

Triassic actinopterygians across Tethys: state of the art

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(Received 21 May 2017; accepted 7 June 2017)

Abstract - During the 5th International Meeting on Mesozoic Fishes held at Santillo, Mexico, we first presented the great novelty of the marine Triassic findings in southern China. The discovery and following first studies had already shown their important implications not only for paleontology but also for paleogeography. One advantage of fishes over marine reptiles is their size when we want to recognize an assemblage and compare it to others. Fishes indeed are far smaller and more numerous than reptiles, so that the chances to have a 'complete' fish assemblage are much higher. We believe that very fast migrations were possible, but not all the fishes were either interested or able to travel such a long distance. Oceanic currents in the Tethys had clockwise direction in the northern hemisphere, making westwards migration easier in the tropical region where our fishes lived.

Keywords: Triassic, Tethys paleobioprovince, actinopterygians

1. Introduction

During the 5th International Meeting on Mesozoic Fishes held at Santillo, Mexico, we first presented (Tintori, 2010; Tintori and Sun, 2010) the great novelty of the marine Triassic findings in southern China. The discovery and following first studies had already shown their important implications not only for paleontology but also for paleogeography. Actually, Tintori and Lombardo (2005) had already postulated a Tethyan bio-province based on the first published Chinese data (Chang and Miao, 2004; Liu *et al.*, 2003). In 2006 our PKU team started studying the first fish specimens collected during excavations in Panxian (Pelsonian, middle Anisian); later on other field works opened at Luoping (around the Anisian/Ladinian boundary – this activity is limited to 2008 with no direct excavations by the authors), at Wusha, Xingyi (now precisely dated to late Ladinian) and at Chaohu and surroundings (end Smithian/Spathian, Early Triassic). Preliminary results are described in Tintori *et al.* (2014), but new data are continuously coming up. Systematic excavations can last several months a year; in Nimaigu (Wusha, Xingyi) they lasted a whole year plus some further periods dedicated to detailed logs. This very intense activity has obviously led to gather a huge amount of material the preparation of which can be either very fast or quite long depending on its conditions. In such a favorable situation, papers about systematics were published in such a series that would have been impossible with the western world timing and funding.

2. Tethys paleobio-province

One advantage of fishes over marine reptiles is their size when we want to recognize an assemblage and compare it to others. Fishes indeed are far smaller and more numerous than reptiles, so that the chances to have a 'complete' fish assemblage are much higher (actually we will never know whether it is complete or not!), with positive reverberations on paleogeographic reconstructions and comparisons. Although excavations in the Alps are definitely smaller than the Chinese quarries, they are generally large enough to give good information on their ichthyofaunal composition.

From the beginning it was clear that at genus level many taxa were spread throughout the Tethys. This is especially true for the miniature fossil fishes (less than 4 cm in total length) which are so much common in the Middle Triassic units. However, some large taxa – and for that period large means 30-60 cm – could have such a wide distribution. *Colobodius* for example, that reached its maximum diversification during the Anisian and then lasted until the beginning of Carnian. We do not consider for paleobiogeographic purposes genera such as *Saurichthys* and *Birgeria*, the top Triassic fish predators: indeed, they had a global distribution, being found in all of the Triassic localities except the Chinese Early Triassic (pre-Spathian) ones.

Thus, now we know for sure that many 'generalist' genera – or with low swimming and trophic specialization – are equally present in Europe and in southern China,

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respectively the western and the eastern ends of the Tethys Ocean in the Triassic. *Sangiorgioichthys*, *Placopleurus*, *Marcopoloichthys*, *Peltopleurus/Peripeltopleurus*, *Habroichthys*, *Altisolepis*, *Perleidus*, *Luopingichthys*, *Thoracopterus* and the already cited *Colobodius* are the most important genera which were spread throughout the ocean, being represented by different species. Comparing faunas at species level is much more complicated. The main reasons are the poor preservation of several alpine specimens and the many, rather meagre, original descriptions that require modern redescriptions. Anyway, differences at specific level are definitely plausible. The distance separating the two extremes of the Tethyan gulf was at least 5000 km; furthermore, the western and eastern assemblages are often not perfectly coeval, which could be a problem with groups like subholosteans showing a great evolutionary speed. On these bases, one should expect remarkable variations between the two regions.

