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**NEW FINDINGS OF *TANYSTROPHEUS LONGOBARDICUS*
(REPTILIA, PROLACERTIFORMES)
IN THE MIDDLE TRIASSIC OF BESANO (LOMBARDY, NORTHERN ITALY)**

The prolacertiform reptile *Tanystropheus longobardicus* is known since the last century (Bassani, 1886) from the Middle Triassic of Northern Italy (Besano Formation, Upper Anisian-Lower Ladinian). Several specimens were collected also in the Grenzbitumenzone (same stratigraphical horizon as Besano Formation) in Monte San Giorgio, Switzerland, (Peyer, 1931; Wild, 1973).

Field work in the new quarries opened in the Besano outcrop since 1975 under the supervision of the paleontological staff of Museo Civico di Storia Naturale di Milano now greatly enhance the diversity and peculiarity of the reptilian fauna of the site, including new spectacular findings of *Tanystropheus longobardicus*. New material include some isolated remains, and two more complete specimens of major interest: a complete skeleton of a juvenile individual (specimen BES SC 265), probably the best preserved one so far known, and a partial skeleton of a larger but still not mature individual (specimen BES SC 1018), with wonderfully preserved limbs.

Since most of the material from Besano housed in Museo Civico di Storia Naturale di Milano was lost during World War II, the importance of the new findings allows the reconstruction of a new paleontological collection from the site; and the study of *T. longobardicus* specimens now in progress is part of a project for a complete description of the recently collected .

The study of the new *Tanystropheus* specimens will undoubtedly add knowledge to the anatomy and relationships of this genus, allowing a relevant contribution to the current debate about the relationships of Prolacertiformes.

In particular, this preliminary work focus on the anatomy of the limbs, and the following characters are reported:

1. Presence of bony structures related to elbow and knee joints, that could be alternatively interpreted as sesamoids or epiphyses; the second hypothesis seems the more probable at present.
2. Structure of the carpus. As previously stated by Wild (1973) the carpus of *Tanystropheus* consists of four ossified elements: radiale, ulnare and two distal carpals that can now be definitely identified as a larger dc4 and a smaller dc3. Distal carpal four is in topological relation with the proximal heads of mtc4 and mtc3 and distal carpal three with the proximal head of mtc2. Following Wild (1973), radiale and ulnare are in close juxtaposition, and a foramen transmitting a perforating artery opens between the two bones.
3. Structure of the tarsus and pes. Specimens BES SC 265 and BES SC 1018 show the best preserved feet of *Tanystropheus* up to now known. Of great interest for a better

understanding of the foot of *Tanystropheus* is also one more specimen recently prepared (V 3730), consisting of an isolated foot from Meride Limestone (Ladinian), which might more probably be ascribed to the species *Tanystropheus meridensis* (Wild, 1980).

In the light of the new findings, the tarsus of *Tanystropheus* is confirmed to consist of four ossified elements (Wild, 1973), i.e. astragalus, calcaneum, and distal tarsals three and four. The calcaneum has a platelike, generalized shape, with neither a lateral expansion nor a calcaneal tuberosity.

The astragalus and the calcaneum make contact along a straight suture line. Contrarily to what stated by Brinkman (1981), there is no evidence in the tarsus of *Tanystropheus* of a complex concave-convex articulation between the astragalus and the calcaneum.

