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TAXONOMY AND BIOSTRATIGRAPHIC RECORD OF THE UPPER TRIASSIC CONODONTS OF THE PIZZO MONDELLO SECTION (WESTERN SICILY, ITALY), GSSP CANDIDATE FOR THE BASE OF THE NORIAN

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Abstract. New taxonomic and biostratigraphic investigations on the late Carnian to Rhaetian (Upper Triassic) platform conodonts from the Pizzo Mondello section (Western Sicily, Italy, Sicano basin) are here presented. Pizzo Mondello is one of the two GSSP candidates for the Carnian/Norian boundary; the section is a 430 m thick continuous succession of upper Carnian to upper Norian marine limestones (Scillato Formation), characterized by uniform facies and high sedimentation rates, and ca. 20 m of Rhaetian white calcilutites (Portella Gebbia limestone). Pizzo Mondello offers one of the most complete conodont records for this time interval in the Tethys. The conodont faunas are characterized by a large variety of species, belonging to the genera *Carnepigondolella*, *Epigondolella*, *Metapolygnathus*, *Misikella*, *Mockina*, *Neocavitella*, *Norigondolella*, *Paragondolella*, and *Parvigondolella*. The richness of the populations allowed a detailed revision and description of all the Upper Triassic species and morphotypes recovered. The revision of the problematic species *Carnepigondolella nodosa* and “*Metapolygnathus communisti B*” was thus possible, leading to the establishment of two new species: *Carnepigondolella tuvalica* n. sp. and *Carnepigondolella gulloae* n. sp. The latter species would be a good proxy for the Carnian/Norian boundary in the case that the FAD of *Halobia austriaca* (sample FNP135a) will be selected as the primary biomarker for the base of the Norian.

Riassunto. Vengono qui presentati i risultati delle nuove indagini tassonomiche e biostratigrafiche sui conodonti a piattaforma del Carnico superiore - Retico (Triassico Superiore) della sezione di Pizzo Mondello (Sicilia occidentale, Italia, Bacino Sicano).

Pizzo Mondello è una delle due sezioni candidate come GSSP per il limite Carnico/Norico; la sezione è composta da una successione continua di 430 m di calcari pelagici (Scillato Formation), di età compresa tra il Carnico superiore e il Norico superiore e caratterizzata da facies uniformi e alti tassi di sedimentazione, e da ca. 20 m di calcilutiti bianche (Portella Gebbia limestone) di età Retica. Pizzo Mondello offre

uno dei record a conodonti più completi per questo intervallo tempo nella Tetide; le sue faune sono caratterizzate da un’ampia varietà di specie, appartenenti ai generi *Carnepigondolella*, *Epigondolella*, *Metapolygnathus*, *Misikella*, *Mockina*, *Neocavitella*, *Norigondolella*, *Paragondolella* e *Parvigondolella*. La ricchezza delle popolazioni ha permesso di fornire descrizioni dettagliate di tutte le specie e i morfotipi del Triassico Superiore che sono stati rinvenuti e di revisionare due specie notoriamente problematiche del Triassico Superiore, *Carnepigondolella nodosa* e “*Metapolygnathus communisti B*”. La loro revisione ha portato all’istituzione di due nuove specie: *Carnepigondolella tuvalica* n. sp. e *Carnepigondolella gulloae* n. sp. Quest’ultima rappresenterebbe un buon proxy per il riconoscimento del limite Carnico/Norico qualora il FAD di *Halobia austriaca* (FNP135a) fosse selezionato come biomarker principale per la base del Norico.

Introduction

Our knowledge of the Upper Triassic conodont taxonomy has gone through significant improvements only during the last 19 years. Orchard was the first, in 1991, to give a fundamental contribution to this knowledge, publishing important studies on the Carnian-Norian conodont faunas of the terranes from the Queen Charlotte Islands (British Columbia, Canada) (Orchard 1991a) and from some North American successions of the Canadian Cordillera (e.g. Black Bear Ridge, Pardonet Hill, Brown Hill) (Orchard 1991b). Moreover, in the last eight years, the taxonomic studies on the Upper Triassic conodonts were further intensified, leading to the institution of a new genus (*Carnepigondolella* Kozur, 2003) and numerous new species

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(Kozur 2003, Moix et al. 2007; Noyan & Kozur 2007; Mazza et al. in press).

One of the reasons of this renewed interest towards the Upper Triassic conodonts is that the Norian and the Rhaetian are two Upper Triassic stages for which a Global Stratotype Section and Point (GSSP) has yet to be ratified, and a conodont First Appearance Datum (FAD) is one of the possible marker events or proxy. For what concerns the Carnian/Norian boundary, there are two official GSSP candidate sections: Pizzo Mondello (Sicani Mountains, Western Sicily, Italy) (Muttoni et al. 2001, 2004; Nicora et al. 2007; Balini et al. 2008, 2010) and Black Bear Ridge (Williston Lake, northern British Columbia, Canada) (Orchard et al. 2001; Orchard 2007a,b, 2010). Pizzo Mondello is a 450 m thick continuous succession of upper Carnian to Rhaetian pelagic-hemipelagic limestones and, thanks to its unusual combination of magnetostratigraphic, stable isotope and biostratigraphic record is one of the world reference sections for the Upper Triassic (Muttoni et al., 2004; Balini et al. 2010 and references therein). In order to support the proposal of Pizzo Mondello as GSSP for the Norian, in the last 4 years the upper Carnian-lower Norian part of the section has been entirely re-sampled bed-by-bed to provide a complete integrated paleontological (conodonts, bivalves, ammonoids and radiolarians) and physico-chemical (microfacies, paleomagnetism and stable isotopes) record (Balini et al. 2010). More recently, also the upper Norian to the Rhaetian parts of the succession have been re-sampled for conodonts.

The conodont populations of the Pizzo Mondello section are very rich and they are well representative of both the Neotethyan and Northern Tethys conodont faunas. In this paper we present the complete conodont biostratigraphy of the Pizzo Mondello succession, comprehensive of the distributions of all the recognizable morphotypes, the systematic description of all the recovered species and the revision of the most problematic ones. This revision is also integrated with the ontogenetic studies of the growth stages of some key species (*Epigondolella quadrata*, *Epigondolella rigoi* and *Metapolygnathus communisti*). The taxonomy here presented is referred only to the conodont platform elements (P1 elements, *sensu* Purnell et al. 2000), while the multielement approach is disregarded due to the absence of natural clusters for the Upper Triassic conodonts and, thus, the uncertainty of the present apparatus reconstructions (see also Mazza et al. in press). The aim of this work is to provide a complete overview of the Neotethyan P1 conodonts in the Upper Triassic and a biostratigraphic record which may become the main reference for global correlations and help to identify a marker event for the definition of the Carnian/Norian boundary in the Pizzo Mondello section.

Stratigraphical settings

The Pizzo Mondello section is a 450 m thick succession of marine limestones ranging from upper Carnian to Rhaetian (Upper Triassic) (Fig. 1). The section is located in the western Sicily (Sicani Mountains, Italy), in the lower part of the Pizzo Mondello tectonic unit, which consists of 1200 m of pelagic to hemipelagic carbonates, radiolarites and marls of Mesozoic to Cenozoic age overthrust onto a thick allochthonous complex of Neogene mudstones and evaporites of the Gela Nappe (Gullo, 1996; Muttoni et al., 2004; Balini et al., 2010). The Pizzo Mondello section consists of two lithostratigraphic units. The first 430 m of the succession (from upper Carnian to upper Norian) are continuous, entirely exposed and constituted by pelagic-hemipelagic limestones with cherty nodules and lists belonging to the Scillato Formation (Cherty Limestone *sensu* Muttoni et al. 2001, 2004 or Halobia Limestone auctorum), characterized by almost uniform facies and high sedimentation rates of 20-30 m/m.y. (Muttoni et al. 2001, 2004; Guaiumi et al. 2007). The Scillato Fm microfacies are mainly represented by mudstone and wackestone beds with thin-shelled bivalves and calcispheres (Scandone 1967; Di Stefano 1990). The cherty limestones of the Scillato Fm of western Sicily are famous for their richness in several fossil groups: conodonts, radiolarians, ammonoids (Balini et al., this volume), foraminifers and bivalves of to the genus *Halobia* (Levera, this volume). Scattered calcarenitic beds characterized by distal features (Tb and Tc of the Bouma sequence) have also been documented (e.g. Bertinelli et al. 2005; Guaiumi et al. 2007; Rigo et al. 2007). The first 143 m of the succession, below the *Slump breccia* level, represents the interval of interest for the definition of the Carnian/Norian boundary (Fig. 2). After Gullo (1996) and Muttoni et al. (2001; 2004), its paleontological content has been re-studied in detail in the last 4 years, together with its geochemical record and its sedimentology. These studies provided a new curve of the stable isotopes (Mazza et al. 2010) that refines the curve previously published by Muttoni et al. (2004), and the identification of the three lithofacies listed in Fig. 2 (see Guaiumi et al. 2007 and Balini et al. 2010 for details). The upper 20 m of the succession, from lower to middle Rhaetian, are represented by the Portella Gebbia Limestone (*sensu* Gullo 1996) and consists of white calcilitites and marls with cherty lists (Figs. 1, 3). Conodonts have been studied in detail throughout the entire Pizzo Mondello succession and with a high resolution sampling in the lower 200 m [from the upper Carnian (Tuvalian) to the lower Norian (Lacian)] and in the last 48 m [from upper Norian (Sevatian) to lower Rhaetian]. During the sampling campaigns, special attention has been reserved to the first 143 m of the section, below the *Slump breccias* level, where the Carnian/Norian boundary is located (Fig. 2).

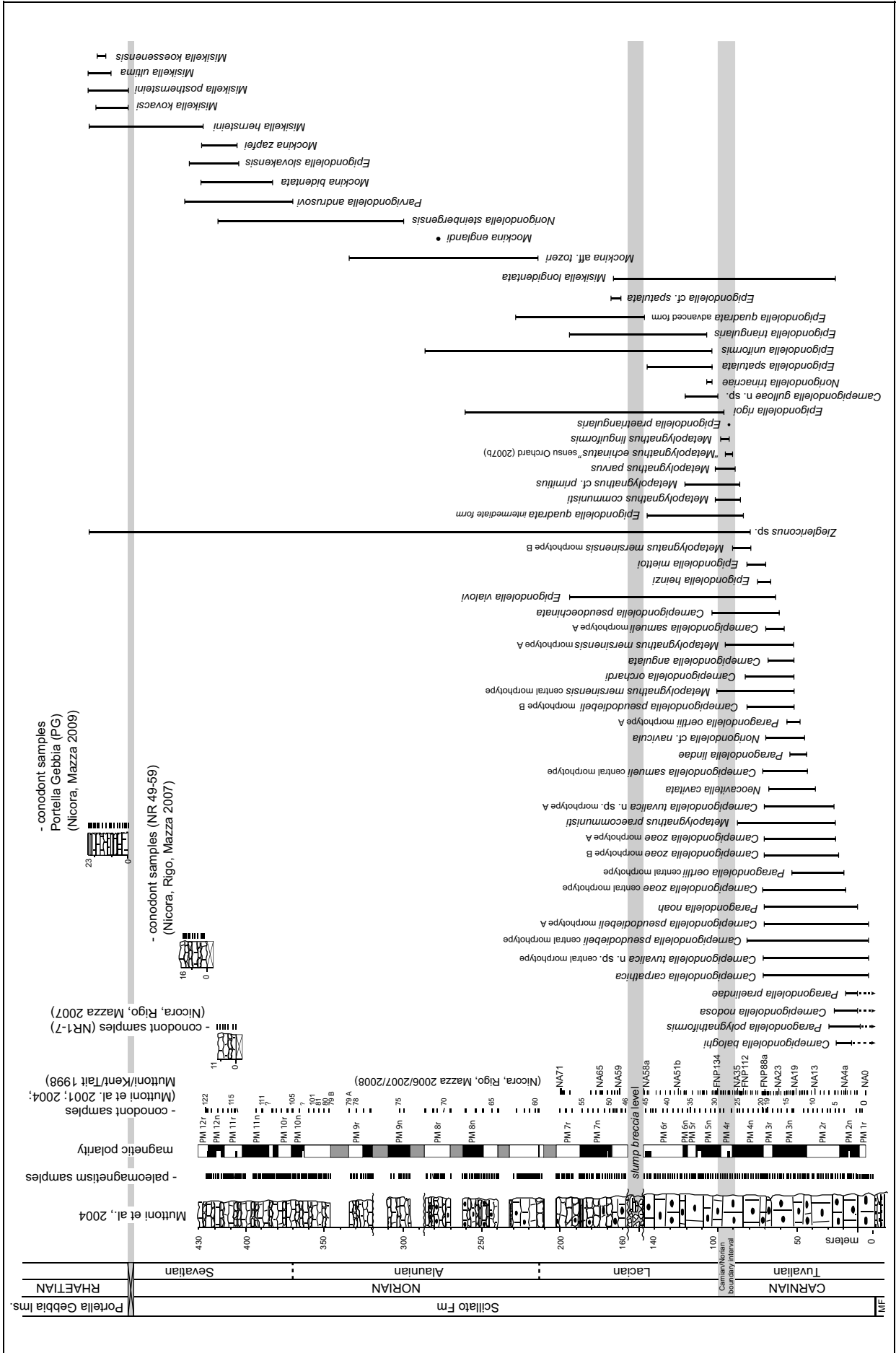


Fig. 1 - Stratigraphic log and paleomagnetic scale of the entire Pizzo Mondello section, from Upper Carnian to Rhaetian (modified after Murtomi et al. 2004 and Balini et al. 2010), with the ranges of all the conodont species and morphotypes.

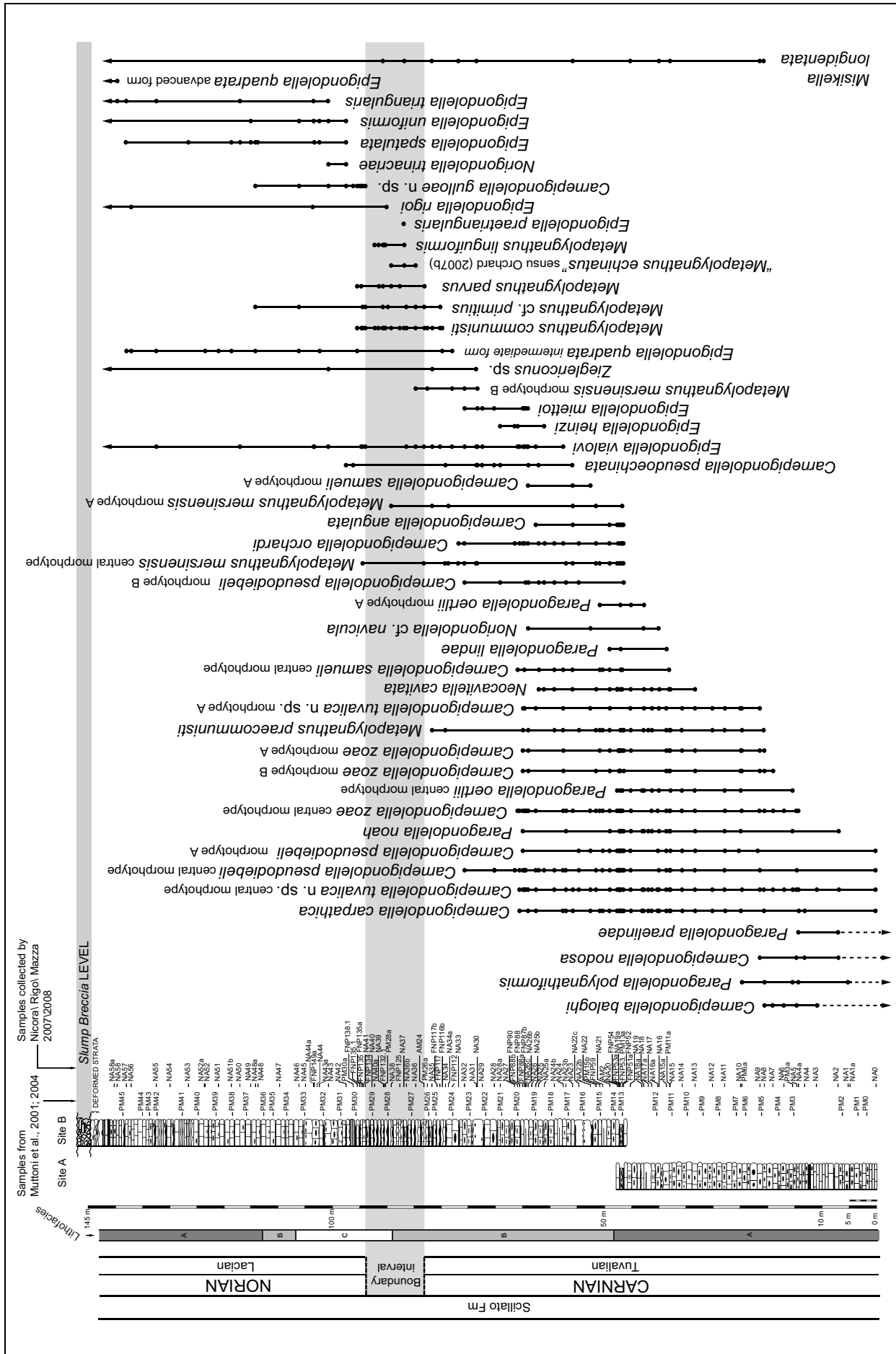


Fig. 2 - Detailed stratigraphic log of the lower 143 meters of the Pizzo Mondello section (from upper Carnian to lower Norian) with the ranges of all the conodont species and morphotypes recovered (modified after Balini et al. 2010).

The stratigraphical and sedimentological features of Pizzo Mondello make this section an ideal locality for taxonomic studies on the Upper Triassic conodonts for several reasons: i) the continuity of the succession and its uniform facies provide a complete conodont record in which the gradual evolution of the conodont species can be observed without *hiati* and without an excessive environmental control related to changes in the facies; ii) the carbonate sediments, being liable to rapid cementation, guarantee slight compaction and consequently a lesser fragmentation and a better preservation of the elements (Purnell & Donoghue 2005); iii) the high sedimentation rates preserve conodonts more quickly from predators or scavengers, reducing the bias arising from these factors and avoiding every possible mixing or overlap of species from different ages in the conodont faunas (Purnell & Donoghue 2005).

Conodont biostratigraphy

After the pioneering work of Gullo (1996), the Pizzo Mondello section has been re-studied with a much higher detail in the last ten years. The upper Carnian to lower Norian interval of the section, represented by the first 143 m of the succession below the *Slump breccia*, is exposed in “La Cava” locality, an abandoned quarry on the southern slope of the Pizzo Mondello mountain. This interval was studied for conodonts by Muttoni et al. (2001; 2004) (samples PM0 to PM46; Fig. 1). In the following years, additional 115 samples for conodonts have been collected from this section, with a bed-by-bed sampling in the intervals of more interest for the definition of the Carnian/Norian boundary (samples labelled NA and FNP. The FNP label refers to the microfacies samples taken by Guaiumi in 2007 and, being a very dense sampling, they have been used also for conodonts, halobiids and some ammonoids) (Fig. 2). Conodont samples from PM46 above the *Slump breccia* to PM122 were taken by G. Muttoni, D.V. Kent, J. Tait in 1998 and studied for biostratigraphy by Balini et al. (2010) and for taxonomy in this study (note that in Balini et al. 2010, these samples are incorrectly attributed to Muttoni et al. 2001). In the 40.8 m overlying the *Slump breccia* another 13 samples (equivalent to the PM46-PM58 interval of Muttoni/Kent/Tait 1998) have been collected (Fig. 3). The middle-upper portion of the Scillato Fm, from sample PM59 to PM122, was not re-sampled after Muttoni/Kent/Tait 1998.

Higher up, above the last sample (PM122) collected by Muttoni/Kent/Tait in 1998, the succession has been logged and sampled (labelled NR) in two separate sites on the eastern slope of the Pizzo Mondello mountain, in the Acque Bianche creek. The two sections are correlated to the main log of the Pizzo Mondello section on the basis of the conodont fauna and the first section results in overlap of the last meters of the section

sampled by Muttoni/Kent/Tait (Fig. 3). Some stratigraphical gap between the two sections is possible. Recently (2009), also the Rhaetian part of the succession has been logged and sampled for conodonts. The section, represented by the Portella Gebbia limestone, is 20 m thick and is located at the Contrada Torcitore locality. 14 samples were collected from this section (labelled PG) (Fig. 3).

Conodonts are abundant in almost all the samples collected and they show an average CAI (Colour Alteration Index) value of 1, indicating none or insignificant thermal alteration (Epstein et al. 1977).

From sample NA0, at the base of the section, to sample NA26, the succession is dominated by a typical Tuvalian (upper Carnian) conodont fauna, characterized by the association of mainly two genera, *Paragondolella* and *Carnepigondolella*, with scarce representatives of the genera *Metapolygnathus* and *Epigondolella* (Fig. 2).

The base of the section is middle/late Tuvalian in age for the occurrence, already from the first sample, of *Carnepigondolella pseudodiebeli*, *Carnepigondolella tivalica* n. sp. and *Carnepigondolella carpathica*. *C. pseudodiebeli* occurs in the first meters of the section (until sample NA9) still in a primitive form, characterized by fewer nodes on the platform margins and a thicker posterior platform, partly transitional from *C. carpathica*. In the interval between samples NA2 and NA12 typical representatives of *C. pseudodiebeli* begin to occur, together with *Paragondolella noah*, *Paragondolella oertlii*, *Carnepigondolella zoeae*, morphotype A of *C. tivalica* n. sp. and *Metapolygnathus praecommunisti*, which is the first metapolygnathid occurring in the section. Even if the first meters of the section are characterized by Tuvalian conodonts, from sample NA0 to NA8 these species occur together with an association which is more common in the Julian: *Carnepigondolella baloghi*, *Carnepigondolella nodosa* (sensu Hayashi, see “Discussion” of *C. tivalica* n. sp. in the “Taxonomy” chapter for details), *Paragondolella polygnathiformis* and *Paragondolella praelindae*. The Tuvalian occurrence of *P. polygnathiformis* and *P. praelindae* is known, while the presence of *C. baloghi* and *C. nodosa* in the Tuvalian is unusual. Nevertheless, their occurrence in the upper Carnian has been already observed in the past: *C. baloghi* was found in the higher Tuvalian of the Northern Calcareous Alps and Western Carpathians (Moix et al. 2007) and *C. nodosa* is present also in surely Tuvalian strata in the Mufara Formation of the Panormide and Imerese domains of north-western Sicily (Martini et al. 1991).

From sample NA13 to NA19 the succession is dominated by a very abundant occurrence of *P. noah*, *C. carpathica* and by all the morphotypes of *C. tivalica* n. sp. and *C. zoeae*. *C. pseudodiebeli* is subordinate. In this interval *Neocavitella cavitata*, *Carnepigondolella samueli*, *Norigondolella* cf. *navicula*, *Paragondolella*

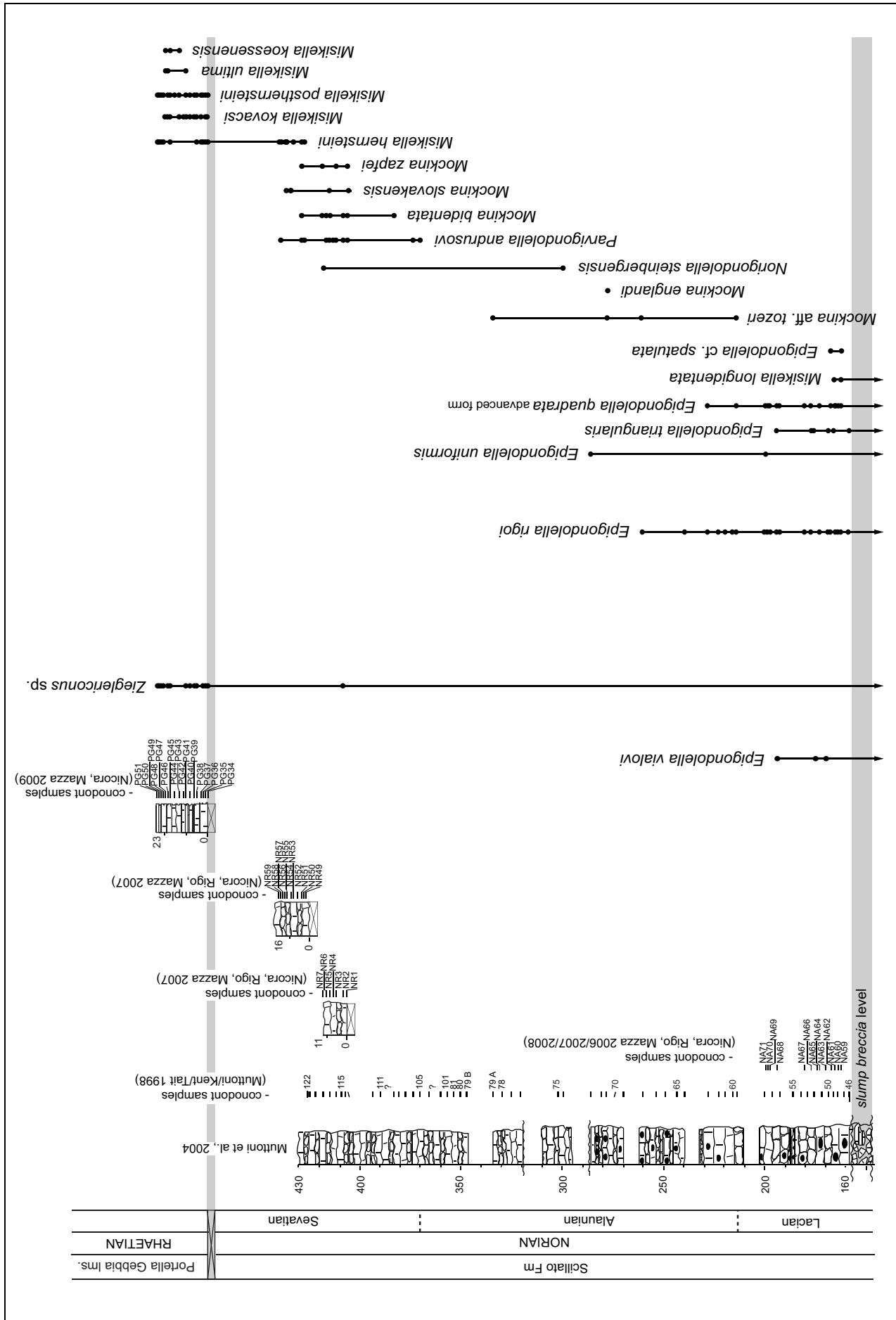


Fig. 3 - Detailed stratigraphic log of the upper part of the Pizzo Mondello section (from lower Norian to Rhaetian) with the ranges of all the conodont species and morphotypes recovered.

lindae and the morphotype A of *P. oertlii* begin to occur. *N. cf. navicula* has been recovered from surely upper Carnian strata also in other two Tethyan sections: the Pignola 2 (southern Italy, Lagonegro basin) (Rigo et al. 2007) and the Feuerkogel (Austria, Northern Tethys) (Krystyn 1980) sections, thus showing that it is not an endemic occurrence exclusively of Pizzo Mondello, but it occurs throughout the western Tethys.