Nonetheless, a continuous exchange inside the Tethys is not in question and is also proved by the first Chinese Pholidophoridae, *Malingichthys* (Tintori *et al.*, 2015), recorded in the Xingyi Fauna. Unfortunately, we mostly ignore which marine actinopterygians lived outside the Tethys during the Middle-Late Triassic because fish-bearing sites are known only in the Tethyan region. The Early Triassic sites on the contrary are mostly located all along the Pangea margin. The recent institution of several new genera skipping any serious comparison of the specimens with known taxa is generating a problematic situation. We really do not need fancy systematics that only bring proliferating genera with dramatic consequences for the paleogeographic interpretation. The Tethyan bioprovince in fact no longer makes sense following this unreasonable line.

On the other hand, a substantial homogeneity inside the Tethys was very recently (AT pers. obs., September

2016) further confirmed by the presence of a same species – for the first time beyond doubt – both in the Alps and in southern China. During a geo-paleontological survey on the Dolomites a Late Ladinian level yielded a specimen of the oldest flying fish *Thoracopterus wushaensis*, first described by Tintori *et al.* (2012) on material collected at Nimaigu (Wusha, Xingyi) (Fig. 1). This finding has also a really high stratigraphic significance, allowing the sites to be correlated on the basis of fossil fishes (*Thoracopterus wushaensis* may not be the only one, but that needs confirmation). The associated ammonoids indeed are problematic because, while the alpine faunas contain the typical taxa making up the basis of Middle Triassic stratigraphy, the Chinese ammonites are mostly endemic (Zou *et al.*, 2015) (Fig. 2). Strange to say, in this case ammonoids are more endemic than fishes!

Thus, if one species is common to the whole Tethys, we suppose that likely some other genera are, as we acknowledged above. There are also a certain number of endemic fish taxa, usually representing highly specialized forms – either in trophism or in swimming. Deep-bodied fishes are among them. The far western territories of the Tethyan gulf yield subholostean Perleidiformes such as *Felberia* and *Stoppania*; the far eastern ones yield the basal neopterygian *Luoxiongichthys*. Although roughly sharing the same body shape and ornamentation, they are actually not equivalent. Dentition in fact is different, and *Luoxiongichthys* is also somewhat older (Anisian) than *Felberia* and *Stoppania* (mostly Ladinian and Early Carnian). Age is an extremely interesting aspect because in several cases the ‘first appearance’ seems to occur in China. We do not know whether the two areas had preservation windows in different times or whatever. Anyway new discoveries and data are constantly turning up, as proved by the case of *Thoracopterus wushaensis*.

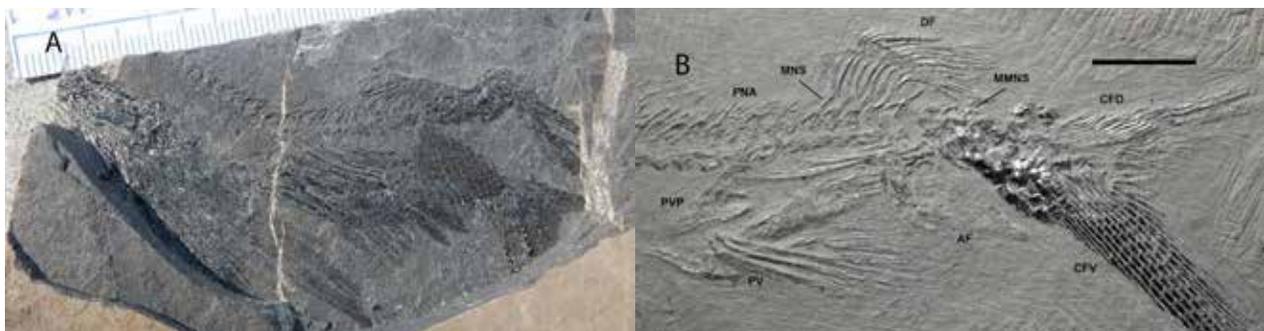


Figure 1. *Thoracopterus wushaensis* A. Specimen from the Dolomites (Belluno, Italy) collected by A.T in September 2016 (at present in field collection of the Paleontological Museum UNIMI). B. specimen GMPKU-P-3071, from the type locality of Nimaigu (Wusha of Xingyi, Guizhou Province, China). (After Tintori *et al.*, 2012)

