Dinosaurs -- stones did not help with digestion

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The giant dinosaurs had a problem. Many of them had narrow, pointed teeth, which were more suited to tearing off plants rather than chewing them. But how did they then grind their food? Until recently many researchers have assumed that they were helped by stones which they swallowed. In their muscular stomach these then acted as a kind of 'gastric mill'.

But this assumption does not seem to be correct, as scientists at the universities of Bonn and Tübingen have now proved. Their research findings can be found in the current issue of the journal *Proceedings of the Royal Society* (doi:10.1098/rspb.2006.3763).

What do you do if you do not have good teeth, and food is hard to digest? Some herbivorous birds which have a toothless beak, such as ostriches, solve the problem with what is known as a gastric mill. Their muscular stomach is equipped with a layer of horn and contains stones which help to break up, crush and thereby also to digest food.

Giant dinosaurs from the Jurassic and Cretaceous period (200 million to 65 million years ago) such as Seismosaurus and Cedarosaurus must have had similar digestive problems. The animals, some of which weighed more than 30 tonnes, were the largest herbivores which have ever existed. Many of them had a very small head, in relation to the size of their body, and narrow, pointed teeth, which were more suited to tearing off plants rather than chewing them. At the same time, they had to digest enormous amounts of food for their rapid growth and the metabolism of

their gigantic bodies. Smoothly polished stones, which were found in several cases at excavations involving skeletons of sauropods, are also interpreted as gastric stones.

However, Dr. Oliver Wings from the Institute of Earth Sciences at the University of Tübingen, and Dr. Martin Sander from the University of Bonn have shown that this cannot at least be a gastric mill such as birds, today's relatives of the dinosaurs possess. Among these the ostrich is the largest herbivore. For their investigations, the scientists therefore offered stones such as limestone, rose quartz and granite as food to ostriches on a German ostrich farm.

After the ostriches had been slaughtered, the scientists investigated the gastric stones. It became clear that they wore out quickly in the muscular stomach and were not polished. On the contrary, the surface of the stones, which had been partly smooth, became rough in the stomachs during the experiments. The mass of the stones then corresponded on average to one per cent of the body mass of the birds.

'Whereas occasionally stones were found together with sauropod skeletons, we don't think they are remains of a gastric mill such as occurs in birds,' Dr. Sander comments. In that kind of gastric mill the stones would have been very worn and would not have a smoothly polished surface. Apart from that, gastric stones are not discovered regularly at sauropod sites. When present, their mass is, in relation to the body size, much less than with birds. 'In comparing these we extrapolate over four orders of magnitude, from an ostrich weighing 89 kilograms to a sauropod weighing 50,000 kilograms. This may seem a bit daring. However, within birds the range of body weight and corresponding masses of gastric stones also spans four orders of magnitude, from the 17 gram robin to the ostrich,' says Oliver Wings, who moved from Bonn University to Tübingen only recently.

Yet what else were the dinosaurs' gastric stones used for? The researchers presume that they were accidentally eaten with their food or could have been swallowed on purpose to improve the intake of minerals. But if the stones did not help to crush vegetable food, the sauropods' digestive system must have used other methods, since the decomposition of large amounts of material which is difficult to digest requires the assistance of bacteria in the digestive system. The smaller the pieces are, the better they can break down the food. Possibly, the scientists conclude, the intestines of the sauropods were formed in such a way that the food was retained there for a very long time, in order to improve the digestive process.

There is another group of dinosaurs, however, whose remains of gastric stones can be linked up with a birdlike gastric mill, according to Oliver Wings' research. From these dinosaurs known as theropods today's birds developed. The gastric mill could therefore have developed in the ancestral line of birds.

Source: University of Bonn