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Generic turnovers of Carnian/Norian conodonts: Climatic control or competition?

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ABSTRACT

Pizzo Mondello section (western Sicily, Italy) yields a very rich conodont record, ranging from Late Carnian to Rhaetian in age, shedding new light into the evolution of conodonts across the Carnian/Norian boundary. Conodont biostratigraphy around the Carnian/Norian boundary is still problematic due to an inferred provincialism that affects most of the conodont species and to the occurrence of a great number of transitional forms, linked to the fast recovery of conodonts after the Middle Carnian crisis. The lower 144 m of the succession, Tuvalian to Lacian in age, were sampled in detail for a biostratigraphic and ecological study of five Upper Triassic conodont genera: *Paragondolella*, *Carnepigondolella*, *Metapolygnathus*, *Epigondolella*, and *Norigondolella*. After a taxonomic revision of the genera studied, meant to define the most significant morphological features for their classification, a statistical approach was applied to the study of conodont populations. Quantitative curves of the absolute abundances for each genus show potential ecological competition between *Paragondolella–Carnepigondolella* and later between *Metapolygnathus–Epigondolella* (and partially between *Epigondolella–Norigondolella*). Recognition of morphoclines among species, integrated by a similar ecological behaviour, supports the phylogenetic derivation of *Norigondolella* and *Metapolygnathus* from *Paragondolella* and that of *Epigondolella* from *Carnepigondolella*. Furthermore, cross checks of the quantitative curves evidenced the presence of three major assemblage changes: at metre 64.76 (named event T1) *Carnepigondolella* is replaced by its descendant *Epigondolella* in an evolutionary step; at metre 80 (event T2) *Epigondolella* is substituted by the mass occurrence of *Metapolygnathus* and at metre 95 (event T3) *Metapolygnathus* is succeeded by advanced Epigondolellae species and by *Norigondolella*. In looking for environmental explanations to these biological events, the conodont assemblages are compared to coeval $\delta^{18}O$ and $\delta^{13}C$ isotopic curves, based on new data from Pizzo Mondello. From the comparison, a correspondence appears between higher $^{13}C/^{12}C$ ratios and the interval between events T2–T3, but not with event T1. This is in accordance with the interpretation of event T1 as an evolutionary turnover. In more detail, we observe the possible influence of environmental conditions on the absolute abundances of all the studied genera: while *Epigondolella* proliferate when seawater $\delta^{13}C$ ranges between 2.1‰ and 2.5‰, *Carnepigondolella* proliferate in the range between 1.6‰ and 2.1‰; *Metapolygnathus* instead appears to be limited to environmental conditions related to higher $\delta^{13}C$ values in the seawater. We explain this behaviour by interpreting the genus *Metapolygnathus* as an opportunist taxon, exactly as its forerunner, the genus *Paragondolella*.

1. Introduction

Conodont biostratigraphy and taxonomy around the Carnian/Norian boundary is rather problematic because of the apparent provincialism of most of the conodont species (Kozur, 2003; Mazza and Rigo, 2008a) and the large number of morphotypes and transitional forms occurring during this stratigraphic interval. In the Upper Triassic, the mass presence of transitional forms is explained by the rapid recovery and evolution of conodonts after the Julian/Tuvalian crisis (Carnian, Late Triassic), probably caused by the so-called Carnian Pluvial Event (Rigo et al., 2007 and references therein). The Pizzo Mondello section (western Sicily, Italy) preserves a 430 m thick, almost continuous succession of marine limestones ranging from Late Carnian to Rhaetian in age. Characterized by almost uniform facies (pelagic to hemipelagic) and a very rich conodont fauna, Pizzo Mondello is an ideal section for a detailed study of the Late Carnian/Early Norian conodont populations and their evolution. Furthermore, the Pizzo Mondello section has been recently proposed as the GSSP for the base of the Norian Stage (Nicora et al., 2007; Balini et al., 2008). For this reason a series of detailed, integrated paleontological (conodonts, bivalves, ammonoids, and radiolarians) and physico-chemical (microfacies, paleomagnetism, stable isotopes) investigations have been carried out or are currently in progress (Guaiumi et al., 2007; Nicora et al., 2007; Guaiumi et al., 2008; Balini et al., 2008; Levera and McRoberts, 2008). The high abundance of recovered conodonts allows to describe and compare

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numerous species, to analyze different morphologies and to explore relationships among genera and species. Abundant literature data augmented by new data presented in this work allow us to infer a more detailed scenario to explain conodont occurrences.

