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Hairs and spines make new fossil mammal a unique find

Spinolestes xenarthrosus is a newly discovered fossil of a mammal that lived 127 million years ago. The specimen, found in Spain by an international team, is so well conserved that it can be inferred that it weighed between 50 and 70 grams in life, had feet made for burrowing, like an armadillo, spines like a hedgehog and a mane down the length of its back. It also had a spine and sharp teeth with a distinctive three-pointed form. While this animal has the classic features of its family, like its fur for example, its very specific spines make it unique, and suggest that the acquisition of spiny hairs has not been gradual during evolution, but has evolved separately and independently in different lineages. These results, obtained with the participation of Romain Vullo, from the _Laboratoire Géosciences Rennes_[1] (CNRS / Université Rennes 1), will be published October 15, 2015 in the journal _Nature_.

Las Hoyas fossil site is a Lower Cretaceous (127 million years ago) bed located in Spain near the city of Cuenca. This sedimentary deposit, the only one of its kind in Europe, contains a wide variety of fossils, trapped in what was once a swampy environment similar to the Florida Everglades. It has been under excavation since 1986 and has already yielded many fossils of aquatic and terrestrial plants, crustaceans, insects and fish, but also crocodiles, dinosaurs and primitive birds. Twenty-five years later, in 2011, the first mammal was finally uncovered, thus completing the structure of the ecosystem.

This fossil has just been described by paleontologists. They concluded that it was a new species, which they named *Spinolestes xenarthrosus*, belonging to the order Eutriconodonta, a line of mammals that became extinct at the end of the Mesozoic era (252.2 to 66 million years ago), and to the Gobiconodonta group. It is a small, 25 cm-long animal weighing about 50 to 70 g, characterized by teeth with three sharp points and vertebrae of the same type as those of the Xenarthra[2]. The proportions of its legs are close to those of burrowing animals, suggesting a similar lifestyle to that of modern armadillos, feeding on insects and grubs. The swamps of Las Hoyas allowed rapid burying and mineralization of animal remains, thus many pieces of skin with hairs and spines have been perfectly conserved. From these remains, the researchers determined that *Spinolestes* had a dense mane of long hairs (3-5 mm) from its head to its shoulder blades, long fine hair on its back and on most of its tail. It also had small spines and some dermal scutes (small oval hairless keratin plates). The rest of its body was covered in soft dense fur.

[1] The Laboratoire Géosciences Rennes also belongs to the Observatoire des Sciences de l'Univers de Rennes.
[2] The word "Xenarthra" means "strange joints" and was chosen because of the unusual vertebral joints that sloths, anteaters and armadillos have compared with other mammals.

The microstructural analysis of the pieces of fur shows that it is composed of a mixture of relatively thick primary hairs, smaller secondary hairs, and spines in the dorsal region. The latter have a scaly surface and are formed of modified primary and secondary hairs, which are shorter, rigid, rod-shaped and have fused together. This process is similar to that observed in some modern mammals like hedgehogs and porcupines. From the case of *Spinolestes*, researchers therefore believe that hairs and spines have been differentiated since the lower Cretaceous. Moreover, the fact that several specimens of Eutriconodonta have dense fur but no spines makes *Spinolestes* a unique species among its kind, whose evolution occurred independently of species such as hedgehogs but led to this surprising convergence with modern spiny species.

Furthermore, the fossil still has pulmonary bronchioles and the remnants of its liver, so the researchers were able to estimate the position of the animal's diaphragm, providing the first fossil evidence that the mammalian respiratory system was present from the Mesozoic.

For the researchers, the diversity of fossils from Las Hoyas is a key to understanding the evolutionary revolution that took place in the Cretaceous, leading to the emergence of today's biodiversity of flora and fauna. They are therefore continuing their analysis of *Spinolestes xenarthrosus* to find out more about its lifestyle and place in this ecosystem that has been frozen in time for 127 million years.

Reconstruction of *Spinolestes xenarthrosus* based on an exceptionally well-preserved fossil found in Las Hoyas. The animal was about 25 cm in length. Photo credit: O. Sanisidro.

Spinolestes xenarthrosus (transferred to an epoxy resin plate and freed from the matrix with acid). Scale bar: 1 cm. Photo credit: G. Oleschinski.

“Protospines" of *Spinolestes xenarthrosus*, localized in the pelvic girdle (dorsal). Scale bar: 1 mm. Photo credit: R. Vullo

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