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Vietnam's Biodiversity Has Deep Roots in Earth's Past

On account of the very high number of animal and plant species which are mostly only found there, Southeast Asia is a global biodiversity hotspot. Despite its highly endangered terrestrial and freshwater ecosystems, Vietnam makes a significant contribution to this biological diversity.

In a current publication the scientific team around Professor Madelaine Böhme, leader of the team on Terrestrial Palaeoclimatology of the Senckenberg Center for Human Evolution and Palaeoecology (HEP) at the University of Tübingen (Germany), demonstrates for the first time that North Vietnam was already a hotspot of biodiversity about 30 million years ago.

Kinship and evolutionary patterns

The group succeeded in recovering mammals, crocodiles, six species of turtles, around 20 fish species and 10 mussel species, snails and various plants from marine sediments as evidence of the early biodiversity. Several of the fossil animals are completely new to science and are still awaiting a precise description. Even so, the yield in knowledge has already been considerable Professor Böhme sums up the objective of her research work: "Since many of the fossil species are closely related to today's plants and animals, the findings not only provide information on living conditions during the Cenozoic, but also help us to learn more about basic evolutionary patterns and the global mechanisms within the Earth system."

The group investigated the Na Duong basin with the Rinh Chua fault in the province Lang Son, the Cao Bang basin North-West of it as well as the Hang Mon basin, not quite 300 kilometres South-Western of it, close to the Laotian frontier. All three basins lie along major dislocations which originated from powerful tectonic movements during the Eocene (c. 56-34 million years ago). The publication presents the first scientific results of the German-Vietnamese research project carried out in 2008 and 2009 in North Vietnam under the leadership of Madelaine Böhme.

A map of primeval landscape

Though the composition of the species spectrum differs within the single basins, the fossil record shows a remarkable variety of species. "These differences are very interesting and instructive for science," says Madelaine Böhme, and explains that if one is familiar with the single species, their way of life and needs, the fossils themselves tell much about their former way of life and the primeval environment. Together with geological observations, these information provide a sort of map. The results of the investigations thus sketch the primeval landscape of North Vietnam with the organisms and climatic conditions that once occurred there.

Because little is known yet about the fossil ecosystem of Vietnam, a great deal was also new to the scientists; that is why even the research team was surprised by the finds of 50 turtle shells within only ten days. They represent at least six genera. In the depositions which are millions of years old they also found tree-like ferns, fragments of tree trunks with up to five metres of length, fossil resins, different leaves and plant seeds. Beside parts of crocodiles and the remains of mammals belonging to a mouse deer and a rhinoceros the fossil report also mentions other vertebrates like small and medium-sized fish, barbel and one as yet undescribed teleost as well as catfish.

Among the finds of molluscs there was an astonishing variety of completely different freshwater mussels and snails. Above all, the composition of fish and mussel fauna points to a habitat with shallow, oxygen-rich freshwater environments. These observations are supported by several aquatic plants, found in their live positions, which normally

occur in tranquil waters, Madelaine Böhme assumes that the large mussel population provided clear water through its filtering activity and hence created ideal conditions for light-dependent plants.

Except for two additional representatives of the animal group, the finds of molluscs from the Rinh Chua formation do not differ from the mollusc deposits in the Na Duong basin. However the fish fauna differs significantly: the sediments contained several species of completely different carp-fish and also one catfish. In particular the deposits of fishes suggest that once a deeper freshwater ecosystem existed here.

In the approximately 70 square kilometre Cao Bang basin both the geological results and the fossil finds indicate a primeval landscape with rivers, lakes and ponds. The fossil record for this region does not mention any mammals. Instead, there is evidence of animals which lived either in or at the edge of the water, including the remains of a gavial crocodile. Remarkable among the species-rich fish deposits is the fossil find of a giant barbel, which according to estimates, must have been up to two metres long.

"This impressive fish find, by far the largest, must be classified not only as a new species but also as a new genus," Madelaine Böhme said. The fish fauna in the Cao Bang basin was not only impressive, but above all more numerous than in the Na Duong basin. In only 100 gram of sediment, remains of more than 100 fish were discovered. Like the molluscs, the fish species here differed overall from those in the Na Duong basin.

A new clue and further pending questions

The diverse mussel fauna of the Na Duong and Cao Bang basins are still full of mysteries. The palaeontologists nevertheless consider it possible that on further investigation, the fossils recovered may not only turn out

to be the oldest representatives of this animal group but also add a new clue to the discussions on the age of the basins.

The Hang Mon basin, at an altitude of 920 metres, had neither fish nor aquatic mussels, with molluscs only represented by three different types of terrestrial snails, making it difficult to outline a habitat. Despite this, the absence of fish and aquatic mussels and the current evidence for primitive ungulates, as well as the evidence of mammals already cited in the literature, indicates a predominantly terrestrial habitat, perhaps traversed by rivers.

The comparison of the current fauna and flora of North Vietnam with that of the Cenozoic still raises a number of questions. One of the key regions for searching for traces of original conditions, such as the occurrence and extent of former and current freshwater organisms, is the Red River. Today it flows through North Vietnam and then into the Gulf of Tonkin, but it was already the main drainage system for Southeast Asia during the Palaeocene (65-23 million years ago) until the Neocene (23 -c. 5 million years ago).

Whereas the Hang Mon basin formed a part of the drainage system of the Red River, there are indications that the basins along the Cao Bang-Tien Yen Fault were supplied in a different way. The geological and the fossil finds raise the question for Madelaine Böhme as to whether another large river might not have existed during the Cenozoic. This, as well as studies on climate and further geological and paleontological analysis, will form part of further research work on the past habitat and ecosystem of North Vietnam.

Source: Böhme, M. et al. The Cenozoic on-shore basins of Northern Vietnam: Biostratigraphy, vertebrate and invertebrate faunas. *Journal of Asian Earth Sciences*, 2010 DOI: 10.1016/j.jseaes.2010.11