At present 29 conodont species belonging to eight genera and five possible new species have been recognized in Pizzo Mondello section, including the species considered as the most important ones for the definition of the boundary, i.e., *Epigondolella quadrata*, *Metapolygnathus communisti*, *Metapolygnathus echinatus*, and the five most widespread Upper Carnian/Lower Norian genera *Paragondolella*, *Carnepigondolella*, *Metapolygnathus, Epigondolella*, and *Norigondolella*.

Provincialism and natural competition among conodont species belonging to these five genera were already pointed out by several authors (Channell et al., 2003; Kozur, 2003; Noyan and Kozur, 2007; Mazza and Rigo, 2008a,b). Therefore, we conducted paleontological and statistical studies on these conodont populations in order to investigate their paleoecology during the Late Triassic.

The finding of several conodont morphoclines in the succession testify that the Sicano Basin was not generally affected by incoming conodont migrations from other provinces (Mazza and Rigo, 2008b), but quantitative analyses of conodont absolute abundances raise problems of coexistence among the five genera studied in this paper. Quantitative curves based on volumetric countings show in fact clear inverse trends among five genera (*Paragondolella*, *Carnepigondolella*, *Metapolygnathus*, *Epigondolella*, and *Norigondolella*) and a series of three rapid turnovers involving only the genera *Paragondolella*, *Carnepigondolella*, *Metapolygnathus*, and *Epigondolella*. These turnovers can be explained by natural competition among conodont animals (according to Kozur, 2003), but in order to gain insights into possible paleoenvironmental influences we obtained new $\delta^{18}O$ and $\delta^{13}C$ data on carbonate bulk samples of the same interval. These data reveal a partial correlation between absolute conodont abundances and stable isotope data.

2. Geological setting

The Pizzo Mondello section is located in western Sicily (Sicani Mountains, Italy) and is one of the most continuous, well preserved and easily accessible Upper Triassic successions in the Tethyan realm (see also Guaiumi et al., 2007; and Fig. 1a,b). Moreover the succession is well exposed, it shows high sedimentation rates on the order of 20–30 m/m.y (Muttoni et al., 2004), and mostly uniform facies.

The Sicani Mountains belong to the western Sicily segment of the Maghrebian thrust and fold belt, consisting of a pile of south-verging thrust sheets, known as Sicanian structural units (Catalano et al., 1995). These units are composed of Permian to Cenozoic pelagic-hemipelagic sediments derived from the Neogene contraction of a deep-water basin (Sicanian basin), developed along the southern margin of the Ionian Tethys (Di Stefano, 1990; Muttoni et al., 2004; Nicora et al., 2007).

The Pizzo Mondello section, which is part of the Pizzo Mondello tectonic unit, consists of about 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 attributed to the Gela Nappe (Bellanca et al., 1993; Bellanca et al., 1995; Guaiumi et al., 2007 and references therein).

The lower part of the Pizzo Mondello succession is composed of 430 m of evenly bedded to nodular *Halobia*-bearing cherty calcilutites named *Calcari con selce* (or *Halobia Limestone auctorum*; Cherty Limestone, Muttoni et al., 2001, 2004). These cherty limestones of western Sicily, and especially of the Sicani Mountains, are famous for their extraordinary rich and well-preserved Late Carnian to Early Norian ammonoid faunas studied by G.G. Gemmellaro (1904) and their very rich halobiid, conodont, and radiolarian record (Dumitrica and Hungerbuhler, 2007; Nicora et al., 2007; Balini et al., 2008; Levera and McRoberts, 2008; Mazza and Rigo, 2008a,b). This thick succession of pelagic–hemipelagic limestones is overlain by 20 m of Lower to Middle Rhaetian calcilutites and marls (Portella Gebbia Formation), which are locally discomformably overlain by Jurassic sediments (Gullo, 1996; Guaiumi et al., 2007).

