Tübingen scientists turn snails into “slugs”

Biologists from Tübingen have reshaped the body plan of snails. Temporary exposure to platinum ions resulted in the formation of an internal shell in place of the normal external shell. The snails, which were artificially turned into slugs, survived normally. In the journal “Evolution & Development”, the researchers reported that the reshaping is most likely the result of altered gene activity. This shows that the shape of organisms may have suddenly changed during evolution as a result of relatively small genetic modifications.

During the embryogenesis of the freshwater snail Marisa cornuarietis, a time slot of just one or two days determines whether the animals form an outer shell or not. Reprogramming of the direction of growth of the molluscs' shell-generating tissue during this sensitive phase prevents the development of the usual convoluted shell. In place of this shell, a small hollow cone grows inside the body - in a similar way to the process in squids, which also belong to the group of molluscs.

The reprogramming also has implications for other snail organs: The gill is not located in a mantle cavity over the head in the normal way, instead no mantle cavity at all is formed and the gill remains at the posterior end of the visceral sack, floating freely in the water. The results, which have recently been published by a group of researchers led by Prof. Heinz Köhler and Prof. Rita Triebskorn from the Institute for Evolution and Ecology of Tübingen University in the journal Evolution & Development, support the theory that relatively minor modifications in signal transduction pathways may have led to sudden body plan alterations during evolution.

Raphaela Osterauer, a doctoral student at the Institute for Evolution and Ecology of Tübingen University, initially discovered the phenomenon of snail-slug conversion while studying the toxicity of metal ions. Several years ago, a research group led by Heinz Köhler developed a relatively sensitive biotest based on developing snail eggs. While she was testing the toxicity of the noble metal platinum, which is released into the environment by abrasion from the catalytic converters of cars, Raphaela Osterauer found that the embryos did not develop a shell when exposed to high concentrations of biovalent platinum ions. Further experiments showed that reprogramming only occurred in a small time slot of one to two days during embryonic development in which the direction of growth of the shell’s gland tissue is defined. During this period, the tissue is either programmed to evaginate and form a shell-secreting mantle covering the dorsal part of the snail’s body, or to invaginate into the snail’s body.

Through temporary exposure to platinum, it is therefore possible to spatially redirect the shell-forming tissue with all its irreversible consequences for the formation of the mantle, the shell and the position of the gill. When the artificial slug embryos are no longer exposed to platinum, they

Marisa snail with shell
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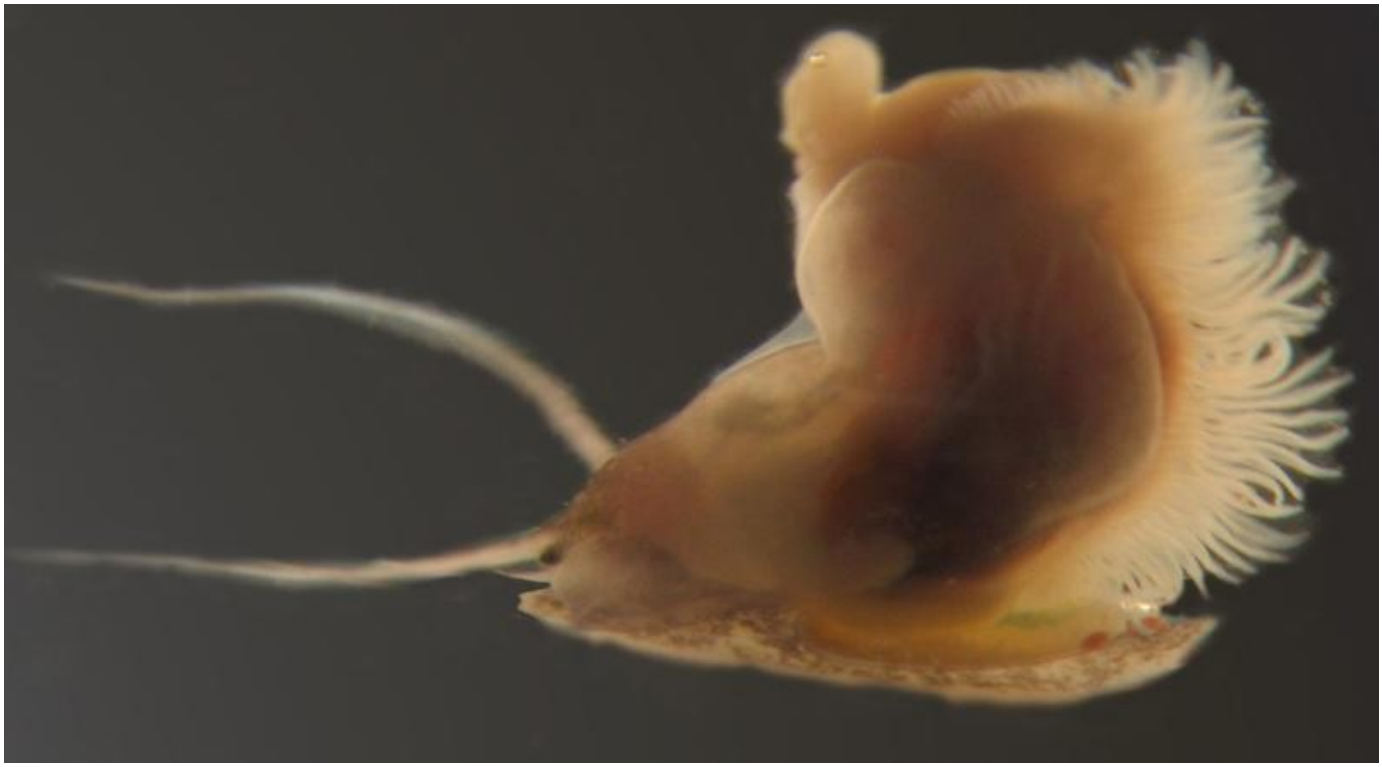
proceed with their development according to the new programme, hatching from their eggs, feeding as normal, and there is no further change to their body plan. They have a lifespan of more than half a year. During this time, an internal calcareous shell in the shape of a slightly bent, hollow cone grows inside their body and remains after their death. Since natural slugs and squid also form smaller internal shells, the artificial Marisa slugs may serve as a model organism for investigating the evolution of shell internalisation. In recent studies, the research group was also able to raise two distantly related lung snail species that did not develop an external shell when exposed to platinum.

As the molluscs are not actually genetically modified by platinum, they are not mutants. However, the researchers assume that the regulation of gene activity, i.e. the switching on and off of genes, is modified and that such modifications may have been important in the evolution of different mollusc body plans. The Tübingen group of researchers is planning to work with colleagues in other groups to focus on the analysis of platinum-sensitive gene activities during the early embryogenesis of snails.

The biologists from Tübingen assume that artificial slugs do not occur in the field since platinum pollution in the environment has not yet reached the concentrations required for the conversion of



Marisa snail that has been turned into a 'slug'.

snails into slugs.

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Raphaela Osterauer, Leonie Marschner, Oliver Betz, Matthias Gerberding, Banthita Sawasdee, Peter Cloetens, Nadine Haus, Bernd Sures, Rita Triebskorn und Heinz-R. Köhler: "Turning snails into slugs: induced body plan changes and formation of an internal shell" in: Evolution & Development, Vol. 12, p. 474 - 483, September 2010.

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