In the interval from sample FNP51a to NA22c, *C. tuvalica* n. sp. and *C. zoeae* are still very abundant while *C. carpathica* and *P. noah* begin to decrease. The morphotype B of *C. pseudodiebeli* first occurs here, but it is abundant in the overlying interval. The association *Carnepigondolella angulata*, *Carnepigondolella orchardi* and *Metapolygnathus mersinensis* begins. In this interval both the morphotypes of *P. oertlii* disappear.

The interval from sample NA23 to NA26b records the first occurrences of *Carnepigondolella pseudoechinata*, *Epigondolella vialovi*, and *Epigondolella heinzi*, while *N. cavitata* and *N. cf. navicula* have here their last occurrences. *C. tuvalica* n. sp., *C. zoeae*, *C. carpathica* and *P. noah* are much scarcer while *C. pseudodiebeli* is very abundant. The association of *C. orchardi*, *E. vialovi* and *E. heinzi*, which are transitional species to the much more evolved Norian epigondolellids, indicates a latest Tuvalian age for this portion of the section.

From sample NA26b to NA35 the succession is dominated by the genus *Epigondolella*, historically considered as a wholly Norian genus (Orchard 1991b; Krystyn et al. 2002; Kozur 2003; Noyan & Kozur 2007; Celarc & Kolar-Jurkovšek 2008), while all the carnepigondolellids, except for *C. pseudoechinata*, and *M. praecommunisti* disappear here. In this interval *Epigondolella miettoi* and *Epigondolella quadrata* first occur and *Epigondolella vialovi* is very abundant. *E. miettoi* was once considered a primitive form of *E. quadrata* (Mazza et al. 2010; Balini et al. 2010) and its FAD was one of the possible candidates as marker event for the Carnian/Norian boundary (Mazza et al. 2010; Balini et al. 2010). More detailed studies on these specimens (see Mazza et al. in press and the “Discussion” of *E. miettoi* in the “Taxonomy” chapter) showed that this form could actually be considered a different species, probably the direct forerunner of *E. quadrata*. Being a strongly transitional species, *E. miettoi* could be easily confused with its forerunner *C. orchardi* or its descendant *E. quadrata*. For this reason, the option of its FAD as possible marker event for the base of the Norian has been now abandoned. *E. miettoi* has a short range, limited entirely to the latest Tuvalian. It disappears in sample NA32, just below the FAD of true *E. quadrata* (sample FNP112).

The interval from sample FNP116b to NA40 of the succession is characterized by the mass occurrence of the *Metapolygnathus communisti* group. The association consists of *Metapolygnathus communisti*, *Metapo-*

lygnathus parvus, *Metapolygnathus linguiformis*, “*Metapolygnathus echinatus*” sensu Orchard (2007b) and *Metapolygnathus cf. primitius*. True *M. parvus* and “*M. echinatus*” are quite rare, while *M. communisti* is very abundant. The FADs of “*M. echinatus*” sensu Orchard (2007b) and *M. parvus* have been considered two possible markers for the base of the Norian (Orchard 2007a; Balini et al. 2010). These species were first proposed in North America as a marker for the base of the Norian, at the Black Bear Ridge section (Orchard 2007a). The Tethyan representatives of *M. parvus* are quite different from the North American ones, having a larger platform and a shorter free blade. “*M. echinatus*”, even if rare at Pizzo Mondello, is instead extremely similar to the North American representative and it would thus provide a good correlation between the Tethys and the North America. Nevertheless, these two species are affected by some biases. At Black Bear Ridge the association “*M. echinatus*” + *M. parvus* first occurs just above the FAD of *Halobia austriaca*, which is now considered by the Subcommittee on Triassic Stratigraphy (“New Developments on Triassic Integrated Stratigraphy” workshop; Palermo, Italy, 12-16 September, 2010) a good proxy or even a possible primary marker for the boundary (see Levera, this volume). In the Pizzo Mondello section, instead, *M. parvus* first occurs 11.5 meters (sample AM24) and “*M. echinatus*” 9.25 meters (sample NA36) below *H. austriaca*. Furthermore, at Pizzo Mondello the FOs of *M. parvus* and “*M. echinatus*” coincide with a mass occurrence of almost all the metapolygnathids (*M. communisti* group) that is probably influenced by an external event.

At sample PM28 *Epigondolella rigoi* first occurs and at sample NA37 the presence of *Epigondolella praetriangularis* is recorded, although the latter species is very rare and occurs only in this sample. Before sample NA42 all the metapolygnathids definitely disappear, except for *M. cf. primitius*, which has its last occurrence in sample NA48a.

From sample FNP134 to NA48a, the section is characterized by the association *Carnepigondolella gulloae* n. sp. - *M. cf. primitius* - *Norigondolella trinacriae*. *C. gulloae* n. sp. coincides with “*Metapolygnathus communisti* B”, informally illustrated by Krystyn (1980) but never described, and here formally instituted and named. *C. gulloae* n. sp. could be a possible conodont marker for the base of the Norian, since it first occurs 5 cm below *H. austriaca* everywhere in the Tethys. The problem concerning with *C. gulloae* n. sp. is that the occurrence of this species is not confirmed in North America. In this interval also the more advanced epigondolellids have their FADs: *Epigondolella spatulata*, *Epigondolella uniformis* and *Epigondolella triangularis*. *E. quadrata*, *E. rigoi* and *E. vialovi* are still very common in this interval. This association can be referred to the lower Lacion (Orchard 1991a,b; Krystyn & Gallet

2002; Channell et al. 2003; Kozur 2003). *C. pseudoechinata* has its last occurrence at the beginning of this interval.

From sample NA51 to PM58 (1.30 m above NA71) the conodont association is composed mainly of *E. quadrata*, *E. vialovi*, *E. rigoi*, *E. uniformis* and *E. triangularis*. *E. rigoi* is very abundant in this interval and it occurs in its typical form, with a very short platform, a strongly enlarged posterior margin and large denticles on the platform margins. *E. vialovi* instead is very scarce and occurs only in few specimens. The specimens of *E. quadrata* occurring in this interval are much bigger and characterized by a broader and thicker platform than those occurring in the interval below. *E. spatulata* disappears before the *slump breccia* and, above it, is substituted by a similar but less ornamented form, here named *Epigondolella* cf. *spatulata* (between samples NA59-NA62). *E. vialovi* and *E. triangularis* have their last occurrence at the end of this interval (sample NA68).

From sample PM59 to PM64 the conodont association is characterized by the first occurrence of *Mockina* aff. *tozeri*, which marks here the beginning of the Alaunian. In this interval *E. quadrata* and *E. rigoi* have their last occurrence.

From sample PM68 to PM79A a typical middle Norian association is present, being composed of *E. uniformis*, *Mockina englandi*, *Mockina* aff. *tozeri* and *Norigondolella steinbergensis* (Orchard 1991a,b; Kozur 2003).

From sample PM104 to PM122 the section is Sevatian in age for the occurrence of the following conodont association (sensu Kozur & Mock 1991): *Mockina bidentata*, *Parvigondolella andrusovi* and *Epigondolella slovakensis*. *Norigondolella steinbergensis* also occurs.

The two non continuous sections located in the upper portion of the Pizzo Mondello section along the Acque Bianche creek, are characterized by a similar conodont association represented by *Mockina bidentata*, *Mockina zapfei*, *Parvigondolella andrusovi* and *E. slovakensis* (NR 1-7), several *Misikella hernsteini* occur only in the uppermost part of the section (NR 50-59). This conodont association suggests a Sevatian age (e.g. Kozur & Mock 1991; Rigo et al. 2005; Reggiani et al. 2005; Giordano et al. 2010).

The Rhaetian interval is represented by the Portella Gebbia limestone. From its outcropping base, the Portella Gebbia limestone yields a typical Rhaetian conodont fauna, consisting in *Misikella posthernsteini* and *Misikella kovacsi*. (Gullo 1996; Bertinelli et al. 2005; Bazzucchi et al. 2005; Giordano et al. 2010; Muttoni et al. 2010), along with *M. hernsteini* and *Zieglericonus* sp. Towards the top (PG 41), *Misikella ultima* and *Misikella koessenensis* also occur.

Taxonomy (M. Mazza & M. Rigo)

In the following, all the conodont species and their morphotypes occurring in the Pizzo Mondello section, from upper Carnian to Rhaetian, are described. The main description is referred to a central morphotype; the other morphotypes are described apart and named with letters starting from A for each species. The taxonomy here presented is a parataxonomy, restricted to the P1 elements, with no references to the structure of the apparatuses (as pointed out in the Introduction). The terminology used in the systematic descriptions of genera and species is based on the morphological and structural terms illustrated in the *Treatise* (Sweet in Clark et al. 1981). The synonymies list *per* species is limited to the original type and to significant biostratigraphic or taxonomic references.

The number of specimens in the "Material" section may be variable for some species because it includes the transitional forms and the extremely juvenile specimens.

Phylum **Chordata** Bateson, 1886

Subphylum **Vertebrata** Linneus, 1758

Class **Conodonta** Eichenberg, 1930

Order **Ozarkodinida** Dzik, 1976

Superfamily Gondolellacea (Lindström, 1970)

Family Gondolellidea Lindström, 1970

Genus *Carnepigondolella* Kozur, 2003

Type species: *Metapolygnathus zoae* Orchard, 1991b

Description. In this genus the basal cavity is sub-terminal with respect to the keel end and to the platform, or it may be slightly forwardly shifted, but it always lies distinctly behind the middle of the platform. The platform is long to moderately long and it bears nodes or short node-like denticles on the anterior platform margins and often on its entire length. A strong microcrenulation (honeycomb structure) always occurs on both the platform margins and the nodes. The free blade, when present, is short to moderately long. The keel termination is broadly rounded, blunt or bifurcated.

Discussion. The genus *Carnepigondolella* was defined by Kozur (2003) as a monophyletic group which grouped the direct forerunners of the genus *Epigondolella*. Cladistic analyses on the Upper Triassic conodonts revealed that this genus is actually a paraphyletic group which includes species representing the transitional forms between *Paragondolella* and the genera *Metapolygnathus* and *Epigondolella* (Mazza et al. in press).

In genus *Metapolygnathus* the pit is more forwardly shifted or it is centrally located and the keel is prolonged behind the pit. Furthermore, the platform may bear nodes on the anterior and lateral margins but it never shows any denticle. *Epigondolella* differs from *Carnepigondolella* for the central pit, a strong bifurcation of the keel end, the absence of the honeycomb structure on the platform margins and the occurrence of high denticles, and not nodes, on the platform margins.

Stratigraphical range. From Tuvalian (upper Carnian) to Lacinian (lower Norian).

Carnepigondolella angulata Mazza, Cau & Rigo,
in press

2010 *Carnepigondolella* n.sp. A - Balini et al., pl. 2, fig. 4.
in press* *Carnepigondolella angulata* - Mazza et al., fig. 9/A-B.

Material: 40 specimens from 8 samples.

Description. The platform is long and slender; it extends for almost the entire length of the element, leaving a free blade of only 1-2 denticles. The posterior end of the platform is rounded and it may show an enlargement confined only to the very terminal portion of the platform. The platform margins are thick and parallel, and they have low and rounded nodes occurring only at the beginning of the platform. The cusp is the last node of the carina and it is undifferentiated in size. In the most adult growth stages a very small accessory node follows the main denticle. The pit lies in the posterior half of the platform but it is never terminal and the keel end is bifurcated. The profile of the element is strongly arched in the posterior third and the anterior part is very bent downwards. The blade is not very high anteriorly, but it stays always quite low above the platform. The frontal termination of the blade ends abruptly giving to it a truncated appearance.

Discussion. *C. carpathica* has a larger platform with a squared posterior margin, a less arched profile and a higher blade. *C. tivalica* n. sp. has larger nodes which occur also on the lateral platform margins, a higher blade and the keel termination is never bifurcated.

Stratigraphical range. Uppermost Tuvalian (upper Carnian).

Carnepigondolella baloghi (Kovacs, 1977)

Pl. 1, Fig. 1

1977* *Metapolygnathus baloghi* Kovacs, p. 79, pl. 3, fig. 2; pl. 4, fig. 1; pl. 5, fig. 1,2; pl. 7, fig. 1,2.

1995 *Metapolygnathus baloghi* - Mastandrea, p. 500, pl. 2, fig. 3-5, 7, 8.

Material: 18 specimens from 5 samples.

Description. The platform is about $\frac{3}{4}$ of the element, with a sub-oval outline and with a wide anterior trough margin. The most characteristic feature of this species is the occurrence of wide nodes on the lateral margins of the platform which are strongly projected into the adcarinal groove, in the direction of the carina. The margins of the platform are broad and both they and the nodes are covered by an intense microcrenulation. The free blade is composed of only 2-3 denticles. The cusp is large and is the last denticle of the carina. The pit lies in the posterior half of the platform, but near the centre. The keel termination is squared. Laterally the element is straight, while the posterior margin of the platform is bent downward. The blade is anteriorly high and it descends rapidly towards the cusp. The first denticle of the blade decreases only slightly in height, giving to its termination a truncated appearance. A low step may occur at the geniculation point.

Discussion. *C. baloghi* differs from *Carnepigondolella tivalica* n. sp., and all the other carnepigondolellids, for the ovoid platform outline and the very wide and strongly elongated nodes in the direction of the carina.

Stratigraphical range. Uppermost Ladinian - middle/upper Tuvalian (upper Carnian).

Carnepigondolella carpathica (Mock, 1979)

Pl. 1, Figs 2, 3

1979* *Gondolella carpathica* Mock, p. 171-3, pl. 1, fig. 1-5.

1991 *Paragondolella carpathica* - Martini et al., pl. 19, fig. 1-9.

1991a *Metapolygnathus nodosus* - Orchard, pl. 2, fig. 9.

2001 *Paragondolella carpathica* - Muttoni et al., fig. 10/3.

2003 *Paragondolella carpathica* - Channell et al., pl. A1, fig. 4, 5, 9, 10.

2007 *Metapolygnathus linguiformis* - Rigo et al., fig. 5/3.

2007a *Metapolygnathus carpathicus* - Orchard, pl. 1, fig. 26-31 (only).

2010 *Carnepigondolella carpathica* - Balini et al., pl. 2, fig. 5.

Material: about 140 specimens from 35 samples.

Description. The platform extends for the entire length of the element, it is broad, with thick and parallel margins covered by an intense microcrenulation. 2-3 low nodes occur at the geniculation point. The anterior trough margin is large and well developed. The cusp is the last denticle of the carina; it is larger and separated from the preceding nodes. Typical of this species is the posterior platform, which is always widened. The pit lies distinctly behind the middle of the platform and it is sub-terminal with respect to the keel end. The keel is broad and its termination is always bifurcated. Laterally the element is arched in its posterior third and the keel is low. The geniculation point descends gently into the anterior trough margin without abrupt steps. The blade is high in its anterior part and it decreases gradually

towards the posterior margin. The blade denticles are highly fused.

Discussion. *C. carpathica* differs from *C. tuvalica* n. sp. because in the latter species the nodes are larger and they often reach the centre of the platform, the cusp is never the last denticles of the carina and the platform is more tapered and not posteriorly widened.

Stratigraphical range. Lower - upper Tuvalian (upper Carnian).

***Carnepigondolella gulloae* n. sp.**

Pl. 1, figs 4-9

1980 *Metapolygnathus communisti* morphotype B Krystyn, pl. 12, fig. 15-19.

2010 "*Metapolygnathus communisti* B" - Mazza et al., pl. III, fig. 4.

2010 "*Metapolygnathus communisti* B" - Balini et al., pl. 4, fig. 2.

Material: 45 specimens from 7 samples.

Origin of the name: In honor of Dr. Maria Gullo whose studies on the conodonts of the Pizzo Mondello section allowed to understand the importance of this succession for the definition of the Carnian/Norian boundary.

Holotype: The specimen illustrated in Pl. 1, Fig. 4.

Type horizon: Bed FNP134 of the Pizzo Mondello section, a white micritic calcilitite with black-brown cherty nodules and rich in halobiids, belonging to the Scillato Fm [Lacian (Lower Norian), Upper Triassic]. It occurs together with *Halobia radiata* and *Halobia austriaca*.

Type locality: Pizzo Mondello section (Monti Sicani, Western Sicily, Italy), the abandoned quarry ("la Cava" locality) on the south-western slope of Pizzo Mondello Mountain.

Repository: MPUM 10872 in the Dipartimento di Scienze della Terra "A. Desio" (Università degli Studi di Milano).

Diagnosis: Conodont with parallel platform margins, extended for 2/3 of the element length, low platform parapets and a sub-squared posterior platform. The free blade is short. Rounded nodes usually occur on the anterior and lateral margins; the nodes are weakly elongated into the adcarinal groove, perpendicularly to the carina. The cusp is terminal, isolated, posteriorly inclined and larger than the other carinal nodes. The pit lies in the posterior half of the platform but close to the middle. The keel end may be squared or have an asymmetrical bifurcation and it may show a short posterior prolongation. The blade is anteriorly high and it descends gradually to the cusp with a convex profile.

Description. The platform is 2/3 of the entire element. The lateral margins of the platform are sub-parallel and the posterior margin is usually squared or it may be slightly rounded (Pl.1, fig. 5). The anterior trough margin is reduced and it leaves a short free blade composed of 3-4 denticles. The anterior and lateral platform margins bear rounded nodes, which are weakly elongated inside the adcarinal groove, perpendicularly to the carina. The elongation of the nodes is more evident in some forms, where it may coincide with an enlargement of the central platform (Pl. 1, fig. 5), and in the adult growth stage specimens (Pl. 1, fig. 6), where

the more posterior nodes are almost in contact with the carina. Both the platform margins and the nodes are covered by an intense microcrenulation. The cusp is the last denticle of the carina, it is bigger than the other denticles, isolated and strongly posteriorly inclined.

The pit lies in the posterior half of the platform or near the middle, but it is never completely centrally located; the loop surrounding the pit is quite flat. The keel end is slightly prolonged behind the pit and usually squared or bifurcated. The bifurcation of the keel end is however never very pronounced, except that in the super-adult growth stages (Pl. 1, fig. 6). The bifurcation is absent in the most juvenile growth stages; the keel begins to bifurcate in the adult growth stages, usually starting only from one corner of the keel end, giving to the keel termination a typical asymmetric form (Pl. 1, figs. 5, 7, 9).

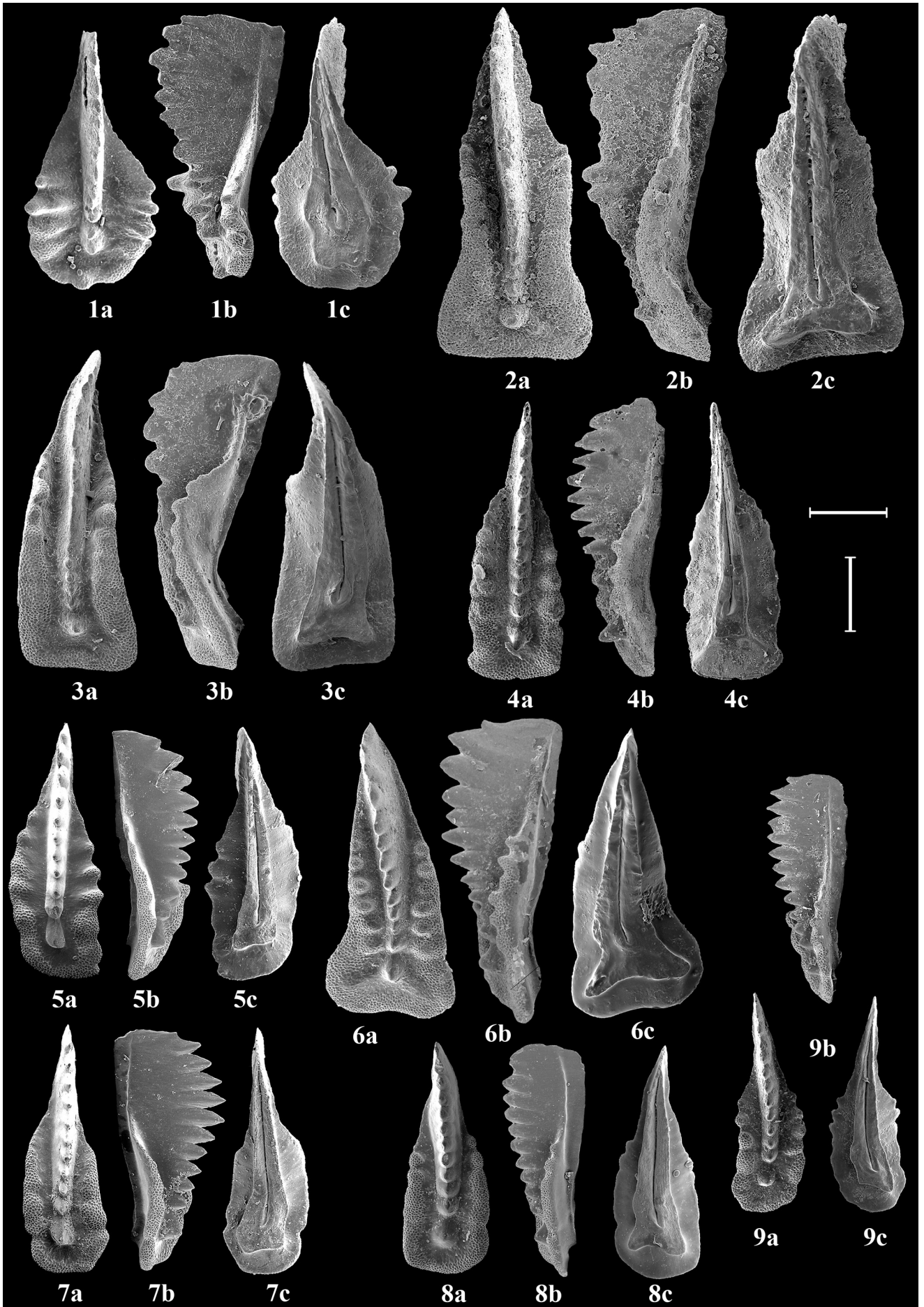
The element profile is from straight to slightly arched. The lateral parapets of the platform are very low in lateral profile and they decrease very gently into the anterior trough margin, with no steps at the geniculation point. The blade is high in its anterior part, with lower denticles at its frontal termination, and it descends gradually to the cusp with a slightly convex profile.

In the juvenile specimens the platform nodes are usually already developed (Pl. 1, fig. 9). The pit is more posterior with respect to the middle of the platform

PLATE 1

SEM micro-photographs of conodont species from the Pizzo Mondello section. Scale bars are 200 µm, all specimens are at the same scale. Three views for each specimen are provided: a = upper view; b = lateral view; c = lower view.

