Predicting the formation of new species

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When animals or plants colonize new habitats, a number of new species may evolve from a single ancestor. But it is difficult to predict on the basis of environmental conditions or species-specific traits alone whether and to what extent diversification will occur. An Eawag study of African lake cichlids has now shown what combination of extrinsic factors and intrinsic traits leads to high rates of speciation, thus promoting biodiversity.

Why do some groups of species diversify – in just a few thousand years – to the point of forming a wide variety of new species, while others remain essentially unchanged for millions of years? This is one of the key questions for scientists investigating the emergence and decline of biodiversity. From various studies, it is known that speciation is influenced both by environmental factors (e.g. habitat diversity, climate) and by species-specific traits (e.g. coloration, behaviour patterns). However, little is known about how the extrinsic and intrinsic factors interact.

These interactions have now been explored in more detail by a team of researchers led by Eawag and the University of Bern. In a study published in the latest issue of Nature, they demonstrate for cichlids from 46 African lakes that the probability of diversification, or "adaptive radiation", depends on a combination of environmental factors and sexual selection. African cichlids are particularly suitable for this type of study because of the extremely high species richness that developed over time from what was originally a small number of species in large African lakes. For Lakes Victoria and Malawi alone, more than 800 endemic cichlid species have been recorded.

According to the study, diversification is more likely to occur in deep lakes and in areas with relatively high solar radiation. By contrast, lake size has practically no influence on the likelihood of speciation – which is surprising, as speciation in terrestrial species is known to depend in part on the available habitat area. Among the species-specific traits, the intensity of sexual selection (mate choice) was shown to be a key factor, as indicated by the association between sexual dichromatism (distinctive coloration of males and females) and diversification.

If the relevant ecological factors coincide with sexual selection, the divergence of species is most likely to occur. The speciation process is thus, to a certain extent, predictable. At the same time, these findings also make it possible to predict adverse impacts of human activities on biodiversity – for example, if the habitable depth of lakes is altered as a result of pollution or the lowering of water levels rates of species formation will decline and existing species diversity is expected to collapse.

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