



Competitors can pose more of a threat than predators

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Topics: Biodiversity | Ecosystems

When the biodiversity of an ecosystem is reduced by invasive species, competition for food plays a more important role than has previously been supposed. This was the conclusion of research conducted by Eawag and Bern University scientists on cichlid species in Lake Victoria, which suffered mass extinction following the introduction of the fish-eating Nile perch in the 1950s. The study also demonstrates the threat which rapid environmental changes pose to highly specialized species.

Although an evolutionary innovation can open up new ecological niches, traits which are essentially beneficial can put species at a disadvantage in the context of rapid environmental changes. The costs of specialization are highlighted in an article published this week in *Science* on fish-eating cichlids in Lake Victoria which became extinct following the proliferation of the Nile perch, introduced around 60 years ago.

In the article, the evolutionary and fish biologists Matt McGee and Ole Seehausen report that, because of a specialized jaw structure, fish-eating cichlids in Africa's largest lake take a long time to swallow their prey and are thus no match for competitors that can feed much more rapidly.

Predation or competition?

Over the past 15,000 years, around 500 cichlid species developed in the geologically young Lake Victoria. But after the Nile perch was introduced – for commercial reasons – in the 1950s, and the lake also experienced substantial eutrophication, about half of the cichlid species became extinct.

As the Nile perch is a skilful predator, with a large mouth and a voracious appetite, it has previously been regarded by biologists as a classic example of an invasive species which can literally “eat up” the biodiversity of an ecosystem. “The Nile perch, preying on cichlids, did indeed decimate stocks of these species in Lake Victoria,” says Matt McGee, who studied the ecology and evolution of fish-eating cichlids for his doctoral thesis at the University of California, Davis, and is now carrying out research on invasive fish species with Ole Seehausen at Eawag and Bern University.

But while a number of cichlid species, feeding largely on crustaceans or plants, managed to adapt and recover, of the 100 or so species which, like the Nile perch, live on larger fish, more than 80 became extinct. “This indicates that feeding competition is more important than has so far been assumed.”

Risks of specialization

To find out more about the feeding performance of Nile perch and cichlids, the scientists investigated differences in functional morphology, observed their behaviour in the aquarium and analysed fish prey consumed in the wild. They found that, while Nile perch can swallow a fish within a few minutes, cichlids of the same size take many hours to do so.

What slows cichlids down is the second set of jaws at the back of their throat – the pharyngeal jaws – which originally enabled these species to exploit a wide range of food sources. The pharyngeal jaws allowed them, for example, to crush plants or hard-shelled animals, while the oral jaws were specialized exclusively for catching prey. The price paid for this was a narrow, rigid pharynx which makes it impossible to swallow large items. This was a crucial disadvantage for many fish-eating cichlids when the first competitor lacking pharyngeal jaws appeared in Lake Victoria around 60 years ago: while the Nile perch can swallow fish whole, cichlids have to grind them down in an extremely time-consuming process.

Lessons for Switzerland

The main survivors in Lake Victoria have been cichlid species feeding on plants, snails, plankton or small crustaceans and very small fish. In this respect, the spectrum of species in Lake Victoria is now similar to that found in Lake Tanganyika or in marine habitats, where fish with pharyngeal jaws have existed alongside competitors without such jaws for up to 60 million years and have therefore never become specialized for predation on large fish.

Ole Seehausen comments: “All our analyses of interactions between fish with and without pharyngeal jaws showed that, in competing for fish as food, pharyngognathous are always inferior to non-pharyngognathous species. This gives us confidence in our conclusions.”

Seehausen believes that, in studies of invasive fish species in Switzerland, greater attention should now also be paid to the neglected question of feeding competition: “That also applies for fish transferred from one Swiss waterbody to another which have not previously been regarded as potentially invasive.” After all, the distance between Lake Victoria and the nearest naturally occurring populations of Nile perch is no greater than that between Lake Constance and Lake Geneva.

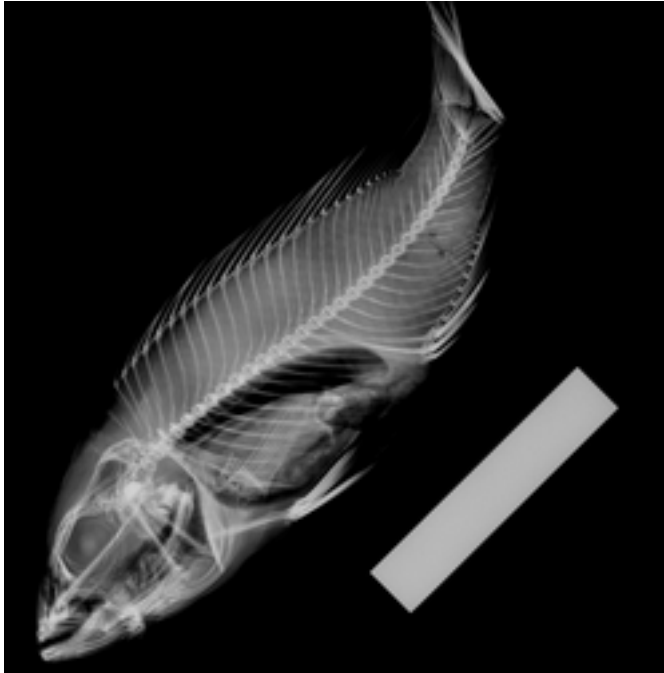
McGee adds: “The endemic species found in postglacial Swiss lakes are all even younger than the Victorian cichlids and therefore potentially even more vulnerable, as the new adaptations have been less exposed to competition.” Accordingly, it would also be worthwhile to carry out comparative phylogenetic-ecological studies on various Swiss lakes.

For further informations

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An X-ray sheds light on the contents of a cichlid's stomach.
(Photo: Heinz Büscher, Basel University)



The Nile perch was introduced to Lake Victoria in the 1950s, leading to the extinction of numerous cichlid species.
(Photo: Heinz Büscher, Basel University)



Cichlids – unlike the Nile perch – have a second set of jaws, but this trait is not always advantageous.

(Photo: Eawag)



Ole Seehausen, Eawag (Photo Eawag)



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<https://www.eawag.ch/en/info/portal/news/news-archive/archive-detail/competitors-can-pose-more-of-a-threat-than-predators>