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Review Article

40 years of field work in the Triassic marine vertebrate sites

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Abstract - During the first 70 years of the XX century very few researches have concerned the marine Triassic fishes. They were prevalently related to the many scientific expeditions carried out in the first half of that century in localities situated along the Pangea margins during the Early Triassic: Greenland, Canada, Spitzbergen, Madagascar. My story starts when, still undergraduate, in 1975 I joined Prof. Maurizo Gaetani on a mapping trip in the Belluno Dolomites: there I found my first fossil remain of a Triassic fish. Since then, excavations and field works have followed one another, almost always concerning new fossil- bearing levels, going back very recently to the same spot in Dolomites, Last September, 41 years after my first discovery of a Triassic fossil fish, I had the opportunity of a new survey on Monte Civetta where I found much more than I expected.

Keywords: Triassic, Tethys, Lagerstätten, fossil fish, marine vertebrates

1. Introduction

During the first 70 years of the XX century very few researches have concerned the marine Triassic fishes. They were prevalently related to the many scientific expeditions carried out in the first half of that century in localities situated along the Pangea margins during the Early Triassic: Greenland, Canada, Spitzbergen, Madagascar. Apart from those sites, even in the most famous Triassic sites - such as Monte San Giorgio or the German Muschelkalk- the focus of research was on reptiles rather than on fishes. Together with my background of geological studies, this scarcity of marine vertebrate collections of middle-late Triassic age has led me to a prevalent and intense field activity which, though extremely time-demanding, has allowed both the discovery of new taxa and the modern re-description of old taxa on very well preserved specimens.

The story starts when, still undergraduate, in 1975 I joined Prof. Maurizo Gaetani on a mapping trip in the Belluno Dolomites: there I found my first fossil remain of a Triassic fish. Since then, excavations and field works have followed one another, almost always concerning new fossil-bearing levels, going back very recently to the same spot in Dolomites, just after 41 years.

The first papers on systematic paleontology dealt with Norian faunas, but through the years I also worked on the Middle and finally also on the Early Triassic.

2. The Zorzino Limestone Fauna, the beginning

Some 50 years ago, in a small stone chippings quarry in Cene, near Bergamo, a landslide exposed some laminated layers of the Zorzino Limestone. This unit had been always considered paleontologically barren, but those layers proved to be a true treasure chest (Fig. 1). Unfortunately, the news rapidly spread among collectors who seized many specimens for their private collections. Actually, Cene was only the first of several new sites that were then located in the territory between Bergamo and Brescia. It became clear that fossil fishes are widespread, especially near the boundary between the Zorzino Limestone and the overlying Riva di Solto Shale. Certainly, preservation can greatly vary from one site to another as the lithology in the same fossiliferous horizon is from almost pure shale to almost pure limestone. Three among the new localities proved fit for more detailed field research, with the help of new roads and landslides.

The basic workforce of my campaigns has always been made up of students and volunteers. Some of these friends have been collaborating for over 30 years, and collections would not be as rich and important without their help. The real problem is that specimens require an extremely long and careful preparation to remove the marly/calcareous matrix generally overlying the bones. This process can only be mechanic because the shale and the organic matter content prevent the action of the acid which is ordinarily used to dissolve the calcium carbonate to clean the specimens in pure limestone. Furthermore, the highly compressed and broken bones would crumble away when completely freed from matrix. This is a general problem for most of the Triassic marine vertebrates, not only for the Norian ones: almost all the fossil bearing rocks are black (compare to the usually 'white' Late Jurassic/ Cretaceous limestones).

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Since the first 1990s, field research in the Norian rocks of Lombardy has just been sporadically carried out at Cene by the Museo di Scienze Naturali di Bergamo. Yet, preparation of specimens collected during the old campaigns is slowly progressing. (Lombardo and Tintori, 2005; Tintori, 1998).

Figure 1. The Cene Quarry (Bergamo, Italy), 1976. Prof. M. Gaetani standing in red jacket; Andrea Tintori sitting in red.

