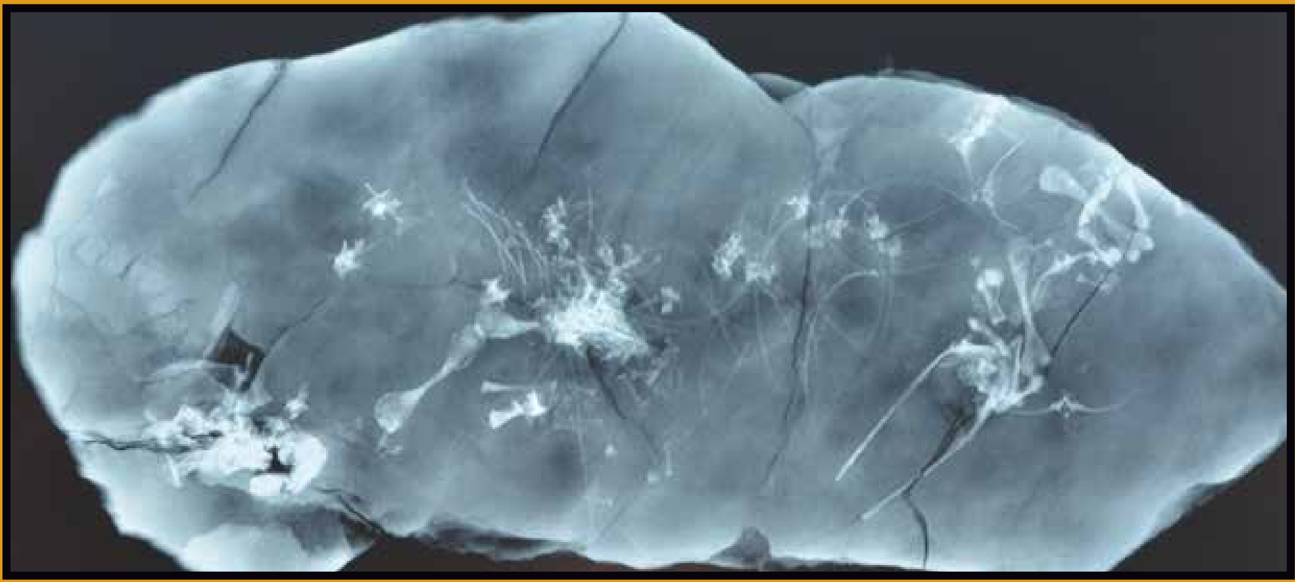

Some new and exciting Triassic Archosauria from the Dolomites (Northern Italy)

Edited by
Thomas Perner and Michael Wachtler

DOLOMYTHOS-Museum
Oregon Institute of Geological Research

A new interesting archosaur from the Ladinian (Middle Triassic) of the Dolomites (Northern Italy)

Preliminary report

by
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Abstract

A small-sized archosaur from the Ladinian (Fassanian-Langobardian) stage of the Southern Dolomites is described. The skeleton is mostly complete; the skull is characterized by its powerful teeth, the ribs are slender, and the prominent pelvis including the ilium, ischium, and pubis suggests a classification in an early group of avian-line archosaurs. Fore limbs and hind limbs are equally long. Since very little is known about the phylogenetically earliest members of the Avemetatarsalia, this new animal helps to fill a gap in the knowledge. It will be named *Wachtlerosaurus ladinicus* gen. nov. sp. n.

Online: August 2018
Archosaurs, new genus, Ladinian, Middle Triassic, Dolomites, Northern Italy

Wachtlerosaurus ladinicus nov. gen. sp n.

Entire slab

Stratigraphical setting and age

The skeleton was collected between a rich plant horizon pertaining to the Ladinian stage (Fassanian-Langobardian) on the Southern part of the Parco Naturale Adamello-Brenta in the World Heritage site of Dolomites, but outside the area of the nature park. The horizon could be defined well as the Global boundary Stratotype Section and Point (GSSP) between the Anisian and Ladinian stage (upper Middle Triassic) is exposed on the nearby Ponte di Romanterra, south of Bagolino (Brack et al., 2005). The older Buchenstein-Formation is still characterized with predominantly air-borne volcaniclastic material (Pietra Verde), whereas a marked change in sedimentation follows with an abrupt switch to the volcanoclastic to the siliciclastic Wengen Formation. This stratum named by Heinrich Ludolf Wissmann (1841) after the village Wengen (La Valle) in the Gader-Valley, encompasses various vulcanite deposits with changing amounts of tuffs, clays and limestones. The name Wengen-Formation was later extended to the whole Southern Alps indicating basinal terrigenous and volcanoclastic sediments and conglomerates, followed sometimes by submarine fine-grained volcaniclastic turbiditic sandstones and dark mudstones. The layers can be observed in many parts of the Dolomites, from Corvara, till Braies, Gardena Valley, Passo Giau, Zoldo, staying in this form till the Lombardian Alps. Their colour is usually dark-brown to greyish.

