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Diadectes absitus (David S. Berman et al., 1998) & *Ichniotherium cottae* – another glimpse of permian terrestrial locomotion

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Category: **Scientific modelling (Master)**

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Bromacker quarry

INTRODUCTION:

Diadectes absitus is an extinct species of *Diatectidae* – an evolutionary family of vertebrates combining conservative amphibian and advanced reptil-like characteristics during middle Permian age about 260 million years ago. *Diadectes absitus* is known since 1998 from perfectly preserved fossils: an almost complete articulated skeleton, isolated limbs and skulls and rare fossilized footprints and track marks named *Ichniotherium cottae* from the world famous sandstone quarry of Bromacker (Thuringia) in central Germany.

The combination of fossilized footprints together with complete articulated skeleton finds is unique worldwide. Other fossils of the same level show subterranean burrows which can also be assigned to the raleted genus of *Orobates pabsti* (also as fossil traps for complete skeleton preservation inside). The Bromacker finds present a complex Ecosystem of the middle Permian age with a diverse fauna and flora of early terrestrial species. Its sand- and clay stones were sediment at continental high level plateau pervaded by periodical water streams, ponds and flood-lands. This Permian area far from the sea was characterized and formed by an extremely continental climate with hot day and cool night temperatures – it was the age of the single supercontinent Pangäa before it starts to crack and spread into the modern landmasses. Periodical temperatures below zero degrees Celsius are documented too – so that fauna and flora had to adapt on quite a lot climatic extremes into their functional anatomy to survive. The herpetofauna vertebrates of that time are called “Ursaurier” - also as there are not close ancestors or even relatives of the million years later evolving Dinosaurs – but they were the first documented real terrestrial vertebrates in evolution of life.

Material and Interpretation:

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Holotypus *Diadectes absitus*

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scull of Holotypus

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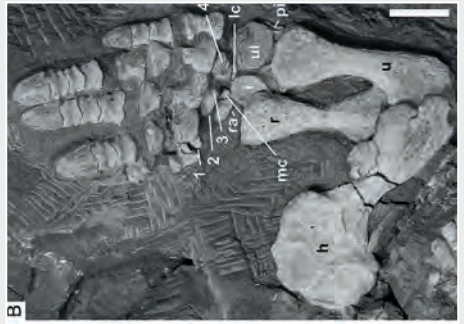
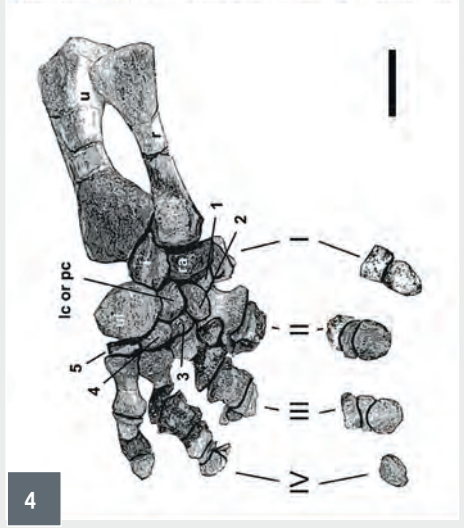
Holotypus von *Diadectes absitus*





The Holotype skeleton and other fossils of *Diadectes absitus* are stored at Museum der Natur Gotha (Thuringia, Germany).
All anatomical measurements from this specimen were transferred in scale 1:1 to create the presented reconstruction model. It shows following features:

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- a compact and strong torso with a large volume to contain a massive gastrointestinal tract to digest vegetarian food
- a short but very strong neck with massive cervical muscles
- a compact scull with enforced rostrum, implied eye bulges, strong front-ground orientated jaws
- a terminal epigyneous orientated mouth with a high grade specialized dentition: strong stick-like frontal teeth sparsely differentiated to grab and pick; behind there are two pointed molars arranged diagonal turned inwards and crushing in each other (first time ever recorded molars of that type in land vertebrate evolution - functional appropriate to really chew a plant-fiber diet
- tail with strong basal muscles for powerful lateral undulating moves
- very strong and short forelegs, very strong and much longer hind legs – both with powerful limbs with strong fingers and toes
- toes and fingers show no pointed claws but flat fingernail like tips

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To reconstruct the volume of the fossilized torso the author adjusted his model according to how torso skeletons of modern reptiles change in shape after death. This two images show the same individual of a *Pogona barbata* corpus. Its obvious how ribs are pulled back to the spine after death and during drying - and so give a fake image of a very narrow torso which was very much larger during lifetime. The fossilized torso of *Diadectes absitus* (Holotypus) is deformed in a similar way – so this effect had to be equalized during reconstruction.

In addition there is a well preserved fossilized track-mark, assigned to Diadectes absitus, classified as *Ichniotherium cottae* disclose exceptional further information about the quadrupedal locomotion of *Diadectes absitus*:

– The footprints point out that while working hands and feet were turned body inwards in a partly rotational movement.