- Fig. 1 - *Carnepigondolella baloghi*. Mature growth stage, sample NA8.
- Fig. 2 - *Carnepigondolella carpathica*. Mature growth stage, sample NA10 (from Balini et al. 2010, Pl. 2, fig. 5).
- Fig. 3 - *Carnepigondolella carpathica* partly transitional to *Carnepigondolella pseudodiebeli*. Mature growth stage, sample NA14.
- Fig. 4 - *Carnepigondolella gulloae* n. sp. Holotype, mature growth stage, sample FNP134.
- Fig. 5 - *Carnepigondolella gulloae* n. sp. Mature growth stage, more posteriorly rounded morphotype, sample PM30a (from Mazza et al. 2010, Pl. 3, fig. 1).
- Fig. 6 - *Carnepigondolella gulloae* n. sp. Super-adult growth stage, sample FNP134.
- Fig. 7 - *Carnepigondolella gulloae* n. sp. Weakly ornamented form, sub-mature growth stage, sample PM30a.
- Fig. 8 - *Carnepigondolella gulloae* n. sp. Weakly ornamented form, mature growth stage, sample PM30a.
- Fig. 9 - *Carnepigondolella gulloae* n. sp. Sub-mature growth stage, sample PM30a.



than in the adult growth stages. This is typical of genus *Carnepigondolella*; in genus *Metapolygnathus* the pit is centrally located already in the juvenile growth stage specimens. The keel end bifurcation is usually less developed.

The super-adult growth stage specimens of *C. gulloae* n. sp. are very characteristic (Pl. 1, fig. 6). In this stage the platform increases in length and the margins become much thicker and broader. The posterior platform, in particular, shows a remarkable broadening and lateral enlargement, which is accompanied, on the lower side, by a stronger bifurcation of the keel end. The platform nodes increase in number and have the tendency to coalesce. In particular, the nodes behind the middle of the platform are particularly broadened and elongated perpendicularly to the carina, producing in this way a narrowing of the adcarinal groove towards the posterior end of the platform (Pl. 1, fig. 6).

A less ornamented morphotype may be distinguished inside the *C. gulloae* n. sp. population (Pl. 1, figs 7, 8). This form is characterized by a weaker ornamentation: the platform nodes are confined to the anterior margins and they are less developed. In some specimens of this morphotype the nodes are extremely fused together, producing a broadening of the platform. Sometimes the single nodes may be undistinguished but an undulation of the internal platform margins is well visible, indicating the presence of relict nodes (Pl. 1, fig. 7). All the other morphological characters of this morphotype are typical of *C. gulloae* n. sp.

Discussion. *Carnepigondolella gulloae* n. sp. coincides with "*Metapolygnathus communisti* B", a species illustrated by Krystyn (1980) but never formally established or described. This species is now here officially instituted and both a diagnosis and a holotype are provided. *C. gulloae* n. sp. was first recovered from Lower Norian beds (Lacian) of the Hallstatt Limestone in the Feuerkogel sections (Krystyn 1980), in northern Austria. This species is spread in the Tethyan and Neotethyan provinces in a short interval in the Lacian (lower Norian), and it first occurs everywhere just below the FAD of *Halobia austriaca* and above, or in correspondence with, the LO of *Metapolygnathus communisti* (Krystyn & Gallet 2002; Balini et al. 2010), as in the Pizzo Mondello section. The range of *C. gulloae* n. sp. in the Pizzo Mondello section thus coincides with its range in sections where it was first recovered. The only difference is the co-occurrence, in the Feuerkogel sections, of *C. gulloae* n. sp. with *N. navicula* and *C. pseudodiebeli*.

N. navicula is however a facies controlled taxon (Kozur 2003), thus its range may change in the various Tethyan regions, while the specimens assigned to *C. pseudodiebeli* in the Lacian (Krystyn 1980, Pl. 13, Figs. 4-6) are actually super-adult specimens of *C. gulloae* n.

sp. The same forms occur in fact together with *C. gulloae* n. sp. also at Pizzo Mondello and they differ from *C. pseudodiebeli* for the more arched profile of the blade, the broader platform nodes and the less terminal pit. Furthermore, *C. pseudodiebeli* has a very different posterior platform, more squared, flat and with up-turned corners.

We decided to rename "*M. communisti* B" into *C. gulloae* n. sp. to avoid misunderstandings on the phylogenetic relationships of this species. The original name, i.e. "*M. communisti* B", was in fact assigned to indicate that it was a possible subspecies of *M. communisti*. *C. gulloae* n. sp., instead, has no relationships with *M. communisti*, as already argued by Channell et al. (2003).

Recent cladistic analysis (Mazza et al. in press) confirms this hypothesis: *C. gulloae* n. sp. resulted, in fact, the sister group of *C. twvalica* n. sp. (named *C. nodosa* in Mazza et al. in press) and the two species form a basal branch of the *Metapolygnathus* lineage. As a consequence, *C. gulloae* n. sp. is not closely related to *M. communisti* and cannot even be considered as a species of the genus *Metapolygnathus*. *C. gulloae* n. sp. may be, instead, a Norian derivative of *C. twvalica* n. sp.

Comparisons with other species. *C. twvalica* n. sp. has a rounded posterior platform, smaller platform nodes and a less bifurcated keel end. *M. communisti* has a shorter platform, a centrally located pit, a long posterior keel prolongation and the platform nodes are smaller and confined to the geniculation point.

Stratigraphical range. Lower Lacian (lower Norian).

***Carnepigondolella orchardi* (Kozur, 2003)**

Pl. 2, figs 1-2

- 1980 *Epigondolella primitia* - Krystyn, pl. 13, fig. 1-3 (only).
- 1980 *Epigondolella abneptis abneptis* - Krystyn, pl. 13, fig. 9.
- 2003 *Epigondolella nodosa* - Channell et al., pl. A1, fig. 17, 23.
- 2003 *Epigondolella permica* - Channell et al., fig. 40, 42, 54, 56 (only); pl. A2, fig. 11, 19.
- 2003 *Epigondolella primitia* - Channell et al., pl. A1, fig. 44, 55.
- 2003* *Epigondolella orchardi* Kozur, p. 69-70, pl. 1, fig. 1, 2, 7a, 7b.
- 2007 *Epigondolella orchardi* - Nicora et al., pl. 3, fig. 7, 11.
- 2010 *Carnepigondolella orchardi* - Mazza et al., pl. I, fig. 11.
- 2010 *Carnepigondolella orchardi* - Balini et al., pl.2, fig.3.

Material: from 120 to 130 specimens from 18 samples.

Description. The platform is about 2/3 of the entire element length, larger towards the posterior margin and with parallel and thin lateral margins. The posterior platform is characterized by an evident constriction. The anterior margin bears three low and sharp denticles on the outer side of the platform and two on the inner side. The anterior platform tapers gradually

into a short anterior trough margin. The posterior margin of the platform is commonly smooth but it may be wavy in some specimens. The cusp is very large and it is the last denticle of the carina. A weak microcrenulation occurs on the platform margins and on the platform denticles. The pit lies a little behind the middle of the platform and it is terminal to slightly forwardly shifted with respect to the keel end. The keel is high and its termination is always bifurcated. Laterally the profile of the element is from arched to weakly stepped. The blade is high, composed of highly fused denticles and it descends gradually to the cusp. The free blade is short (2-3 denticles) and the cusp is separated from the rest of the carina.

Discussion. *Carnepigondolella pseudodiebeli* has a more posteriorly shifted pit, lower denticles and a longer platform. *Epigondolella miettoi* and *Epigondolella quadrata* have a more central pit and parallel platform margins with higher denticles.

Stratigraphical range. Upper Tuvanian (upper Carnian).

Carnepigondolella nodosa (Hayashi, 1968)

Pl. 2, figs 3-4

1968* *Gladigondolella abneptis* var. *nodosa* var. nov. Hayashi, p. 69, pl. 2, fig. 9.

1975 *Epigondolella carnica* sp. n. - Kristan-Tollmann & Kryszyn, p. 273-275, taf. 3, fig. 2-4.

1991 *Paragondolella nodosa* - Martini et al., pl. 19, fig. 10-15 (only).

1995 *Metapolygnathus carnicus* - Mastandrea, pl. 2, fig. 6.

Material: 8 specimens from 7 samples.

Description. The platform is 2/3 of the entire element, typically large in the centre and with a narrower posterior end. The platform margins are thin and upturned, and they bear round nodes which often reach the middle of the margins and lie perpendicular to the platform surface. The anterior trough margin is reduced and the free blade is composed of 2-3 denticles. The cusp is large and it is the last denticle of the carina. In some specimens it may be followed by a small accessory node. The pit lies near the middle of the platform and it is slightly forwardly shifted with respect to the keel end. The keel termination may be squared or slightly bifurcated. Laterally the element is slightly arched. The blade is anteriorly high and it descends quite rapidly towards the cusp. A low step occurs at the geniculation point.

Discussion. *C. tuvalica* n. sp. has a longer platform, parallel margins, a more posteriorly situated pit and the platform nodes are elongated into the adcarinal groove towards the carina. *C. baloghi* has a more rounded platform outline and larger and radially elon-

gated platform nodes. For more discussions on this species see the *C. tuvalica* n. sp. section.

Stratigraphical range. From upper Julian (lower Carnian) to middle/upper Tuvanian (upper Carnian). More typical in the Julian, *C. nodosa* occurs only as relict forms in the Tuvanian of Pizzo Mondello.

Carnepigondolella pseudoechinata (Kozur, 1990)

Pl. 2, fig. 5

1990* *Epigondolella pseudoechinata* Kozur, p. 430-431.

2003 *Epigondolella pseudoechinata* - Channell et al., pl. A2, figs. 14, 18, 24.

2007a *Carnepigondolella pseudoechinatus* - Orchard, fig. 1/4-6.

2010 *Epigondolella pseudoechinata* - Mazza et al., pl. II, fig. 1.

2010 *Carnepigondolella pseudoechinata* - Balini et al., pl. 2, fig. 6.

Material: from 30 to 40 specimens from 11 samples.

Description. This species is characterized by an extremely reduced platform with an ovoid outline. The platform margins are thick but with low parapets and they bear 2-3 low denticles. In the stratigraphically younger forms two very low denticles may occur on the rounded posterior margin. The cusp is undistinguished in size and it may be followed by another carinal node. The pit lies just behind the middle of the platform and it is slightly forwardly shifted with respect to the keel end. The keel termination may be squared or slightly bifurcated. Laterally, the element is straight, the blade is high and it descends gently towards the posterior margin. The free blade is long and it is composed of 5-6 highly fused denticles.

Discussion. *Epigondolella spatulata* has higher and more numerous denticles on the platform margins, they have no microcrenulation and the platform shape is more rounded. "*Metapolygnathus echinatus*" and *Metapolygnathus parvus* have a still shorter platform with a strongly forwardly shifted pit and the keel has a long posterior prolongation. *M. parvus* has no platform ornamentation.

Stratigraphical range. Upper Tuvanian (upper Carnian) - Lacyan (lower Norian).

Carnepigondolella pseudodiebeli (Kozur, 1972)

Pl. 2, figs 6-10

1972* *Metapolygnathus spatulatus pseudodiebeli* Kozur, p. 8-9, pl. 4, fig. 5.

2003 *Epigondolella pseudodiebeli* - Channell et al., pl. A1, fig. 45, 47.

2007 *Carnepigondolella pseudodiebeli* - Moix et al., pl.1, fig. 13.

2010 *Carnepigondolella pseudodiebeli* - Mazza et al., pl. I, fig. 9.

2010 *Carnepigondolella pseudodiebeli* - Balini et al., pl. 2, fig. 12.

Material: about 120 specimens from 36 samples; about 70 specimens of morphotype A from 19 samples; 42 specimens of morphotype B from 10 samples.

Description. The platform has a rectangular outline and it extends nearly to the anterior end, leaving a free blade of only 1-2 denticles. The posterior platform is always broader. The platform descends gently into a large anterior trough margin, with a low step at the geniculation point. The platform margins bear high and sharp nodes (5-6 in adult growth stages) which are elongated into the adcarinal groove in a rib-like fashion in the direction of the carina. The posterior end of the platform is smooth, but it commonly bears two denticulate ribs in correspondence to the two corners of the posterior margin. The cusp is separated from the rest of the carina, it is discrete in size, and it is usually the last denticle, but it may be followed by a smaller one. The pit lies in the posterior half of the platform and it is sub-terminal to the keel end. The keel termination has always a distinct bifurcation. Laterally, the lower profile is weakly stepped. The blade is high and it descends gradually towards the cusp.

Morphotype A (Pl. 2, Figs 7, 8) is distinguished for the slender platform, less sharp nodes and the larger anterior trough margin. The pit is a little bit more posterior in position, but never terminal.

Morphotype B (Pl. 2, Fig. 9) has a longer platform which bears more numerous and sharper nodes on the anterior and lateral margins. The lateral profile of the platform is more arched and the blade decreases more gradually into the carina.

Discussion. *C. pseudodiebeli* is very common in the Neotethys and in the Northern Tethys, but it is rare in North America, where it is replaced by the occurrence of abundant *Metapolygnathus primitius*.

Carnepigondolella samuelli differs for the occurrence of low denticles also on the posterior margin of the platform; compared with *C. orchardi*, this species has a longer and thicker platform, less sharp platform denticles and more posterior pit position.

Stratigraphical range. Middle/upper Tuvalian (upper Carnian) - uppermost Tuvalian (upper Carnian).

Carnepigondolella samuelli (Orchard, 1991b)

Pl. 3, figs 1, 2

1991b* *Metapolygnathus samuelli* Orchard, p. 318-9, pl. 1, fig. 10-12.

2007a *Carnepigondolella samuelli* - Orchard, fig. 1/22-24.

2007 *Carnepigondolella samuelli* - Nicora et al., pl. 1, fig. 5.

2008 *Carnepigondolella samuelli* - Celarc & Kolar-Jurkovsek, fig. 1/4.

2010 *Carnepigondolella samuelli* - Balini et al., pl. 2, fig. 13.

Material: about 50 specimens of *C. samuelli* from 10 samples; about 15 specimens of morphotype A from 3 samples.

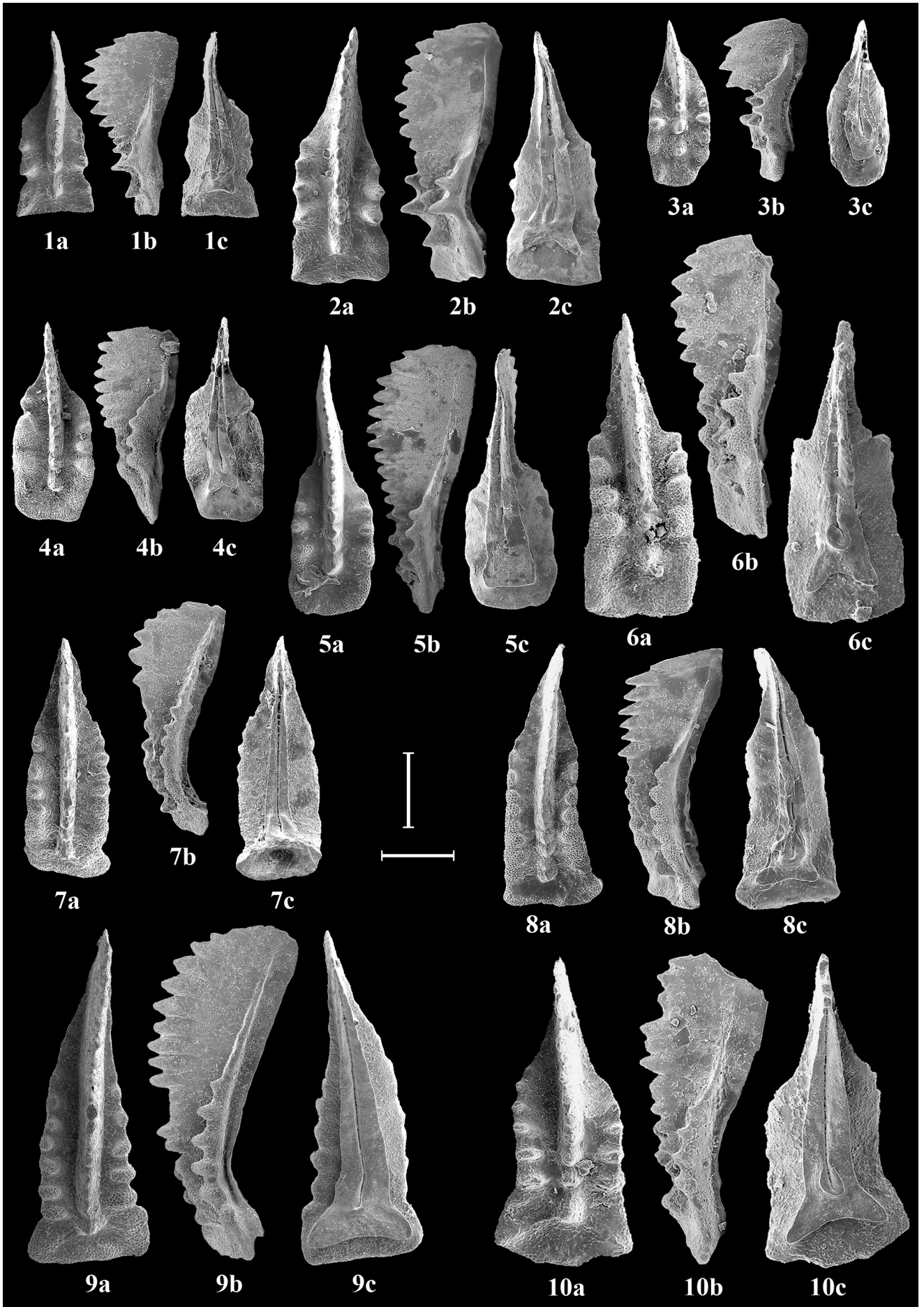
Description. The platform is rectangular in shape and it extends for 2/3 of the entire element, with a very reduced anterior trough margin. The main features of this species are the sharp and well separated low denticles that occur on both the lateral and the posterior margins. The free blade is composed of 3-4 denticles. The platform margins are thin and upturned. The cusp is the last denticle of the carina; it is undistinguished in size and separated from the other denticles. A typical constriction characterizes the posterior third of the platform. The pit lies always in the posterior third of the platform, it is sub-terminal to the keel end and it is surrounded by a prominent loop. The keel end is squared or bifurcated. The profile of the element is from straight to weakly arched. No step occurs at the geniculation point. The blade is high; it descends gradually anteriorly and posteriorly to the cusp with an arched profile.

Morphotype A (Pl. 3, Fig. 2): this morphotype is characterized by a shorter platform, with a more rounded posterior margin and sub-parallel lateral margins. The sharp nodes on the platform are higher and somehow more similar to denticles. The pit is more forwardly shifted.

PLATE 2

SEM micro-photographs of conodont species from the Pizzo Mondello section. Scale bars are 200 μ m, all specimens are at the same scale. Three views for each specimen are provided: a = upper view; b = lateral view; c = lower view.

- Fig. 1 - *Carnepigondolella orchardi*. Sub-mature growth stage, sample FNP53.
- Fig. 2 - *Carnepigondolella orchardi*. Mature growth stage, sample FNP88a.
- Fig. 3 - *Carnepigondolella nodosa*. Sub-mature growth stage, sample NA5.
- Fig. 4 - *Carnepigondolella nodosa*. Mature growth stage, sample NA9.
- Fig. 5 - *Carnepigondolella pseudoechinata*. Mature growth stage, sample NA25 (from Balini et al. 2010, Pl. 2, fig. 6).
- Fig. 6 - *Carnepigondolella pseudodiebeli* central morphotype. Mature growth stage, primitive specimen, partly transitional from *Carnepigondolella carpathica*, sample NA21.
- Fig. 7 - *Carnepigondolella pseudodiebeli* morphotype A. Mature growth stage, FO, sample NA0.
- Fig. 8 - *Carnepigondolella pseudodiebeli* morphotype A. Mature growth stage, sample FNP53a (from Mazza et al. 2010, Pl. I, fig. 10).
- Fig. 9 - *Carnepigondolella pseudodiebeli* morphotype B. Mature growth stage, sample NA25a.
- Fig. 10 - *Carnepigondolella pseudodiebeli* central morphotype. Mature growth stage, typical upper Tuvalian specimen, sample NA24 (from Mazza et al. 2010, Pl. I, fig. 9).



Discussion. The Neotethyan representatives of *C. samueli* have some differences with the North American holotype (Peril Formation, Kunga Group, on the Queen Charlotte Islands, British Columbia): the platform is less slender and less squared and the sharp nodes on the posterior platform margin are more numerous. This advanced *Carnepigondolella* is spread in North America but rare in the Tethys, where *C. pseudodiebeli* is more common in the same stratigraphical interval in the upper Tuvalian (Channell et al. 2003; Noyan & Kozur 2007). However, the two species are very similar and *C. samueli* differs from *C. pseudodiebeli* mainly for the occurrence of sharp nodes also on the posterior margin of the platform, which are absent in *C. pseudodiebeli*, and for the thinner and shorter platform.

Stratigraphical range. Upper Tuvalian (upper Carnian).

***Carnepigondolella tuvalica* n. sp.**

Pl. 3, figs 3-10

1980 *Gondolella nodosa* - Krystyn, pl. 12, fig. 1-7.

1980 *Epigondolella primitia* - Krystyn, pl. 13, fig. 5 (only).

1991a *Metapolygnathus nodosus* - Orchard, pl. 2, fig. 9-13.

2001 *Paragondolella carpathica* - Muttoni et al., fig. 10/3a-b.

2003 *Epigondolella nodosa* - Channell et al., pl. A1, fig. 14, 15, 19, 20, 21, 24, 25, 28, 30, 31, 32, 33, 37, 38.

2007 *Paragondolella nodosa* - Rigo et al., fig. 5/1.

2007 *Carnepigondolella pseudodiebeli* - Nicora et al., pl. 3, fig. 4.

2007 *Metapolygnathus pseudoechinatus* - Rigo et al., fig. 5/5.

2007b *Metapolygnathus carpathicus* - Orchard, pl. 1, fig. 20-25 (only).

2007b *Metapolygnathus nodosus* - Orchard, pl. 1, fig. 11-19.

2010 *Carnepigondolella nodosa* - Mazza et al., pl. I, fig. 4.

2010 *Carnepigondolella nodosa* - Balini et al., pl. 2, fig. 2-3.

Origin of the name: for its very common occurrence in the Tuvalian.

Holotype: the specimen illustrated in Pl. 3, Fig. 4.

Material: about 300 specimens of *C. tuvalica* n. sp. from 44 samples; about 70 specimens of morphotype A from 18 samples.

Type horizon: Bed NA2 of the Pizzo Mondello section, a white micritic calcilutite with black-brown cherty nodules and rich in halo-biids, belonging to the Scillato Fm [upper Tuvalian (Carnian), Upper Triassic].

Type locality: Pizzo Mondello section (Monti Sicani, Western Sicily, Italy), the abandoned quarry ("la Cava" locality) on the south-western slope of Pizzo Mondello Mountain.

Repository: MPUM 10873 in the Dipartimento di Scienze della Terra "A. Desio" (Università degli Studi di Milano).

Diagnosis: Conodont with a long platform characterized by a wide and long anterior trough margin, with parallel platform margins. The anterior margins of the platform bear rounded nodes, laterally elongated into the adcarinal groove. The nodes occur also on the lateral margins. The cusp is larger than the other carinal nodes and usually in terminal position. The pit lies in the posterior half of the platform and is slightly forwardly shifted with respect to the keel end. A high step occurs at the geniculation point.

