Insights into the evolution of bioluminescence in echinoderms

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Bioluminescence — the emission of visible light by living organisms — relies on the oxidation of a luciferin substrate catalysed by a luciferase enzyme. The bioluminescence of brittle stars has long fascinated scientists and it's not over yet! Recent research found that the luciferase enzyme of the brittle star *Amphiura filiformis* shares homology with the luciferase of the sea pansy Renilla (Cnidaria).

Surprisingly, these enzymes share high sequence identity and structural similarity with haloalkane dehalogenases that are mostly microbial enzymes that cleave carbon-halogen bonds in diverse halogenated hydrocarbons. This suggests that ancestral non-luciferase enzymes were convergently co-opted into luciferases in cnidarians and echinoderms. Using chromosome-scale genome and extensive transcriptome analyses, we identified multiple luciferase genes in the brittle star and studied their expression during development and arm regeneration. Luciferase mRNAs and proteins were detected in the light-emitting spines and the central nervous system of adults, and the peak of luciferase expression corresponds to the differentiation of spines during regeneration. In parallel, recombinant protein expression and biochemical experiments confirmed the bioactivity of two luciferase candidates. One of which exhibited a dual function, supporting the idea that Renilla- type luciferases evolved from haloalkane dehalogenases, the second one exhibited a clear luciferase activity comparable to the one of Renilla. This research provides valuable insights into the comprehensive characterization of echinoderm bioluminescence and enhances our understanding of how this fascinating ability evolved within the tree of life.

Keywords
Bioluminescence; Marine Invertebrates; Molecular Evolution; Echinoderms; Brittle Stars