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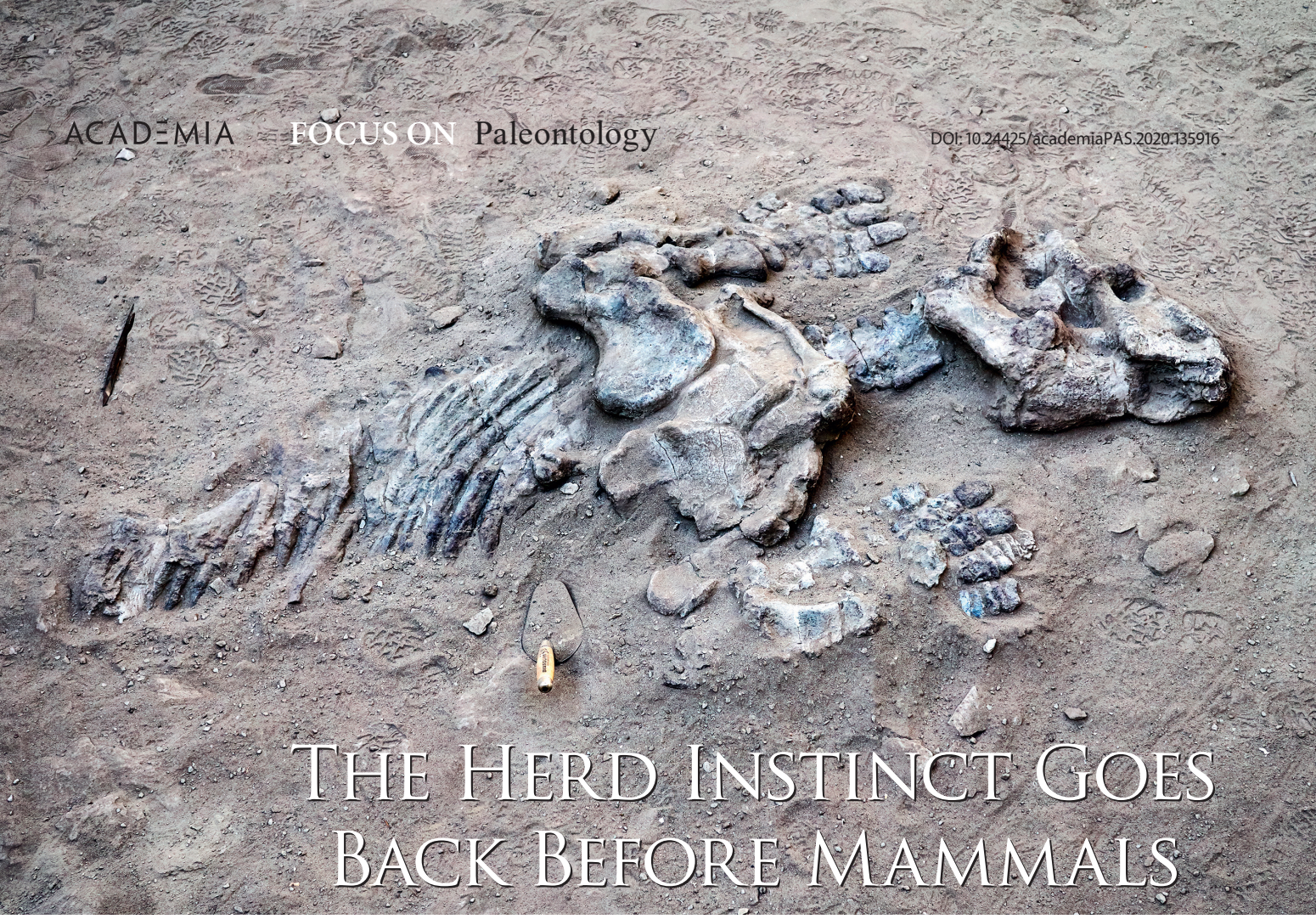

The Herd Instinct Goes Back Before Mammals

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On the question when mammals first started to rear their offspring, the jury is still out. Was such care-giving behavior actually inherited from our reptilian ancestors?