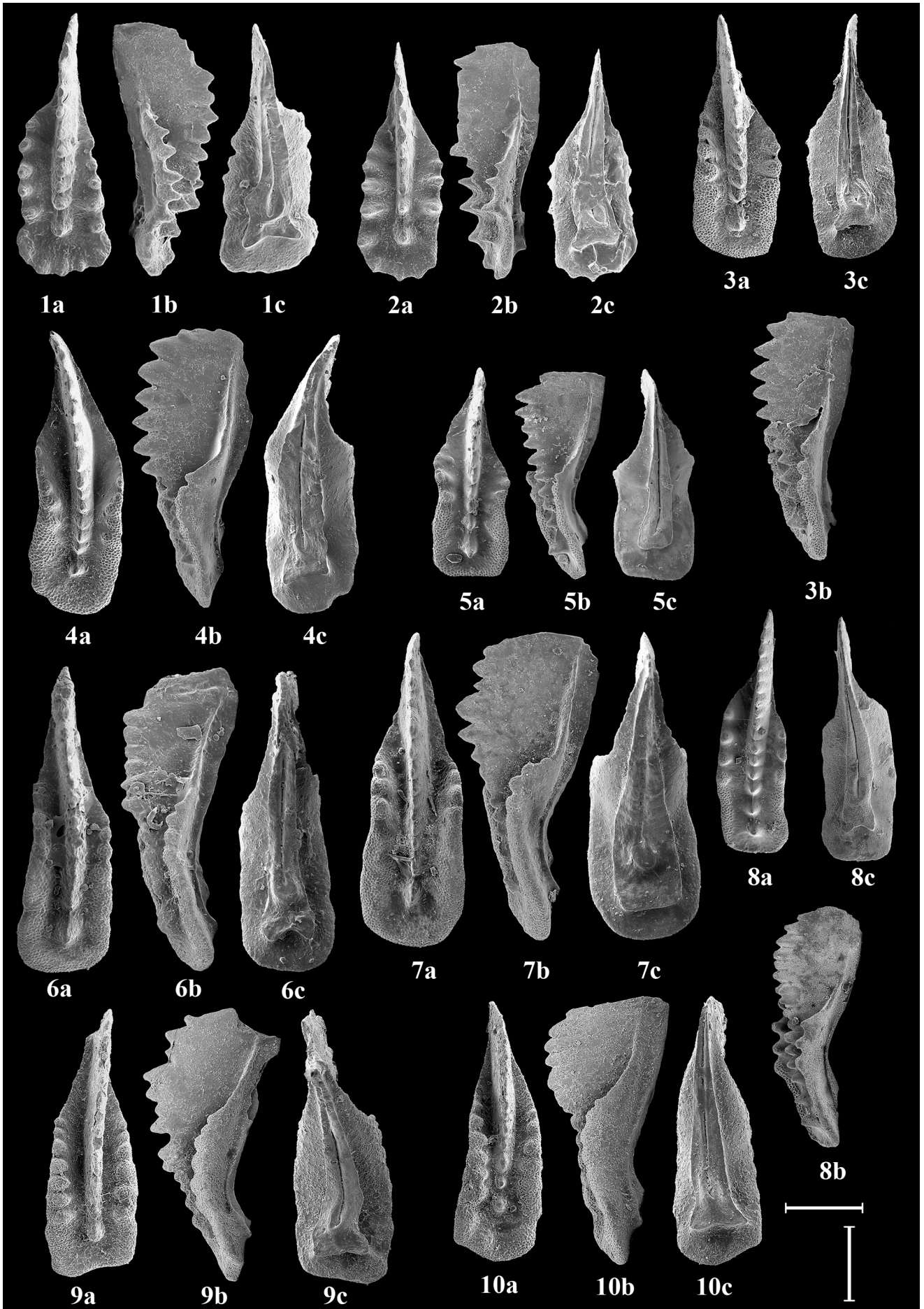
Description. The platform is more than 2/3 of the entire element length; it is characterized by thick and

broad sub-parallel margins and a rounded or sub-squared posterior end. The anterior margins of the platform bear from 3 to 4 rounded nodes, which are elongated into the adcarinal groove in the direction of the carina; the nodes are often developed also on the lateral margins of the platform. In some specimens a lateral compression in the middle of the platform may occur, producing a slight enlargement of the anterior margin in correspondence of the geniculation point (Pl. 3, figs 4, 5). The anterior trough margin is very developed, leaving a free blade of only 2-3 denticles. The cusp is large and strongly backwardly inclined. It is usually the last denticle but, in some specimens, it may be followed by one smaller carinal node. The pit lies in the posterior half of the platform, it is surrounded by a very prominent loop and it is slightly forwardly shifted with respect to the keel end. The keel termination may be squared or slightly bifurcated. Laterally, the element is slightly arched. The blade is anteriorly high and it descends gradually into a low carina with fused nodes. The platform margins descend into the anterior trough margin with a high and rounded step.

PLATE 3

SEM micro-photographs of conodont species from the Pizzo Mondello section. Scale bars are 200 µm, all specimens are at the same scale. Three views for each specimen are provided: a = upper view; b = lateral view; c = lower view.

- Fig. 1 - *Carnepigondolella samueli* central morphotype. Mature growth stage, sample NA24 (from Nicora et al. 2007, Pl. 3, fig. 5).
- Fig. 2 - *Carnepigondolella samueli* morphotype A. Mature growth stage, sample FNP53.
- Fig. 3 - *Carnepigondolella tuvalica* n. sp. central morphotype. Sub-mature growth stage, sample NA8.
- Fig. 4 - *Carnepigondolella tuvalica* n. sp. Holotype, mature growth stage, sample NA2.
- Fig. 5 - *Carnepigondolella tuvalica* n. sp. central morphotype. Juvenile growth stage, sample NA15 (from Mazza et al. 2010, Pl. I, fig. 4).
- Fig. 6 - *Carnepigondolella tuvalica* n. sp. Morphotype with a slightly bifurcated keel end, mature growth stage, sample FNP53.
- Fig. 7 - *Carnepigondolella tuvalica* n. sp. Morphotype with a more pronounced posterior prolongation of the keel, mature growth stage, sample NA14.
- Fig. 8 - *Carnepigondolella tuvalica* n. sp. Morphotype with an accessory carinal node behind the cusp, sub-mature growth stage, sample NA19.
- Fig. 9 - *Carnepigondolella tuvalica* n. sp. morphotype A. Mature growth stage, sample NA10.
- Fig. 10 - *Carnepigondolella tuvalica* n. sp. morphotype A. Mature growth stage, sample PM6a.



Morphotypes. The *C. tuvalica* n. sp. population is characterized by a discrete intraspecific variability. The characters most interested in this variability are three:

i) the number of the nodes on the platform margins: they usually occur in the number of 3-4 on the anterior margins of the platform but, if they increase in number they may reach also the middle of the platform;

ii) the occurrence of accessorial nodes behind the cusp: usually the cusp is the last denticle of the carina, but in some specimens or in the most adult growth stages, it may be followed by one smaller accessorial node (Pl. 3, fig. 8);

iii) the length of the posterior keel: the pit is never completely terminal to the keel end, but a reduced posterior prolongation is usually present. In some specimens, this prolongation is more pronounced, even if always less developed than in the metapolygnathids (Pl. 3, figs. 6-8).

Besides these intraspecific variations, a well defined morphotype is also recognisable.

Morphotype A (Pl. 3, figs. 9, 10). This morphotype is characterized by a narrow and long platform which extends almost to the anterior end, with sub-parallel lateral margins, provided with rounded nodes on the anterior margins. Typical of this form is the very thick platform margins, in particular the posterior one, which embeds the terminal portion of the carina. The anterior trough margin is more reduced, but the free blade is very short, being composed of 1-2 denticles. The cusp is discrete in size and it is the last denticle of the carina. In some specimens a small accessorial node placed on the posterior margin may follow the cusp. Laterally, the element is very arched and a very high and rounded step occurs at the geniculation point.

Discussion. *C. tuvalica* n. sp. corresponds to that form, very common in the Tuvalian, which has always been referred until now to *Carnepigondolella nodosa*. Its institution has the aim to solve the numerous biostratigraphic issues generated in the Carnian by the unconditioned use of the name *C. nodosa* to indicate a large variety of forms. The problems related to *C. nodosa* are due to the uncertain age and the scarce illustration of the holotype. The holotype of *C. nodosa* (Hayashi 1968) derives from cherts of the Adoyama Formation (Ashio Mountains, Japan) which was originally regarded as Permian but, according to the conodont fauna illustrated in Hayashi (1968), appears to span Ladinian to early Norian in age (Moix et al. 2007). *C. nodosa* may thus range from the late Longobardian to the early Norian. During the years, this name has been then used to indicate forms typical in the Tuvalian and similar to the holotype but, given the very low photographic quality of the original plate, without giving much attention to its true morphological characters. Actually, there are

several differences between the holotype of *C. nodosa* and the Tuvalian forms. Careful studies of the holotype by Kozur (Kozur in Moix et al. 2007 and Noyan & Kozur 2007) revealed that the *C. nodosa sensu* Hayashi differs from the supposed Tuvalian specimens for the enlargement in the middle of the platform and the strongly upturned and narrow lateral platform margins with nodes that are perpendicular to the platform surface. Thanks to the great abundance of *C. tuvalica* n. sp. in the Pizzo Mondello section, we could also observe other important differences between the Tuvalian forms and the holotype of *C. nodosa*: the platform of *C. tuvalica* n. sp. is longer and with a well developed anterior trough margin (absent in the holotype of *C. nodosa*) and the pit is clearly in the posterior half of the platform, while in *C. nodosa* it is more forwardly shifted, almost centrally located.

Krystyn (in Kristan-Tollman & Krystyn 1975) found another form similar to the holotype of *C. nodosa* also in the Julian of the Antalya nappes in southern Turkey and, given its different age, he established a new species, *Epigondolella carnica*. Kozur (2003) observed that *C. carnica* is more similar to the holotype of *C. nodosa* than the Tuvalian forms and, thus, he argued that *C. carnica* should be considered as the true *C. nodosa*. In Moix et al. (2007), the authors suggested that if the features which characterize the holotype (see above) are present, these forms should be assigned to *C. nodosa*, independently from a late Julian or a Tuvalian age. In Noyan & Kozur (2007), instead, the authors suggest that if the Julian and Tuvalian forms are different species, it would be better to suppress the name *C. nodosa*, and then use the name *C. carnica* for the Julian forms and *C. zoeae* for the Tuvalian forms. Since the upper Tuvalian forms of *C. nodosa* are not all similar to *C. zoeae*, but they have different and well identifiable characters, not all upper Tuvalian *C. nodosa* can be regarded as *C. zoeae*.

The remarkable morphological differences between the Julian and Tuvalian forms of *C. nodosa* (the different length of the platform and the position of the pit in particular) lead us to believe that they belong to different species. New detailed phylogenetic studies, based also on cladistic analyses (Mazza et al. in press), support this argument showing that the two species has no phylogenetic relationships. The Tuvalian form (i.e. *C. tuvalica* n. sp.) has instead a strict relation with *Paragondolella noah*, which is very probably its ancestor.

We thus propose to proceed as following:

- all the Tuvalian forms that have always been referred to *C. nodosa* should be referred to *C. tuvalica* n. sp.;
- the names *C. nodosa* and *C. carnica* are synonyms and they should be used only for all the Julian-

Tuvalian forms with exactly the same morphological characters of the holotype.

Comparisons with other species. *C. carpathica* has a more sub-terminal pit, a squared posterior end and fewer nodes on the platform margins. *C. pseudo-diebeli* has a squared posterior platform, a bifurcated keel end and sharper nodes on the platform margins. *Carnepigondolella zoeae* has a more slender platform, larger nodes and a well developed posterior constriction. *Metapolygnathus praecommunisti* has a longer posterior keel prolongation and fewer nodes on the platform margins.

Stratigraphical range. Upper Tuvalian (upper Carnian).

***Carnepigondolella zoeae* (Orchard, 1991b)**

Pl. 4, figs. 1-3

1991a *Metapolygnathus* n. sp. F Orchard, pl. 1, fig. 7-11.

1991b* *Metapolygnathus zoeae* Orchard, p. 319-320, pl. 1, fig. 7-9.

2003 *Paragondolella carpathica* - Channell et al., pl. A1, fig. 7.

2003 *Epigondolella nodosa nodosa* - Channell et al., pl. A1, fig.

37.

2003 *Epigondolella nodosa zoeae* - Channell et al., pl. A1, fig. 16, 34, 39.

2010 *Carnepigondolella nodosa* B - Mazza et al., pl. I, fig. 5.

2010 *Carnepigondolella zoeae* - Mazza et al., pl. I, fig. 7.

2010 *Carnepigondolella zoeae* B - Mazza et al., pl. I, fig. 8.

2010 *Carnepigondolella zoeae* - Balini et al., pl. 2, fig. 7.

Material: about 200 specimens of *C. zoeae* from 37 samples; about 90 specimens of morphotype A from 21 samples; about 45 specimens for morphotype B from 18 samples.

Description. The platform is 2/3 of the entire element, with a rounded posterior end, parallel and broad lateral margins. The posterior third of the platform is characterized by a constriction which is usually strongly pronounced. Peculiar to this species are the very large and well rounded nodes that occur on the lateral platform margins. The anterior trough margin is reduced and the free blade is composed of 3-4 denticles. The cusp, which is the last node of the carina, is large, strongly backward inclined and separated from the preceding carinal nodes. All the carinal nodes between the cusp and the blade are widely separated from each other. The pit lies always behind the middle of the platform and it is slightly forwardly shifted with respect to the keel end. The termination of the keel may be squared or rounded, but never bifurcated. Laterally, the element is arched and a low step occurs at the geniculation point. The blade is high and it decreases abruptly with an evident step into a low carina. The carina is low beneath the platform margins.

Morphotype A (Pl. 4, Fig. 2). This morphotype is longer and the platform more slender, with more numerous nodes on the lateral margins. In some specimens

the posterior platform is more squared and an additional and small accessorial node may occur behind the cusp. In the very adult growth stages a short prolongation of the keel may occur behind the pit.

Morphotype B (Pl. 4, fig. 3). This morphotype is resembled in the *C. zoeae* population for the occurrence of large and rounded nodes on the lateral platform margins, typical of this species. It differs from the central morphotype of *C. zoeae* mainly for the broader platform, for an enlargement at the beginning of the platform, for a wider anterior trough margin and a slightly bifurcated keel termination.

Discussion. *C. zoeae* differs from the metapolygnathids for the position of the pit in the posterior half of the platform and the large nodes on the lateral margins. Furthermore the metapolygnathids have a longer posterior prolongation of the keel.

Stratigraphical range. Upper Tuvalian (upper Carnian). All the morphotypes have the same stratigraphic range.

Genus *Epigondolella* Mosher, 1968

Type species: *Polygnathus abneptis* Huckriede, 1958

Description. The most diagnostic features of this genus are the occurrence of high denticles on the lateral margins of the platform and, in some species, also on the posterior margin; the centrally located pit; the relatively short and flat platform; and the strong bifurcation of the keel end. The platform lacks of the strong microcrenulation characterizing most of the other Upper Triassic genera and it is replaced by a weak reticulation on the platform margins and denticles. This feature is probably the result of the progressive flattening of the platform margins and the evolution of nodes into denticles, which produces a sort of stretching of the pre-existing honeycomb structure and, thus, the development of this reticulation. The anterior trough margin is always extremely reduced or absent.

Discussion. *Epigondolella* differs from *Carnepigondolella* for the centrally located pit, the higher denticles on the platform margins and the shorter platform. *Epigondolella* differs from *Metapolygnathus* for the sub-terminal position of the pit with respect to the keel end, the more squared platform outline, the occurrence of high denticles on the platform margins and the flat platform.

Stratigraphical range. Uppermost Tuvalian (upper Carnian)-middle Norian (Alaunian).

***Epigondolella heinzi* Mazza, Cau & Rigo in press**

2010 *Epigondolella* n. sp. A - Balini et al., pl. 3, fig. 4.

in press* *Epigondolella heinzi* - Mazza et al., fig. 9/C-E

Material: 63 specimens from 4 samples.

Description. The platform is short (half element) and it has thin margins. Three or four sharp and low denticles occur on the lateral margins and four low nodes on the posterior. The platform rapidly tapers anteriorly, while posteriorly it is typically enlarged. The posterior margin, usually asymmetric on one side, is rounded, even if in some specimens it may be slightly squared. The anterior trough margin is reduced and the free blade is composed of 5-6 denticles. The cusp, which is the last node of the carina, is discrete in size and isolated. The pit is centrally located or slightly backwardly shifted, and it is terminal to the keel end. The keel termination is always bifurcated. The blade is high and it descends slowly anteriorly and posteriorly towards the cusp. The denticles of the blade are highly fused but the tips are separated.

Discussion. *E. heinzi* is a primitive *Epigondolella* since the platform denticles are still small, but it can be considered definitely an *Epigondolella* for the short and flat platform and for the centrally located pit. It is probably the forerunner of *Epigondolella spatulata* (see Mazza et al. in press for details). *E. heinzi* is similar to *Carnepigondolella* n. sp. N Orchard (2007b) and to *C. pseudoechinata*, but it differs from both for its more expanded posterior end, more denticulate platform margins, the bifurcated keel end and the more centrally located pit. *E. spatulata* has a more rounded platform outline and higher and larger platform denticles.

Stratigraphical range. Uppermost Tuvalian (upper Carnian).

Epigondolella miettoi Mazza, Cau & Rigo, in press

Pl. 5, fig. 1

- 1980 *Epigondolella primitia* - Krystyn, pl. 13, fig. 8.
 1983 *Epigondolella abneptis* subsp. A - Orchard, fig. 4P (only).
 1997 *Metapolygnathus primitia* - Buryi, pl. III, figs. 2-3.
 2003 *Epigondolella abneptis* - Channell et al., pl. A2, figs 16, 17,
 26.
 2007 *Epigondolella quadrata* - Noyan & Kozur, fig 4.1-4.4, 24.6,
 4.7.
 2007 *Epigondolella quadrata* - Nicora et al., pl. 3, fig. 8.
 2010 *Epigondolella quadrata* - Balini et al., pl. 3, fig. 5.
 in press* *Epigondolella miettoi* Mazza et al., fig. 9/F-H.

Material: 44 specimens from 7 samples.

Description. The platform is short, with a sub-rectangular outline, extended from half to two-thirds of the entire element and characterized by thin and parallel lateral margins covered by a "spider web" like micro-crenulation. Very typical of this species is the morphology of the posterior platform, which is squared, flat, with posterior-laterally pointed corners and it lacks any constriction or posterior enlargement. The anterior

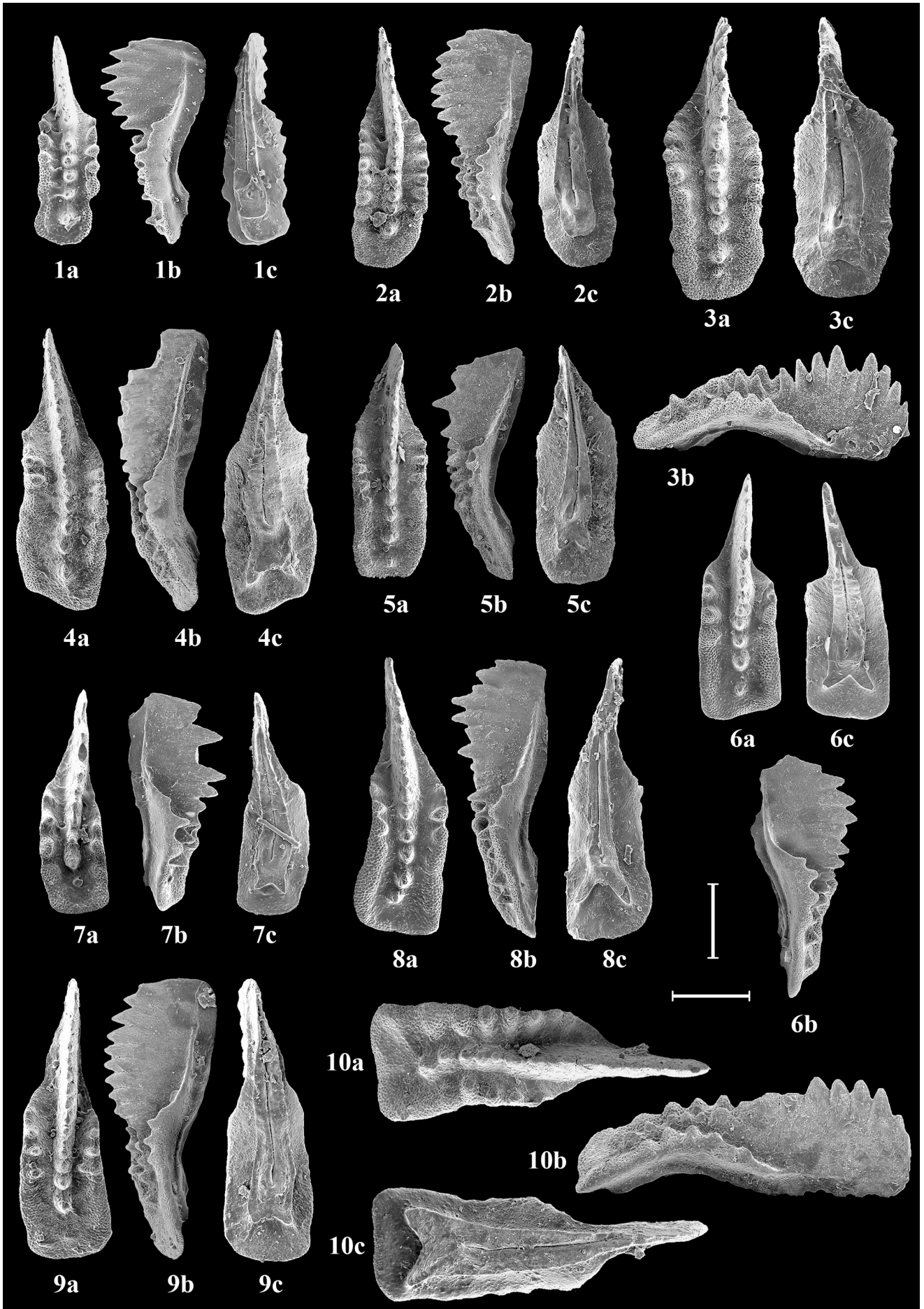
trough margin is reduced, leaving a short free blade of 3-4 denticles. The lateral margins of the platform bear usually 2 high and large denticles on the inner side and 3 on the outer side. The carina is composed by 2 low and fused nodes, which are followed by two further wide, separated nodes on the posterior platform. The cusp is the last node of this series of carinal nodes; it is larger in size than the other nodes and strongly backwardly inclined. The pit is narrow and surrounded by a prominent loop; it lies in the middle of the platform or slightly behind it. The keel termination is always bifurcated in correspondence to the pit. The lower profile of the element is stepped and the corners of the posterior margin are slightly upturned. The blade is high in its anterior part, with lower denticles at its frontal termination and it decreases gradually into the low carina with an arched profile. A low step may occur at the geniculation point.

Discussion. *E. miettoi* is probably the most direct forerunner of *E. quadrata* (Mazza et al. in press). This species was considered in Mazza et al. (2010) and Balini et al. (2010) as a primitive form of *E. quadrata*. More detailed observations revealed that the size and the position of the cusp in *E. miettoi* are very different from true *E. quadrata*. In *E. miettoi* the last carinal node is strongly backwardly inclined and, thus, its attachment

PLATE 4

SEM micro-photographs of conodont species from the Pizzo Mondello section. Scale bars are 200 μ m, all specimens are at the same scale. Three views for each specimen are provided: a = upper view; b = lateral view; c = lower view.

- Fig. 1 - *Carnepigondolella zoae* central morphotype. Mature growth stage, sample PM19 (from Nicora et al 2007, Pl. 3, fig. 6).
 Fig. 2 - *Carnepigondolella zoae* morphotype A. Mature growth stage, sample NA8.
 Fig. 3 - *Carnepigondolella zoae* morphotype B. Mature growth stage, sample NA8 (from Mazza et al. 2010, Pl. I, fig. 5).
 Figs. 4, 5 - *Metapolygnathus mersinensis* central morphotype. Mature growth stages, sample FNP53 (fig. 4 is from Balini et al. 2010, Pl. 3, fig. 2).
 Fig. 6 - *Metapolygnathus mersinensis* morphotype A. Mature growth stage, sample FNP52.
 Fig. 7 - *Metapolygnathus mersinensis* morphotype A. Sub-mature growth stage, NA34 (from Nicora et al. 2007, Pl. 3, fig. 10).
 Fig. 8 - *Metapolygnathus mersinensis* morphotype A. Mature growth stage, sample NA22 (from Nicora et al. 2007, Pl. 3, fig. 3).
 Fig. 9 - *Metapolygnathus mersinensis* morphotype B. Mature growth stage, sample NA30.
 Fig. 10 - *Metapolygnathus mersinensis* morphotype B. Super-adult growth stage, sample NA32.



on the platform falls in correspondence to the pit. This is a substantial difference between *E. miettoi* and *E. quadrata*, because in *E. miettoi* this node becomes the cusp and not an accessorial carinal node as in true *E. quadrata*. In the more advanced forms of *E. miettoi*, closer to *E. quadrata*, an accessorial node on the posterior platform may occur, but it is always smaller than the cusp. Furthermore, *E. miettoi* is always smaller than mature *E. quadrata* and they have a different platform outline: in *E. miettoi* is sub-rectangular while in *E. quadrata* is posteriorly enlarged. In order to exclude the possibility that *E. miettoi* was a juvenile stage of *E. quadrata*, the growth series of *E. quadrata* have been provided from an almost monospecific sample (NA60), in which a very rich population of advanced *E. quadrata* occurs (Pl. 5). The most juvenile stages of *E. quadrata* have a more central pit than *E. miettoi* and the accessorial nodes behind the cusp, absent in *E. miettoi*, already occurs. Thus, the occurrence of a node behind the cusp is not a character acquired during the growth but it is diagnostic of *E. quadrata* from the most juvenile stages. Furthermore, in *E. miettoi* the platform is always longer than the platform of the juvenile specimens of *E. quadrata*. A comparison between the *E. quadrata* and the *E. miettoi* growth series would be useful for a still better separation of the two species, but there are not *E. miettoi* monospecific samples in the Pizzo Mondello section, thus it was not possible to reconstruct its growth series. *E. miettoi* is similar to *C. orchardi*, but it differs for the sub-rectangular platform outline, the shorter anterior trough margin, the bigger platform denticles, the more centrally located pit and the absence of the posterior constriction.

Stratigraphical range. Uppermost Tuvalian (upper Carnian).

***Epigondolella praetriangularis* Kozur & Moix, 2007**

2007* *Epigondolella praetriangularis* Moix et al., p. 292-293, pl. 1, fig. 9-11.

2007 *Epigondolella praetriangularis* - Nicora et al., pl. 4, fig. 5.

2010 *Epigondolella praetriangularis* - Balini et al., pl. 4, fig. 4.

Material: 3 specimens (very rare) from 1 sample.