The first formal recognition of a stratigraphic interval, comprising what is now called Ladinian, originates from the subdivisions of the Triassic System proposed by Edmund von Mojsisovics. Ammonoids served as the main biostratigraphic tool for these divisions. After that, Bittner (1892) introduced the term "'ladinisch" (Ladinian, after the "'Ladin"'-people of the Dolomites area) as a new label for the stratigraphic interval comprising the South Alpine Buchenstein and Wengen beds. The base of the Ladinian Stage (Middle Triassic) is defined by the first occurrence of the ammonoid *Eoprotrachyceras curionii*. The Wengen-Formation is known for its richness in the brackisch water-shell *Daonella* and *Posidonomya*.

A late Ladinian (Longobardian) for the Wengen-Formation is also supported with *Dijkstraisporites beutleri* and *Maexisporites meditectatus* (Wachtler & Van Konijnenburg-Van Cittert, 2000). The macro-plant assemblage is characterized especially by the conifer *Voltzia dolomitica*, and also holding other conifers (*Alpia ladinica*) like the cycads *Bjuvia dolomitica, Nilssonia faustinii* and *Apoldia wengensis*, some ferns (*Neuropteridium, Gordonopteris*) and horsetails (Equisetites arenaceus).

Even in a layer of the Wengen-Formation holding spectacular *Voltzia dolomitica* twigs and *Daonella*-shells, a complete skeleton of an archosaur, probably belonging to the base of the avian stem lineage (Avemetatarsalia) conducting to the dinosaurs and birds, was found.

Systematic Paleontology

Subclass DIAPSIDA Osborn, 1903
Infraclass NEODIAPSIDA Benton, 1985
Division ARCHOSAUROMORPHA Huene, 1946
Subdivision ARCHOSAURIA Cope, 1869
Infradivision AVEMETATARSALIA Benton, 1999

Wachtlerosaurus gen. n. (PERNER, 2018)

Etymology

Dedicated to Michael Wachtler honouring his intensive and long-lasting research in the Dolomites.

Type horizon and ages

Southern Dolomites, Pessina, Middle Triassic, Ladinian (Fassanian-Langobardian).

Wachtlerosaurus ladinicus sp. n. (PERNER, 2018)

Etymology

After the Ladinian (Middle Triassic) strata where the fossil was found.

Holotype

PRE 01, is a disassociated skeleton of one individual, including: complete skull, cervical, trunk, and caudal vertebrae, forelimb and hind limbs, pelvis and most part of the tail. Coll. Wachtler, Dolomythos Museum, Innichen, Südtirol.

