Expanding theory of evolution

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An Indiana University professor is part of an international team of biologists working to expand Darwin's theory of evolution to encompass factors that influence a species' growth and development beyond genetics—as well as to consider the impact of species on the environment.

The concepts originally laid out in Charles Darwin's "On the Origin of Species" in 1859 continue to serve as a major foundation for the modern theory of evolutionary biology.

In recent decades, however, biologists in previously overlooked fields such as developmental biology and ecology have made discoveries that extend the basic principles upon which Darwin's theory was founded.

Yet many scientists—and science textbooks—regard these modifications merely as "proximate considerations," not as core aspects of evolution. Indiana University biologist Armin Moczek and a team of international collaborators want to change these assumptions.

Their new approach, dubbed the "extended evolutionary synthesis," appears in the Aug. 5 issue of the *Proceedings of the Royal Society B: Biological Sciences*.

"Our long-term goal is to lay out an extended conceptual framework for evolutionary biology that delivers answers to questions that traditional methods have been unable to provide," said Moczek, a professor in the IU Bloomington College of Arts and Sciences' Department of Biology, who is an author on the paper.

Other collaborators include distinguished scientists from the the United Kingdom, Israel, Australia, Austria, Sweden and the United States. The work is the journal's 2015 "Darwin Review," an honorary name given each year to a single paper judged highly significantly by the journal's editors.

"It's important that conceptual frameworks themselves evolve in response to new data, theories and methodologies," said Moczek, an internationally known expert on the evolution and development of insects. "This isn't always straightforward since habits of thought and practice can grow deeply entrenched."

In the paper, Moczek and others focus on several processes that, they argue, play critical roles in evolution but typically are not regarded as part of current evolutionary theory.

The authors discuss the way an organism's growth from egg to adult influences species' evolution. The field of evolutionary developmental biology, or "evo-devo," has found that highly different organisms—from sea urchins to insects and mammals—use the same "building blocks" to grow their bodies during development. This shared "toolbox" enables unrelated organisms to evolve strikingly similar structures over time—the independent evolution of eyes in insects and vertebrates, for example.

These same building blocks may also be re-used in different ways. Moczek's research, for example, shows that genes and developmental pathways that originally gave rise to legs and other appendages were later re-used to create beetles' extravagant horn-like structures.

Moczek and colleagues also argue that the role of "plasticity"—or the ability of many organisms to adjust their growth and development in response to environmental changes over their lifetime—has been overlooked in evolutionary theory. They cite growing evidence that novel traits prompted by the environment may be genetically fixed in subsequent generations.

Lastly, the scientists say evolutionary theory should expand to consider how organisms systematically modify their own environment, such as building nests or burrows; change the atmosphere or soil; or create cultures. And they show that factors beyond genetic inheritance influence species across generations, including prenatal hormones, care after birth and learning.

Traditional evolutionary biology emphasizes a single direction: Genes give rise to observable traits, such as its physical characteristics, biological processes or behaviors. The environment may favor certain traits but in the process remains external from the organism.

"We're arguing for a reciprocal model, one in which genes not only contribute to an organism's observable traits, but also where an organisms' own traits, behaviors and actions significantly impact the rate and direction of evolutionary change," Moczek said.

This shift in approach could also have an impact on fields related to biology, such as medicine, Moczek added.

The new conceptual framework could help advance research on how diseases—and their cures—may have roots in factors beyond genes, he said. A growing number of studies suggest autoimmune diseases may stem in part from a lack of "natural challenges" caused by widespread use of antibiotics, lack of parasites and even flush toilets, for example. Others show that controlled inoculation with helminths, a parasitic worm, can alleviate symptoms from asthma, inflammatory bowel disease and multiple sclerosis; or that non-obese diabetic mice prone to type 1 diabetes will not develop the disease upon infection with pig whipworms.

"Collectively, these studies provide growing support that co-development with microbial or infectious agents may be key to healthy development," Moczek said. "We may find the conditions that favor or discourage diseases actually arise from the environments we create through our actions."

More information: The Extended Evolutionary Synthesis: Its Structure, Assumptions, And Predictions, rspb.royalsocietypublishing.or … .1098/rspb.2015.1019

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