Description. The platform is sub-triangular in shape, flat and very short (half of the entire element), with an extremely reduced anterior trough margin. The free blade is composed of 6-7 denticles. High denticles are present on the lateral margins of the platform and low and elongated denticles on the posterior one, where they occur usually in the number of three. The cusp is undistinguished in size and it is followed by a larger node separated from the rest of the carina. The pit is centrally located, surrounded by a smooth loop. The keel end is strongly bifurcated in correspondence to

the pit. Laterally the profile of the element is from straight to weakly stepped, never arched. The blade is very high in its anterior part and it decreases gradually towards the cusp. A low step occurs at the geniculation point.

Discussion. *E. praetriangularis* is recorded in the Meliata-Hallstatt and Kùre oceans in the Northern Tethys and now also in the Neotethys but, as pointed out by Moix et al. (2007), it is always rare.

C. samueli has a longer platform and the pit is backwardly shifted. *E. triangularis* has a longer platform and more denticles on the posterior margin.

Stratigraphical range. Lower Lacia? (lower Norian).

***Epigondolella quadrata* Orchard, 1991b**

Pl. 5, figs 2-10

1983 *Epigondolella abneptis* subsp. A - Orchard, fig. 4C-J, O (only).

1991b* *Epigondolella quadrata* Orchard, p. 311, pl. 2, fig. 1-3, 7-9, 10.

1996 *Metapolygnathus permicus* - Buryi, pl. 1, fig. 16.

2000 *Epigondolella quadrata* - Martini et al., pl. V, figs. 7-10.

2001 *Epigondolella quadrata* - Muttoni et al., fig. 10.6a.

2003 *Epigondolella abneptis* - Channell et al., pl. A2, fig. 31, 32, 36; pl. A3, fig. 8, 18.

2003 *Epigondolella primitia* - Channell et al., pl. A2, fig. 20.

2007 *Epigondolella quadrata* - Nicora et al., pl. 3, fig. 8a-b.

2008 *Epigondolella quadrata* - Celarc & Kolar-Jurkovšek, fig. 7/3.

2010 *Epigondolella quadrata* - Mazza et al., pl. II, fig. 2, 3; pl. III, fig. 8.

2010 *Epigondolella quadrata* - Mazza et al., pl. 3, fig. 7.

Material: about 370 specimens from 36 samples.

PLATE 5

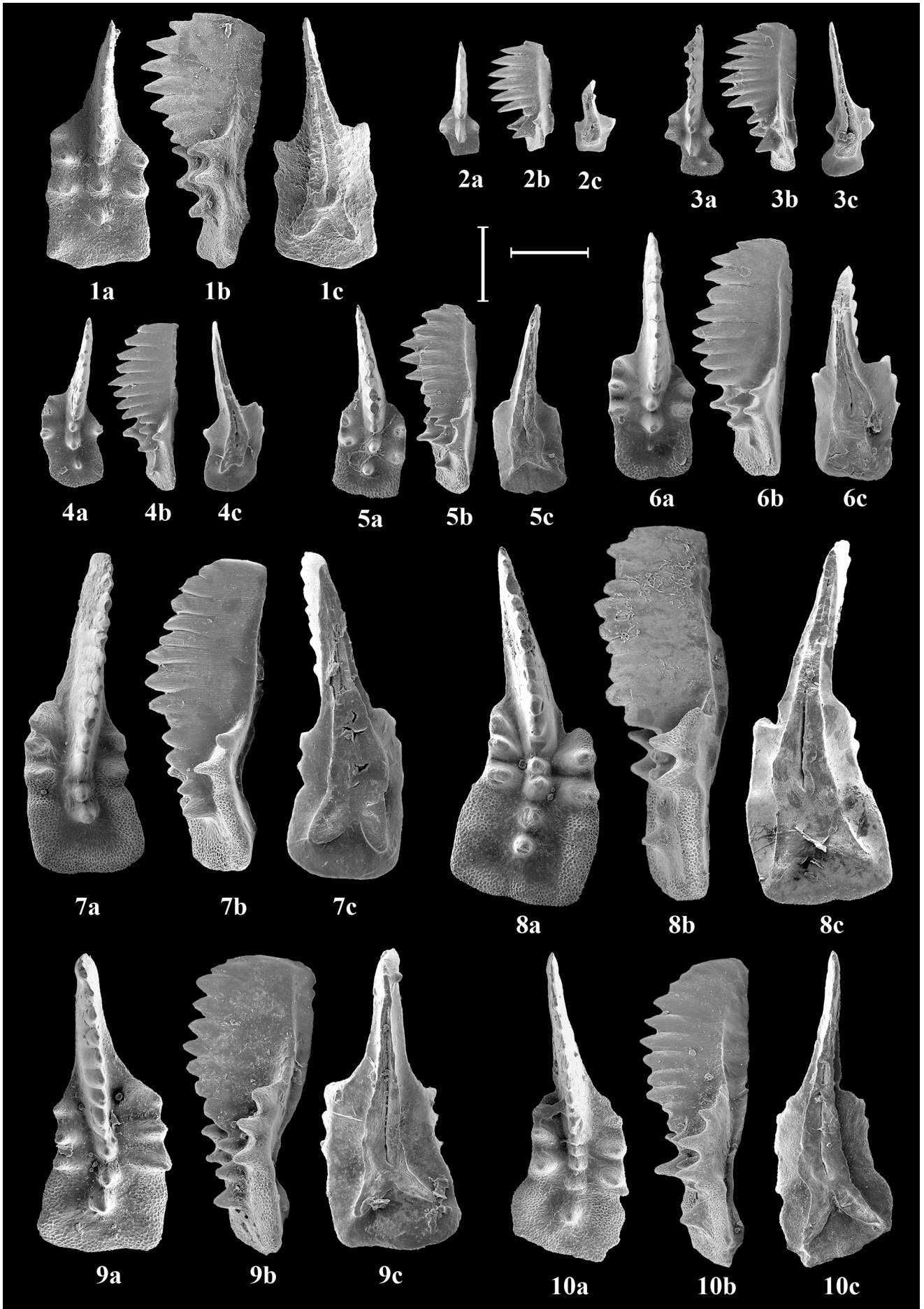
SEM micro-photographs of conodont species from the Pizzo Mondello section. Scale bars are 200 µm, all specimens are at the same scale. Three views for each specimen are provided: a = upper view; b = lateral view; c = lower view.

Fig. 1 - *Epigondolella miettoi*. Mature growth stage, sample FNP88a (from Mazza et al. 2010, Pl. II, fig. 2).

Figs. 2-8 - *Epigondolella quadrata* growth series. This sequence of images represents the growth series of advanced (i.e. stratigraphically young) *Epigondolella quadrata*, from the most juvenile stage (Fig. 2) to the super-adult stage (Fig. 8). All the specimens are from the same sample (NA60), in which only two species occur: *Epigondolella quadrata* and *Epigondolella rigoi*.

Fig. 9 - *Epigondolella quadrata*. Advanced morphotype, mature growth stage, sample NA58.

Fig. 10 - *Epigondolella quadrata*. Intermediate morphotype, mature growth stage, sample NA56.



Description. The platform is 2/3 of the element and is characterized by a squared, symmetrical posterior margin with posterior-laterally pointed corners. The posterior margin is usually enlarged, giving a more sub-triangular shape to the platform outline. The anterior trough margin is extremely reduced or absent. The long free blade is composed of 5-6 denticles. The lateral margins of the platform bear 2-3 high denticles on the inner side and 3-4 on the outer side. The carina is composed by 1-2 low and separated nodes followed by a larger one placed at the centre of the posterior platform. Behind it, a tiny accessorial node may occur near the posterior margin. The cusp is never the last denticle and it is undistinguished in size. The pit lies in the middle of the platform. The keel termination is bifurcated in correspondence to the pit. Laterally, the profile of the element is stepped and the corners of the posterior margin are slightly upturned. The blade is high in its anterior part and it decreases gradually into the low carina.

Discussion. We have distinguished two slightly different morphologies of *E. quadrata*: one is considered the most typical *E. quadrata*, very close to the holotype (Pl. 5, fig. 10), while the other is named “advanced form” and it is stratigraphically younger (see Figs. 1, 2). The advanced form (Pl. 5, figs. 2-9) differs from the more typical *E. quadrata* for the bigger size, a wider platform and, in particular, the thicker posterior margin. *E. quadrata* differs from *Epigondolella vialovi* for the absence of the constriction in the posterior third of the platform which occurs instead in *E. vialovi* and for the marginal node-like denticles on the posterior margin of the platform, absent in *E. quadrata*. *Epigondolella rigoi* has a sub-triangular platform which is posteriorly very widened and often asymmetrical, and it lacks the two carinal nodes behind the blade. *E. quadrata* has been confused in the past also with *Metapolygnathus primitius*, but the latter species differs from *E. quadrata* for the posterior prolongation of the keel, the thicker platform margins, the occurrence of nodes (even if high), and not denticles, on the lateral margins and the constriction at the posterior third.

Stratigraphical range. Uppermost Tuvalian? (upper Carnian) - Alaunian (middle Norian).

Epigondolella rigoi Noyan & Kozur, 2007

Pl. 6, figs 1-7

1983 *Epigondolella abneptis* - subsp. A Orchard, fig. 4A, B (only), 15E.

1991b *Epigondolella spatulata* - Orchard, pl. 2, fig. 4-6, 11.

2000 *Epigondolella quadrata* - Martini et al., pl. V, fig. 3,4.

2001 *Epigondolella spatulata* - Muttoni et al., fig. 10.9.

2003 *Epigondolella abneptis* - Channell et al., pl. A1, fig. 27, 30,

33.

2007 *Epigondolella rigoi* - Moix et al., p. 293.

2007* *Epigondolella rigoi* Noyan & Kozur, p. 167, fig. 6.2-6.5.

2007 *Epigondolella rigoi* - Nicora et al., pl.3, fig. 12; pl. 4, fig. 6.

2010 *Epigondolella rigoi* - Mazza et al., pl. II, fig. 5.

2010 *Epigondolella rigoi* - Balini et al., pl. 3, fig. 8.

Material: about 250 specimens from 28 samples.

Description. The platform has a typical sub-triangular shape and it is relatively short (2/3 of the element). The anterior trough margin is present but it is strongly reduced. The free blade is composed of 3-4 denticles. The lateral margins of the platform bear high denticles which are always more numerous on the outer side. The posterior platform is strongly widened, often with one lobe more developed than the other. The posterior margin is usually flat, but it may be slightly undulated (never ornate) in some specimens. The cusp is undistinguished in size, it is always the penultimate denticle of the carina and it is followed by a larger node. The pit lies in the middle of the platform. The keel is large and its termination is bifurcated. The bifurcation does not begin exactly in correspondence to the pit, but it is slightly backwardly shifted. Laterally the element is straight or slightly stepped. A low step at the geniculation point is present. The blade is high and it decreases rapidly but gradually towards the cusp.

Discussion. *E. rigoi* has the same sub-triangular platform and blade profile of *Epigondolella triangularis*, but the latter species bears denticles also on the posterior margin. *E. rigoi* differs from *E. quadrata* for the shorter and sub-triangular platform and a more expanded posterior end.

Stratigraphical range. Lower Lacin? (lower Norian) - Alaunian (middle Norian).

PLATE 6

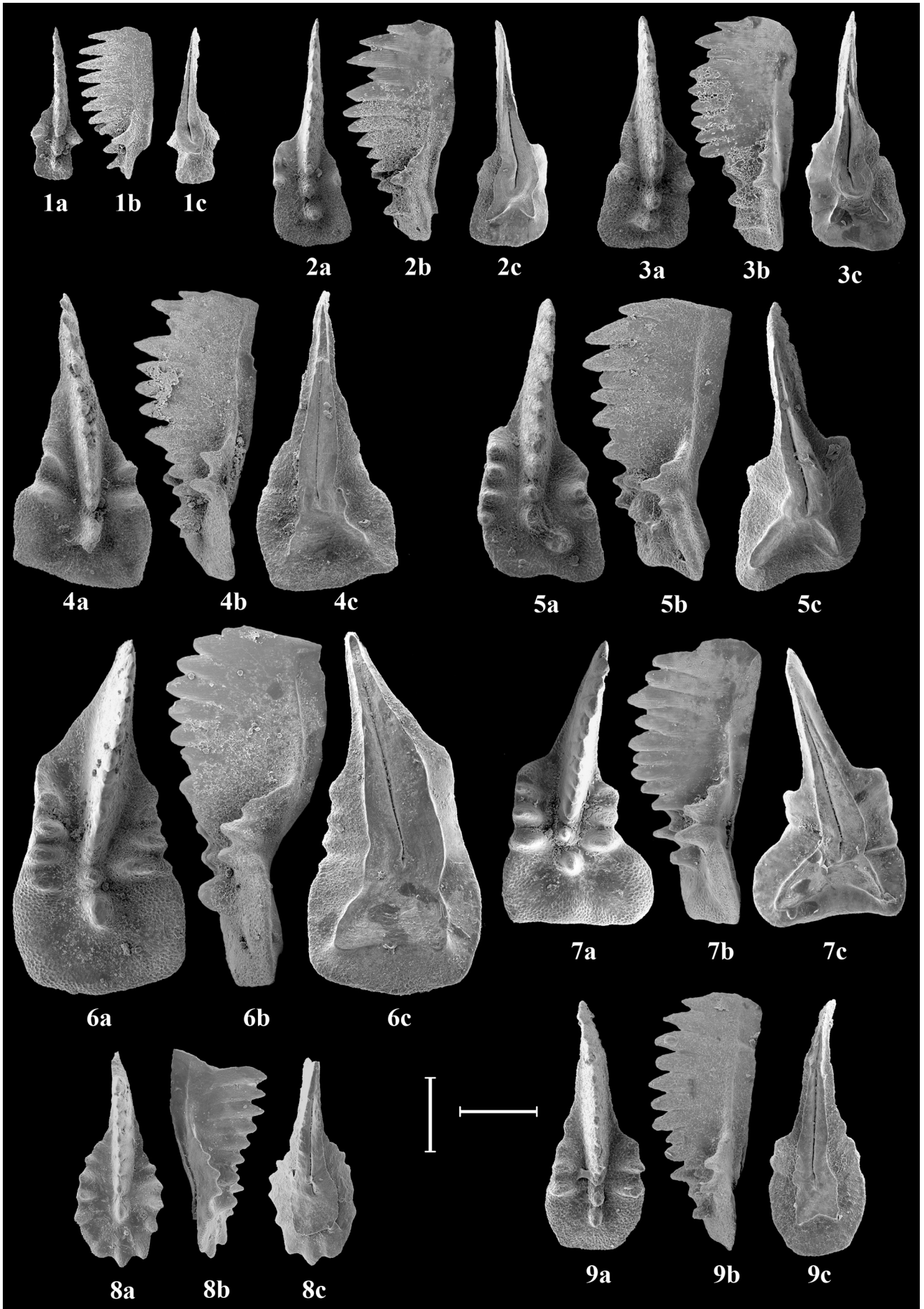
SEM micro-photographs of conodont species from the Pizzo Mondello section. Scale bars are 200 µm, all specimens are at the same scale. Three views for each specimen are provided: a = upper view; b = lateral view; c = lower view.

Fig. 1-6 - *Epigondolella rigoi* growth series. This sequence of images represents the growth series of *Epigondolella rigoi*, from the most juvenile stage (Fig. 1) to the super adult stage (Fig. 6). All the specimens are from sample NA59, in which only *Epigondolella quadrata*, *Epigondolella rigoi* and *Epigondolella* cf. *spatulata* occur.

Fig. 7 - *Epigondolella rigoi*. Mature growth stage, sample NA61.

Fig. 8 - *Epigondolella spatulata*. Mature growth stage, sample NA42 (from Mazza et al. 2010, Pl. III, fig. 6).

Fig. 9 - *Epigondolella* cf. *spatulata*. Mature growth stage, sample NA62.



Epigondolella spatulata (Hayashi, 1968)

Pl. 6, fig. 8

1968* *Gladigondolella abneptis* var. *spatulata* var. nov. Hayashi, p. 69, pl. 2, fig. 5.

1981 *Epigondolella abneptis* - Cafiero & de Capoa Bonardi, pl. 58, fig. 10.

2009 *Epigondolella spatulata* - Mazza et al., pl. III, fig. 5-6.

2010 *Epigondolella spatulata* - Balini et al., pl. 4, fig. 6.

Material: about 15 specimens from 11 samples.

Description. The platform is very short (less than half of the entire element), sub-circular or oval in shape, with a strongly reduced or absent anterior trough margin. The free blade is long and it is composed of 6-7 high denticles. The platform margins bear centrally radiated denticles that occur on the entire perimeter of the platform. The cusp is discrete in size; it is the last node of the carina and separated from it. The pit is centrally located and slightly forwardly shifted with respect to the keel end. The keel termination is squared. The profile of the element is from straight to weakly stepped. The blade is very high and it descends rapidly towards the cusp.

Discussion. The species here illustrated is very close to the holotype, which has a sub-circular platform outline (Hayashi, 1968, pl. 2, fig. 5). Nevertheless, in the original description of *E. spatulata*, forms with a spatula-like platform are inserted in the range of variability of the species as well. As a consequence, several lower Norian forms with a strongly reduced platform with a sub-triangular shape were named by different authors as *E. spatulata* (i.e. Orchard 1991b; Ishida & Hirsch 2001; Muttoni et al. 2001). These specimens are also characterized by a very short free blade and by a poorly ornate posterior margin, against the original illustration of the holotype. These forms, recovered also from the Pizzo Mondello section (sample NA58), are seemingly only juvenile growth stages of *E. rigo* (see Pl. 6). The growth series of *E. rigo* (Pl. 6), in fact, confirm that this species shows the typical sub-triangular platform outline already in the most juvenile growth stages, together with a short free blade. *E. spatulata* is instead here limited only to the forms with a sub-circular platform outline.

Stratigraphical range. Lower Lacyan (lower Norian).

Epigondolella cf. spatulata

Pl. 6, fig. 9

Material: 8 specimens from 2 samples.

Discussion. This species is identical to *E. spatulata* for all the characters, except for the ornamentation. *E. spatulata* has high and centrally radiated denticles on

all the platform margins; in *E. cf. spatulata*, instead, the denticles are lower and they occur only on the lateral margins. Also in *E. cf. spatulata* the platform denticles are centrally radiated.

C. pseudoechinata has a more elongated platform and the platform denticles are lower and fewer and perpendicular to the platform surface.

Stratigraphical range. Upper Lacyan (lower Norian).

Epigondolella triangularis (Budurov, 1972)

1972* *Ancyrogondolella triangularis* Budurov, p. 857, pl. 1, fig. 3-6.

1980 *Epigondolella abneptis spatulata* - Krystyn, pl.13, fig. 14.

1981 *Epigondolella abneptis* - Cafiero & de Capoa Bonardi, pl. 58, fig. 9.

1983 *Epigondolella abneptis* subsp. B - Orchard, p.181-3, fig. 6A,E,L,Q.

1991a *Epigondolella triangularis* - Orchard, pl. 4, fig. 13.

1991b *Epigondolella triangularis triangularis* - Orchard, p. 315, pl. 3, fig. 7-9.

1996 *Metapolygnathus spatulata* - Buryi, pl. 1, fig.1.

1997 *Ancyrogondolella triangularis* - Buryi, pl. II, fig. 16, 17.

2000 *Epigondolella triangularis* - Martini et al., pl. V, fig. 5-6.

2003 *Epigondolella triangularis* - Channell et al., pl. A3, fig. 88.

2010 *Epigondolella triangularis* - Mazza et al., pl. III, fig.9.

2010 *Epigondolella triangularis* - Balini et al., pl. 4, fig. 7.

Material: 12 specimens from 7 samples.

Description. The platform has a typical sub-triangular shape, relatively short (2/3 of the element) and with a strong widened posterior margin. The anterior trough margin is absent, leaving a free blade composed of 3-4 denticles. The lateral margins bear high denticles and the posterior one a strong denticulation. The cusp is undistinguished in size and it is never the last denticle of the carina. The pit lies in the middle of the platform. The keel is narrow and its termination is strongly bifurcated in correspondence to the pit. Laterally the element is straight, with a high anterior blade which remains constant towards its frontal termination. The blade is high and it descends quite gradually towards the posterior platform.

Discussion. *E. uniformis* has a rounded posterior platform and *E. vialovi* a weaker posterior ornamentation.

Stratigraphical range. Lower - upper Lacyan (lower Norian).

Epigondolella uniformis (Orchard, 1991b)

Pl. 7, fig. 1

1980 *Epigondolella abneptis spatulata* - Krystyn, pl. 13, fig. 12, 13.

1983 *Epigondolella abneptis* subsp. B - Orchard, p. 181-3, fig. 15G.

- 1983 *Epigondolella abneptis* subsp. B - Orchard, fig. 6D, G, M.
1991b* *Epigondolella triangularis uniformis* Orchard, p. 315, pl. 3, fig. 1-3.
1996 *Epigondolella multidentata* - Buryi, pl.1, fig. 22.
2003 *Epigondolella triangularis* - Channell et al., pl. A3, fig. 17, 38.
2003 *Epigondolella triangularis uniformis* - Channell et al., pl. A3, fig. 13.
2010 *Epigondolella uniformis* - Mazza et al., pl. III, fig. 7.
2010 *Epigondolella uniformis* - Balini et al., pl. 4, fig. 5.

Material: about 90 specimens from 9 samples.

Description. The platform is short (from half to 3/4 of the entire element) with sub-parallel margins and a rounded posterior end. The free blade is composed of 5-6 denticles and the anterior trough margin is extremely reduced. The lateral and posterior margins of the platform bear large and high denticles. The posterior denticles are radially projected on the platform margins. An enlargement of the posterior platform may often occur. The cusp is undistinguished in size and is not terminal in position. Behind the cusp, a large node typically occurs in the centre of the posterior platform. The pit is very narrow, with a hardly visible loop and located in the middle of the platform. The keel termination is bifurcated, but the bifurcation point is slightly backwardly shifted with respect to the pit, showing a slight posterior prolongation of the keel. Laterally the element is from straight to slightly stepped. The blade is high in its anterior part and it descends gradually and gently towards the posterior margins.

Discussion. *E. uniformis* is here considered as an independent species and not as a subspecies of *E. triangularis* as it was defined by Orchard (1991b). The rounded posterior shape of the platform, in fact, makes it believe that *E. uniformis* belongs to a different phylogenetic lineage than that of *E. triangularis*, which is instead characterized by a sub-triangular and angulated platform. *E. spatulata* has a shorter and more rounded platform.

Stratigraphical range. Laciaan (lower Norian) - Alaunian (middle Norian).

Epigondolella vialovi (Buriij, 1989a)

Pl. 7, figs 2, 3

- 1981 *Epigondolella abneptis* - Cafiero & de Capoa Bonardi, pl. 58, fig. 12.
1989a* *Metapolygnathus vialovi* Buriij, p. 47-48, pl. II, fig. 4-6, 8-11; pl. III, fig. 1-8.
1989b *Metapolygnathus vialovi* Buriij, p. 44-45, pl. V, fig. 1-8, pl. VI, fig. 5-10.
1997 *Metapolygnathus vialovi* - Buryi, pl. II, fig. 1-3, 6-11.
2003 *Epigondolella pseudodiebeli* - Channell et al., pl. A1, fig. 50.
2003 *Epigondolella abneptis* - Channell et al., pl. A2, fig. 27, 29.
2003 *Epigondolella triangularis* - Channell et al., pl. A2, fig. 39; pl. A3, fig. 16, 19, 20.

- 2008 *Epigondolella quadrata* - Celarc and Kolar-Jurkovšek, fig. 7/7.

- 2010 *Epigondolella vialovi* - Mazza et al., pl. II, fig. 4.
2010 *Epigondolella vialovi* - Balini et al., pl. 3, fig. 6.

Material: about 145 specimens from 32 samples.

Description. The platform is 2/3 of the total element length, with a very reduced anterior trough margin. The platform lateral margins are parallel and they get wider towards the posterior end, which may be rounded or slightly squared. Very typical of the species is the posterior platform: a weak constriction usually occurs at the posterior third and in its correspondence the platform is bent on one side; the posterior margin is wavy and it bears a few marginal node-like denticles. Occasionally, a small notch in the middle of the posterior margin divides it into two lobes. The lateral margins of the platform bear high and widely spaced denticles, which are rib-like elongated into the adcarinal groove perpendicularly to the carina. A very short carina, composed of 2-3 nodes, is present behind the blade. The cusp is undistinguished in size and it is followed by a larger and higher denticle placed in the centre of the posterior platform. The pit lies in the middle of the platform or slightly behind it and it is surrounded by a flat loop. The keel termination is always strongly bifurcated in correspondence to pit. The lateral profile is slightly stepped. The blade is high in the centre of its anterior part, but it descends quite rapidly both anteriorly and posteriorly, giving the blade a strongly arched profile.

Discussion. *E. vialovi* is a very common species in the Pizzo Mondello section. It is somehow similar to *E. quadrata*, but it differs for the longer lateral platform margins and for the morphology of the posterior platform, which is more widened and with node-like denticles on the margin. We believe that *E. vialovi* descends, together with *E. miettoi*, from the *C. pseudodiebeli*-*C. orchardi* lineage. *E. miettoi* evolves then in *E. quadrata* which, keeping a more squared and flat platform, probably evolves later in *E. rigoi*-*E. triangularis*. *E. vialovi*, instead, has a more widened, rounded and ornate platform, which probably evolves later directly into *E. uniformis* (see also Noyan & Kozur 2007 and Mazza et al. in press).