Diagnosis

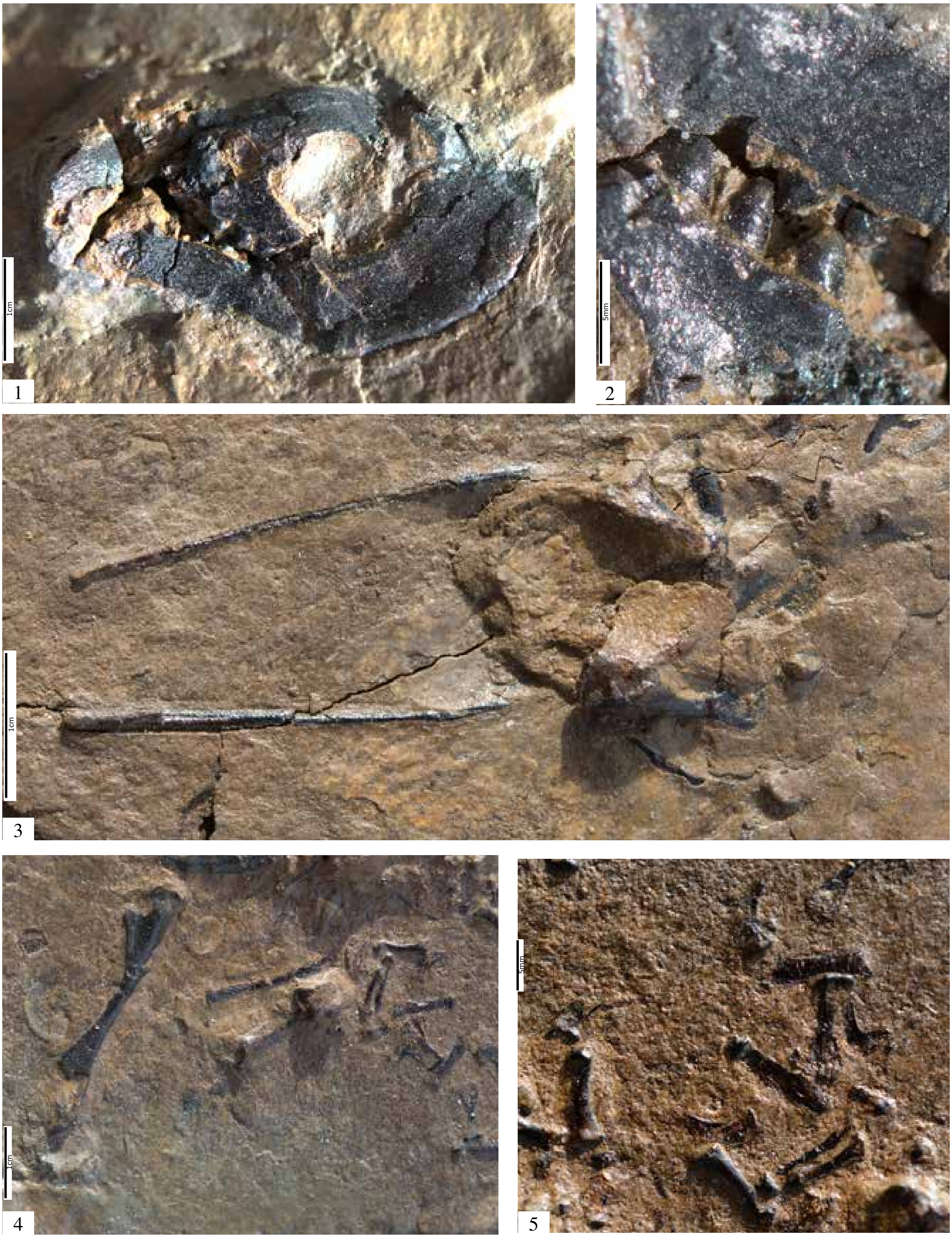
Small Archosauria, with a diapsid skull. Dentary and premaxillary ending elongated and holding powerful and robust teeth. Humerus and femur mainly equal long. Presence of incurved sharp claws. Ribs thin and fragile. Pubis and ischium mainly isometric and pointed backwards.

Description

Skull: The skull is 35 mm long, 20 mm wide, and consists of several major bones: the dentary measures 20 mm, the surangular is separated, the premaxilla is partly broken by fossilisation, but evidence presents a nasal aperture. Both hold prominent and powerful teeth, approximately 1 mm long and not recurved. The orbita is distinctive and rounded and 10 mm in diameter.
Cervical vertebrae: The upper spinal column is hidden in the rock and only visible on X-Ray: 7 vertebrae can be observed attached, 3 probably lie separate.
Ribs: They could reach a maximum length of 45 mm and are long and slender.
Fore legs: The humerus is 26 mm long and flattened in an anteroposterior direction, the proximal portion is expanded more than twice the width of the midshaft of the humerus. The ulna is 11 mm long, and the distal ends the convex. Digits approximately are 5 mm, whereas the claws reach a length of 5 mm and are incurved.
Pelvis: Ilium, ischium and pubis fused together. Pubis 35 mm long, ischium probably 1 mm shorter. Ilium crest dorsal to the supraacetabular crest/rim and anterodorsally inclined.
Hind legs: Left and right femur are 26 mm long and powerful. The femur has expanded proximal and distal heads and a narrow shaft with a sygmoidal curvature. The tibia is 11 mm long and the tarsus 11 mm.

