Lizards are larger and retain heat longer in high-altitude habitats

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University of Granada scientists confirm that ectotherms–like reptiles and amphibians–do follow "Bergmann's rule". The 19th-century naturalist posited thatanimals inhabiting colder climates have a larger body size. The study has been published in the prestigious *Journal of Evolutionary Biology*.

Scientists at the University of Granada (UGR) have found that the long-tailed lizard,Psammodromus algirus, is larger when living at high altitude–with a cold climate–than at a lower, and therefore warmer, altitude. In addition, lizards living at over 2000 meters retain heat longer because they are larger.

The study, published in the prestigious *Journal of Evolutionary Biology*, confirms for the first time since the so-called "Bergmann's rule" was put forward in the nineteenth century, that it can also be applied to ectotherms. Bergmann's rule states that animals inhabiting colder climates have a larger body size. University of Granada researchers' have found that the underlying mechanism really is that proposed by Bergmann himself, namely the greater thermal inertia of large animals in cold habitats.

Together with Allen's rule,Gloger's rule, and others, Bergmann's is one of the great, classical,macroecological rules. It was established by the German naturalist Carl Bergmann in 1847. He postulated that endotherms like birds and mammals, which generate heat by using metabolically-costly, internal physiological mechanisms,are larger in cold habitats so their surface/body volume ratio decreases and, therefore, the rate of heat loss decreases too.

Ectotherms

This tendency, called the "Bergmann cline", has been found in many endotherms. However, until now the situation with ectotherms–like reptiles and amphibians, among others–was not so clear because they depend on external sources of heat, often solar heat, to control body temperature.

Studies prior to that conducted at the UGR found cases of ectotherms that follow the Bergmann cline but there are also many cases with no relationship between body size and environmental temperature. There are even cases where the opposite prevails: representatives of some ectotherm groups in cold habitats are actually smaller.

The generally accepted explanation is that larger ectotherms take longer to lose heat in cold habitats, which would benefit them, but would also raise their temperature more slowly, which would be disadvantageous. Moreover, the mechanism that Bergmann proposed as an explanation for the clines–the greater heat-conservation capacity of larger animals–has never been demonstrated.

In their article, Francisco Javier Zamora-Camacho, Senda Reguera and Gregory Moreno-Rueda, researchers from the UGR's Department of Zoology, have shown that an ectotherm, the long-tailed lizard Psammodromusalgirus, reaches larger sizes at higher altitudes in the Sierra Nevada mountainsof southern Spain, which correspond to the Bergmann clines.

Under debate since the 19th century

"Our work, therefore, resolves two controversial issues that have been widely studied since the nineteenth century, yet remain very much alive. First, we've found that in ectotherms Bergmann's rule can be followed if there are mechanisms that permit the heating rate to remain stable despite larger body size. In this case, that mechanism is the lizard's darker colour, "said the principal author of this work, Francisco Javier Zamora-Camacho, of the UGR's Department of Zoology.

In addition, for the first time in nearly 200 years, the researchers have shown that the mechanism underlying the Bergmann clines is effectively that proposed by Bergmann himself: larger animals really do have slower cooling rates. This is an advantage in cold climates as it enables them to retain heat–which they find difficult to aqcuire–for longer periods.

More information: "Bergmann's Rule rules body size in an ectotherm: heatconservation in a lizard along a 2200-metre elevational gradient", F. J. Zamora-Camacho, S. Reguera & G. Moreno-Rueda *J . EVOL. BIOL .* 27 (2014) 2820–2828

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