Biologists propose new research roadmap for connecting genes to ecology

April 30 2013

The top panel shows a lizard beginning to jump, a critical anti-predatory behavior in the wild. The bottom panel illustrates a fish protruding its jaws, a key predatory behavior. UMass Amherst researchers propose an integrative research plan to understand the genomic innovations that have promoted the evolution of these behaviors. Credit: UMass Amherst

(Phys.org) —A team of researchers at the University of Massachusetts Amherst is proposing a new investigative roadmap for the field of evolutionary developmental biology, or "evo devo," to better understand

how innovation at the genetic level can lead to ecological adaptations over time. Evo devo seeks to understand the specific genetic mechanisms underlying evolutionary change.

Seven UMass Amherst authors, all biologists but with diverse research programs including evolutionary genetics, developmental biology, biomechanics and behavioral ecology, describe the new framework they created to link genes to ecology in the May issue of *Trends in Ecology and Evolution*. They propose a set of hypotheses that can form the basis for further studies. "We advocate strengthened collaborations," they point out, among evo devo disciplines "to consider all links from genes to resource use."

In the past, evo-devo research has focused narrowly on connecting gene-level changes with evolution of different anatomical shapes, known as morphology, but it has been less successful in identifying mechanisms of more subtle, continuous changes that are important for how an organism performs in its particular environment. For example, how do genes and mechanisms evolve in relation to how fast an animal runs, how far it jumps or how hard it bites?

Lead co-authors of a new paper, Duncan Irschick and Craig Albertson, say that the field has to date been "hugely successful" in providing a mechanistic basis for the evolution of specific traits including bat wings and turtle shells, but they also point out that the old approach left a major gap in our understanding of what drives evolutionary change.

"Connecting genes to a single discrete trait does not necessarily tell you how that animal performs in its environment, and it is the way an organism interacts with its environment that directly affects its survival," says Albertson. "Performance traits are often multi-dimensional. While gene for jaw width, for example, can tell you something about how an animal feeds in the wild, the full picture involves much more

information, such as jaw length, skull depth, muscle size, the kinetics of jaw movement and a slew of other factors."

"We want to expand the research program beyond genes and discrete traits. We argue that if researchers focus on the phenotype and work back to the genes, we will gain a much more comprehensive understanding of how the genome affects an organism's survival in a particular environment. A key first step in this process should be to figure out how genes influence the way an animal negotiates its world."

Co-author Betsy Dumont point out that this work also has immediate practical implications. "We believe this approach has the potential to provide a more comprehensive understanding of how the genome influences an organism's ability to adapt to a changing environment."

Irschick adds, "As a group, we set out to create new intellectual ideas and to provide a platform for scientists to understand the world. I could not have been more pleased at how we all worked together towards that goal, and how we accomplished it."

Albertson says of the team's work, "Understanding how changes at the genomic level can influence an organism's survival in a changing environment is a long-standing question in biology, and one that no single research program can address in a comprehensive manner. It is a rare and special thing to be among colleagues who can pull together their collective expertise in order to begin to tackle this important question."

"By integrating ideas from the disparate fields of developmental biology, functional morphology and evolutionary ecology, we lay out a research program to examine how changes at the genomic level promote ecological success in a changing environment. Our long term goal is to turn these ideas into an integrative training experience for graduate students in the organismic and evolutionary biology program here at

UMass Amherst," he adds.

More information: www.cell.com/trends/ecology-ev … 0169-5347(13)X0005-9

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