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Clearly, we humans are herd animals. There is a growing recognition that we have a need for relationships, for intimacy, or even for just a simple cuddle now and again. Unquestionably, we like to stick together; nowadays we teach our children empathy and train them in cooperative skills from as early as nursery school. In other words, we do not suffer solitude very well. Among the mammals, we humans are no exception in this regard. This comes as no surprise, since even birds and fish live in gregarious groups, which can be quite large and very orderly (not to even mention ants and other invertebrates). But how and when did such behavior begin? That's a question that can only be answered, it seems, by paleontologists.

Paleontology gleans information about the ancient world mainly from excavations. For instance, the dig in Krasiejów near Opole yielded the remains of 14 *Silesaurus* specimens in a single fossil-bearing stratum. The *Silesaurus* was a rapidly-moving, meter-and-a-half long, herbivorous dinosauriform (or "pre-dinosaur"), which lived approximately 230 million years ago. Did these 14 individuals together form a herd? Possibly so, but conclusive evidence is lacking. Only two of the skeletons are relatively complete; the others are known merely from several bones. To compound matters even further, it is not clear whether the whole clutch comes from the same fossil-bearing stratum because it was found amidst river deposits, and therefore it is not possible to know which skeletons and bones were deposited by the river in a single sedimentation episode. As we can see, looking for evidence of a herd-based lifestyle is not so simple in paleontological work.

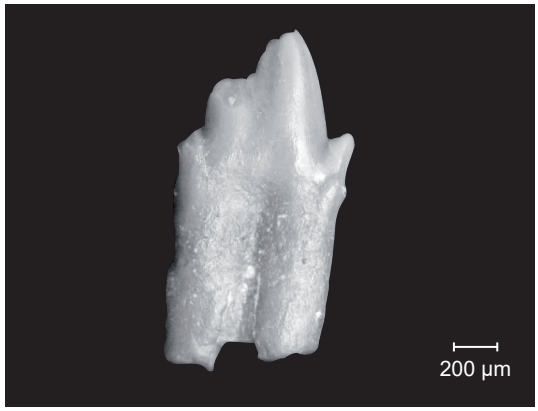
A team of Brazilian paleontologists had a bit more luck in this respect: they recently found and described a tiny herd of mammal-like reptiles, dicynodonts, living approximately 240 million years ago. But is there any link between such mammal-like reptiles and re-

al mammals? Indeed there is: the first mammals did originate from the mammal-like reptiles (now often called "synapsids") – an extremely varied group of reptiles in terms of size and diet (herbivorous and predacious) as well as lifestyle (burrowing, slow and fast running). The last major lineage link preceding mammals was the "cynodonts," animals which resembled wolves in the early Triassic, but were more like shrews by the Late Triassic. Mammals evolved from them at some point between the Triassic and the Jurassic, although at which point in particular is a hotly debated issue at the moment and probably nobody knows today when mammals per se first appeared.

At one time, the criterion of having three ossicles (auditory bones) was considered a sufficient trait for mammalhood, but nowadays researchers instead study a whole constellation of mammalian features. One such feature is the presence of mammary glands, and – as a consequence – the rearing of offspring. In 2018, a report in *Nature* described an unusual fossil find from the early Jurassic – a clutch comprising several dozen individuals of the genus *Kayentatherium* (the members of which are variously considered to be mammals, protomammals, or cynodonts – depending on who's writing): the remains of an adult plus 38 baby skeletons. The skulls of these tiny individuals, several centimeters long, are fully toothed, which suggests that they were able to lead an independent life. This night be a sign that they required no rearing, but not necessarily so. The find invites a number of questions. Was this perhaps a "nursery" together with an adult carer? Were these the offspring of a single set of parents, or aggregated from more than one mother? These are fundamental questions, but ones we are not likely to find answers anytime soon.

