

Reply to Giribet: Caterpillars evolved from onychophorans by hybridogenesis

Gonzalo Giribet (1) points out that “multiple researchers have addressed the issue of the phylogenetic position of onychophorans.” They have, and their methodology and conclusions have been questioned (2), but the phylogenetic position of onychophorans has little bearing on my proposal that an onychophoran was the source of caterpillar insect larvae (3). This example is part of my much larger thesis that the basic forms of all larvae were transferred from other taxa, and they all originated as adults (4). Across the animal kingdom, I claim that larvae were acquired from animals at all levels of relationship: bilateral larvae of radial echinoderms originated in an animal in a different superphylum from echinoderms, but most crustacean larvae were acquired from other crustaceans. As yet, no geneticist has carried out tests for larval transfer along the lines that Giribet suggests, but I hope my PNAS article (3) will prompt some of them to do so.

Since 2000, several workers have suggested that many planktonic larvae were “secondarily acquired” and have been “intercalated” into the life histories of echinoderms, molluscs, and other phyla (ref. 5 and references therein). These authors do not discuss the sources of these intercalated larvae or

mention my work, which does, but they seem to be following in my footsteps, unwittingly, and some distance behind.

Those that are aware that ascidian eggs fertilized with sea urchin sperm can develop into fertile sea urchins (4) are likely to take a different view from Giribet's on the possibility of fertilizing insect eggs with onychophoran sperm in the laboratory.

I thank Giribet for drawing attention to my paper (6) that outlines the importance of hybridization in the Cambrian explosion, and in which I claim that there is no cladistic explanation of the origins of phyla. We are indebted to Darwin for his description of a gradual and continual type of evolution, but biologists should also recognize the importance of saltational and sporadic evolutionary processes like symbiogenesis and hybridogenesis.

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1. Giribet G (2009) On velvet worms and caterpillars: Science, fiction, or science fiction? *Proc Natl Acad Sci USA*, 10.1073/pnas.0910279106.
2. Wägele JW, et al. (2009) Phylogenetic support values are not necessarily informative: The case of the Serialia hypothesis (a mollusk phylogeny). *Front Zool* 6:12.
3. Williamson DI (2009) Caterpillars evolved from onychophorans by hybridogenesis. *Proc Natl Acad Sci USA*, 10.1073/pnas.0908357106.
4. Williamson DI (2003) *The Origins of Larvae* (Kluwer, Dordrecht, The Netherlands).
5. Page LR (2009) Molluscan larvae: Pelagic juveniles or slowly metamorphosing larvae? *Biol Bull* 216:216–225.
6. Williamson DI (2006) Hybridization in the evolution of animal form and life-cycle. *Zool J Linnean Soc* 148:585–602.

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