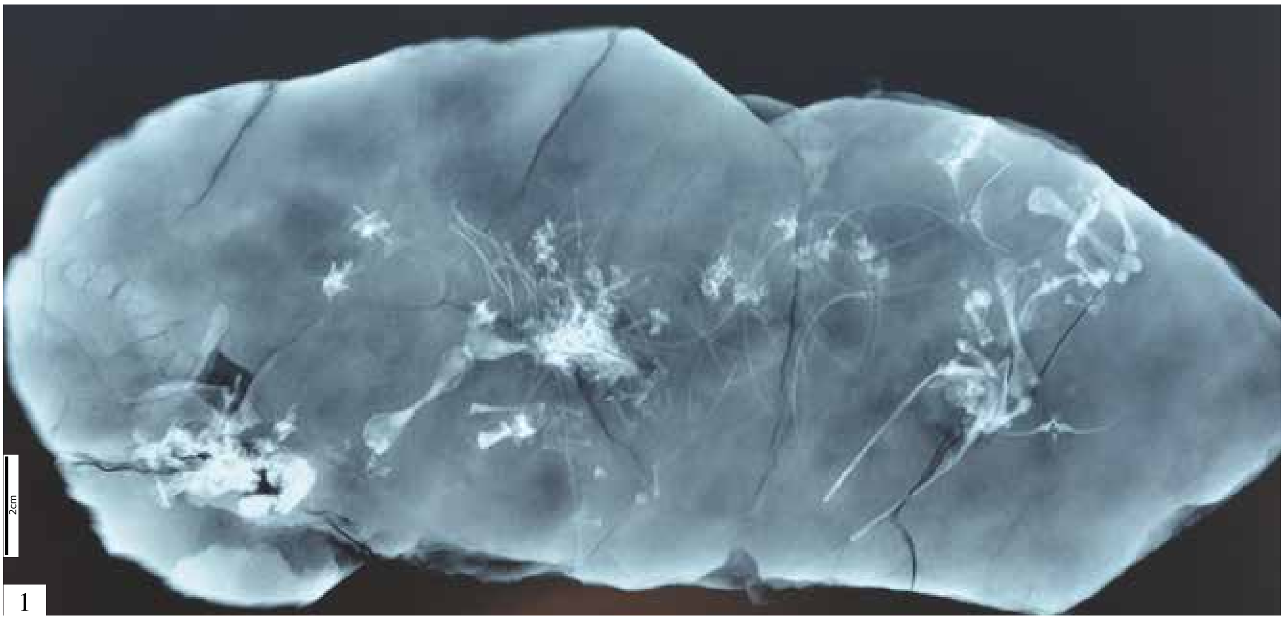
Remarks

The archosaurs have a 250-million-year record that originated shortly after the Permian-Triassic boundary and is continued today by two extant clades – the crocodylians and the avians. The phylogeny of Archosauriformes indicates that an initial diversification occurred during the Early Triassic. Early archosaur evolution is characterized by high rates of homoplasy, long ghost lineages, and high rates of character evolution (Nesbitt et al., 2017). Archosaurs were diverse by the Middle Triassic and had there a cosmopolitan distribution. During the Triassic, archosauriforms settled in many different habitats from terrestrial (e.g., dinosaur, ‘‘rauisuchian,’’ aetosaur, crocodylomorph), aquatic terrestrial (phytosaur), till aerial (pterosaur). Following the Triassic, two main lineages remained – the Crocodylomorpha and the Dinosauria.
The early members of Crocodylomorpha from the Triassic and the Early Jurassic were lumped into the Sphenosuchia prior to explicit phylogenetic analyses (Nesbitt, 2011). The other comprise the Avian-line archosaurs consisting of pterosaurs, dinosaurs, and a range of intermediate forms. Today, the only surviving members are modern birds. Benton proposed the name Avemetatarsalia in 1999 to include all bird-line archosaurs – referring to all archosaurs more closely related to dinosaurs than to crocodilians. The Avemetatarsalians first appeared in the Middle Triassic but they remained a rare component until the origin of the dinosaurs in the Late Triassic. Even in the Late Triassic, avian-line archosaurs were dominated in number of taxa, body types, and overall abundance by the crocodylian-line archosaurs (Nesbitt, 2011).
It is thought that the basal archosaurs changed their posture from sprawling to erect and showed decreases in femur stress with a more upright walking way (Kobe & Benton, 2007). All theropods share several common features; they have a gracile body, slender and hollow limb bones, a foot with three main toes, and they were bipeds, where the long neck was cantilevered over the hindlimbs. The ilium has a low, convex dorsal border and a long preacetabular process. The ischium and pubis are elongated and rod-like. The femur and tibia are strong bones. The forelimbs are different from the hind limbs. The humerus and femur are equally long and powerful, whereas the ulna is more fragile and slenderer than the tibia. This is also valid for metacarpus and tarsus (Kubo & Benton, 2007).
It is not easy to insert *Wachtlerosaurus* in one of the known families. Therefore, maybe it is more useful to study the same. From this point of view, it can be established that *Wachtlerosaurus* was only a little rhyncho-



