Scientists simulate dinosaur digestion in the lab

February 6 2008

Scientists from the University of Bonn are researching which plants giant dinosaurs could have lived off more than 100 million years ago. They want to find out how the dinosaurs were able to become as large as they did. In actual fact such gigantic animals should not have existed. The results of the research have now been published in the journal *Proceedings of the Royal Society B*.

Take 200 milligrammes of dried and ground equisetum, ten millilitres of digestive juice from sheep's rumen, a few minerals, carbonate and water. Fill a big glass syringe with the mix, clamp this into a revolving drum and put the whole thing into an incubator, where the brew can rotate slowly. In this way you obtain the artificial 'dinosaur rumen'.

With this apparatus (also used as a ‘Menke gas production technique’ in assessing food for cows) Dr. Jürgen Hummel from the Bonn Institute of Animal Sciences (Bonner Institut für Tierwissenschaften) is investigating which plants giant dinosaurs could have lived off more than 100 million years ago, since this is one of the pieces which are still missing in the puzzle involving the largest land animals that ever walked the earth. The largest of these 'sauropod dinosaurs' with their 70 to 100 tonnes had a mass of ten full grown elephants or more than 1000 average Germans.

Larger than permitted

How the dinosaurs could ever attain this size is something which

scientists from Germany and Switzerland are investigating. The Bonn palaeontologist, Professor Martin Sander, the coordinator of the research group 'Biology of the Sauropod Dinosaurs: The Evolution of Gigantism', says, 'There is a law to which most animals living today conform. The larger an animal, the smaller the density of the population, i.e. the fewer animals of the same species there are per square kilometre.' The larger an animal is, the larger the amount of food it has to have in order to survive. Therefore a specific area can only feed a certain maximum number of animals.

At the same time there is a lower limit to the density of population. If this is undercut, the species dies out: 'In this case diseases can rapidly wipe out the whole stock. Moreover, finding a mate becomes difficult,' Martin Sander explains. An animal like the 100-tonne argentinosaurus should have normally not had this 'minimum population density', actually it should not have been able to exist. But there are hypotheses for this apparent paradox: for example the giant dinosaurs presumably had a metabolism that was lower than that of mammals. In this context it is unclear how nutritious the plants were that formed their diet.

This question is being investigated by Dr. Jürgen Hummel in conjunction with Dr. Marcus Clauss from the University of Zurich. 'We assume that the herbivorous dinosaurs must have had a kind of fermenter, similar to the rumen in cows today.' Almost all existing herbivores digest their food by using bacteria in this way. The panda is the exception. Because the panda is not like this its digestion is inefficient. It stuffs bamboo leaves into its mouth all day long, in order to meet its energy needs, despite the fact that it does not move about much, thereby saving energy.

Jürgen Hummel transforms glass syringes into simple fermenters, which he fills with bacteria from the sheep's rumen. 'These micro-organisms are very old from an evolutionary point of view; we can therefore assume that they also existed in the past,' he explains. To the mix of

bacteria he adds dried and ground food plants: grass, foliage or herbs which still form part of animals' diet, and for comparison equisetum, Norfolk Island pine or ginkgo leaves, i.e. parts of plants which have been growing for more than 200 million years on earth. The gas formed during the fermentation process presses the plunger out of the syringes. Jürgen Hummel can therefore read the success of the fermentation process directly off their scales. This is measured according to a simple rule: the more gas is produced, the 'higher the quality' of the food.

Equisetum is bad for the teeth

These 'old' plants stand their ground surprisingly well compared to today's flora. 'The difference is not as great as might be expected,' Jürgen Hummel emphasises. The bacteria digest ginkgo even better than foliage, but they seem to prefer equisetum most. With it gas production is even higher than with some grasses. Nevertheless, equisetum figures in the diet of comparatively few animals. The reason is that in addition to the toxins present in many modern species it wears down animals' teeth too much. 'Equisetum contains a lot of silicates,' Jürgen Hummel says. 'It acts like sand paper.'

However, many dinosaurs did not have any molars at all. They just pulled up their food and gulped it down. The mechanical break-up may have been carried out by a 'gastric mill'. Similar to today's birds, dinosaurs may have swallowed stones with which they ground the food to a paste with their muscular stomach. However, there are no clear indications of this. Only recently the Bonn palaeontologist Dr. Oliver Wings doubted that dinosaurs had bezoar stones, at least this assumption could not be verified from fossil findings.

Source: University of Bonn