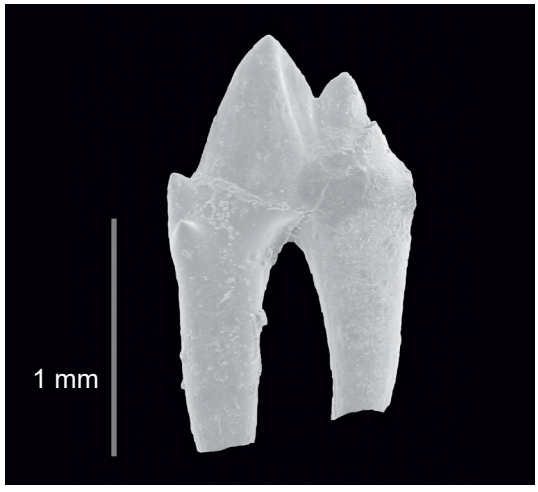
Mammals from Silesia

There is a chance, though, that greater elucidation of several issues concerning the origin of mammals will come from Poland's Silesia region. Recently, we described a new cynodont species on the basis of over 20 teeth found in the clay-pit in Woźniki near Częstochowa, containing the remains of animals living 230 million years ago. The entire assemblage resembles the one in Krasiejów, but regretfully comprises a much smaller number of specimens. The findings include remains of piscivorous (fish-eating) phytosaurs, armored aetosaurs, gliding ozimeks, and semi-aquatic cyclotosaurs. The cynodont teeth we found are only several millimeters long, which indicates a tiny skull. Their size and age appear consistent with the first mammals from the *Adelobasileus* genus, known only from a posterior part of the skull, but as yet, the dentition of mammaliamorpha living in that period remains unknown. However, there is a layer in the Woźniki clay-pit which has also yielded concretions (spherical masses formed by the precipitation of minerals on organic remains) with complete skulls and whole reptile skeletons approximately 20 cm long. It seems likely, therefore, that a complete mammaliamorpha skeleton will eventually be found there. We also described the tooth of a somewhat younger mammaliamorpha found in Lisowice near Lubliniec, a site approximately 208 million years old. Hard as it is to draw conclusions based on a single tooth, we suppose it belonged to an animal of the genus *Hallautherium*. Perhaps an accumulation of its skeletons will be unearthed in the future, allowing us to gain some insights into its behavior.

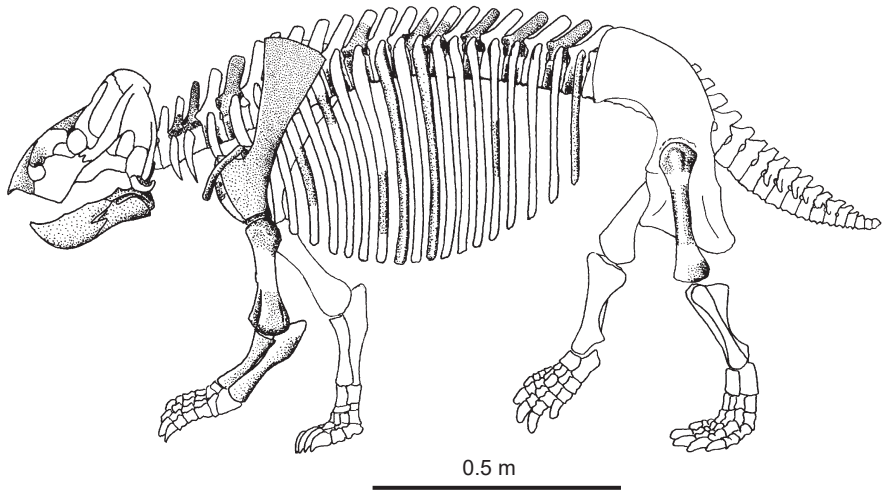


A *Polonodon woznikensis* (cynodont) tooth from Woźniki near Częstochowa. Visible cusps with complex morphology and a root with longitudinal narrowing