***Wachtlerosaurus ladinicus* nov. gen. sp n.**

1. Skull; 2. Detail of the teeth; 3. Pelvis, pubis and ilium; 4. Humerus, ulna, and part of the hand bones with claws; 5. Detail of the hand bones and the claws



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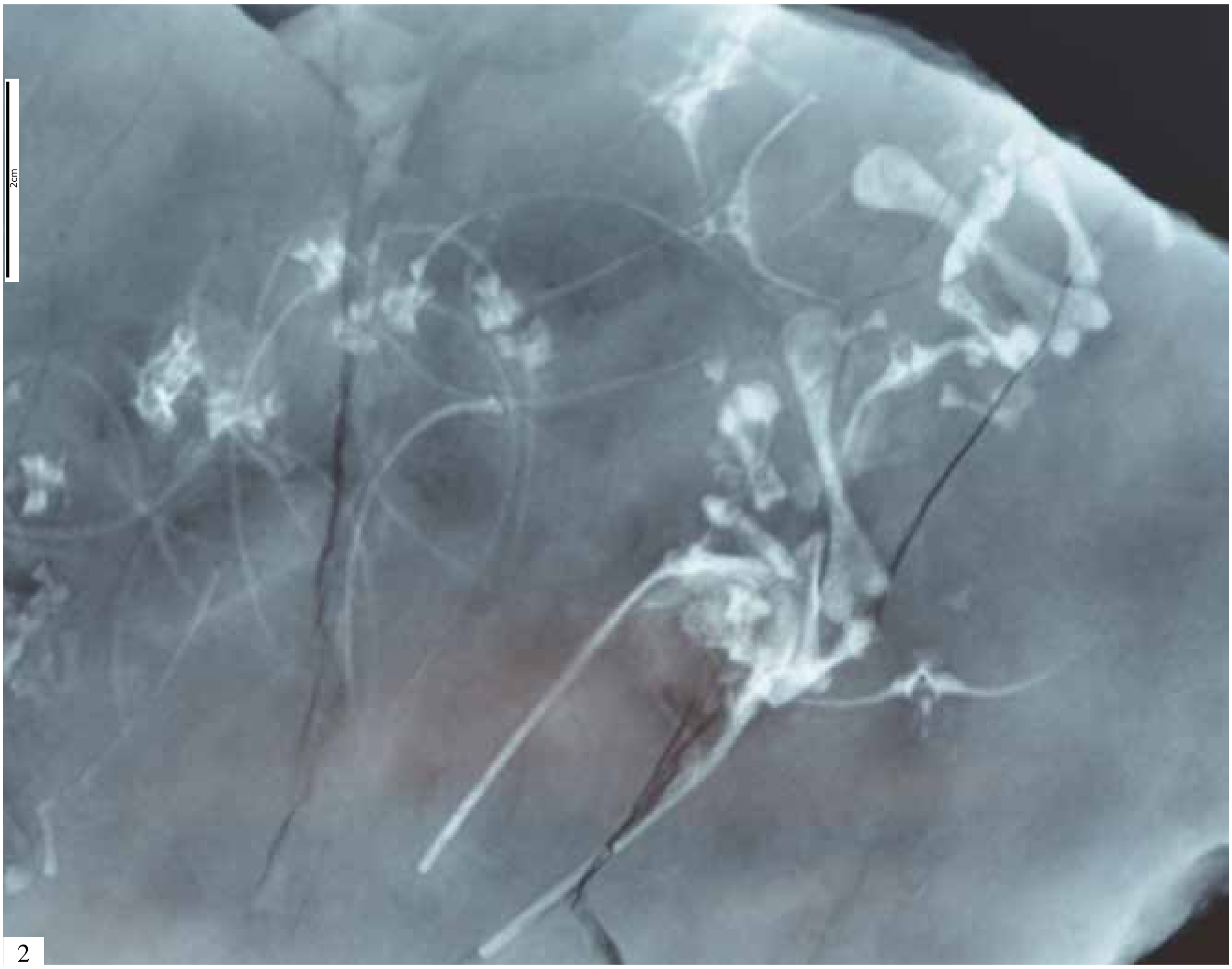

