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BIOLUMINESCENCE EVOLVED AT LEAST 29 TIMES IN MARINE FISHES ALONE

FINDINGS SUGGEST THAT “GLOWING” PHENOMENON HAS EVOLVED MANY MORE TIMES ACROSS ENTIRE TREE OF LIFE THAN PREVIOUSLY THOUGHT

New research shows that bioluminescence – a phenomenon in which organisms generate visible light through a chemical reaction – has evolved many more times among marine fishes, and likely throughout the entire tree of life, than previously thought. In a study published in the journal *PLOS ONE* today, scientists from the American Museum of Natural History, St. Cloud State University, and the University of Kansas reveal that bioluminescence evolved 27 times in marine ray-finned fishes.

“Our findings completely change how we look at the evolution of bioluminescence across all life,” said paper co-author John Sparks, curator-in-charge of the Museum’s Department of Ichthyology.

Most people are familiar with bioluminescence in fireflies, but the phenomenon is also found in bacteria, fungi, and throughout the ocean, where at certain depths, nearly all organisms glow. It has generally been hypothesized that bioluminescence evolved independently about 40 times across the entire tree of life, but this new study makes that number seem like a drastic underestimate.

Using a comprehensive phylogenetic analysis, the researchers have shown that bioluminescence has evolved at least 27 times in ray-finned fishes – and 29 times if sharks and rays are counted. This is the first study to explore how frequently bioluminescence has evolved in vertebrates.

“If we are seeing these kind of numbers in marine fishes alone, bioluminescence has evolved far more than 40 times across the tree of life,” Sparks said. “This suggests that we need to take a closer look at the evolution and diversification of other lineages with

bioluminescent members.”

Sparks and colleagues W. Leo Smith from the University of Kansas and Matthew P. Davis from St. Cloud State University found that the fish they examined all evolved bioluminescence between the Early Cretaceous, some 150 million years ago, to the present day. Further, the team shows that once an evolutionary line of fish developed the ability to produce light, it tended soon afterward to branch into many new species.

“When things evolve independently multiples times, we can infer that the feature is useful,” Smith said. “You have this whole habitat with everything that’s not living at the top or bottom of the ocean or along the edges – nearly every vertebrate living in the open water. Around 80 percent of those fish species are bioluminescent, so this tells us bioluminescence is almost a requirement for fishes to be successful.”

The researchers also found that the present-day diversity of several inshore and deep-sea bioluminescent fish lineages that utilize bioluminescence for communication, feeding, and reproduction – as opposed to solely for camouflage – exhibit exceptional species richness given the age of the group. This finding suggests that bioluminescence may facilitate diversification, especially in the deep open ocean, a region without obvious barriers to reproduction.

The scientists are now are trying to identify specific genes associated with the production of bioluminescence in fish.

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AMERICAN MUSEUM OF NATURAL HISTORY (AMNH.ORG)

The American Museum of Natural History, founded in 1869, is one of the world’s preeminent scientific, educational, and cultural institutions. The Museum encompasses 45 permanent exhibition halls, including the Rose Center for Earth and Space and the Hayden Planetarium, as well as galleries for temporary exhibitions. It is home to the Theodore Roosevelt Memorial, New York State’s official memorial to its 33rd governor and the nation’s 26th president, and a tribute to Roosevelt’s enduring legacy of conservation. The

Museum's five active research divisions and three cross-disciplinary centers support approximately 200 scientists, whose work draws on a world-class permanent collection of more than 33 million specimens and artifacts, as well as specialized collections for frozen tissue and genomic and astrophysical data, and one of the largest natural history libraries in the world. Through its Richard Gilder Graduate School, it is the only American museum authorized to grant the Ph.D. degree and the Master of Arts in Teaching degree. Annual attendance has grown to approximately 5 million, and the Museum's exhibitions and Space Shows can be seen in venues on five continents. The Museum's website and collection of apps for mobile devices extend its collections, exhibitions, and educational programs to millions more beyond its walls. Visit amnh.org for more information.

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