The Carnian to Rhaetian interval is developed entirely within the *Calcari con selce* in the lower 430 m of the Pizzo Mondello succession. We concentrated on the lowest 144 m of the succession, from the base of the section, through the lithostratigraphic interval II of Muttoni et al. (2001; see also Nicora et al., 2007), up to the "slump-breccia level" (a 11.5-m-thick interval of brecciated limestones, referred to as interval III by Muttoni et al., 2001, 2004). The sampled interval, in which the Carnian/Norian boundary based on conodonts has been placed (Nicora et al., 2007; Balini et al., 2008; Mazza and Rigo, 2008b), is completely exposed at the "La Cava" locality, an abandoned quarry on the southern slope of the Pizzo Mondello mountain. This interval has been recently the target of a high-resolution sedimentological study (Guaiumi et al., 2007; Nicora et al., 2007), which allowed the subdivision of the section into three facies A, B and C (in stratigraphic order). These facies are very similar each other but they show, from facies A to C, an increasing abundance of cherty nodules, bioturbation, lamination, and fossil content (thin-shelled bivalves, calcispheres, coquinas, and conodonts). Facies C, in particular, differs from the other two facies because it contains 8- to 15-cm-thick calcilutite layers that are mostly silicified. These three facies alternate in an A-B-C-B-A sequence (Guaiumi et al.,

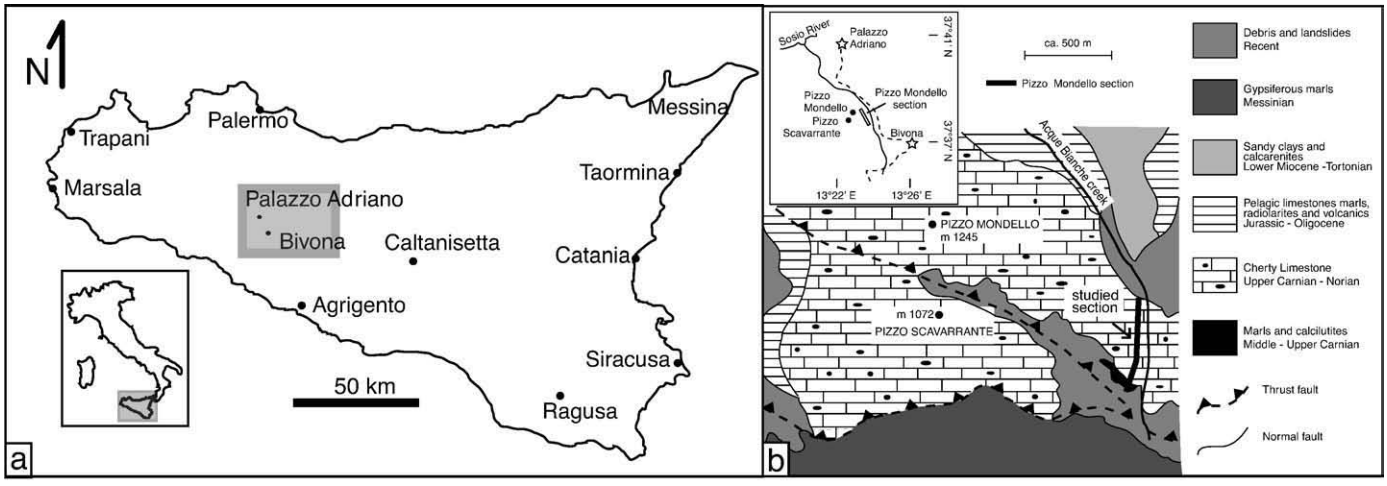

Fig. 1. Location (a) and geological map (b) of Pizzo Mondello (Sicani Mountains, Sicily) (modified after Muttoni et al., 2004).