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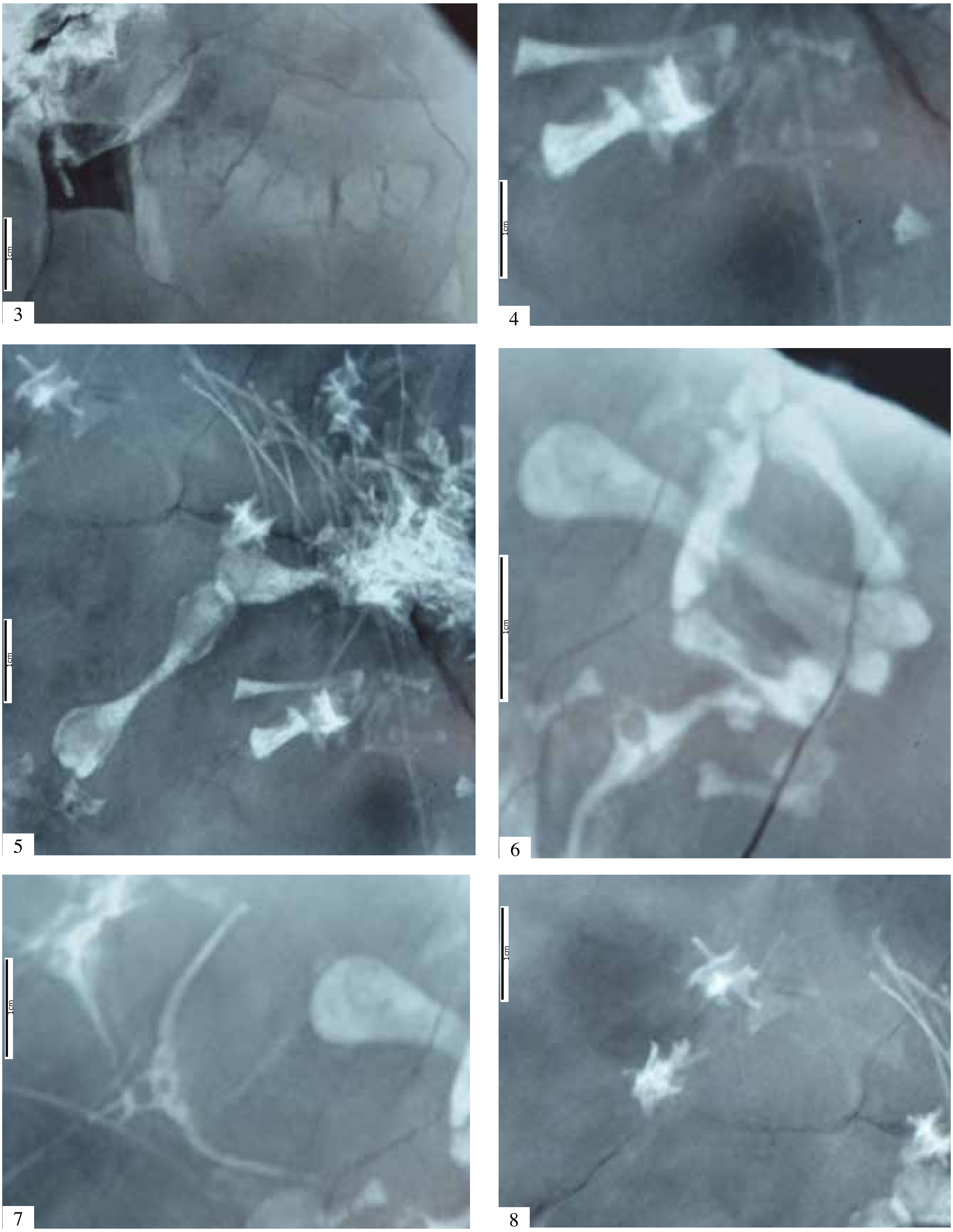
***Wachtlerosaurus ladinicus:* X-Ray-Images:**

1. Whole slab measuring 24 cm; 2. Back view with image of the pelvis, and the hind legs. Also detail of the vertebrae and the costae.



