LIMB DEVELOPMENT

Gene Ties Arthropods Together

From creepy-crawly centipedes to sideways-stepping crabs, legs are arthropods' claim to fame—and keys to disputes over arthropod ancestry. Many crustaceans, for example, feature limbs with two or more branchlike extensions, while insects possess only unbranched limbs. With no clear transitional forms in the fossil record, some paleobiologists assert the two groups must have gone separate ways almost 600 million years ago, a time of odd, poorly fossilized animals, and today they are hardly related at all. Other researchers, however, argue that the groups shared a common ancestor as recently as 400 million years ago, when insects first appeared, and that limb differences arose because insects simply shed their extra branches. Over the years, these arguments have "run themselves into the ground," says Graham Budd, a paleontologist at Uppsala University in Sweden.

Recently, however, geneticists and developmental researchers have joined the debate—on the side of those arguing for a closer insect-crustacean relationship. On page 1363 of this issue, a team led by developmental geneticist Sean Carroll at the University of Wisconsin, Madison, reports that limb branching is a second-order phenomenon, affected by a single gene that initiates development of unbranched limbs in fruit flies and branched limbs in crustaceans such as brine shrimp. Any differences in limb branching correspond with differences in the way this gene, called *Distal-less* (*Dll*), is regulated during development, the group found. The gene's plasticity means "you don't need separate ancestors" to explain the diversity of arthropod limb patterning, Carroll asserts.

Developmental geneticist Michael Akam of Cambridge University in England calls the work "intriguing stuff." He notes that it adds to a growing current of research tying arthropods more closely together. For instance, Jeffrey Boore, Markus Friedrich, and their colleagues recently noted similarities among mitochondrial and ribosomal DNA sequences from insects and crustaceans that also imply the two groups share a close evolutionary history (*Nature*, 13 July, pp. 163 and 165).

Carroll's group—which includes researchers Grace Panganiban, Angela Sebring, and Lisa Nagy—had been studying the role of *Dll* expression in limb development in flies and butterflies. Without the gene, limbs can't grow. Given the insect-crustacean controversy, they decided to explore *Dll* expression among crustaceans as well, hoping it might yield clues about the relationships of the organisms.

Antibody staining of developing limbs of the brine shrimp *Artemia franciscana* and the opossum shrimp *Mysidopsis bahia* showed that each branch of each crustacean limb expresses *Dll*, just as if they were unbranched insect limbs. The exact pattern of expression, however, varied with the body section of the organism. Branches on the head limbs of *Mysidopsis*, for example, grew simultaneously from a single group of *Dll*-expressing cells, while those on thoracic limbs developed sequentially from separate cell groups. "That tells you there is a lot of room to operate within a single class of arthropods ... using the same genes," says Carroll. Branches thus shouldn't be viewed as a distinguishing characteristic of any arthropod group, he argues.

GRACE PANGANIBAN

Leg show. A brine shrimp's branched limbs show activity of the limb-regulating gene *Dll (brown segments)*, as do insect limbs. (Topmost limbs are 0.3 millimeters.)

Donald Anderson, an emeritus biologist at the University of Sydney in Australia and a champion of the multiple-lineage theory, admits that "at the moment, the weight of the evidence seems to be pointing" toward a close insect-crustacean relationship. But he notes that because even vertebrates share versions of *Distal-less*—indicating that the gene first arose in some distant progenitor of both the vertebrates and the arthropods—its ubiquity makes it hard to use *Dll* to pinpoint a time for arthropod divergence.

Carroll's group is taking another tack in tracing that divergence: looking for *Dll* expression in possible arthropod precursors, such as the legless annelids. Finding *Dll* expressed in annelids' leglike body projections—called parapodia—would suggest that the groups are related. And that, in turn, may take researchers another step closer to understanding arthropod relations.

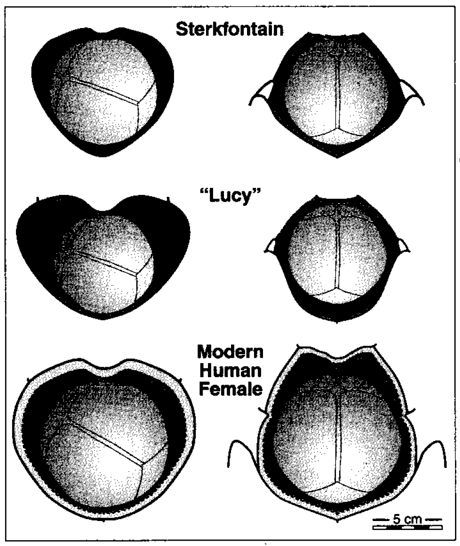
–Wade Roush

PALEOANTHROPOLOGY

Sexing Fossils: A Boy Named Lucy?

Have anthropologists been engaged in a 20-year affair with a gender-bending hominid? Two Swiss anthropologists think so. They've examined the bones of one of the most famous female figures of all time—a 3-million-year-old skeleton known as "Lucy," discovered in 1974—and when their gaze moved below the waist, they got a shock: She was not a she.

This is not the script for a sequel to the movie *The Crying Game*, but an argument made in the October issue of the *Journal of Human Evolution* by Martin Häusler and Peter Schmid of the University of Zurich in Switzerland. Judging from Lucy's pelvis, they say, this little representative of the species *Australopithecus afarensis*, long posed near the base of the human family tree, was more likely a male. Their study does more than challenge Lucy's gender. If correct, it threatens to reignite one of the hottest controversies in anthropology: whether *A. afarensis* was one species—or two.



M. HÄUSLER AND P. SCHMID

Male delivery? A reconstruction of the inlet *(left)* and midplane *(right)* of Lucy's pelvis shows the shape, compared to another fossil pelvis and a modern one, is the wrong one for giving birth.

Opinion on this species-splitting gender switch is, well, divided. Häusler and Schmid argue that Lucy was a male because the skeleton's pelvis was too narrow to accommodate an australopithecine baby. The contention, says anthropologist Robert Taugue of Louisiana State University, "will certainly challenge people to evaluate this specimen again." But many other anthropologists think the pelvic data are being stretched. "This analysis is so tortuous and labyrinthine I don't know where to start," says Owen Lovejoy of Kent State University, who undertook the original reconstruction of Lucy's pelvis.

Lucy was discovered at Hadar in Ethiopia by paleoanthropologist Donald Johanson. Standing barely a meter high, and with a tiny mandible and canine tooth sockets, its body proportions were considered far too petite to be male. (Male primates are generally larger