Fournier-Vinas C. (1986). Les formations paléozoïques (Cambrien à Carbonifère) des Monts Péloritains (Sicile). Premières datations par Acritarches et Conodontes. *Comptes Rendus de l'Académie des Sciences*, 303: 1315-1320.

Männik P. & Malkowski K. (1997). Silurian Conodonts from the Goldap Core, Poland. *In* Szaniawski H. (ed.), Proceedings of the Sixth Europen conodont Symposium (ECOS VI). *Palaeontologica Polonica*, 58: 141-151.

Martínez Pérez C. (2012). Conodontos del Emsiense (Devónico Inferior) del Pirineo Central Español. Unpublished Ph.D. thesis. 376 pp. Universitat de Valencia, Spain.

Messina A., Somma R., Macaione E., Carbone G. & Careri G. (2004). Peloritani Continental Crust composition (Southern Italy): geological and petrochemical evidence. *Bollettino della Società Geologica Italiana,* 123: 405-441.

Miller S.A. (1889). North American geology and palaeontology for the use of amateurs, students, and scientists. 718 pp. Western Methodist Book Concern, Cincinnati, Ohio.

Navas-Parejo P., Rodríguez-Cañero R., Somma R., Martín-Algarra A. & Perrone V. (2009a). The Frasnian Upper Kellwasser event and a lower Famennian stratigraphic gap in Calabria (southern Italy). *Palaeobiodiversity and Palaeoenvironments*, 89: 111-118.

Navas-Parejo P., Somma R., Martín-Algarra A., Perrone V. & Rodríguez-Cañero R. (2009b). First record of Devonian orthoceratid-bearing limestones in southern Calabria (Italy). *Comptes Rendus Palevol*, 8: 365-373.

Rejebian V.A., Harris A.G. & Huebner J.S. (1987). Conodont color and textural alteration: An index to regional metamorphism, contact metamorphism, and hydrothermal alteration. *Geological Society of America Bulletin*, 99: 471-479.

Rodríguez-Cañero R., García-López S. & Sarmiento G.N. (1997). Conodontos siluro-devónicos de la Peña de Ardales (Complejo Maláguide, Cordillera Bética. *In* Grandal D'Anglade A., Gutiérrez-Marco J.C. & Santos Fidalgo L. (eds), V Reunión Internacional Proyecto 351. A Coruña. Programa Internacional de Correlación Geológica. *Paleozoico inferior del noroeste de Gondwana*. Libro de resúmenes y excursione: 92-94.

Sanz-López J. (2004). Silúrico, Devónico y Carbonífero pre- y sinvarisco de los Pirineos. *In* Vera J.A. (ed.), Geología de España, SGE–IGME, Madrid, Spain: 250-254.

Schönlaub H.P. & Histon K. (2000). The Palaeozoic evolution of the Southern Alps. *Mitteilungen der Oesterreichischen Geologischen Gesellschaft*, 92: 15-34.

Simpson A.J. & Talent J.A. (1995). Silurian conodonts from the headwaters of the Indi (upper Murray) and Buchan rivers, southeastern Australia, and their implications. *Courier Forschunginstitut Senckenberg*, 182: 79-215.

Slavík L., Kříž J. & Carls P. (2010). Reflection of the mid-Ludfordian Lau Event in conodont fauna of Bohemia. *Bulletin of Geosciences*, 85: 395-414.

Somma R. (2006). The south-western side of the Calabrian Arc (Peloritani Mountains): geological, structural and AMS evidence for passive clockwise rotations. *Journal of Geodynamics*, 41: 422-439.

Somma R., Martin-Rojas I. & Perrone V. (2013). The stratigraphic record of the Alì-Montagnareale Unit (Peloritani Mountains, NE Sicily, Italy). *Rendiconti Online Società Geologica Italiana*, 25: 106-114.

Somma R., Messina A. & Mazzoli S. (2005a). Syn-orogenic extension in the Peloritani Alpine Thrust Belt (NE Sicily, Italy): evidence from the Alì Unit. *Compte Rendus Geoscience Paris*, 337: 861-871.

Somma R., Messina A. & Perrone V. (2005b). The Cambrian to Aquitanian geological record of the Longi-Taormina Unit (Calabria-Peloritani Arc, southern Italy): geodynamic implications. *Geodinamica Acta*, 18: 417-430.

Somma R., Navas-Parejo P., Martín-Algarra A., Martínez-Pérez C., Perrone V. & Rodríguez-Cañero R. (2012). Vincoli biostratigrafici sull'età del vulcanismo alcalino paleozoico dei Monti Peloritani (Sicilia nord-orientale) [Biostratigraphic constraints on the Palaeozoic alkaline volcanism of the Peloritani Mountains (north-eastern Sicily)]. *Rendiconti Online Società Geologica Italiana*, 21: 1098-1100.

Sweet W.C. (1988). The Conodonta: Morphology, Taxonomy, Paleoecology, and evolutionary history of a long-extinct animal phylum. 212 pp. Oxford Monographs on Geology and Geophysics, No. 10, Clarendon Press, New York, Oxford.

Uyeno T.T. (1981). Stratigraphy and conodonts of Upper Silurian and Lower Devonian rocks in environs of the Boothia uplift, Canadian Artic Archipelago. Part 2: Systematic study of conodonts. *Bulletin Geological Survey of Canada*, 292: 39-75.

Walliser O.H. (1957). Conodonten aus dem oberen Gotlandium Deutschlands und der Karnischen Alpen. *Sonderdruck dem Notizblatt des Hessischen Landesamtes für Bondenforschung zu Wiesbaden*, 85: 28-52.

Walliser O.H. (1964). Conodonten des Silurs. *Abhandlungen des Hessischen Landesamtes für Bodenforschung zu Wiesbaden*, 41: 1-106.

Yolkin E.A., Kim A.I., Weddige K., Izokh N.G. & Erina M.V. (1994). New Emsian conodont zonation (Lower Devonian). *Courier Forschunginstitut Senckenberg*, 168: 139-157.

Manuscript received 4 October 2012
Revised manuscript accepted 20 August 2013
Published online 30 October 2013
Editor Annalisa Ferretti