How worms snare their hosts

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Acanthocephala are parasitic worms that reproduce in the intestines of various animals, including fish. However, only certain species of fish are suitable as hosts. A study by the University of Bonn now shows how the parasites succeed in preferably infecting these types. The results will be published in the journal *Behaviour*, but are already available online.

The parasitic worm Pomphorhynchus laevis does not have an easy life: In order to reproduce, the parasite must first hope that its eggs will be eaten by a freshwater shrimp. The larvae hatching from the eggs then need a change of scenery: They can only develop into adult worms if they are swallowed by a fish. However, not every fish species is suitable as a final host. Some species have defense mechanisms that kill the parasite before it can mate and release new eggs into the water through the fish intestine.

In order to improve their chances of reproduction, the worms have developed several sophisticated strategies in the course of evolution. "For example, parasite-infected shrimp change their behavior," explains Dr. Timo Thünken from the Institute for Evolutionary Biology and Ecology at the University of Bonn. "They no longer avoid certain fish species and are therefore eaten more frequently." Another thesis was so far controversial: Freshwater shrimp are beige-brownish; their body shell is also relatively transparent. They therefore barely stand out from their surroundings. Pomphorhynchus laevis larvae, on the other hand, are bright orange. It is therefore possible to see with the naked eye whether a shrimp is infected: Its parasitic cargo is marked by an orange spot.

Infected shrimp attract more attention

It may be that the shrimp are less well camouflaged as a result and are more frequently eaten by fish. Study director Prof. Dr. Theo Bakker already investigated this thesis several years ago. He was indeed able to determine that shrimp with an orange mark more frequently ended up in the stomachs of sticklebacks. Yet this finding was not confirmed in studies with brown trout.

However, the brown trout, in contrast to the stickleback, is not a suitable final host for Pomphorhynchus laevis. Its immune system usually prevents a successful infection with Pomphorhynchus laevis. "It is

therefore possible that the orange coloring attracts particular those fish that are especially suitable for the parasite's further reproduction," Thünken suspects. "We have now conducted experiments to put this thesis to the test."

The biologists marked the shrimp with an orange dot in order to simulate larval infestation. Then they tested how often the shrimp in question were eaten by different fish in comparison to unmarked species. The mark did in fact increase the risk of being eaten—but only in some types of fish: Barbels and sticklebacks were particularly interested in the marked freshwater shrimp; the dot made no difference to brown trout.

In another experiment, the researchers fed their fish exclusively with larvae-infested shrimp. "We were able to show that this diet often led to infection in barbels and sticklebacks, but very rarely in brown trout," explains Thünken. Evidently, their conspicuous coloring ensures that the larvae end up mainly in the stomach of suitable final hosts. However, it is unclear whether they have acquired their orange hue in the course of evolution in order to reach precisely these hosts. "Perhaps over time they have simply adapted better to the digestive tract of those fish that responded particularly strongly to the orange color," says Thünken.

The study also shows that the striking coloring of the larvae is not without disadvantages. The scientists used a different population of sticklebacks in their experiments. In contrast to their counterparts, this group avoided the marked shrimp: In the course of evolution they may have learned to interpret orange coloring as a warning signal.

More information: Timo Thünken et al, Parasite-induced colour alteration of intermediate hosts increases ingestion by suitable final host species, *Behaviour* (2019). DOI: 10.1163/1568539X-00003568

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