Sexual selection influences the evolution of lamprey pheromones

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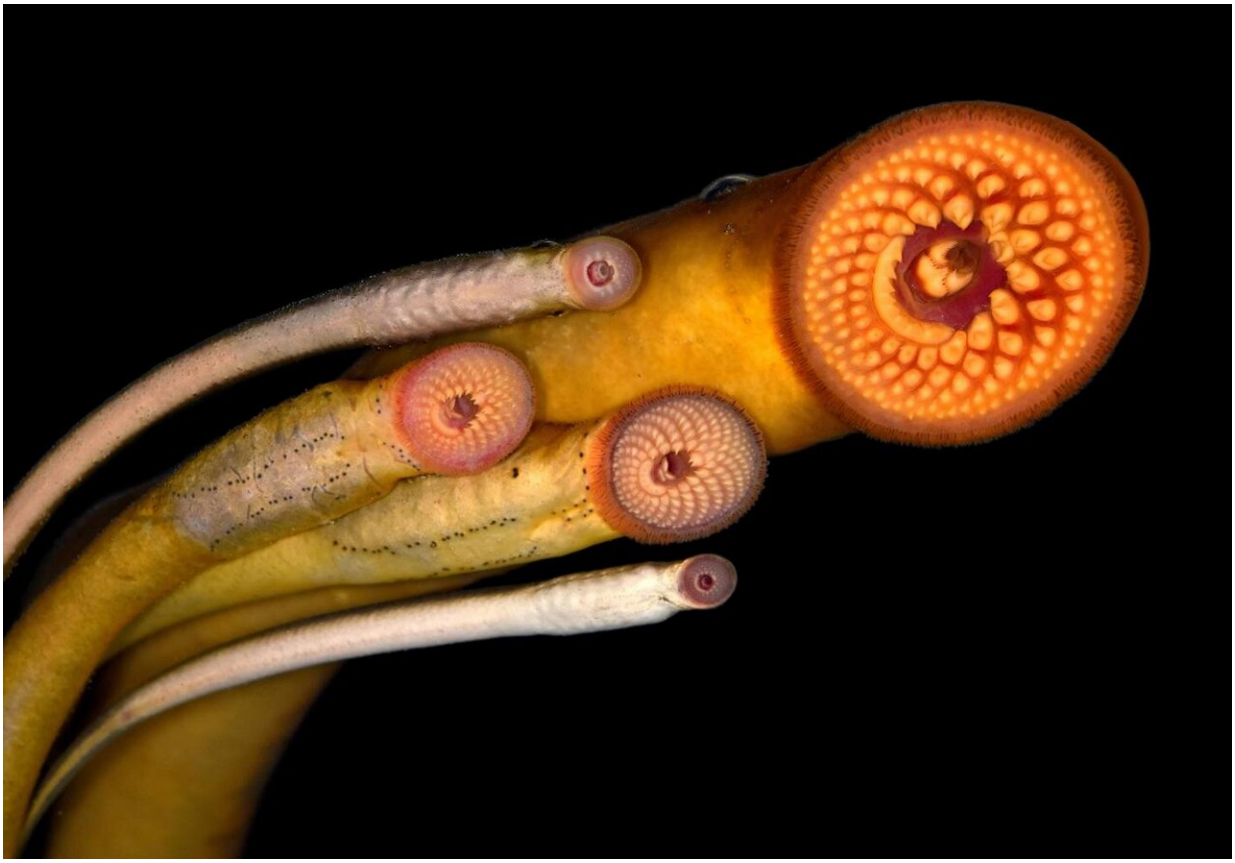

The invasive massive-mouthed sea lamprey (Petromyzon marinus), at the far right, is pictured with the four native Great Lakes lamprey species. From right to left: American brook lamprey (Lethenteron appendix), chestnut lamprey (Ichthyomyzon castaneus), silver lamprey (Ichthyomyzon unicuspis), and northern brook lamprey (Ichthyomyzon fossor). By profiling pheromone-related bile acids from these and other lamprey species from around the world, Buchinger et al. offers rare evidence that sexual selection drives evolution of

pheromone production. Credit: This photograph was taken by Andrea Miehls and is provided courtesy of the Great Lakes Fishery Commission/USGS.

In "Intra- and Interspecific Variation in Production of Bile Acids that Act As Sex Pheromones in Lampreys," published in *Physiological and Biochemical Zoology*, Tyler J. Buchinger and others find that sexual selection may play a role in the evolution of lamprey pheromones.

Although most existing pheromone research has focused on insects, lampreys have a relatively well-understood pheromone communication system that offers a useful opportunity to study pheromone evolution in a vertebrate. "Our results help address biases in the animal communication literature, in which research on the evolution of vertebrate pheromones remains relatively scarce."

The key to the research centers on bile acids produced in the livers of sea lamprey, as well as other lamprey species. Within the sea lamprey species, both larvae and sexually mature males synthesize many of the same bile acids. However, bile acids produced by larvae are involved with digestive processes, while those produced by sexually mature males—who do not feed and have a degenerate digestive system—act as pheromones. Since the same bile acids serve different purposes depending on life stage, sea lampreys offer a unique opportunity to compare the evolution of bile acids produced for sexual versus nonsexual functions, Buchinger writes.

Buchinger's study aimed to understand not only how current life stage affects the makeup of bile acids in sea lampreys, but also across other lamprey species. Buchinger conducted an experiment quantifying liver concentrations of eight pheromone-related bile acids in sea lamprey larvae and sexually mature males. In a second experiment, he determined

the effect of life stage on the similarity of bile acid across several lamprey species, including the pouched lamprey, silver lamprey, and American brook lamprey.

Results showed that within the sea lamprey species, bile acid profiles were generally less varied among mature male sea lampreys than for larvae sea lamprey. However, in the experiment that included other species of lamprey, liver bile acids varied more for males than larvae. This result supports the argument that sexual selection influences the pheromone evolution. Buchinger suggests that within sea lamprey males strive to produce one particular pheromone mixture—that which females find most attractive. In contrast, bile acid mixtures may have diversified across species as each evolved slightly different mate preferences or needed to recognize the correct species when mating.

Buchinger stresses the need for further research, including studies that use a larger number of lamprey species, to further investigate his findings. Despite the results pointing to sexual selection's role in pheromone evolution, there are also many ecological factors that may be at play, he writes. For instance, whether a lamprey species is polygynous, polygynandrous, or monogamous, or what they feed on are just a couple of the possible contributing factors to bile evolution. "Although we hypothesize that female mate choice and male competition have some role in the diversification of lamprey pheromones, their effects are almost certainly intertwined with other aspects of lamprey ecology," Buchinger writes.

Physiological and Biochemical Zoology: Ecological and Evolutionary Approaches primarily publishes original research in animal physiology and biochemistry as considered from behavioral, ecological, and/or evolutionary perspectives. Studies at all levels of biological organization from the molecular to the whole organism are welcome, and work that integrates across levels of organization is particularly encouraged.

Studies that focus on behavior or morphology are welcome, so long as they include ties to physiology or biochemistry, in addition to having an ecological or evolutionary context.

More information: Tyler J. Buchinger et al, Intra- and Interspecific Variation in Production of Bile Acids That Act as Sex Pheromones in Lampreys, *Physiological and Biochemical Zoology* (2019). DOI: 10.1086/705278