***Wachtlerosaurus ladinicus:* X-Ray-Images:**

3. Detail of the cervical vertebra; 4. Detail of the claws and the hand-bones; 5. Humerus and ulna; 6. Femur and tibia; 7. Vertebra and ribs; 8. Two dorsal vertebra.

cephalians); the squamosal lacks an anteriorly concave articulatory facet for the postorbital; a well-developed alar process of the prootic and a radial condyle on the humerus; an ulnar patella; a secondary curvature of the clavicles; and an expanded epiphysis of the first metacarpal along with the absence of the first distal carpal (suggesting its fusion with the first metacarpal, as observed in modern squamates (Simões et al., 2018). Many of these features are not visible in *Wachtlerosaurus ladinicus*. Also, the ribs are more fragile, whereas the elongated pubis is not preserved in *Megachirella wachtleri.*

Another line is the Pseudosuchia, which first appeared in the Early Triassic. Their ankles, the astragalus, were joined to the tibia by a suture, and the joint rotated around a peg on the astragalus, which fitted into a socket in the calcaneum. It doesn't seem that *Wachtlerosaurus* was equipped with this feature.

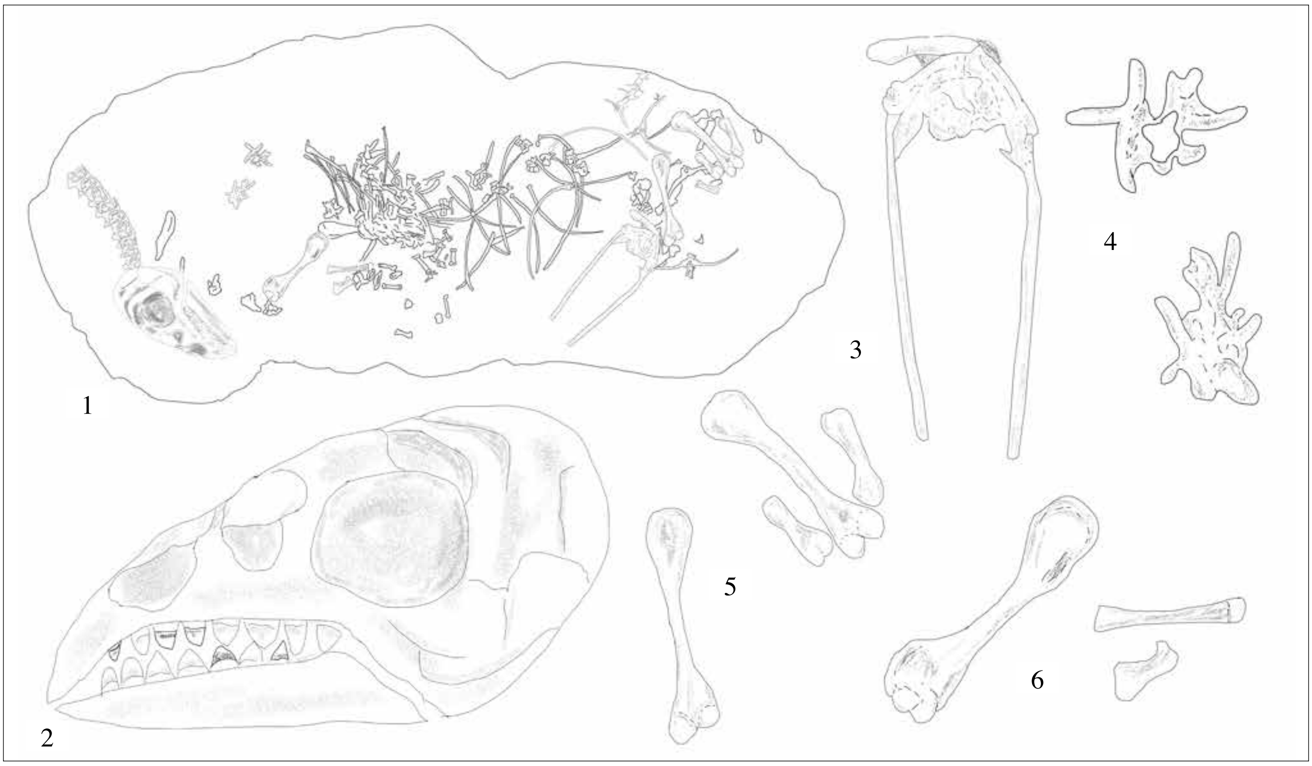
The Ornithodira include the last common ancestor of pterosaurs and dinosaurs and also the birds; the Crurotarsi comprise the ancestors of crocodilians but also some group of Triassic archosaurs like the ornithosuchids, aetosaurs, and phytosaurs.

Early Crurotarsans walked with sprawling limbs but some later developed fully erect limbs (most notably the Rauisuchia), whereas modern crocodilians can walk with their limbs sprawling or erect depending on the speed of locomotion.