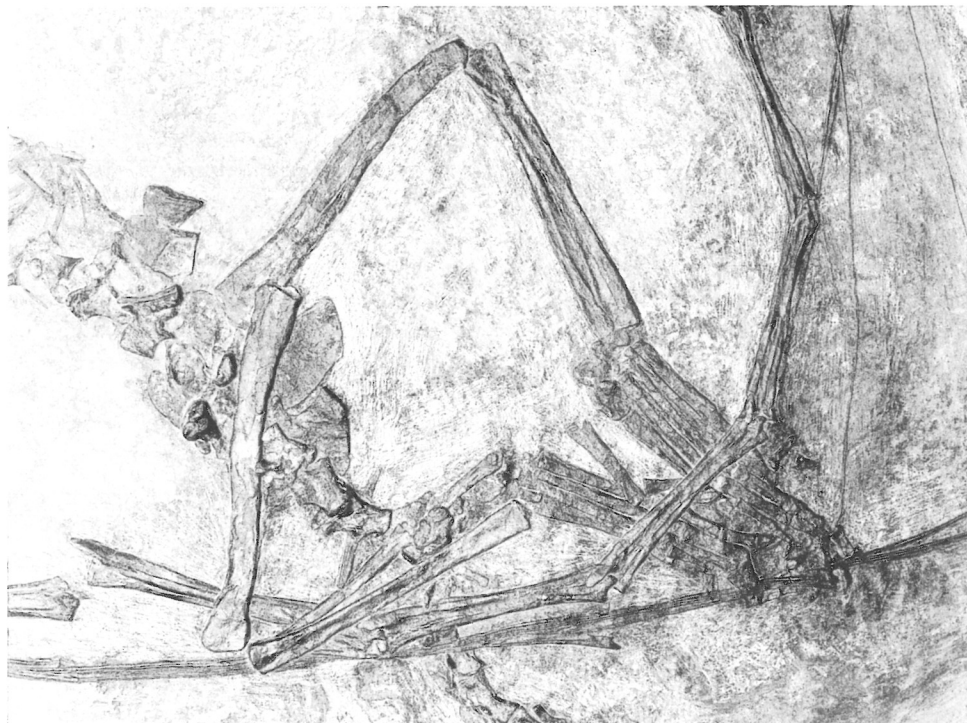
Of great interest in specimen BES SC 265 is the presence of an apparently calcified area lying externally to the astragalus and proximally to mtt1; if this area is not an artifact, the only possible interpretation of it would be as a centrale. However, a centrale was previously never observed in *Tanystropheus*, and this is ever more strange if it were such a large element as it appears to be in specimen BES SC 265. A centrale was recognized in all prolacertiforms with enough well preserved tarsus, but its absence in *Tanystropheus* might be due to skeletal paedomorphosis related to aquatic habits. A better understanding of patterns and sequences of chondrification, ossification and secondary reduction of tarsal elements in prolacertiforms, and particularly in *Tanystropheus*, would be of great help, and is an aim of our future research.

The pes of *Tanystropheus* is a very compact structure, with all the metatarsals, enclosed mtt5, tight together in a single functional unit, their proximal heads being overlapped; so, the abduction movement of the fifth digit looks to have been of far lesser extent than supposed by Wild (1973).

The comparison of specimen BES SC 265 with the larger specimens BES SC 1018 and V 3730 (having feet of approximately the same size, i.e. one third longer than the foot of specimen BES SC 265) raises problems in the interpretation of some characters of the foot of *Tanystropheus*. It may be hypothesised however that the differences observed in the three specimens might be related to ontogenesis. For instance, a foramen between the astragalus and the calcaneum is not still developed in the immature specimen BES SC 265, but it is clearly present in the larger specimens. In the juvenile, the general structure of the tarsus is very compact, with the bones in close juxtaposition, and no clear evidence of a mesotarsal joint. However, the study of specimens BES SC 1018 and V 3730 now in progress suggests that such a joint might develop in mature individuals of *Tanystropheus*.

The morphology of the fifth hooked metatarsal and its topological relations with dt4 and the calcaneum are apparently age-related as well. During ontogenesis the head of mtt5 becomes more deflected medially, forming with the thick shaft of the bone an embayment in which the proximal head of mtt4 fits. The proximal head of mtt5 gains full contact with a large dt4, and only its proximal surface makes contact with the calcaneum. The fifth metatarsal develops an outer process and lateral tubercle. Distal tarsal four comes to lie distally to the astragalus, fitting into an embayment of the distal surface of the bone. This embayment continues itself on the calcaneum, where the dorsal surface of the proximal head of mtt5 fits. Finally the astragalus becomes less transversally oriented with increasing age.

The improved knowledge of the anatomy of *Tanystropheus* resulting from the study of the



new material will be the basis of future research, aimed to the assessment of the phylogenetical relationships of *Tanystropheus* and to the interpretation of its mode of life. In this respect, a good theory would have to satisfactorily and simultaneously explain the functional meaning of a pool of characters, some of which have not previously been enough taken into account. The key-character is the extremely elongated neck, with the problems related to its posture in the living animal. Other characters of major interest are the dentition, and the structure of the limbs. In particular, the structure of the tarsus and the metatarsal-like elongation of the first phalanx of digit 5 raise intriguing questions related to terrestrial and aquatic locomotion of *Tanystropheus*.

At the moment, we think that the overall anatomy of *Tanystropheus* reveals its close terrestrial ancestry, with a low degree of specialization for an aquatic mode of life. The assumption of aquatic habits was probably related to the need of solving the mechanic problems raised by the elongation of the neck, a trend typical of the group of prolacertiforms which becomes extreme in *Tanystropheus*, because of the highly positive allometric growth of the cervical vertebrae.

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