Appendix: Hollow Dinosaurs?

For a long time it was assumed that it was the enormous size of dinosaurs which proved to be their downfall. However, since it was probably the impact of one or more meteorites which caused their sudden extinction, gigantism no longer works as an evolutionary dead end. On the other hand, it appears from more recent scientific studies that before the emergence of reptiles, a giant meteorite also hit the earth. Thus an asteroid or comet impact may have caused mass death at the end of the Permian 251 million years ago. Ecological systems have proven themselves to be relatively robust: external disturbances whether storm, conflagration, newly immigrating species or human destructions are patiently absorbed – up to a point. Once the disturbance crosses a certain tolerance threshold, the entire system goes off balance and a new, previously unforeseeable balance kicks in. Did the age of the dinosaurs begin as it ended - with an apocalyptic impact?

Why did dinosaurs rule the world during this period? From ecology we know that it is not always the biggest and strongest who emerge as the victors in the struggle for scarce means of survival. In fact it tends to be the other way around. "Obviously evolutionary processes as developed by Charles Darwin do not correspond with reality" (Reichholf, 1992, p. 82).

Probably the dinosaurs were not at all inferior to "modern" birds and mammals since the internal structure of dinosaur bones shows a similarly fine structure, as is otherwise only found in warm-blooded mammals but not in reptiles. If dinosaurs were not slow-moving giants but active large animals then the idea of a gradual extinction become less understandable and they also could not have represented the end of an evolutionary cul-de-sac. But what purpose did the dinosaurs' great size serve?

Animals which live off plant matter need to consume many times more food than carnivores since plants are so low in protein. A big elephant eats between 100–360 kg of vegetation every day and spends up to 18 hours per day feeding. Once it has been through the intestine, the food pulp is expelled more or less half-digested.

In relation to their weight, which in some instances exceeded 100 tons, dinosaurs had tiny heads. Given their body weight, many times that of an elephant, they must have needed to take in a correspondingly greater amount of food which had to pass through a small opening and be transported down their long necks. Since the comparison with elephants can't work, herbivorous dinosaurs must have been able to process more food than today's herbivores.

The enormous bodies of the dinosaurs may have been almost completely hollow. The typical posture of a herbivorous dinosaur illustrates its highly developed production of energy. The zoologist, Prof. Dr. Josef Reichholf (*Bavarian Zoological Collection in Munich*) says that huge, enormously heavy dinosaurs could *not survive directly* from plants of relatively low nutritional value (Reichholf, 1992, p.83ff). In his opinion, rather than tons of greenery, the dinosaurs subsisted on 300–1,500 kg of food per day. They managed this with their hollow bodies, which acted as a fermenting chamber, in which fatty acids were produced. These "bred" bacteria or single-cell microbes on the plant pulp in the body. With the help of the vegetable matter, these in turn produced energy-rich protein, the real food of herbivores.

For poorly digested vegetable matter, fermenting chambers are all the more effective the bigger they are. Does this explain why herbivorous dinosaurs were so big? From this viewpoint, the seemingly useless gigantism would even appear to offer distinct survival advantages. The greater mass of these gigantic bodies also stored heat - such as solar energy - thus making more time available for food intake. The even warmth created favorable living conditions for the microbes, without a constant body temperature being necessary. In addition, the activity of the microorganisms would have created fermentation heat, as one sees in compost heaps.

The dinosaur's fermenting chamber - in other words, the stomach - was warmed externally by an evenly high temperature of over 20ºC. The water of the oceans was over 20 ºC from the North to the South Pole, as demonstrated by fossilised warm water coral in Arctic and Antarctic regions, since there was no permafrost at the Poles and the average temperature during the earth's middle period was over 20 ºC.

Today too, there are animals in whose bodies plant proteins are transformed into bacterial protein: both cows and horses have "fermentation casks". The cow's "fermentation cask" is situated in a place where the food is not yet digested, whilst in horses it is located in the lower intestine, where the food has already been digested, i.e. between the large intestine and the anus. Cows use around 75% of the protein and expel only 25%; in horses these proportions are exactly reversed. This is why horses are less well able to survive extended periods of drought or severe winters.

Perhaps the huge herbivorous dinosaurs with their "fermentation chambers" weren't classic warm or cold-blooded animals in the normal sense. Nor do they appear to have been muscle-bound giants as was concluded from their huge size.

