Biologists flock to 'evo-devo' in a quest to read the recipes of life

How has the diversity of animal and plant forms evolved? Researchers are combining evolution, development and genetics to address this hot topic.

Atlanta, Georgia

The emerging discipline of evolutionary developmental biology — nicknamed 'evo-devo' — was the star turn at last week's annual meeting of the Society for Integrative and Comparative Biology, held in Atlanta, Georgia.

Two symposia, sponsored by the US National Science Foundation, were devoted to the discipline, and addressed both animal and plant research. The society, formerly known as the American Society of Zoology, also created an evo-devo division. In recent months, two journals focusing on evo-devo research have been formed.

The meeting of the 2,200-member society drew more than 1,200 scientists, the most in recent years. This is attributed largely to the evo-devo sessions, which attracted European scientists.

One of the symposia focused on the 'Hox' gene clusters. These are believed to be integral to the structuring of animal bodies during development, and to the evolution of morphology (the shape and form of organisms). The second symposium linked the history of evo-devo to methods for combining techniques from molecular biology with older disciplines such as phylogeny (study of the evolutionary relationships between species) and morphology.

Hox of delights

Evo-devo is described by symposia organizer Billie Swalla, a zoologist at the University of Washington, Seattle, as the way in which "changes in developmental genes cause evolution and morphology". Zoologists believe that they are looking at "profound developmental genes" that provide the signals responsible for creating various parts of the organism.

As an example, she cites her research on the development of marine animals called tunicates (sea squirts), from their distinctive larvae. While the fossil record for tunicates is negligible, possibly because they have no hard parts, she says that the use of studies of genes and morphology to reconstruct their evolutionary relationships has shown that tunicate larvae have repeatedly gained and lost their tails during the course of evolution: a small cassette of genes seems to be responsible for the switch.

These questions are the stuff of evo-devo, she says. Tunicates are also interesting because they are closely related to vertebrates. During the evo-devo symposia, scientists discussed studies of animals ranging from butterflies to the chick.

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Mighty squirts: tunicates are among the closest living invertebrate relatives of the vertebrates. Study of the genes that control their development can help to reveal how this evolutionary transition occurred.

Corresponding Hox gene clusters instruct cells to produce organism parts in humans, chicks, flies and other animals. Sean Carroll of the University of Wisconsin at Madison presented studies showing how a regulatory gene called *hedgehog*, identified in the fruitfly *Drosophila melanogaster*, directs the formation of eyespots on the wings of butterflies (see *Nature* **384,** 236–242; 1996).

To ensure a broad approach, and to draw analogies between evo-devo studies of plants and animals, the society included plant systematist Michael Donoghue, director of Harvard University's herbaria.

Scientists have found Hox genes in plants, but they are not thought to be as deeply involved in the organism's body plan as they are in animals. Michael Purugganan, of North Carolina State University, reported that another class of genes, called MADS-box genes, control plant development in ways analogous to the Hox genes of animals (see *Nature* **399,** 144–148; 1999).

Although this line of work is well known to botanists, few animal biologists are aware of it. It was felt that an approach combining work on plants and animals would yield more of the comparative information on which evo-devo is increasingly based.

> Evo-devo seeks to answer how development varies between organisms.

Possibilities and constraints

Rudolph Raff, a zoologist at the University of Indiana and the first president of the society's evo-devo division, says that he expects the discipline to answer how the course of development varies between organisms, how this evolves, and how the evolutionary 'choices' made during development constrain evolution.

Developmental constraints are one reason why organisms cannot evolve into an infinite variety of forms. Evo-devo seeks to find out why, and what these constraints are.

A number of participants at last week's meeting said that, as the field matures, they expect researchers to study the genomes of many species — not just standard models such as the nematode worm or mouse.

"Molecular technologies are permeating all disciplines," says Martin Feder, a zoologist at the University of Chicago who is president of the society and a strong supporter of the evo-devo symposia. "Evolutionary studies are now permeating all disciplines. We stand at the crossroads of this."

But some researchers, such as Paula Mabee, a specialist in phylogenetic systematics at the University of South Dakota, warn that evo-devo still needs the foot soldiers of basic zoology.

Raff agrees."We could fool ourselves pretty badly" with an over-reliance on genetic tools, he says.

Rex Dalton