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Ichniotherium cottae fossil track of *Diadectes absitus*

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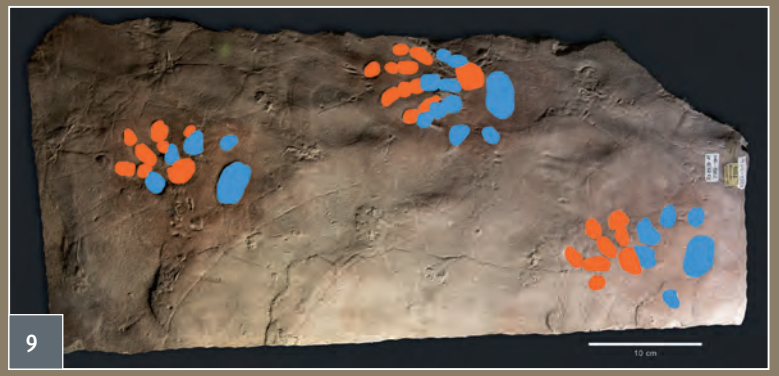
a walking comodo dragon throwing his limbs centrifugal outside

Today reptiles do a centrifugal outside movement with its limbs – a kind of "throwing them" from front around the body and just behind them. It seems to be the common way of a typical reptiles walk.
Diadectes had its unique way to walk, similar but not same to amphibians like *Salamandra* or newts. Together with its related genus Orobates, a first try of nature to evolve a permanent quadrupedal walk on land.

– The most important information of this track mark is that *Diadectes absitus* stepped with its hind legs into the footprints of the forelegs (in contrast to its related genus *Orobates pabsti* with its track mark Ichniotherium spherodactylum).



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foreleg-prints in orange, hindlegs in blue

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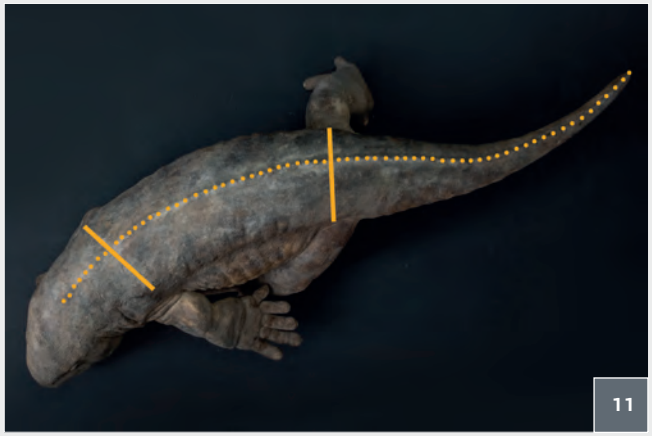

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lateral view of *Diadectes absitus* reconstruction

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Spinal undulations and alternating rotation of shoulder girdle and pelvis

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Diadectes tail didn‘t touch the ground while walking

In mind the much shorter length of forelegs to its hind legs it is obvious that *Diadectes* did a strong spinal undulation movement with it torso by walking to push its body forward to the next step. By this and also in relation to its relative wide step length a quite fast and persisting walking ability can be assumed.

– The rare finds of *Ichniotherium cottae* (only two in relation to more then 100 specimens of *Ichniotherium sphearodactylum* (*Orobates pabsti*) can be seen as a reference that at the one hand maybe the Bromacker flood-lands were not the resident habitat of *Diadectes* (skeletons could be preserve by flood catastrophies) – or they are a hint that *Diadectes* avoided to step into wet soil – in contrast to the more aquatic Orobates pabsti. For sure this dramatic difference in numbers of this two types of fossilized tracks sets an important link to understand the behavior and biology of this two animals in this Permian ecosystem.

– The footprints of *Ichniotherium cottae* by walking were set quite narrow in relation to the central body axis – more then it could be expected according to the measurements of the skeleton in comparison to a modern reptile as a crawler. That fact shows that the angles of elbows and knees had at least 90 degrees and so the body was held quite high up the ground without touching it with its belly. The spinal column of the torso was lifted from a straight position up to a slightly convex curve as modern caudates do.

– Also measurements between the footprints and central body axis indicate that the vertebra column of torso and also tail did serpentine undulating movements while walking. Further the shoulder girdle and pelvis were alternate rotating horizontal by doing step by step.

– A very interesting and until now sparsely noticed fact is that there are not any stress marks of the elongated tail in the fossilized soil. That proves the tail usually did not touch the ground while walking. This opens up the question of the anatomical structure and the function of that very huge part of the body.

Reconstruction of *Diadectes absitus* in its ecosystem:

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reconstructed Bromacker-ecosystem with *Diadectes* and *Orobates*

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fossil imprints of Walchia sp.

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fossil imprints of fern fronds of *Callipteris* sp.

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scheme of the specialized dentition of *Diadectes* sp.