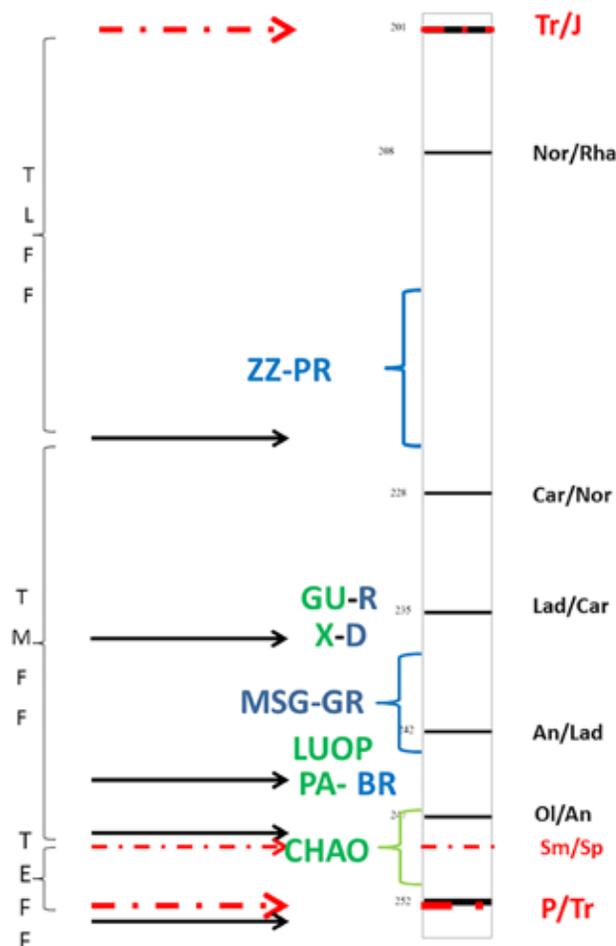


Figure 2. TEFF: Triassic Early Fish Fauna. TMFF: Triassic Middle Fish Fauna. TLFF: Triassic Late Fish Fauna. Tr/J: Triassic/Jurassic boundary. Nor/Rha: Norian/Rhaetian boundary. Car/Nor: Carnian/Norian boundary. Lad/Car: Ladinian/Carnian boundary. An/Lad: Anisian/Ladinian boundary. Ol/An: Olenekian/Anisian boundary. Sm/Sp: Smithian/Spathian boundary. P/Tr: Permian/Triassic boundary. CHAO: Majiashan (Chaohu, Anhui), from Smithian to Anisian. PA-BR: Panxian (Guizhou) Fauna – Braies Dolomites, Pelsonian (Middle Anisian). LUOP: Luoping (Yunnan), Upper Anisian. MSG-GR: Monte San Giorgio sites (Upper Anisian-Upper Ladinian) and Northern Grigna (Lower Ladinian). X-D: Xingyi Fauna (Guizhou/Yunnan) and Dolomites, Upper Ladinian. GU-R: Raibl-Cave del Predil (Udine) and Guanling (Guizhou), Lower Carnian. ZZ-PR: Zorzino Fauna from Lombardy and Friuli Italy) and Seefeld and Hallein (Austria), Middle-Upper Norian. In blue color: western Tethys sites; in green color: southern China sites. Red arrows: Major biological crises events. Black arrows: main fish fauna changes.

3. Conclusions

We believe that very fast migrations were possible, but not all the fishes were either interested or able to travel such a long distance. *Luoxiongichthys* for example was not fit for long-distance swimming. Oceanic currents in the Tethys had clockwise direction in the northern hemisphere, making westwards migration easier in the tropical region where our fishes lived. Traveling in the opposite direction must have been a far more challenging undertaking.

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