The dinosaurs' relatively thin legs would not have been able to support a massive, heavy, muscle-bound body (cf. p. 245). The inference may therefore be drawn that dinosaurs lived in swamps, since their weight would have been reduced by buoyancy of the water. If the dinosaurs were almost completely hollow, their weight would have been reduced to a third or less, thanks to the hollow spaces (fermentation chambers). From a purely static viewpoint alone, only under these conditions would

their thin legs then have been able to bear the weight of the lighter body, contrary to conventional reconstructions of animals bulging with muscles. The vertebrae of many dinosaurs were also hollow and therefore light. The interior of many of their bones contained a weight-reducing honeycomb-shaped structure, made up only of beams and struts. This applied in particular to the spine. As such, contrary to the image of "massive" dinosaurs, it would be conceivable that enormous "hollow" dinosaurs could also move on land.

Enormous bodies, up to 50 meters in length and packed with muscle would not be able to survive at all today without some form of weight reduction. If one does not entertain the possibility of "hollow dinosaur", it must be assumed that gravity was much weaker at the time of the dinosaurs than it is today, e.g. only about half as powerful, as is the case on Mars. An increase in "gravitational pull" linked with the effect of natural catastrophe could have been one or even *the* decisive factor in the extinction of the dinosaurs, whilst smaller animals (crocodiles) survived. However, there could then been no connection between the mass of a body (earth) and the directly proportional resulting gravity in accordance with Isaac Newton, although this was also not proven. If one considers the expansion of the earth discussed in the previous chapter, this scenario could have resulted in a Newtonian corresponding increase in gravity, if the earth's mass had increased as well. However, no source mechanism has been found and, on the basis of what we know today, a significant increase in mass appears questionable, even if cosmic dust continuously rains down onto the earth's surface. In future, dinosaur studies will have interdisciplinary consequences for various areas of science, ranging from geophysics to biology.

Since dinosaurs could not raise their heads to the level of the treetops (wedging of neck vertebrae, drop in blood pressure) and their peg teeth most closely resembled a rake, it appears that these animals were more probably swamp-dwellers. Their body weight would have been further reduced by the buoyancy of the water and, like the crocodiles we see swimming today; only the upper side of the body would have been visible above the surface of the water.

How did dinosaurs living under water manage to get air into their lungs? They lay up to their nostrils in the water. Unlike hippos and crocodiles the nose openings were not in the skull but between the eyes, at the highest point of the head.

A new study by Lawrence M. Witmer of the University of Ohio shows that in comparison with animals living today, the fleshy nostrils were more on the tip of the snout than behind it. Going only on bone finds, it is difficult to reconstruct how dinosaurs really looked. Previous reconstructions placed the nose *on* the snout with *nostrils which opened upwards*, as would be an advantage for animals living in water. Witmer worked on the basis of the prevailing assumption that dinosaurs were exclusively land-dwelling animals and when reconstructing the skulls of Tyrannosaurus and Triceratops placed the nostrils at the tip of the snout, unlike

today's animals whose nostrils are on the upper side of the snout.

In Tyrannosaurus, the nose opening in the skull is simultaneously at the tip of the snout. In sauropods, on the other hand, these openings are between the eyes to the back of the skull and not at the front at the tip of the snout. Witmer however assumes that the nostrils of sauropods were also somewhat further to the front. However, this is only a guess - there is no proof as no fossil finds have been made. The nostrils must have been located to the rear, upper part of the skull in sauropods, and further to the front at the tip of the snout in theropods and ornithischia - corresponding to the position of the nose opening in the skull as otherwise the nostrils of sauropods could also have been positioned directly at the end of the snout as in Tyrannosaurus rex. Placing the nose opening between the eyes would make no sense if the fleshy nostrils were very far away, i..e to the front close to the tip of the snout.

Scientists today are convinced that dinosaurs lived exclusively on land and - at least - were not amphibian. If these animals lived in water, they left no tail drag marks, since the tails would have been swimming on the surface, so to speak, and assisted propulsion. At the same time, however, these tails must have been very flexible in a horizontal direction, as compared with vertical and, so that the tail did not break off because of its length, it must have been very stiff in the vertical. But these long tails, which probably had a tail frill from coccyx to the end tip (Zillmer, 2002a, p. 95 ff.), also had another important function.

For the reasons stated, we can assume that sauropods lived predominantly in water. Their teeth were peg-like and formed a kind of rake. It would appear that the sauropods sieved something out of the water and therefore did not need to lift their necks much above shoulder height – the tails swam on the water (Fig. 68, p. 247). Thus the positioning of the large nose openings at the highest point of the skull makes sense. Apparently, these giants simply lay up to their nostrils in water most of the time. But *contrary* to previous opinion, carnivores too went into the water and "swam" (Fig. 69, p. 247). Because of the external water pressure the dinosaurs could only have swum directly beneath the surface of the water because otherwise the lungs could not have expanded because of the pressure of the water on the body - the dinosaurs would literally have lost their breath. "Hollow" dinosaurs would also have been incapable of diving because of the buoyancy of the water.