E. triangularis and *E. uniformis* bear higher and more numerous denticles on the posterior margin.

Stratigraphical range. Uppermost Tuvalian (upper Carnian) - upper Laciaan (lower Norian).

Genus *Metapolygnathus* Hayashi, 1968

Type species: *Metapolygnathus communisti* Hayashi, 1968

Description. This genus is characterized on the lower side by a very narrow basal cavity, hardly visible,

centrally located in primitive specimens and anteriorly shifted with respect to the middle of the platform in advanced forms. The keel shows a strong posterior prolongation behind the pit. The cusp is undistinguished in size and it is followed by two or more carinal nodes. The platform is robust but reduced and generally lacks ornamentation. In some species a few nodes may be present, but are always confined to the anterior platform margins or to the geniculation point. A distinct free blade is present, with highly fused denticles. The keel end is often, but not necessarily, bifurcated (emended diagnosis from Mazza et al. 2011).

Discussion. In the original diagnosis of genus *Metapolygnathus* there are no remarks about a very diagnostic character that characterizes the type species of this genus: the presence of a pronounced posterior prolongation of the keel behind the pit. Remarks concerning the occurrence of ornamentation on the platform margins are also absent. The image of the holotype (Hayashi, 1968, pl. 3, fig. 11), which is however hardly visible, seems to lack any kind of ornamentation on the platform margins. Nevertheless, the analyses of rich populations of true *Metapolygnathus communisti* (type species of the genus) from the Pizzo Mondello section reveals the occurrence of 1-2 tiny nodes confined to the geniculation point. According to a complete morphological and phylogenetic revision of this genus (Mazza et al. 2011, Mazza et al. in press), the assignment to genus *Metapolygnathus* is here restricted only to those species that have the combination of the following three characters: a well evident posterior prolongation of the keel end, a centrally or anteriorly located pit and the absence of ornamentation or, at most, the presence of tiny nodes confined at the geniculation point.

Genus *Paragondolella* differs from *Metapolygnathus* mainly for the sub-terminal position of the pit, the absence of the posterior prolongation of the keel, the long platform which covers almost the entire length of the element allowing the development of only a very short free blade, and the complete absence of nodes on the platform margins.

Genus *Carnepigondolella* is characterized by a pit placed behind the middle of the platform, or slightly behind it, but never so centrally located as in *Metapolygnathus*, and slightly forwardly shifted with respect to the keel end, but never so pronounced to generate a posterior prolongation as in *Metapolygnathus*, which is set between 1/4 up to half of the total keel length. Furthermore, genus *Carnepigondolella* shows a strong ornamentation on the platform anterior and lateral margins which is absent in genus *Metapolygnathus*.

Occurrence. From upper Tuvalian (upper Carnian) to lower Laciian (lower Norian).

Metapolygnathus communisti Hayashi, 1968

Pl. 8, figs 1-6

- 1968* *Metapolygnathus communisti* Hayashi, p. 72, pl. 3, fig. 1.
 1980 *Metapolygnathus communisti* - Krystyn, pl. 12, fig. 8, 9, 13, 14 (only).
 2001 *Metapolygnathus communisti* - Muttoni et al., fig. 10/4.
 2007 *Metapolygnathus communisti communisti* - Noyan and Kozur, p. 171, fig. 7.3, 7.5-7.8.
 2008 *Metapolygnathus communisti* - Celarc and Kolar-Jurkovšek, fig. 7/1.
 2010 *Metapolygnathus communisti* - Mazza et al., pl. II, fig. 6.
 2010 *Metapolygnathus echinatus* - Mazza et al., pl. II, fig. 8.
 2010 *Metapolygnathus parvus* - Mazza et al., pl. II, fig. 9.
 2010 *Metapolygnathus* cf. *primitius* - Mazza et al., pl. II, fig. 10.
 2010 *Metapolygnathus communisti* - Balini et al., pl. 3, fig. 10.

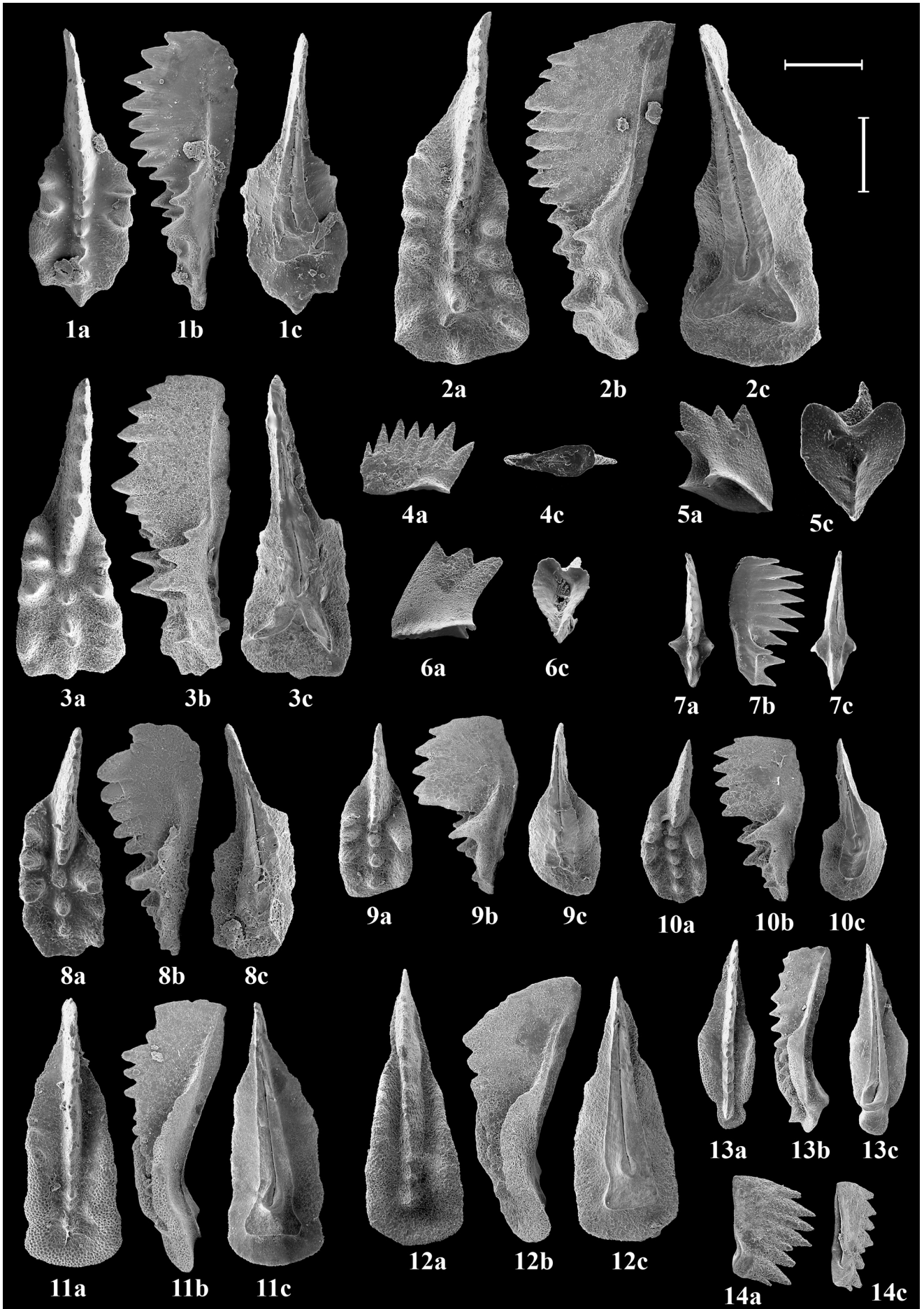
Material: about 240 specimens from 12 samples.

Description. The platform is about half of the entire element, with sub-parallel and thick lateral margins, covered by an intense microcrenulation. The anterior trough margin is absent. Few tiny nodes may occur at the geniculation point, which descends with a weak step into a very low rib on the two sides of the long free

PLATE 7

SEM micro-photographs of conodont species from the Pizzo Mondello section. Scale bars are 200 µm, all specimens are at the same scale. Three views for each specimen are provided: a = upper view; b = lateral view; c = lower view.

- Fig. 1 - *Epigondolella uniformis*. Mature growth stage, sample NA46.
 Fig. 2 - *Epigondolella vialovi*. Mature growth stage, sample FNP88a.
 Fig. 3 - *Epigondolella vialovi*. Mature growth stage, stratigraphically young specimen, sample NA66.
 Fig. 4 - *Misikella hermsteini*. Mature growth stage, sample NR59 (from Balini et al. 2010, Pl. 4, fig. 11).
 Fig. 5 - *Misikella ultima*. Mature growth stage, sample PG34 (from Balini et al. 2010, Pl. 4, fig. 13).
 Fig. 6 - *Misikella posthermsteini*. Mature growth stage, sample PG41 (from Balini et al. 2010, Pl. 4, fig. 12).
 Fig. 7 - *Mockina bidentata*. Mature growth stage, sample NR1 (from Balini et al. 2010, Pl. 4, fig. 9).
 Fig. 8 - *Mockina* aff. *tozeri*. Mature growth stage, sample PM68.
 Fig. 9 - *Mockina slovakensis*. Mature growth stage, sample NR5.
 Fig. 10 - *Mockina slovakensis*. Mature growth stage, sample NR5.
 Fig. 11 - *Paragondolella oertlii* central morphotype. Mature growth stage, sample NA19.
 Fig. 12 - *Paragondolella oertlii* morphotype A. Mature growth stage, sample NA18.
 Fig. 13 - *Paragondolella praelindae*. Sub-mature growth stage, sample NA4a.
 Fig. 14 - *Paragondolella andrusovi*. Mature growth stage, sample NR1 (from Balini et al. 2010, Pl. 4, fig. 10).



blade. The cusp is undistinguished in size and it is always followed by 3-4 carinal nodes. The pit lies always in the middle of the platform or it is even more forwardly shifted. The basal cavity is very narrow. Behind the pit, a long prolongation of the keel towards the posterior end of the platform always occurs. The keel termination may be bifurcated but it is more often irregular. In profile, the element is slightly stepped. The blade is high in its anterior part and it descends gradually into a low but long carina. The long free blade is composed of 6-10 denticles.

Discussion. *Metapolygnathus praecommunisti* has a more centrally located and less forwardly shifted pit, a longer platform and a shorter posterior prolongation of the keel. *Metapolygnathus linguiformis* has a longer and wider, sub-triangular platform with distinct posterior enlargement and a stronger bifurcated keel end. *Metapolygnathus parvus* has a shorter platform, ovoid in shape and no nodes on the platform margins occur.

Stratigraphical range. Uppermost Tuvalian (upper Carnian) - lowermost Lacion (lower Norian).

“Metapolygnathus echinatus” sensu Orchard (2007b)

Pl. 8, figs 7-8

2007 *Metapolygnathus echinatus* - Nicora et al., pl. 4, fig. 1,4.

2007b *Metapolygnathus echinatus* - Orchard, pl. 2, fig. 7-12, 22-24 (only).

2010 *Metapolygnathus echinatus* - Mazza et al., pl. II, fig. 8, 12.

2010 *Metapolygnathus echinatus* - Balini et al., pl. 3, fig. 11.

Material: about 18 specimens from 3 samples.

Description. The platform is sub-rectangular in shape; it has no anterior trough margin and is very reduced (less than half of the entire element). The platform margins bear from one to three tiny nodes. The cusp is undistinguished in size, it is separated from the rest of the blade and it is followed by another accessory node in the middle of the posterior platform. The pit is forwardly shifted in the anterior half of the platform. The basal cavity is narrow. The keel is prolonged behind the pit and its termination may be squared or pointed. Laterally, the element is straight, with a high blade composed by few and poorly fused denticles (8-10). The parapets are high, especially at the geniculation point, where they are upturned in a sort of cusp, generating an abrupt step.

Discussion. The name *M. echinatus* is here used for those conodonts which show the same morphology as the North American morphotype of “*M. echinatus*”, illustrated in Orchard (2007b). This species is very common in the Black Bear Ridge section but quite rare in the Pizzo Mondello section. The original holotype from Hayashi (1968) is very probably only a juvenile stage of *M. communisti*: the element has a very small size and the

denticles of the blade are well separated on both their tip and base. In the Upper Triassic platform elements, the occurrence of these two characters simultaneously is indicative of a juvenile growth stage. Thus, the Tethyan morphology of *M. echinatus* is actually referable to juvenile specimens of *M. communisti*. The North American morphotype has a very narrow platform, more rectangular in shape than the holotype, with more evident nodes on the margins. Furthermore, the free blade is longer and composed by highly fused denticles. The growth series of *M. communisti* illustrated in Pl. 8 shows the differences between juvenile specimens of *M. communisti* and “*M. echinatus*” sensu Orchard (2007b), characterized by a narrower platform and a longer free blade. We believe that this species should be renamed and the name *M. echinatus* (sensu Hayashi 1968) not to be used anymore. “*M. echinatus*” sensu Orchard (2007b) is not re-described in this work because this species is rare in the Pizzo Mondello section, while it occurs in very rich populations in North America. For this reason we believe that the diagnosis of the type species and type series should be based on North American material.

M. parvus differs from “*M. echinatus*” because it has an ovoid platform and no ornamentation on the margins.

Stratigraphical range. Lower Lacion? (lower Norian).

Metapolygnathus linguiformis Hayashi, 1968

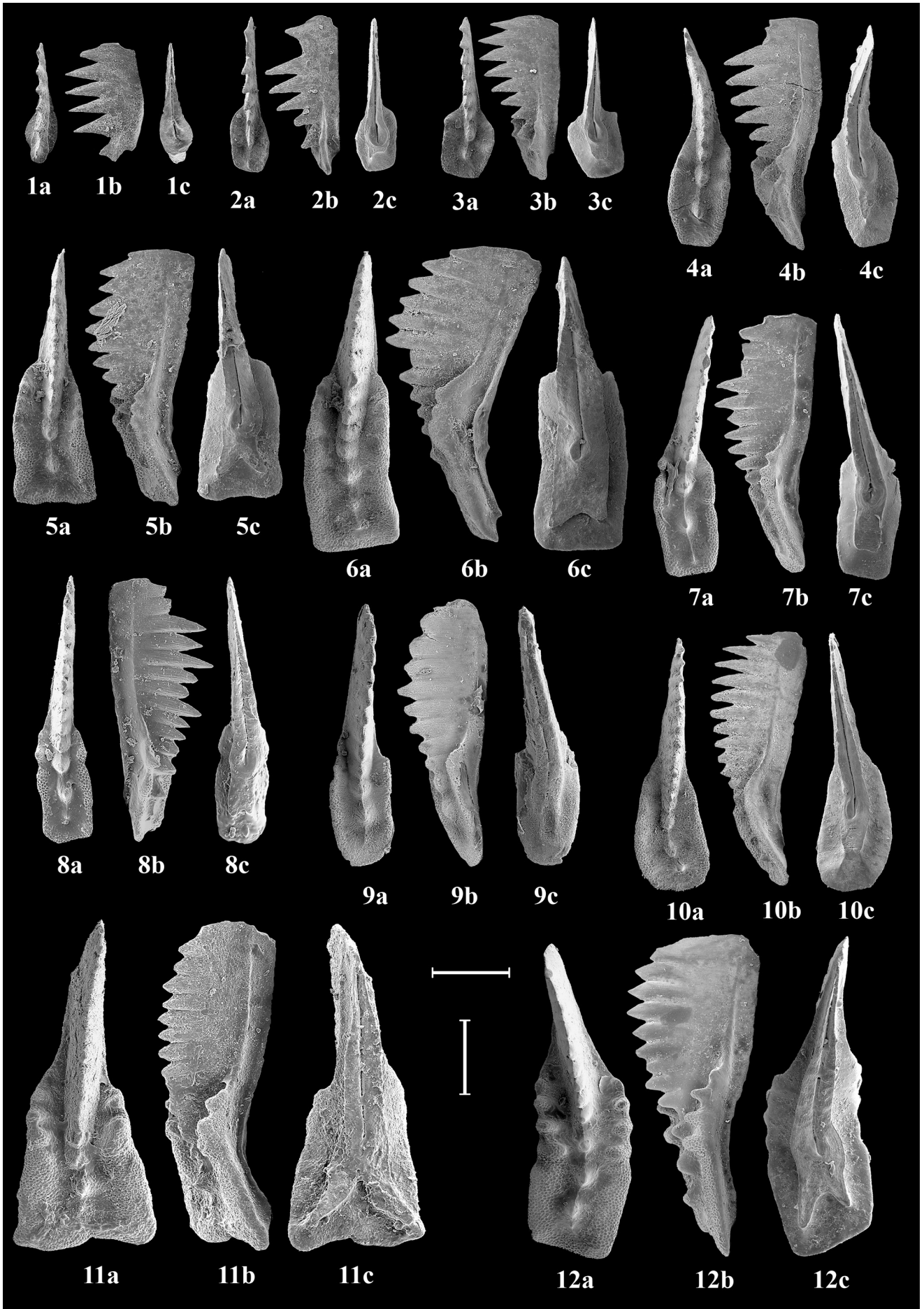
Pl. 8, fig. 11

1968* *Metapolygnathus linguiformis* gen. et sp. nov. Hayashi, p. 72, pl. 3, fig. 9.

PLATE 8

SEM micro-photographs of conodont species from the Pizzo Mondello section. Scale bars are 200 µm, all specimens are at the same scale. Three views for each specimen are provided: a = upper view; b = lateral view; c = lower view.

- Fig. 1-6 - *Metapolygnathus communisti* growth series. This sequence of images represents the growth series of *Metapolygnathus communisti*, from the most juvenile stage (Fig. 1) to the super-adult stage (Fig. 6). All the specimens are from sample NA37.
- Figs. 7-8 - “*Metapolygnathus echinatus*” sensu Orchard (2007b). Mature growth stage, sample NA39 (fig. 8 is from Mazza et al. 2010, Pl. II, fig. 12).
- Fig. 9 - *Metapolygnathus parvus*. Mature growth stage, sample NA38.
- Fig. 10 - *Metapolygnathus parvus*. Mature growth stage, sample NA40a.
- Fig. 11 - *Metapolygnathus linguiformis*. Mature growth stage, sample NA39 (from Balini et al. 2010, Pl. 4, fig. 1).
- Fig. 12 - *Metapolygnathus* cf. *primitius*. Mature growth stage, sample FNP134.



2010 *Metapolygnathus linguiformis* - Balini et al., pl. 4, fig. 1.

Material: about 20 specimens from 6 samples.

Description. The platform covers half of the entire element and is characterized by a tongue shape outline, very narrow anteriorly and wider posteriorly. The anterior trough margin is very reduced or absent. The free blade is composed of 8-10 denticles. The platform margins are thick and covered by an intense microcrenulation. The platform generally lacks of ornamentation, but 1-2 tiny nodes may occur at the geniculation point. A small notch that divides the posterior margin of the platform into two lobes usually occurs. The cusp is undistinguished in size and it is followed by 2 carinal nodes. The pit is located in the middle of the platform and the termination of the keel is strongly bifurcated. The two branches of the bifurcation are usually slightly curved towards the lateral margins of the platform and they reach the two posterior corners of the platform, generating almost two additional keels. The point of bifurcation is not in correspondence of the pit, but backwardly shifted. Laterally, the element is slightly arched in the posterior third. The blade is high anteriorly and it descends gradually towards the posterior margin in a short carina.

Discussion. *M. communisti* has a narrower platform, no posterior enlargement and the keel end is not so strongly bifurcated.

Stratigraphical range. Lower Lacián? (lower Norian).

Metapolygnathus mersinensis Kozur & Moix, 2007

Pl. 4, figs 4-10

2003 *Epigondolella primitia* - Channell et al., pl. A1, fig. 44, 53 (only); pl. A2, fig. 1-3.

2007* *Metapolygnathus mersinensis* Moix et al., p. 293, pl. 1, fig. 14, 15.

2007 *Metapolygnathus communisti* B - Nicora et al., pl. 3, fig. 3.

2007 *Metapolygnathus primitius* - Nicora et al., pl. 3, fig. 10.

2010 *Metapolygnathus mersinensis* - Balini et al., pl. 3, fig. 2.

Material: about 50 specimens from 17 samples; about 30 specimens of morphotype A from 6 samples; about 20 specimens of morphotype B from 5 samples.

Description. The platform is 2/3 of the entire element, with thick and parallel margins. In some forms a compression at the middle of the platform may occur. The posterior margin has usually an asymmetry which generates a more developed postero-lateral lobe on the outer side of the element. The anterior trough margin is quite developed in length but not in width. The free blade is composed by 2-3 denticles. The anterior margins of the platform bear tall nodes that are typically elongated into the adcarinal groove in the direction of

the carina. In some specimens the nodes reach the middle of the platform and both the platform margins and the nodes are covered by an intense microcrenulation. The cusp is undistinguished in size and it is followed by other 2 nodes of the same size. The pit is narrow and it is from centrally located to slightly backwardly shifted. The carina is prolonged behind the pit and its termination is always bifurcated. Laterally, the element is slightly arched. The blade is high anteriorly and it descends with a low step into a long carina that reaches the posterior margin of the platform.

Morphotype A (Pl. 4, figs 6-8). This morphotype is characterized by a slender and more symmetric platform outline, with a squared posterior margin. The nodes are fewer, less projected towards the carina and they are confined on the anterior margins of the platform. The pit lies in the same position as in the central morphotype but the posterior prolongation of the keel is shorter. The step at the geniculation point is more pronounced.

Morphotype B (Pl. 4, figs 9, 10). This morphotype is similar to the main morphotype, but it has a more squared posterior platform, only one node occurs behind the cusp and the posterior prolongation of the keel is reduced.

Discussion. *M. mersinensis* is a quite anomalous metapolygnathid for the intense ornamentation of the lateral margins of the platform, atypical in this genus. Nevertheless, the central position of the pit and the posterior prolongation of the keel allow assigning it to genus *Metapolygnathus*. Morphotype A is more similar to the holotype of *M. mersinensis* than the main morphotype here described which has a longer platform and an asymmetric posterior end. Nevertheless, the two forms have the same stratigraphic range and they occur always in the same samples. For these reasons we can assume that they both belong to *M. mersinensis* and that the morphological differences between the two morphotypes fall in the range of variability of the species. The holotype of *M. mersinensis* was described from section C of the Kocatabur Block of the Mersin Mélange, where it occurs in association with *C. orchardi* and *M. communisti*, which is considered the descending species by the authors (Moix et al. 2007). The specimens of *M. communisti* illustrated in Moix et al. (2007) are not true *M. communisti* (pl. 1, figs. 11, 12), but they are rather advanced *M. praecomunisti*. *M. mersinensis* occurs thus with *C. orchardi* and *M. praecomunisti* in section C of the Kocatabur Block, as in the Pizzo Mondello section, and below true *M. communisti*. Thus, *M. mersinensis* could not be the descending species of *M. communisti*, but it is more probably the forerunner of *M. cf. primitius*. Most of the *Metapolygnathus primitius* formerly reported from the Tethys (e.g. Krystyn 1980 Channell et al. 2003), instead, are not true *M. primitius*

but, more probably, *M. mersinensis* (Moix et al. 2007). True *M. primitius* is definitely absent in the Neotethys, where is replaced in the Carnian by *M. mersinensis*.

M. cf. primitius has a shorter platform, a longer and squared posterior platform, a centrally located pit and a longer posterior prolongation of the keel.

Stratigraphical range. Upper Tuvalian (upper Carnian) - lower Lacin (lower Norian).

Metapolygnathus parvus Kozur, 1972

Pl. 8, figs 9, 10

1972* *Metapolygnathus parvus* Kozur, p. 8, pl. 6, fig. 2-5.

1980 *Metapolygnathus communisti* - Krystyn, pl. 12, fig. 10-12.

1991a *Metapolygnathus communisti* - Orchard, pl. 2, fig. 14.

1991a *Metapolygnathus echinatus* - Orchard, pl. 1, fig. 26.

2007 *Metapolygnathus communisti parvus* - Noyan & Kozur, p. 171, fig. 7.1.

2007b *Metapolygnathus echinatus* - Orchard, pl. 2, fig. 19-21.

Material: about 30 specimens from 5 samples.

Description. Small conodont, characterized by a very reduced platform (less than half element), with a very typical ovoid shape and completely lacking of ornamentation, except for the intense microcrenulation. The free blade is composed by 6-10 denticles. The cusp is undistinguished in shape and it is followed by an accessorial node, placed in the centre of the posterior platform. The pit is strongly forwardly shifted, often placed in a very frontal position, just behind the anterior margin of the platform. The keel is posteriorly prolonged and its termination is pointed. The profile of the element is straight, the blade is anteriorly high and it descends rapidly but gradually towards the cusp.

Discussion. The holotype of this species, like those specimens collected from the Pizzo Mondello section, is characterized by strongly neothenic features: small size, short platform and poorly fused denticles. Being this species very similar to *M. communisti*, it has been supposed that *M. parvus* is just a juvenile growth stage of *M. communisti*, and not a true species. Adult growth stage specimens of *M. parvus* have been, however, recovered from the Pizzo Mondello section: they still preserve a very short and ovoid platform, different from *M. communisti*, and they also show a longer free blade and more fused denticles. Thus, even if very similar, *M. parvus* and *M. communisti* are actually two separate species (see Pl. 8).