Conclusion

Wachtlerosaurus ladinicus leaves open probably only a very early line of the Avemetatarsalia, although it is suggested that they appeared in the Carnian age of the late Triassic (Benton, 1999). Like *Wachtlerosaurus*, they were lightly built and usually adapted to a biped life. This small archosaur was probably about 25-30 cm long but had not assimilated to a life in water. So, a nothosaurian line can be excluded. It holds no mammalian features; the skeleton was light-weighty, but no shadows of the skin or feathers are visible. The animal would have adapted to a climbing and arboreal lifestyle with the miniaturization of body size to evade predation.

Scleromochlus taylori, about 18 cm long, from the late Carnian Lossiemouth Sandstone Formation, provides evidence of a primitive ankle structure, and it has a slen-



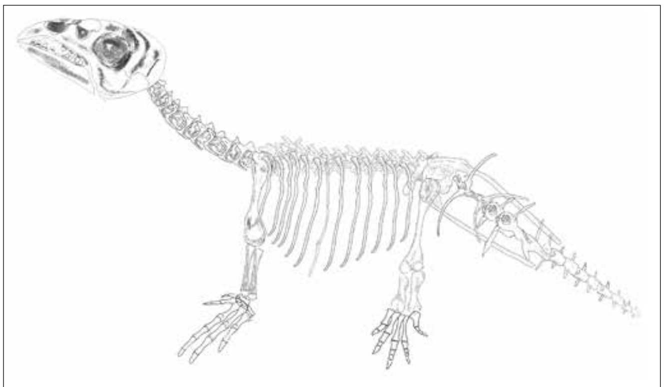
Wachtlerosaurus ladinicus drawings: 1. Whole slab; 2. Skull; 3. Pubis and ilium; 4. Dorsal vertebrae; 5. Humerus and Ulna; 6. Femur and Tibia der humerus, femur, and fibula having additionally the classic bird-like characters of a tibia that is longer than the femur, and a closely appressed group of four elongate metatarsals (Benton, 1999). These characters are only partly recorded in *Wachtlerosaurus*. However, the poor preservation of *Scleromochlus* could not be scored for many of the important characters that optimize near the base of Avemetatarsalia.

The synapsids, mammal-like reptiles, were the dominant land vertebrates throughout the Permian, but they perished mostly between the Permian-Triassic border. Only a few synapsids, especially *Lystrosaurus,* an herbivorous dicynodont, survived, but in the Early Triassic, the archosaurs were just the dominant land vertebrates.

Otherwise, it is difficult to establish when the archosaurs first appeared. The Permian reptiles *Archosaurus rossicus* from Russia and Poland or *Protorosaurus speneri* from Germany appeared in the late Permian, but there is some doubt if they can be classified as true archosaurs or only archosauriforms.

Also, early members of the rauisuchians, such as *Scythosuchus basileus* from the Lower Triassic of the Donskaya Luka locality (Russia) or *Tsylmosuchus jakovlevi* found in the Pechora region in the Urals do not fit well in the blueprint of *Wachtlerosaurus.*

Another interesting fossil, *Megachirella wachtleri,* found in the Anisian layers of the Dolomites, is the first unequivocal squamate from the Triassic worldwide (Renesto & Posenato, 2003; Simões et al., 2018). It preserves traits that indicate a lepidosaurian reptile, such as the presence of a well-developed quadrate conch, an ectepicondylar foramen in the humerus and pleurodont dentition. But results from the micro-CT scans include a combination of features that are found uniquely in squamates: a triradiate squamosal (not tetraradiate as in most other diapsids, including small; their necks were long and had an S-shaped curve; and their skulls were much more lightly built. Only the bipedal movement was not very good evolved in *Wachtlerosaurus*. Altogether it can be stated, that this Ladinian animal opens a window to the evolution of the birdlike dinosaurs, many further studies are required.



Suggested reconstruction of *Wachtlerosaurus ladinicus*

Measurements taken on the *Wachtlerosaurus ladinicus*

Length of the preserved slab: 240 mm
Skull: 35 mm long x 20 mm high
Orbit 10 mm length x 9 mm wide
Length of the ribs: Longest 45 mm
Humerus: 26 mm
Ulna: 14 mm
Claws: 5 mm
Pubis: 35 mm
Illium: 40 mm
Femur left: 26 mm
Femur right: 25 mm
Tibia: 11 mm

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