If one takes the idea of enormous fermentation chambers into consideration, the previously unexplained size of the dinosaurs makes sense and if one then considers the onset of reduced air pressure and increased gravity (earth expansion), we can see that they would no longer have been able to survive after the occurrence of cataclysmic events (earth catastrophe). The reduced air pressure would have caused the dinosaurs' hollow bodies to explode which is why, in contrast to other animals, no intact mummified dinosaurs have ever been found. An example of an exploded hollow stomach is given in the corpse of an Edmontosaurus (Fig. 73).

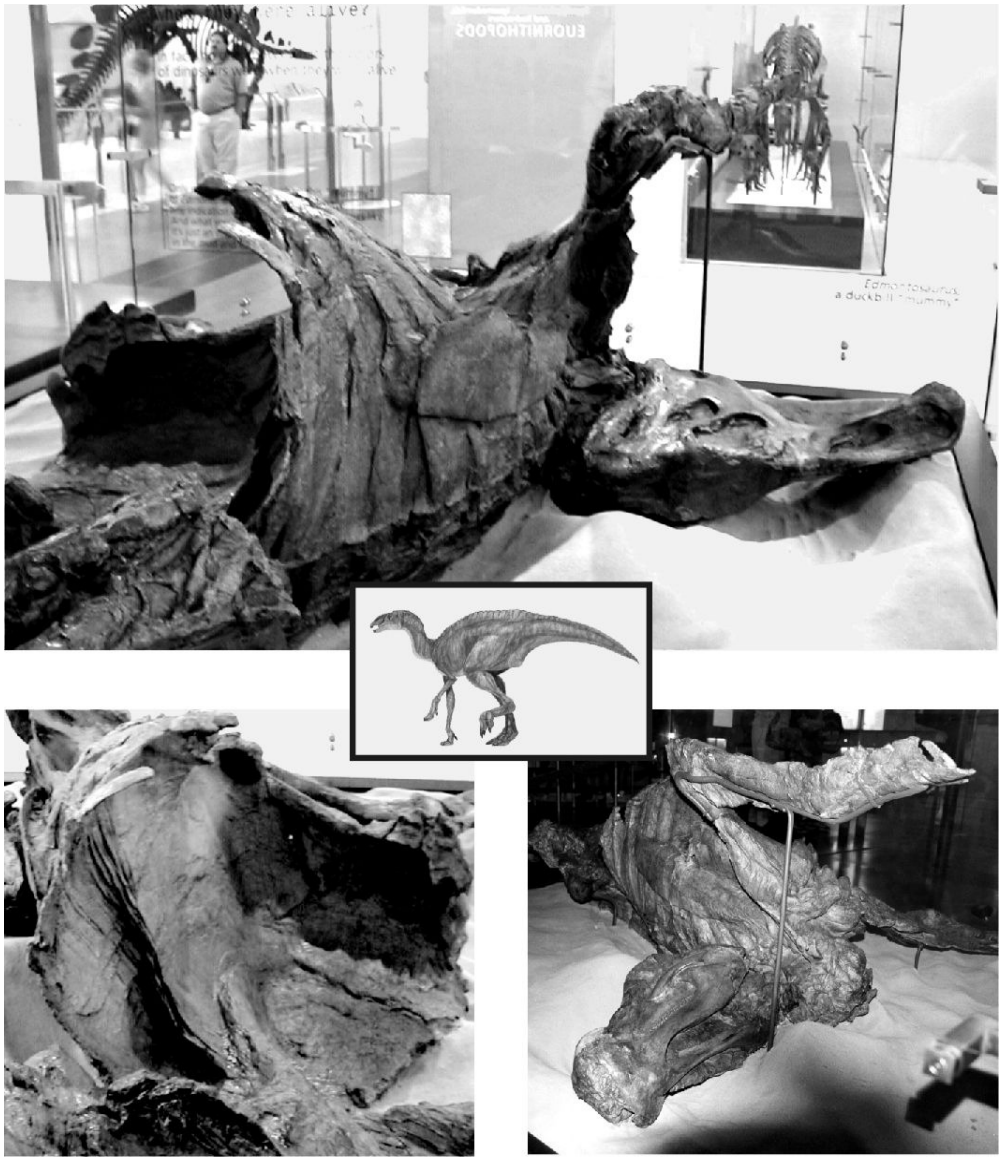

Fig. 73: Hollow dinosaur. *The corpse of an Edmontosaurus, exhibited at the American Museum of Natural History in New York. The drawing shows a modern reconstruction of a young Edmontosaurus which should be false with regard to the streamlined form of the body.*