Stratigraphical range. Lower Lacin? (lower Norian)

Metapolygnathus praecommunisti

Mazza, Rigo & Nicora, 2011

1991a *Metapolygnathus communisti* - Orchard, pl. 2, fig. 18-20.

2007 *Metapolygnathus communisti* - Moix et al., pl. 1, fig. 11, 12.

2007b *Metapolygnathus* n. sp. Y - Orchard, pl. 2, fig. 37-39.

2007 *Metapolygnathus communisti* - Rigo et al., fig. 5/4.

2010 *Metapolygnathus praecommunisti* n. sp. (nomen nudum) - Mazza et al., pl. 1, fig. 6.

2011* *Metapolygnathus praecommunisti* n. sp. Mazza et al., p. 124, fig. 2/C-J; 3/B-H.

Material: 82 specimens from 27 samples.

Description. The platform is relatively short (2/3 of the element), slender, with sub-parallel margins and a rounded posterior end. The anterior trough margin is wide and it leaves a free blade of only 1-2 denticles. The platform margins are thick and they bear three tiny nodes on the inner side and 2-3 nodes on the outer side at the geniculation point. Both the margins and the nodes are covered by an intense microcrenulation. The cusp is undistinguished in size and it is followed by a posterior carina composed of 2-3 nodes. In terminal or sub-terminal position, a larger carinal node is always present. The pit is centrally located or slightly backwardly shifted with respect to the middle of the platform. An evident prolongation of the keel behind the pit is always present. The keel termination may be pointed, squared or rounded and it is often deformed, presenting a typical asymmetric shape. The basal cavity is narrow. Laterally, the element is slightly arched. The blade is anteriorly high and it descends gradually in a low and long carina which reaches the posterior end of the platform. A low step occurs at the geniculation point.

Discussion. *C. tuvalica* n. sp. has a more backwardly shifted pit, it lacks of the long posterior prolongation of the keel, the posterior platform is always symmetric, the nodes on the platform are more numerous and they often reach the middle of the lateral margins.

Stratigraphical range. Middle - uppermost Tuvalian (upper Carnian).

Metapolygnathus cf. primitius

Pl. 8, fig. 12

2010 *Metapolygnathus cf. primitius* - Mazza et al., pl. II, fig. 11.

2010 "*Metapolygnathus communisti* B" - Mazza et al., pl. III, fig. 4.

2010 *Metapolygnathus cf. primitius* - Balini et al., pl. 3, fig. 9.

Material: about 85 specimens from 10 samples.

Description. The platform is about half of the entire element, it is slender and with parallel lateral margins. The posterior platform may be from squared to slightly enlarged. From 3 to 5 tall and large nodes, horizontally elongated into the adcarinal groove in the direction of the carina, occur on the anterior and the

lateral platform margins. The anterior trough margin is reduced and the free blade is composed of 5-9 denticles. A constriction of the posterior platform commonly occurs. The cusp is undistinguished in size in the adult growth stage specimens and slightly enlarged in the juvenile ones, and it is followed by a posterior carina composed of well separated accessorial nodes. The pit is from central to forwardly shifted, with a very narrow basal cavity. The keel is prolonged behind the pit and it may be squared or bifurcated. Laterally the element is slightly arched. The blade is anteriorly high and it descends gradually without steps into a long carina that reaches the posterior end of the platform.

Discussion. The holotype of *M. primitius* was described by Mosher (1970) from the Kerri Zone (lower Norian) of the Pardonet Formation at Brown Hill (Canada, British Columbia). This species is very abundant in the uppermost Carnian and lower Norian of the North American province while it is probably absent both in the northern Tethys and in the Neotethys. In these provinces different species were gathered into *M. primitius* (Kozur 2003): *C. pseudodiebeli*, *C. orchardi*, *C. zoeae* and, recently, *M. mersinensis*. The herein described *M. cf. primitius* is similar to true *M. primitius*, but it lacks the long and narrow posterior platform and the long posterior carina, which are very typical for this species and are already present in its juvenile forms. True *M. primitius* should be definitely restricted only to North America and use, in the Tethys and Neotethys, *M. mersinensis* for the Carnian forms while the Norian ones should be referred to the forms here named *M. cf. primitius*. Given the rich morphological variety and the large number of specimens occurring in the Pizzo Mondello section, a detailed description of the *M. cf. primitius* population will be presented in a future paper shortly.

Stratigraphical range. Uppermost Tuvalian (upper Carnian) - lower Lacion (lower Norian).

Genus *Misikella* Kozur & Mock, 1974

Type species: *Spathognathodus hernsteini* Mostler, 1967

Description. Small and short conodonts without platform and characterized by a large and very excavated basal cavity. The carina is composed by 3-9 partly fused denticles, with divergent and separated tips. The cusp is usually in terminal position and it is larger and higher than the other carinal denticles.

Discussion. *Misikella* is a long ranging genus which groups a series of species from the upper Carnian to the Rhaetian, all characterized by a large basal cavity and by the absence of a platform developed alongside the carinal denticles. However, *Misikella* is seemingly a polyphyletic genus, which groups together homeomorphic species without true phylogenetic relation-

ships. The upper Norian/Rhaetian *Misikellae* (e.g. *Misikella hernsteini*), in fact, probably descend directly from genera *Mockina* through the same evolutionary patterns that characterize the evolution of the conodont platform elements in the upper Carnian/lower Norian (see Mazza et al. 2009; in press). A derivation of the Rhaetian from the upper Carnian ones cannot be proven by now.

Stratigraphical range. From upper Carnian to upper Rhaetian.

Misikella hernsteini (Mostler, 1967)

Pl. 7, fig. 4

1967* *Spathognathodus hernsteini* n. sp. Mostler, p. 182, fig. 2.1, 1b.

1990 *Misikella hernsteini* - Budurov & Sudar, pl. 6, fig. 15.

1980 *Misikella hernsteini* - Krystyn, pl. 14, fig. 10-12.

1991 *Misikella hernsteini* - Amodeo et al., pl. 1, fig. 4; pl. 3, fig. 2, 4, 5, 7; pl. 4, fig. 9; pl. 5, fig. 11-13.

1996 *Misikella hernsteini* - Gullo, pl. 1, fig. 1,2.

2003 *Misikella hernsteini* - Channell et al., pl. A3, fig. 57, 58, 59, 60, 61, 62, 63, 66, 67, 68, 69, 70, 84.

2005 *Epigondolella bidentata* trans *Misikella hernsteini* - Bertinelli et al., fig. 4/7.

2005 *Misikella hernsteini* - Rigo et al., fig. 5/2,4.

2005 *Epigondolella bidentata* trans *Misikella hernsteini* - Rigo et al., fig. 5/1.

2009 *Misikella hernsteini* - Rigo et al., fig. 2/3.

2010 *Misikella hernsteini* - Giordano et al., fig. 3/A-B.

2010 *Misikella hernsteini* - Balini et al., pl. 4, fig. 11.

Material: more than 200 specimens from 16 samples.

Description. This unit consists of a blade composed by 4 to 6 denticles. These denticles decrease in height to the cusp, which is backwardly inclined and always the terminal one. The whole lower surface is occupied by the elliptical basal cavity (drop in shape) with rounded termination.

Discussion. *Misikella koessenensis* has usually a shorter blade, composed by 3 to 5 denticles, and the cusp is not terminal but followed by other one or two denticles. *Misikella posthernsteini* has a very deep incision on the lower side of the cusp and a typical heart-shaped basal cavity.

Stratigraphical range. Sevatian (upper Norian) - Rhaetian

Misikella koessenensis (Mostler, 1978)

1978* *Misikella koessenensis* n. sp. Mostler in Mostler, Scheuring & Ulrichs, pl. 2, fig. 3.

1979 *Misikella hernsteini* - Gazdzicki et al., pl. 5, fig. 75.

1990 *Misikella posthernsteini* - Budurov & Sudar, pl. 6, fig. 19.

1991 *Misikella koessenensis* - Amodeo et al., pl. 5, fig. 14.

2007 *Misikella koessenensis* - Moix et al., pl. 2, fig. 1.

2009 *Misikella koessenensis* - Rigo et al., fig. 2/1-2.

Material: 15 specimens from 3 samples.

Description. This unit blade consists usually of 3 to 5 high and large denticles which points are large and triangular. The height of the unit is greater than the length. Accessory little denticles (1-2) are always present behind the cusp. The basal cavity is elliptical and very large, deeply excavated.

Discussion. *M. hernsteini* has a similar basal cavity but never posterior denticles after the cusp.

Stratigraphical range. Rhaetian (very rare in the uppermost Norian).

Misikella kovacsi (Orchard, 2007)

2007* *Misikella kovacsi* n. sp. Orchard in Pálffy et al., fig. 6.8.

2010 *Misikella kovacsi* - Giordano et al., fig. 3.10.

Material: about 80 specimens from 12 samples.

Description. This unit is robust and consists of a blade composed of 2 thick denticles. The basal cavity is expanded and deeply excavated, with a V-shaped incision on the posterior margin and on the lower side of the cusp.

Discussion. *M. kovacsi* and *Misikella posthernsteini* have the same basal cavity characterized by the posterior incision, but the former species has three (rarely four) denticles in the blade while the latter only two. In the transitional forms between *M. posthernsteini* and *M. kovacsi* the gradual reduction of the denticle in the middle of the blade may be observed.

Stratigraphical range. Rhaetian.

Misikella longidentata Kozur & Mock, 1974

1974a* *Misikella longidentata* n. gen. n. sp. Kozur & Mock, p. 136-7, pl. 1, fig. 4.

2003 *Misikella longidentata* - Channell et al., pl. A2, fig. 4.5.

2010 *Misikella longidentata* - Balini et al., pl. 2, fig. 9.

Material: 24 specimens from 14 samples.

Description. This conodont is characterized by a very long and well-developed cusp, posteriorly bended. Behind the cusp, no denticles are present. The blade is composed by 4-5 wide spaced denticles, posteriorly inclined. The height of the denticles decreases forward. A deep sub-oval basal cavity extends on all the lower surface.

Discussion. *M. longidentata* differs from *Neocavitella cavitata* for the big and terminal cusp, for the smaller size of the element and for the reduced number of the denticles.

Stratigraphical range. Tuvalian (upper Carnian) - upper Laciian (lower Norian).

Misikella posthernsteini (Kozur & Mock, 1974)

Pl. 7, fig. 6

1974b* *Misikella posthernsteini* n. sp. Kozur & Mock, p. 247-9, fig. 1,2.

1980 *Misikella posthernsteini* - Krystyn, pl. 14, fig. 7-9.

1990 *Misikella posthernsteini* - Budurov & Sudar, pl. 6, fig. 17,18.

1991 *Misikella posthernsteini* - Amodeo et al., pl. 1, fig. 3, 5, 6; pl. 2, fig. 2, 4, 7; pl. 3, fig. 1, 3, 6, 8; pl. 4, fig. 1-5, 7, 10, 12, 13; pl. 5, fig. 2-4, 5-9.

1991b *Misikella posthernsteini* - Orchard, p. 320, pl. 5, fig. 21.

1996 *Misikella posthernsteini* - Gullo, pl. 1, fig. 3-6,8.

2005 *Misikella posthernsteini* - Bertinelli et al., fig. 4/8.

2005 *Misikella posthernsteini* - Rigo et al., fig. 5/7,8.

2007 *Misikella posthernsteini* - Krystyn et al., pl.1, fig. 1-4.

2009 *Misikella posthernsteini* - Rigo et al., fig. 2/4-5.

2010 *Misikella posthernsteini* - Giordano et al., fig. 8/A-B.

2010 *Misikella posthernsteini* - Balini et al., pl. 4, fig. 12.

Material: more than 200 specimens from 16 samples.

Description. This unit consists of a blade composed of 3 (rarely 4) thick denticles. The cusp is in posterior position and inclined backwardly. Behind the cusp, a very deep incision is present, affecting also the posterior margin of the basal cavity, creating the typical heart-shaped basal shape, which occupies the whole lower surface. The basal cavity is deeply excavated.

Discussion. *Misikella ultima* has a secondary posterior blade, on the posterior V-shaped incision.

Stratigraphical range. Rhaetian

Misikella ultima (Kozur & Mock, 1991)

Pl. 7, fig. 5

1991* *Misikella ultima* n. sp. Kozur & Mock, p. 273, pl. 5, fig. 2; pl. 6, fig. 2, 4-6.

1991 *Misikella ultima* - Amodeo et al., pl. 4, fig. 8.

2005 *Misikella ultima* - Rigo et al., fig. 5/9-11.

2010 *Misikella ultima* - Giordano et al., fig. 3/A-B.

2010 *Misikella ultima* - Balini et al., pl. 4, fig. 13.

Material: 4 specimens from 3 samples.

Description. This unit consists of 2 blades: the anterior main blade is composed by 3 (rarely 4) straight denticles, laterally compressed. At the posterior end of the anterior blade, a deep V-shaped incision is present. From this incision, a second posterior blade develops, consisting of strongly inclined denticles, sometimes almost horizontally. The basal cavity is deeply excavated.

Discussion. *M. posthernsteini* has only one anterior blade usually composed of 3 thick denticles.

Stratigraphical range. Upper Rhaetian.

Genus *Mockina*

Type species: *Tardogondolella abneptis postera* Kozur & Mostler, 1971

Description. This genus has a short platform, extremely reduced in width in some species, and charac-

terized by thin margins. On the anterior platform margins from one to three backwardly inclined sharp denticles usually occur. The free blade may be long or short, depending on the development of the platform; the blade is high and with a convex outline. The posterior platform is long and narrow and rarely bears any kind of ornamentation. The cusp is never terminal but it is followed by some carinal nodes, which occur in a variable number from one to three. The pit lies in the middle of the platform or it is even more forwardly shifted. The keel shows a posterior prolongation and its termination may be pointed or squared, but it is never bifurcated.

Remarks. The genus *Orchardella* has a longer posterior platform, usually characterized by a strong ornamentation, and the posterior carina has more than three nodes. The free blade is longer than in *Mockina*. The genus *Epigondolella* has a much wider platform with a stronger ornamentation and the keel end is bifurcated.

Stratigraphical range. From middle (Alaunian) to upper Norian (Sevatian), very rarely in the lower Rhaetian.

Mockina bidentata (Mosher, 1968)

Pl. 7, fig. 7

1968* *Epigondolella bidentata* n. sp. Mosher, p. 936, pl. 118, fig. 31-35 (only).

1980 *Epigondolella bidentata* - Krystyn, pl. 14, fig. 1,2,3 (only).

1981 *Epigondolella bidentata* - Cafiero & de Capoa Bonardi, pl. 58, fig. 13-16.

1981 *Epigondolella multidentata* - Cafiero & de Capoa Bonardi, pl. 58, fig. 17.

1983 *Epigondolella bidentata* population - Orchard, p. 188-9, fig. 15 W, X (non V).

1989 *Epigondolella bidentata* - Orchard in Carter et al., pl. 1, fig. 13.

1990 *Epigondolella bidentata* - Budurov & Sudar, pl. 5, fig. 9, 13-16.

1991b *Epigondolella bidentata* Orchard, p. 307-8, pl. 4, fig. 12.

1999 *Epigondolella bidentata* - Amodeo, pl. 1, fig. 20-22.

2003 *Mockina bidentata* - Channell et al., pl. A2, fig. 44, 46, 47, 48, 51, 54; pl. A3, fig. 3, 4, 6, 7, 9, 25, 27, 28, 37, 39, 41, 42, 47, 48, 50, 54, 56, 71, 72, 74, 75, 76, 77, 78, 79.

2005 *Epigondolella bidentata* - Bertinelli et al., fig. 4/5.

2005 *Epigondolella bidentata* - Rigo et al., fig. 4/6.

2007 *Mockina bidentata* - Moix et al., pl.2, fig.3.

2007 *Epigondolella bidentata* - Krystyn et al., pl. 1, fig. 5-14.

2010 *Mockina bidentata* - Giordano et al., fig. 1/A-B.

2010 *Mockina bidentata* - Balini et al., pl. 4, fig. 9.

Material: about 50 specimens from 7 samples.

Description. Small unit characterized by two prominent denticles on the anterior lateral margins of an extremely reduced platform. The cusp is the penultimate node of the carina and large in size. A smaller accessory node occurs behind the cusp. The blade is

composed of high denticles not entirely fused together; it is high anteriorly and it descends gradually into a low carina. The pit is centrally located, just behind the pair of marginal denticles. The keel termination is pointed.

Discussion. Given the neothenic characters of this species, juvenile forms of the other middle and upper Norian species can be easily confused with *Mockina bidentata*. *Mockina mosheri* has 5 or more denticles in the carina. *Mockina englandi* has a broader platform.

Stratigraphical range. Sevatian (upper Norian) - lowermost Rhaetian.

Mockina englandi (Orchard, 1991b)

1991b* *Epigondolella englandi* n. sp. Orchard, p. 309, pl. 5, fig. 9, 11, 13, 19, 20.

Material: one specimen from one sample.

Description. Small conodont characterized by a short (half element length) and ovoid platform with thin margins. The anterior margins bear one or two sharp and backwardly inclined denticles and a couple of small denticles may occur also on the lateral margins. The posterior platform is rounded. The anterior trough margin is absent and the free blade is composed of about three denticles. The cusp is undistinguished in size and it is followed by one or two carinal nodes. The pit is placed in front of the middle platform. The posterior keel has an evident prolongation and its termination is pointed. Laterally, the blade is high and it descends quite rapidly into the carina. The element profile is quite straight.

Discussion. Only one specimen of *M. englandi* has been recovered from the Pizzo Mondello section. This species is similar to *Mockina spiculata* for the ovoid platform, but *M. spiculata* has a pointed posterior platform with strongly inclined denticles, missing in *M. englandi*. Furthermore, *M. spiculata* has a posterior-lateral enlargement of the platform typical of the species. *Mockina* aff. *tozeri* has a rectangular and longer posterior platform, characterized also by a weak ornamentation.

Stratigraphical range. Alaunian (middle Norian).

Mockina aff. **tozeri** (Orchard, 1991b)

Pl. 7, fig. 8

1970 *Epigondolella abneptis* - Mosher, pl. 110, fig. 14,18 (only).

1983 *Epigondolella multidentata* population - Orchard, p. 183, fig. 8/E,F (only).

1991b* *Epigondolella tozeri* n. sp. Orchard, p. 313-314, pl.5, fig. 1-3, 6-8.

Material: 23 specimens from 4 samples.

Description. Conodont characterized by a narrow and rectangular platform with thin margins. The anterior platform margins bear 2-3 sharp and backwardly inclined denticles. Behind these denticles the platform shows a long posterior prolongation, which ends with a squared and weakly denticulate margin. A couple of very small denticles rarely occur on the lateral margins of the posterior platform. The anterior trough margin is absent and the free blade is composed of about three denticles; the blade is anteriorly high and decreases rapidly into the carina. The cusp may be slightly larger than the other carinal nodes but it is more often undistinguished in size; it is followed by one or more carinal nodes. The pit lies in front of the middle platform; the keel is large, it shows a long posterior prolongation and its termination is squared. In profile, the element is from straight to weakly stepped.

Discussion. This species is here referred to *Mockina* aff. *tozeri*, because it has some typical characters of *Orchardella tozeri* (the rectangular platform, the posterior ornamentation, the forwardly shifted pit) but the cusp is followed by a maximum number of three nodes, while in genus *Orchardella* they are usually much more numerous. Since the high number of nodes in the posterior carina is a diagnostic feature of genus *Orchardella* (Kozur, 2003), we assign this species to genus *Mockina* and, given that *Orchardella* seem to be absent in the Tethys, we use the terminology aff. *tozeri*.

M. englandi is smaller and has an ovoid platform. *E. uniformis* has a posterior enlarged platform, a stronger ornamentation and the keel termination is bifurcated.

Stratigraphical range. Alaunian (middle Norian).

Mockina slovakensis (Kozur, 1972)

Pl. 7, figs 9, 10

1972* *Metapolygnathus slovakensis* n. sp. Kozur, p. 10-11, fig. 23.

1983 *Epigondolella* n. sp. C population - Orchard, p. 185-186, fig. 9.

1990 *Epigondolella multidentata* - Budurov & Sudar, pl. 5, fig. 20-22.

2003 *Mockina slovakensis* - Channell et al., pl. A2, fig. 56, 57, 58; pl. A3, fig. ?49.

Material: about 10 specimens from 4 samples.

Description. Compact species characterized by a short blade and thick platform margins. The platform is about half of the entire element, it bears sharp and high denticles on the anterior lateral margins and, in some specimens, other accessory nodes occur also on the posterior margin. The anterior trough margin is absent and the free blade is composed of 4-5 denticles. The

cusp is undistinguished in shape and it is never terminal, but followed by two (rarely three) carinal nodes. The blade is very high anteriorly and it descends abruptly inside the platform before the carina, which is low and composed by small and well separated nodes. The last carinal node is usually larger than the preceding ones and posteriorly inclined. In lateral view, the profile is very peculiar, being characterized by a strong upward bend of the lower side just before the pit. The pit is centrally located; the keel is posteriorly prolonged and its termination is pointed.

Discussion. *Mockina spiculata* and *Mockina serulata* bear thin and outwardly projected denticles on the platform margins. *Epigondolella praeslovakensis*, which is the precursor of *M. slovakensis*, shows a bifurcated keel end.

Stratigraphical range. Sevatian (upper Norian).

Mockina zapfei (Kozur, 1973)

1972 *Metapolygnathus* n. sp. Kozur, pl.7, fig.1.

1973* *Metapolygnathus zapfei* Kozur, p. 18-20.

1983 *Epigondolella postera* - Orchard, p. 186-8, fig. 15 P-R.

1989 *Epigondolella postera* - Orchard in Carter et al., pl. 1, fig. 15.

1990 *Epigondolella postera* - Budurov & Sudar, pl. 5, fig. 1-3, 4-5.

1991 *Epigondolella postera* - Orchard, pl. 4, fig. 16-19.

2003 *Mockina zapfei* - Channell et al., pl. A2, fig. 43, 45, 53, 55; pl. A3, fig. 5, 24, ?31, 32, 33, 34, 36, 43, 51, 52, 53.

Material: 5 specimens from 4 samples.

Description. The platform is about half length of the entire element and asymmetric, due to the curvature of the carina to one side. One or two sharp denticles occur on the thin lateral margins. The cusp is undistinguished in size and it is followed by two or more carinal nodes. The blade is very high anteriorly and it descends gradually into the low carina. The carina extends to the posterior asymmetric end of the platform, and the last denticle is projected beyond the platform. On the lower side, a strong keel bend towards the asymmetric side and the pit is central. The posterior end of the keel is pointed.

Discussion. *Mockina slovakensis* has a very abrupt step between the blade and the carina. *Mockina postera* differs because the posterior carina ends within the platform.

Stratigraphical range. Sevatian (upper Norian).

Genus *Neocavitella* Sudar & Budurov, 1979

Type species: *Neocavitella cavitata* Sudar & Budurov, 1979

Description. Small conodonts characterized by the absence of a platform and by a large elliptical basal cavity which covers from half to the entire element

length. The carina is composed by a large number of low denticles, separated on their tops and arranged in an elliptical curve. The cusp is usually larger than the other denticles and it is followed by a smaller denticle.

Discussion. The genus *Neocavitella* differs from *Misikella* in the absence of the long cusp, which is in the former genus a little larger than the other denticles but not higher. Furthermore, in *Neocavitella* the cusp is usually followed by another smaller denticle. Another difference between the two genera is the morphology of the denticles: in genus *Neocavitella* they are very numerous, occurring in the number of 10-12, and they all have the same height, while in genus *Misikella* the denticles are only few (about 2-7) and they decrease in height anteriorly.

Stratigraphical range. From upper Ladinian (Longobardian) to lower Norian (Lacian).

Neocavitella cavitata Sudar & Budurov, 1979

1979* *Neocavitella cavitata* n. sp. Sudar & Budurov, p. 49-50, pl. 1, fig. 1-3.

2003 *Neocavitella cavitata* - Channell et al., pl. A1, fig. 26.

2010 *Neocavitella cavitata* - Balini et al., pl. 2, fig. 8.

Material: 31 specimens from 18 samples.

Description. The species is a long cavital unit characterized by a long crest-like blade. The blade is composed of 10-12 denticles of the same size, fused together by the base but widely separated on the tops. The cusp is slightly bigger than the other denticles, and an accessory denticle is usually present just behind it. The basal cavity is large and deeply excavated, it is drop-like shaped and it extends for the entire length of the element.

Discussion. *N. cavitata* differs from *M. longidentata* because it is longer, with more numerous and equally sized denticles. The cusp is smaller and is followed by an accessorial denticle.

Stratigraphical range. Upper Tuvanian (upper Carnian).

Genus *Norigondolella* Kozur, 1989

Type species: *Paragondolella navicula steinbergensis* Mosher, 1968

Description. This genus is characterized by flat lateral platform margins which usually cover the entire length of the element. In some species a very short free blade of 1-2 denticles may occur. The blade is anteriorly high and it descends into a very low carina towards the cusp. The platform margins never bear any ornamentation but only an intense microcrenulation. The cusp is large and always occurs in terminal position. On the lower side, the pit is located in terminal position with

respect both to the keel and to the platform end. The keel is well protruded, excavated and its termination may be pointed, rounded or squared.

