New epigenetic study: Guinea pig fathers pass on adaptive responses to environmental changes

December 28 2018

Wild guinea pig. Credit: Anja Günther

Adaptations to environmental change are the most important asset for the persistence of any plant or animal species. This is usually achieved through genetic mutation and selection, a slow process driven by chance. Faster and more targeted are so called epigenetic modifications which do not alter the genetic code but promote specialisations during cell maturation. A new study carried out by scientists from the Leibniz-IZW in Germany shows that in wild guinea pigs, epigenetic modifications specific to individual environmental factors are passed on to the next generation. The study is published in the scientific journal *Genes*.

The team of researchers around Alexandra Weyrich from the Leibniz Institute for Zoo and Wildlife Research (Leibniz-IZW) in Berlin, Germany, studied two groups of male wild guinea pigs. One group was fed a protein-reduced diet for two months, the other group was exposed to an increase in ambient temperature of ten degrees (Celsius) for the same period. The animals responded to these changes through epigenetic modifications at the cellular level. "Epigenetic modifications have been studied for some time. What we were after was to determine, whether these modifications are passed on to the next generation of guinea pigs and whether fathers played a role in this," says Weyrich.

The team studied offspring sired by males prior to their exposure to the environmental change and those sired by these males after the two-month experimental period – each time sired with the same females who were not exposed to these changes in conditions. The comparison revealed significant differences in the the methylation pattern of the offsprings' DNA – for the scientists documentation that "inheriting" parental epigenetic responses to environmental changes is possible and that males can play an important role in these processes. "We were most interested in comparing the two different groups," Weyrich adds. "Our results show for the first time that the epigenetic response to environmental changes comprises two parts: A general part, which reflects the fact that there was some environmental change –

independent of the specific factor of change. And a very specific part that is the specific response to a particular environmental change."

Rapid environmental change in the context of man-made global change, including climate change, for example rising temperatures or changes in resource availability and food supply, pose significant challenges to plants and animals. For some species these challenges can become existential threats. Corals for instance are highly temperature-sensitive and the reproduction of some frog and crocodile species are closely linked to specific temperature constellations. With the radical environmental changes currently underway, species that show a high adaptability have an advantage. The well-known mechanism of mutation and selection, however, may be too slow to cope with rapid changes. It relies on accidental changes to the genetic code which may or may not provide an advantage to survival and reproduction (natural selection). So-called epigenetic modifications can translate environmental changes much faster provided the genome already contains the necessary flexibility for an adequate response. During epigenetic modifications, the genetic code is not altered but specific genes are activated and strengthened or shut down through several chemical processes. These processes are also common during cell maturation, when cells specialise to differentiate into skin, bone or liver cells.

"One of the most important epigenetic modifications is the so-called DNA methylation," Weyrich explains. The scientists compared methylation patterns of the offspring sired before and after environmental conditions experienced by the fathers, focsuing on sections of the genome that showed differential methylation (differentially methylated regions, DMRs). Specific responses both to rising temperatures and to the altered diet could be traced to the methylation patterns in the genomes of the offspring. "Previously, most epigenetic studies were carried out using populations of laboratory animals that have been living under artificial conditions for generations.

Studies on wild species are still rare," Weyrich says. "Our comparative study design fostered these new insights." In order to understand in more detail how epigenetic modifications in the context of environmental changes are passed on to future generations, further studies in this field are required.

More information: Environmental change-dependent transgenerational epigenetic response. *Genes*

Provided by Forschungsverbund Berlin e.V. (FVB)