New fins evolve repeatedly in teleost fishes

March 5 2014

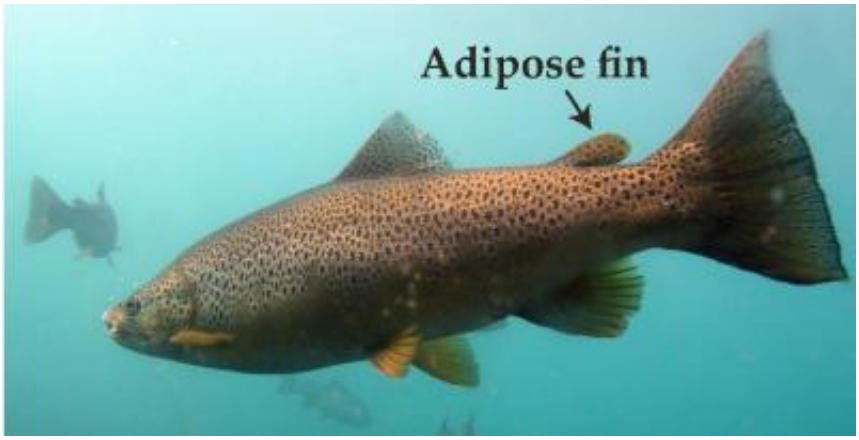
This is a diagram showing the location of the adipose fin on a specimen from the Field Museum in Chicago. Credit: Field Museum of Natural History, Chicago, Illinois

Though present in more than 6,000 living species of fish, the adipose fin, a small appendage that lies between the dorsal fin and tail, has no clear function and is thought to be vestigial. However, a new study analyzing their origins finds that these fins arose repeatedly and independently in multiple species. In addition, adipose fins appear to have repeatedly and independently evolved a skeleton, offering a glimpse into how new tissue types and structural complexity evolve in vertebrate appendages.

Adipose fins therefore represent a unique example of convergent evolution and new model for exploring the evolution of vertebrate limbs and appendages, report scientists from the University of Chicago in the *Proceedings of the Royal Society B* on March 5.

"Vertebrates in general have conserved body plans, and new appendages, whether fins or limbs, evolve rarely," said senior author Michael Coates, PhD, chair of the Committee on Evolutionary Biology at the University of Chicago. "Here, we have a natural experiment re-run repeatedly, providing a superb new system in which to explore novelty and change."

Usually small and structurally simple, adipose fins tend to get attention only when they are clipped from farm-raised trout and salmon as a tag. Despite their presence in thousands of fish species, they have been dismissed as a remnant of a once-functional fin. This assumption puzzled Coates and co-authors, as they saw no evidence of deterioration in adipose fin structure or function in the fossil record.



This image shows the adipose fin of a trout. Credit: Dan Kitchens

To study the evolutionary origins of this fin, Coates and lead author Thomas Stewart, graduate student in organismal biology and anatomy at the University of Chicago, turned to a technique known as ancestral-state reconstruction. With co-author W. Leo Smith, PhD, from the Biodiversity Institute at the University of Kansas, they created an evolutionary tree describing the relationships between fish with and

without adipose fins, using genetic information from more than 200 ray-finned fish and fossil data from known time points. They then used statistical models to predict when and in what species the adipose fin might have first evolved.

They found that adipose fins originated multiple times, independently, in catfish and other groups of ray-finned fishes—a striking example of convergent evolution over a vast range of species.

"It's pretty incredible that a structure which is incredibly common could be so misunderstood," Stewart said. "Our finding, that adipose fins have evolved repeatedly, shows that this structure, long assumed to be more-or-less useless, might be very important to some fishes. It's exciting because it opens up new questions."

More than 600 species of fish were studied in the course of this research, including many from the collections of the Field Museum in Chicago. This analysis revealed that a number of complex skeletal structures, including spines, plates, fin rays and cartilage discs, evolved independently in the adipose fins of different species. And while studies of the fossil record have suggested that new fins originate in a predictable and repeated manner, adipose fins demonstrate multiple routes to building new appendages.

"These results challenge what was generally thought for how new fins and limbs evolve, and shed new light on ways to explore the full range of vertebrate limb and fin diversity," Stewart notes.

Provided by University of Chicago Medical Center