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By putting all that facts and considerations together *Diadectes absitus* was an early experimental side way in evolution of early terrestrial vertebrates. He was something like a missing link between the modern classified amphibians and the so called reptiles. Following ideas seems to create an authentic image:

The Permian plains of Bromacker far from the sea had an extreme continental climate with hot days and cool nights, sometimes below zero degrees Celsius. From neighboring eroding mountain ranges huge amounts of clay and sand were sediment by periodical streams caused by monsoon thunderstorms, rainfalls and also snow melts. Flat muddy rivers meandering into the plains forming flat ponds and shores. Also nutrients like drown insects, carrion and digestible parts of plants were washed up at the flat shores – a main and regular food resource for plants and animals living in that environment. Vertebrates like *Orobates* patrolled along that muddy shores collecting omnivorous food in the seams – and ate whatever they find. Also gymnosperm plants colonized the periodical flood lands. This pioneer flora of coniferous and ferns (*Walchia* sp., *Callipteris* sp. etc.) of the flood-lands was probably at least a seasonal vegetarian food source for *Diadectes absitus*.

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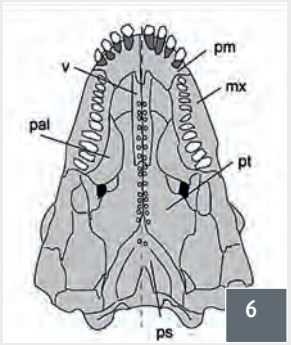

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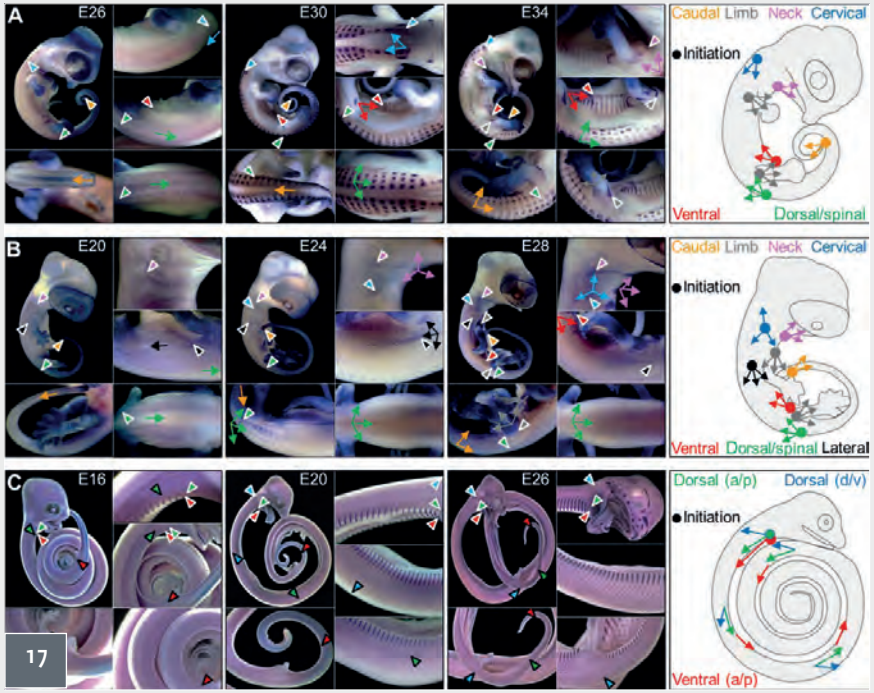
Diadectes absitus probably had a specialized skin for that extreme periodical changing wet and dry, cool and hot environment. The lateral skin was maybe soft and lobed to provide an amphibian like skin respiration at moisture conditions. Beside that rather archaic elements the more exposed bodyparts probably had some new evolved features. To preserve against sun drying, irritations and injuries by predator assaults like by *Dimetrodon* – *Diadectes* was probably wearing ceratin-protoscales. Before scales of fish and amphibians were of bone. There are no bony scales fossilized at *Diadectes*. During the Permian age scales as body surface evolved once again as oval scales of ceratin. The evolution of ceratin-scales is less observed. A question that paleontologists sometimes failing to adhere according to theoretical taxonomic systematic. If a skeleton is classified as amphibian or reptile it should be important to think about what was happening in that age long times between the typical characteristics of that vertebrate class were evolved – an anatomical plan of a modern reptile or something like a ceratin scaled skin did not emerge suddenly or pop out of nothing. It probably was a slow process with several steps between an amphibian skin to one of a modern reptile. It is one purpose of this reconstruction model to show how such an animal "in between" could have looked like. To get an idea of the appearance of that early ceratin scales and to reconstruct an animal just during the long evolutionary process of ceratin scales the author observed images of so called scale "placodes" of turtle and lizard embryos.



These atavistic structures are rounded ceratin shields embedded in skin which evolve during the ontogeny to typical scales. On that the author was inspired to create the presented homogeneous *Diadectes* skin. Nails, fingers and toes and also the head were most exposed and stressed by walking and digging – so these parts were most ceratinized – almost like a real reptile, which *Diadectes* was not.

Some parts of this image of the living animal *Diadectes* absitus of course originate in model makers fantasy, but all of them correspond with the extracted information of the fossil report (skeleton, tracks, environment) at the actual state. It is an outstanding and complex amount of information about a lost animal in view to the unbelievable age of 270 million years of the Bromacker finds.

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