Discussion. At present *Norigondolella* is definitely considered a facies controlled taxon (Krystyn & Gallet 2002; Channell et al. 2003; Kozur 2003; Orchard 2007b): the species belonging to this genus have in fact different stratigraphic and paleogeographic distributions in the various provinces of the Tethys and North America. This genus is very common in the lower Norian of the northern Tethys, above the LAD of *M. communisti*, especially in the Hallstatt type successions. This genus is instead absent or very rare in the Neotethys (Channell et al. 2003).

The genus *Norigondolella* differs from *Paragondolella* for the lower carina, the absence of the free blade, the excavated lower side of the keel and the more terminal position of the pit, which is a little bit more forwardly shifted in genus *Paragondolella*.

Stratigraphical range. From Tuvanian (upper Carnian) to Sevatian (upper Norian).

Norigondolella cf. navicula

1980 *Gondolella cf. navicula* - Krystyn, pl. 11, fig. 8,9.

1991a "*Neogondolella steinbergensis*" - Orchard, pl. 4, fig. 14.

2007 *Norigondolella* sp. - Nicora et al., pl. 3, fig. 1.

2007 *Norigondolella* sp. - Rigo et al., fig. 5/9.

2010 *Norigondolella cf. navicula* - Balini et al., pl. 2, fig. 11.

Material: 4 specimens from 4 samples.

Description. Small conodont characterized by a long and broad platform which extends for the entire length of the element, leaving no free blade. The platform margins are sub-parallel and they never bear any ornamentation, except for a coarse microcrenulation. The posterior end of the platform is always rounded. The cusp is the last denticle of the carina, it is located just in front to the posterior margin of the platform, it is bigger in size with respect to the preceding carinal nodes and it is posteriorly inclined. The pit is narrow and it is terminal with respect both to the platform and to the keel end. The lower side of the keel is excavated, like in Lower and Middle Permian gondolellids (*Mesogondolella*). The keel termination is rounded and it is never prolonged. The pit is surrounded by a prominent loop. The basal furrow is large. Laterally the element is strongly arched in its middle part and the keel is high below the platform. The carina is high in correspondence to the anterior third of the element and it descends gradually both anteriorly and posteriorly. The denticles are fused but the tips are widely spaced.

Discussion. *N. cf. navicula* is not a typical *N. navicula*, but it has all the main morphological characters of this species: the terminally located pit, the very

protruded loop, the large basal furrow (excavated lower side of the keel), the large and high cusp and the platform extended for the entire length of the element. The only differences with true *N. navicula* are the smaller size of the element, the thinner platform margins and the poorly fused denticles of the carina. This species may be thus a primitive form of the true *N. navicula*. *N. cf. navicula* is very rare throughout the Pizzo Mondello section, but its occurrence has been registered in the upper Carnian also in the Lagonegro basin (Rigo et al. 2007, fig. 5/9) and in the northern Tethys (Krystyn 1980, pl. 11, figs. 8, 9).

N. cf. navicula differs from *Paragondolella polygnathiformis* and *Paragondolella noah* for several characters: the lower side of the keel is excavated, the anterior carina is lower and it is never free, the denticles of the carina are less fused and the pit is much more terminal.

Stratigraphical range. Upper Tuvalian (upper Carnian).

***Norigondolella trinacriae* Mazza, Cau & Rigo, in press**

2010 *Norigondolella cf. navicula* - Mazza et al., pl. 3, fig. 2,3.
2010 *Norigondolella n. sp. A* - Balini et al., pl. 4, fig. 3.
in press *Norigondolella trinacriae* Mazza et al., p. fig. 9/I-J.

Material: 31 specimens from 2 samples.

Description. The platform is broad, with low parapets and it extends for all the length of the element. The posterior and lateral platform margins are thick, but they become progressively thinner towards the anterior third of the element. The platform margins bear no ornamentation, except for an intense microcrenulation. The posterior end of the platform is rounded. The cusp is the last node of the carina, is bigger in size than the other carinal nodes and is posteriorly inclined. The pit is narrow and sub-terminal. The keel termination is squared or it may be slightly bifurcated in the most adult growth stages. The basal furrow is large. The element is arched in correspondence to the pit. The blade is high anteriorly and it descends very gradually into a low carina.

Discussion. This species has all the typical characters of the genus *Norigondolella*, except for the morphology of its lower side, which is rather unusual for a *Norigondolella*, being characterized by a slightly anteriorly shifted pit and a squared or bifurcated keel end. For the peculiarity of its lower side, it has been decided to consider this *Norigondolella* as a new species (see also Mazza et al. in press). Its occurrence in other Tethyan provinces has to be proved.

N. cf. navicula has a more terminal pit, a rounded keel end and a higher carina.

Stratigraphical range. Lower Lacyan (lower Norian).

***Norigondolella steinbergensis* (Mosher, 1968)**

1968* *Paragondolella navicula steinbergensis* n. subsp. Mosher, p. 939, pl. 117, fig. 13-22.

1980 *Gondolella steinbergensis* - Krystyn, pl. 11, fig. 13-15.

1981 *Gondolella navicula steinbergensis* - Cafiero & de Capoa Bonardi, pl. 58, fig. 5.

1990 *Paragondolella steinbergensis* - Budurov & Sudar, pl. 2, fig. 10,11.

1991 *Norigondolella steinbergensis* - Kozur & Mock, pl. 7, figs. 8a-b.

1991a *Neogondolella steinbergensis* - Orchard, pl. 4, fig. 14.

2003 *Norigondolella steinbergensis* - Channell et al., pl. A2, fig. 41; pl. A3, fig. 22, 23, 30, 40.

2005 *Norigondolella steinbergensis* - Orchard, fig. 15.

Material: 5 specimens from 2 samples.

Description. The platform is narrow and it covers the entire length of the unit. The posterior end is pointed and upturned. The cusp is the last node of the carina, it is large in size and it is posteriorly projected. The carina is very low and the nodes are often fused. On the lower surface, the keel is very narrow, very excavated and it ends with a wide and rounded loop. The pit, located inside the prominent loop, is elliptic in shape.

Discussion. *Norigondolella hallstattensis* is smaller, with a short free blade and a very broad platform. *N. navicula* and *N. kozuri* have broader platforms and they never have a prominent projected cusp.

Stratigraphical range. Alaunian - Sevatian (middle - upper Norian).

Genus *Paragondolella* Mosher, 1968

Type species: *Paragondolella excelsa* Mosher, 1968

Description. The species belonging to this genus are characterized, on the lower side, by a sub-terminal to backwardly shifted pit (Mosher 1968, original diagnosis and Kozur 1989) with respect both to the platform and the keel end. The platform may extend completely to the anterior end or leave a short free blade. The posterior end of the platform is rounded or blunt. The platform margins never bear any kind of ornamentation except for an intense microcrenulation. The keel end is commonly pointed, squared or rounded; rarely bifurcated.

Discussion. In the original diagnosis of *Paragondolella* (Mosher, 1968) no remarks about the ornamentation of the platform margins are present. Since the type species of the genus has no ornamentation, it is here considered the absence of a strong ornamentation (i.e. nodes or denticles) as diagnostic for the definition

of *Paragondolella*. The microcrenulation of the platform margins is accepted, as also a weak undulation at the geniculation point, which is interpreted as the natural beginning of the development of nodes towards the descending species. Another important character of *Paragondolella*, observed by Kozur (1989) but ignored by Mosher (1968), is the high carina in correspondence to the anterior blade which becomes continuously lower towards the posterior end of the platform. This kind of profile is absent in the other Middle or Lower Triassic genera, such as *Neogondolella* (Kozur 1989), which have a constant or very weakly descending carina. This *Paragondolella* kind of carina is instead typical of all Upper Triassic genera, i.e. *Carnepigondolella*, *Metapolygnathus*, *Epigondolella*, *Norigondolella*, *Orchardella* and also *Mockina*. *Paragondolella* is in fact the only gondolelloid genus surviving the Julian/Tuvalian crisis (Rigo et al. 2007) and, thus, the basic group for the last radiation among gondolelloids, from which all the post-Julian Upper Triassic platform conodonts descend (Kozur 1989).

Orchard (1991a, b) assigned all upper Carnian *Paragondolella* species to the genus *Metapolygnathus*, even if the location of the pit is sub-terminal or considerably backwardly shifted with respect to the middle of the platform, against the original diagnosis of genus *Metapolygnathus* (Hayashi 1968). The Carnian paragondolellids have a less terminal pit compared to the Lower Triassic ones, but it is still strongly backwardly shifted with respect both to the platform and the keel end. Thus, considering the position of the pit very diagnostic for genera separations, genus *Paragondolella* is here used also for some Tuvalian species, while genus *Metapolygnathus* is restricted to species with a more central pit and a posterior prolongation of the keel (see also Mazza et al. in press).

Stratigraphical range. Olenekian (Lower Triassic) - uppermost Carnian.

***Paragondolella lindae* (Orchard, 1991b)**

1991a *Metapolygnathus* n. sp. E Orchard, p.176, pl. 1, fig. 1-6.

1991b* *Metapolygnathus lindae* n. sp. Orchard, p. 316, pl. 1, fig.

1-3.

Material: 3 specimens from 3 samples.

Description. The platform is about 2/3 of the entire element and the anterior trough margin is well developed, leaving a free blade of one or two denticles. The platform is enlarged in its central part and it tapers gradually anteriorly and posteriorly, where is characterized by an evident constriction; the posterior margin is rounded. The platform margins are thin, they bear no nodes and the parapets are low; the step at the geniculation point is very low. The cusp is larger than the other

denticles and it is in terminal position. The pit is sub-terminal; the basal cavity is narrow and surrounded by a prominent loop. Usually no keel occurs behind the pit. In profile, the element is arched; the blade is not very high anteriorly and it descends regularly into a still lower carina.

Discussion. *Paragondolella praelindae* has a longer platform, a lower blade profile and a more excavated basal cavity. *Paragondolella polygnathiformis* and *Paragondolella noah* have higher parapets, a high step at the geniculation point, shorter platforms with parallel lateral margins, the pit is not so terminal and the posterior constriction is absent. A weak constriction may occur sometimes in *P. polygnathiformis*, but it is never so pronounced as in *P. lindae*.

Stratigraphical range. Upper Tuvalian (upper Carnian).

***Paragondolella noah* (Hayashi, 1968)**

1968* *Metapolygnathus noah* Hayashi, pl. 3, fig. 10a-c.

2003 *Paragondolella polygnathiformis noah* - Channell et al., pl. A1, fig. 1, 6, 8, 12, 22, 29, 36.

2007 *Paragondolella noah* - Noyan & Kozur, fig. 5.1-5.

2007 *Paragondolella polygnathiformis noah* - Rigo et al., fig. 4/6.

2008 *Metapolygnathus polygnathiformis* - Celarc and Kolar-Jurkovšek, fig. 7/5.

2010 *Paragondolella noah* - Mazza et al., pl. I, fig. 1.

2010 *Paragondolella noah* - Balini et al., pl. 2, fig. 1.

2011 *Paragondolella noah* - Mazza et al., fig. 4/K-L.

Material: about 120 specimens from 22 samples.

Description. The platform is long (about 3/4 of the entire element), with a well developed anterior trough margin which leaves a short free blade of only 2-3 denticles. The platform margins are thick and up-turned; they are parallel and without any ornamentation, except for the intense microcrenulation. The posterior margin is rounded or slightly squared. The cusp is the last denticle of the carina; it is bigger than the preceding ones and backwardly inclined. Sometimes the cusp may be followed by a smaller and well separated accessory node. The pit lies in the posterior half of the platform, in a sub-terminal position with respect to the platform and to the keel end, but it is never really terminal. In the more advanced specimens, especially, it is slightly forwardly shifted with respect to both the keel and platform ends. The keel termination is squared. Laterally the element is slightly arched. Very characteristic of this species are the high platform margins that descend into the anterior trough margin with a high and abrupt step at the geniculation point. The blade is anteriorly high and it descends gradually towards the cusp.

Discussion. Once considered as a subspecies of *Paragondolella polygnathiformis*, *P. noah* is here consid-

ered as an independent species as it was established by Hayashi (1968), even if the two species are strictly related and very similar. They have the same abrupt step at the geniculation point, but *P. noah* differs from *P. polygnathiformis* for the broader and thicker platform margins, a more forwardly shifted pit with respect to the keel and platform ends, and the more squared posterior margin and keel termination. Furthermore the accessorial node behind the cusp occurs only in *P. noah*. The frontal termination of the blade is also more backwardly inclined and with a truncated appearance. *P. noah* is thus a more advanced *Paragondolella*, partly transitional to *Metapolygnathus*, than *P. polygnathiformis*, which has instead typical Ladinian/Julian characters (slender platform, very sub-terminal pit and rounded keel end).

Stratigraphical range. From lower to upper Tuvallian (upper Carnian).

***Paragondolella oertlii* (Kozur, 1980)**

Pl. 7, figs 11, 12

1980* *Gondolella oertlii* Kozur, p. 153, fig. 2.

2003 *Paragondolella oertlii* - Channell et al., pl. A1, fig. 13, 27, 41.

2007 *Metapolygnathus oertlii* - Rigo et al., fig. 5/6.

2007 *Metapolygnathus communisti* B - Rigo et al., fig. 4/8.

2007 *Metapolygnathus oertlii* - Nicora et al., pl. 3, fig. 2.

2010 *Paragondolella oertlii* - Mazza et al., pl. I, fig. 3.

Material: about 30 specimens of *P. oertlii* from 14 samples; about 10 specimens of morphotype A from 4 samples.

Description. Conodont characterized by a long platform that extends to the anterior end and leaves no free blade. The anterior trough margin is present and it is very wide. The platform margins are very thick and broad, especially the posterior one, and they do not have any kind of ornamentation, except for an intense microcrenulation. The inner side of the anterior margins of the platform may bear a sort of internal undulation that simulate a row of low nodes, but which is not visible in lateral view. The posterior end is widened and it may be rounded or slightly squared. The cusp is larger in size and it may be followed by one smaller carinal node in the most adult growth stage specimens. The pit lies in the posterior half of the platform and it is usually almost sub-terminal to the keel end. The basal cavity is narrow and it is surrounded by a prominent loop. The keel is broad and its termination is bifurcated. Laterally the element is arched. The blade is composed of highly fused denticles, it is anteriorly high and descends gradually into a low carina towards the posterior margin. The anterior termination of the blade is backwardly inclined and the first denticle does not decrease

in height, giving to the blade termination a truncated appearance. The geniculation point has a low step.

Morphotype A (Pl. 7, fig. 12). This morphotype is characterized by a platform which tapers rapidly at the anterior end and remains large at the posterior end, giving to the platform a sort of sub-triangular outline. A pair of tiny nodes may occur at the geniculation point on one side of the platform, unusual for a *Paragondolella*. This morphotype is probably a transitional form to some *Metapolygnathus* species, but it cannot be assigned to this genus because the pit is still sub-terminal to the keel and the platform end.

Discussion. The representatives of *P. oertlii* collected at Pizzo Mondello slightly differ from the holotype illustrated by Kozur (1980) from Sommeraukogel (Austria) for the lateral profile. In the holotype the platform margins seem to extend gently to the anterior end, while in the specimens from Pizzo Mondello a low step connects the platform margins with the broad anterior trough margin. The *P. oertlii* of Pizzo Mondello is instead very similar to *C. carpathica*, differing mainly in the absence of ornamentation on the *P. oertlii* anterior platform, which is otherwise characterized by very broad margins. Since the stratigraphical range of *P. oertlii* corresponds to the upper Tuvallian range of *C. carpathica* and the two species are always present in the same sample populations, it is possible that true *P. oertlii* does not occur at Pizzo Mondello, but that it is only a phenotype of *C. carpathica* (see Mazza et al. in press) in which the platform nodes are merged together in the broad platform margins during the ontogenetic process.

P. oertlii differs from *P. noah* for the broader platform, the thicker margins, the absence of free blade and the bifurcated keel termination.

Stratigraphical range. The central morphotype ranges from middle to upper Tuvallian (upper Carnian), while morphotype A is restricted to the uppermost Tuvallian (upper Carnian).

Paragondolella polygnathiformis

(Budurov & Stefanov, 1965)

1965* *Gondolella polygnathiformis* Budurov & Stefanov, p. 118-119, pl. 3, fig. 3,7.

1968 *Paragondolella polygnathiformis* - Mosher, p. 939-940, pl. 118, fig. 9?-10?, 14-15 only.

1980 *Gondolella polygnathiformis* - Krystyn, pl. 11, fig. 7.

1991 *Paragondolella polygnathiformis* - Martini et al., pl. 18, fig. 1-15.

2000 *Paragondolella polygnathiformis* - Balini et al., p. 50, 52, pl. 3, fig. 3-4; pl. 4, fig. 1-9; pl. 5, fig. 1-4.

2001 *Paragondolella polygnathiformis* - Muttoni et al., fig. 10/2.

2003 *Paragondolella polygnathiformis noah* - Channell et al., pl. A1, fig. 11, 18.

Material: about 8 specimens from 5 samples.

Description. Small conodont characterized by a long and tapered platform, with parallel margins, which extends almost to the anterior end, leaving a short free blade of only 2-3 denticles. The anterior trough margin is well developed but narrow. The platform margins are thin and upturned and they have no ornamentation. The platform gets narrower towards the posterior end, which is rounded and often has a weak constriction. The cusp is the last denticle of the carina; it is larger in size and backwardly inclined. The pit is sub-terminal with respect both to the platform and to the keel end. The basal cavity is quite large and surrounded by a prominent loop. The keel is narrow and its termination is usually rounded. The element is strongly arched just before the pit, so that the posterior margin results downwardly inclined. Very typical of this species are the platform margins that descend into the anterior trough margins with an abrupt step at the geniculation point. The blade is anteriorly high and it descends gradually towards the cusp.

Discussion. In the Pizzo Mondello section, *P. polygnathiformis* is quite rare, since very few specimens were recovered just in the first 25 metres of the section. This species is more common in the Julian (lower Carnian), while in the Tuvalian (upper Carnian) it is mostly replaced by its descending species *P. noah*.

Stratigraphical range. From Julian (lower Carnian) to lower Tuvalian (upper Carnian).

Paragondolella praelindae Kozur, 2003

Pl. 7, fig. 13

1972* *Paragondolella praelindae* n. sp. Kozur, p. 71, pl. 1, fig. 4.
2003 *Paragondolella praelindae* - Channell et al., pl. A1, fig. 3.
2007 *Paragondolella praelindae* - Rigo et al., fig. 4/10, 11.

Material: 2 specimens from 2 samples.

Description. The platform is slender; it extends for the entire length of the unit and commonly presents a central enlargement. A tight constriction typically occurs at the posterior end. The lateral platform margins are distinctly upturned and they bear no ornamentation, except for an intense microcrenulation. The cusp is the last denticle of the carina; it is large and is placed in terminal position to the platform end. The pit is sub-terminal and no keel occurs behind it. The basal cavity is excavated and it is surrounded by a prominent loop. The basal furrow is large. Laterally the element is slightly arched. The blade is low and continuous into a low carina.

Discussion. In *P. polygnathiformis* the platform margins are parallel, the blade is higher and it has a no excavated basal cavity.

Stratigraphical range. From Julian (lower Carnian) to lower/middle Tuvalian (upper Carnian).

Genus *Parvigondolella* Kozur & Mock, 1972

Type species: *Parvigondolella andrusovi* Kozur & Mock, 1972

Description. Conodonts composed by a single blade with high and partially fused denticles and completely lacking a platform. The basal cavity is shallow and narrow and it is in the middle of the unit or posteriorly placed.

Discussion. Genus *Mockina* is always provided with a platform, even if sometimes it may be very reduced in width (e.g. *M. bidentata*).

Stratigraphical range. From Sevatian (upper Norian) to Rhaetian.

Parvigondolella andrusovi Kozur & Mock, 1972

Pl. 7, fig. 14

1972* *Parvigondolella andrusovi* n. gen. n. sp. Kozur & Mock, p. 5, pl. 1, fig. 11, 12.

1980 *Epigondolella bidentata* - Krystyn, pl. 14, fig. 5, 6.

1990 *Epigondolella bidentata* - Budurov & Sudar, pl. 5, fig. 12.

2003 *Parvigondolella andrusovi* - Channell et al., pl. A2, fig. 50, 52, 59, 60; pl. A3, fig. 1, 2, 73, 80, 81, 82.

2005 *Parvigondolella andrusovi* - Bertinelli et al., fig. 4/6.

2005 *Parvigondolella andrusovi* - Rigo et al., fig. 5/5, 6.

2010 *Parvigondolella andrusovi* - Balini et al., pl. 4, fig. 10.

Material: about 25 specimens from 11 samples.

Description. The blade is composed of 7-9 denticles fused only by their base and separated on the tips. All the denticles composing the anterior blade have almost the same height and are nearly straight. The cusp is never terminal and it is larger than the other denticles. The cusp and the 1-2 denticles behind it are quite inclined. In lateral view, this species is quite straight, except for the slightly arched part behind the cusp. The pit is almost terminal in position.

Discussion. *Parvigondolella? vrielyncki* has more than 10 denticles. *Parvigondolella lata* and *Parvigondolella rhaetica* have less than 6 denticles. *M. bidentata* has a similar blade profile but it has a short platform with 2 sharp denticles on it.

Stratigraphical range. Upper Sevatian (upper Norian) - Rhaetian

Genus *Zieglericonus* Kozur & Mock, 1991

Type species: *Zieglericonus rhaeticus* Kozur & Mock, 1991

Original diagnosis: "Single cone conodont with a widely expanded and deeply excavated base. Cone laterally compressed" (Kozur & Mock 1991).

Stratigraphical range. From upper Carnian to upper Rhaetian.

Zieglericonus sp.

2003 *Zieglericonus* n. sp. - Channell et al., pl. A2, fig. 6; pl. A3, fig. 35.

2003 *Zieglericonus* sp. - Channell et al., pl. A3, fig. 65.

2010 *Zieglericonus* sp. - Balini et al., pl. 2, fig. 10.

Material: about 50 specimens from 17 samples.

Description. Very small conodont, represented by a single striated cone element with a widely expanded and deeply excavated basal cavity. The cone is laterally compressed. Its basal part is straight while the higher part is strongly backwardly bent.

Discussion. Genus *Zieglericonus* was established in 1991 by Kozur & Mock exclusively as a Rhaetian conodont. The only species discovered was in fact *Zieglericonus rhaeticus* and its name derived from its occurrence limited to the Rhaetian. However, this single cone element has been found recently also in middle and upper Norian strata (Channell et al. 2003), but not yet described. In the Pizzo Mondello section, *Zieglericonus* was found also in lower Lacinian strata, just below the first occurrence of *M. communisti*, shifting thus the FO of this genus into the lowermost Norian.

Stratigraphical range. Upper Tuvalian (upper Carnian) - Rhaetian.

Conclusions

A detailed and complete systematic revision of the upper Carnian to Rhaetian (Upper Triassic) conodont record of the Pizzo Mondello section (Western Sicily, Italy, Sicano basin), GSSP candidate for the base of the Norian, has been conducted. The new taxonomic studies, based only on the P1 elements, yielded the following results:

1) the Tuvalian conodonts assigned until now to *Carnepigondolella nodosa* (Hayashi) do not actually belong to this species; we now assign these forms to a new species, here named *Carnepigondolella tivalica* n. sp. *C. nodosa* may have some relict representatives in the Tuvalian but they are not phylogenetically related to *C. tivalica* n. sp.;

2) a complete diagnosis and description of “*Metapolygnathus communisti* B” has been provided and the species has been renamed *Carnepigondolella gulloae* n. sp.;

3) the analyses of the *Epigondolella quadrata* growth series showed that *Epigondolella miettoi* is not a primitive or juvenile form of *E. quadrata*, but they are two different species. Thus, the FAD of *E. quadrata* in the Pizzo Mondello section is now moved from sample FNP88a to sample FNP112;

4) the analyses of the *Metapolygnathus communisti* growth series showed that *Metapolygnathus parvus* is an independent species and it is not a juvenile stage of *M. communisti*.

Concerning the definition of the Carnian/Norian boundary, on the base of the new biostratigraphic investigations and the discussions of the Subcommittee of Triassic Stratigraphy during the last meeting held in Palermo in September 2010, which recognized the FAD of *Halobia austriaca* (sample FNP135a) as a possible primary marker event, we identified the FAD of *Carnepigondolella gulloae* n. sp., at sample FNP134, as the possible conodont primary marker to define the base of the Norian. The FOs of *Metapolygnathus parvus* at sample AM24 (11.5 meters below the FAD of *H. austriaca*) or “*Metapolygnathus echinatus*” sensu Orchard (2007b) at sample NA36 (9.25 meters below) could be other marker events because they have a good correlation potential with the North American sections, but these species are rare in the Tethys and their occurrence may be triggered by some external cause. The FAD of true *Epigondolella quadrata* (sample FNP112) is just below (5 meters) the FOs of the “*M. echinatus*” - *M. parvus* group, being thus a good proxy for those sections in which the latter species are absent.

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