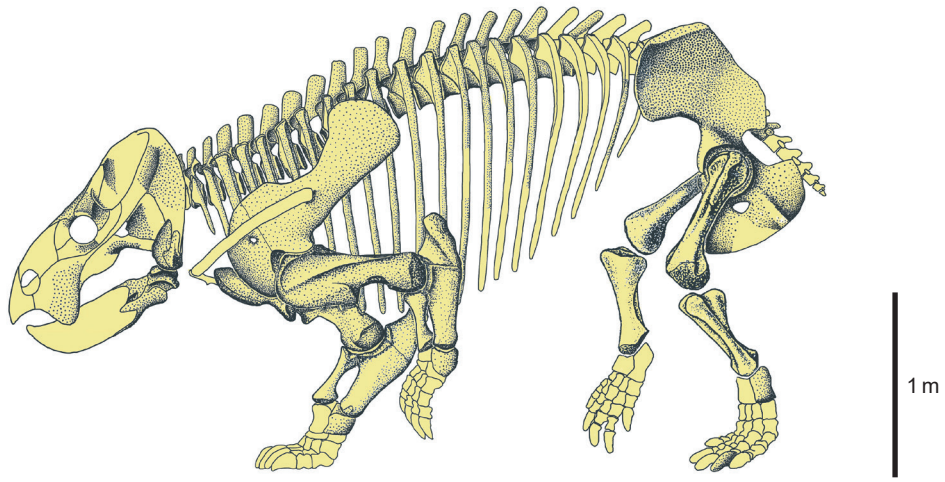
But let us get back to the herd of young dicynodonts. Dicynodonts were a group of herbivorous mammal-like reptiles which originated approximately 270 million years ago, and its youngest representatives are about 208 million years old. Dicynodonts were found nearly on all continents, which means they constituted an important element of the Permian and Triassic ecosystems. They had a huge skull and their forelimbs bent sideways. Six skeletons of young dicynodonts from the *Dinodontosaurus* genus, buried at the same time about 240 million years ago, were found in the Santa Maria Formation in Brazil. Such



A *Hallautherium* sp. tooth from Lisowice with two separate roots



Reconstructed dicynodont skeleton from Woźniki (new genus, as yet not taxonomized)



Reconstructed *Lisowicia bojani* dicynodont skeleton from Lisowice near Lubliniec

an assemblage of individuals at a similar age found in a small space can be viewed as evidence that dicynodonts displayed social behavior. Dicynodonts from the genus *Diictodon* had earlier been suspected of developing relations between individuals. A large accumulation of burrows was found over an area of 500 square meters in the Beaufort Formation in the Karoo region (RSA). The burrows often revealed entire skeletons, or sometimes two skeletons lying together. This suggests it may have been the breeding site of a huge herd. Perhaps in the future it will be Polish excavations that will bring to light new information on the herd behavior of dicynodonts, given that such finds have recently been made more and more frequently in Silesia.

The Lisowice site has yielded the biggest and youngest known dicynodont – *Lisowicia bojani*, which we described in *Science* in 2019. It lived about 208 million years ago in what is now Silesia and reached 2.6 meters in height. Being bigger than Late Triassic dinosaurs, it challenged their dominance. Its skeleton is almost completely known, save for the skull. We can say, for example, that it differed from other dicynodonts by having forelimbs situated vertically under the body, in the fashion of today's rhinoceros. Only isolated bones are known from the skull and jawbone. The skull and jawbone of the other Polish dicynodont are much better preserved. The entire jawbone and snout of the still-unnamed genus comes from Woźniki near Częstochowa. Since many animals described earlier in the Krasiejów site (where the Jurapark Krasiejów is located) are also found in Woźniki, it is suspected that these two sites originate from the same period. A detailed description of the Woźniki dicynodont is yet to appear, but the relevant work is well under way. The Lisowice site is truly special. It has also yielded coprolites (fossilized animal feces) of *Lisowicia bojani* and fossilized tracks made by the animal. So far, such individual imprints have been few and far between, but the site has yielded complete dinosaur and beetle paths. So who knows, maybe one day we will find the tracks of dicynodonts rubbing against each other and thus find evidence of how they manifested tender affection? After all, such traces of a dinosaur mating dance have recently been reported! ■

Further reading:

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