3. Moving down, the Middle and Early Triassic

At the beginning of the 1980s, volunteers of the Civico Museo di Storia Naturale in Induno Olona (VA) found a long-lost site where some fossil fishes had been collected and described nearly 80 years before; an administrative reform had changed many of the toponyms in the 1920s and Ca' del Frate had been turned to Besnasca and disappeared from the maps. The site is part of Monte San Giorgio, but this is not one of the most famous and exploited levels. The Kalkschieferzone infact, top member of the Meride Limestone, can be rich or even very rich in fishes (Tintori, 1990) and arthropods, but reptiles are rather rarely found. And we know how fossil research has always been dependent on the big reptiles! The last campaign at Ca' del Frate dates back to 1996-97 (Fig. 2), when Cristina Lombardo was doing her PhD. Enthusiastic about the findings on the Italian side of Monte San Giorgio, Markus Felber – at the time curator at the Museo Cantonale in Lugano – offered a collaboration for field work on the Swiss side. For the first – and, unluckily, also the last – time a cross-border team was set up! The fossil-bearing level concerned by the excavation is a few dozen meters lower in the succession than that of Ca' del Frate, while the distance separating the sites is about 4 km, allowing the composition of the two associations to be compared. Non only fossil fishes came to light: the most important new discovery was insects. After 150 years of paleontological research on Monte San Giorgio! Again many specimens are still waiting for preparation and description. Some genera, like *Peltopleurus* for example, count dozens of specimens with astonishing variability of characters. Some others, like *Perleidus*, *Allolepidotus*, *Prohalecites*, are represented by a single species for the same stratigraphic interval. The presence of fresh-water invertebrates associated to a marine ichthyofauna proves a strong influx by fresh waters, suggesting and confirming the hypothesis of alternating marine, brackish and fresh water environments. Unfortunately, so far there is no biological or geochemical evidence to prove it. The story of our research on Monte San Giorgio came to an end in 2003 when the Swiss side was inscribed in the UNESCO heritage list. In 2010, after a long and challenging bureaucratic work by Markus Felber and myself, the procedure finally closed with the inscription also of the Italian side.

Beside the above described works, throughout the years there have been also collaborations with small local museums for surveys - for example in the Carnian of Raibl/Cave del Predil and in the Upper Cretaceous of the Karst region (Gorizia and Trieste) - as well as a long series of scientific expeditions to the mountains of Asia (Karakorum and Himalaya), to the Canadian Rocky Mountains, to the desert of Oman. In many cases the outcome was no good for Mesozoic fishes, but certainly very important for a paleontology teacher.

Figure 2. Ca' del Frate/Besnasca (Viggiù, Italy), 1996. Andrea Tintori in white T-shirt, Markus Felber standing, Gianluca Danini in background.

The new millennium began with the field work in a Lower Ladinian level on the Grigna Settentrionale, discovered 20 years before during a didactic excursion. The fossil fish level was the first ever found out in the Buchenstein Formation. Excavation campaigns were carried out for a few years (2003-2009) with remarkable logistic difficulties (Fig. 3). The inclosing rock being a very hard cherty limestone, fishes preparation is extremely time-demanding. Because of this and the economic difficulties of the local Park, only few specimens among the 1500 collected have been prepared (Tintori 2013). At the moment it is impossible to proceed with the study. In the same recent years Tomaz Hitji and his friends have discovered several sites on the Slovenian Alps, yielding very interesting new ichthyofaunas dating back to Lower Anisian and up to the Early Carnian.

The year 2005 sees the crucial encounter with Da-Yong Jang, from the PKU. I joined a newly formed group of specialists in marine reptiles who were already involved in the description of the new, hugely numerous

specimens coming from southern China. Though, as usual, fishes had been considered less interesting than reptiles, their study was equally necessary and could not be further postponed. This collaboration has led me to deal with a series of detailed excavations in the Middle Triassic and later on also in the Lower Triassic. Working bed-by-bed has been an absolute novelty for Chinese paleontology and our team is actually the only one still keeping at this method. Panxian/Yangjuan, Xingyi-Wusha-Dinxiao, Chaohu are among the investigated sites throughout months and months of field work (Fig. 4). On the other hand, the results are astonishing (Tintori *et al.*, 2014a; 2015). In such a short time they have led to the total reshaping of the post P/T event recovery and have allowed to subdivide the Triassic ichthyofaunas into three main assemblages. The appearance of the typical forms/taxa, formerly fixed to topmost Anisian, is now advanced to lowermost Anisian. Equally impressive is the tight succession of sites throughout the Lower/Middle Triassic: approximately one assemblage every million years! So different from the Late Triassic, where the number of associations is dramatically lower, perhaps expressing a more stable environment (not so good for preserving fishes!) but also a higher evolutionary stability(Tintori *et al.*, 2014b).

Figure 3. Northern Grigna (Lecco, Italy), 2008. Andrea Tintori and Tomaz Hitij (orange T-shirt).

Figure 4. Nimaigu (Wusha, Xingyi, China), 2012. From left: Andrea Tintori, Ryosuke Motani, Da-Yong Jiang.

4. Conclusions, for now!

Finally, the loop closes on the Dolomites, exactly in the same locality where it had begun. Last September, 41 years after my first discovery of a Triassic fossil fish, I had the opportunity of a new survey on Monte Civetta where I found much more than I expected (Fig. 5). A new perspective is now open, based on the demonstration that the site is extremely rich and certainly coeval to the Chinese Xingyi fauna. I could recently ascribe my first fish find to the genus *Marcopoloichthys* but the last news is that this site shares even some species with the Xingyi Fauna. Surprises are always just around the corner, despite 150 years of constant paleontological and geological researches on the Dolomites!

As a 'side effect' of the systematic excavations in the Lagerstätten, a great number of well-preserved invertebrates (echinoderms, corals, crustaceans, insects, mollusks…) has been recovered, which all contribute to a more valid reconstruction of the original paleoenvironment where marine fishes and reptiles used to live.

Figure 5. The view from the new site in Belluno Dolomites (Italy), 2016.

Acknowledgments

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