record. The Ruddle group is now looking at the homeobox genes in the wormlike amphioxus, the most primitive chordate, and the lamprey, which is more complex than amphioxus, but less so than mammals.

Meanwhile, preliminary evidence in support of the idea that more complex species have a greater number of homeobox genes comes from Peter Holland of Oxford University in England. The homeobox gene Holland is analyzing does not belong to one of the four main complexes, but he has found that advanced vertebrates, including the mouse and the zebrafish, have three forms of the gene, whereas the fruit fly and an ascidian have only one. By comparing the sequences of the genes, Holland says, "you can tentatively conclude that there's been a duplication of that gene about the time of origin of the vertebrates."

Nevertheless, researchers clearly have a long way to go in documenting the role of the homeobox genes in evolution. One question they want to answer concerns how the structural organization of the gene clusters has been maintained so rigorously over millions of years. The leading view at present is that the regulation of all the genes in a cluster has to be closely coordinated. Krumlauf's group has evidence, for example, that the regulatory elements of one gene may overlap with those of another. If that's the case, then if the cluster were disrupted, the whole system might break down. Hence only organisms in which the genes maintained the correct order could survive.

And to uncover the actual mechanisms by which the homeobox genes might have contributed to evolution, researchers will have to try to correlate variations in the genes and their patterns of expression with the developmental changes that give rise to different body structures. Achieving that goal will require a great deal of work, but it's at least getting under way. In one of the early examples, Michael Akam's group at the Wellcome/CRC Institute of Cancer and Developmental Biology in Cambridge, England, is comparing the expression patterns of various homeobox genes in the fruit fly and in another insect, the locust *Schistocerca gregaria*. "We wanted to see if we can relate evolutionary diversity to the genes or whether they are irrelevant," Akam explains. In preliminary work, the researchers have seen subtle differences in the expression patterns of some of the genes in the two species, which might account for a structural difference in their last abdominal segments.

Such findings are only the earliest indications that biologists will be able to find homeobox differences that can explain why two species' embryos develop in different ways—and hence, ultimately, why those species diverged in evolution. While the final marriage of developmental biology and evolutionary theory is clearly some way off, perhaps one day it will produce an offspring that can explain, in satisfying molecular detail, how new species evolved. ■ JEAN MARX

ADDITIONAL READING

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Jawing With Our Georgian Ancestors

Not only are old cold war secrets being unearthed in former Soviet republics these days, but the citizens of these new nations also are digging up other surprising relics from their (very ancient) past. Word is just now spreading through the scientific world of a startling new discovery in the republic of Georgia, where archeologists began excavating the cellar of a ruined medieval house last summer and came upon a lower jawbone. What's surprising is its age—it may be the earliest hominid remnant ever found in Europe and possibly the earliest anywhere outside Africa. If the oldest preliminary date for the jawbone—1.6 million years—holds up, the find could throw new light on how and when early hominids migrated outward from Africa.

Although rumors of a major new find had been circulating in the archeological community for months, the discovery was made public only last month at a meeting on the human ancestor *Homo erectus* in Frankfurt, held to commemorate the 100th anniversary of the discovery of the million-year-old Asian find called Java Man. At a workshop, Leo Gabunia of the Georgian Academy of Sciences produced the mandible, which he kept in a tobacco tin.

Those who got a good look say it is a remarkably complete mandible that is clearly a hominid in origin and archaic. "It's not just a recent Georgian who fell into a pit," says Philip Rightmire, an anthropologist at the State University of New York at Binghamton, who is an expert on *Homo erectus*. Adds Christopher Stringer, head of the human origins section at the Natural History Museum in London, "It is a very significant find."

The large and heavy mandible, with all 16 teeth still in place, was embedded in the foundation of a house in the long-deserted city of Dmanisi, along with archaic stone tools, the skulls of two saber-toothed tigers, and the rib of an elephant. A team of Georgian and German scientists, led by Vachtang Dzarparidce of the Georgian Academy of Sciences and Gerhard Bosinki of the University of Cologne, has dated the surrounding sediments and animal remains, and they claim the mandible is from a *Homo erectus* who lived 900,000 or 1.6 million years ago—but not in between.

The reason the German-Georgian team argues that the jawbone is unlikely to be of an intermediate age is that their dating method relied on measuring the orientation of the earth's magnetic field in a lava flow underneath the jawbone. As the lava cooled, metallic particles in it "locked in" the orientation of the earth's magnetic field, which reverses over long periods. The particles' orientation fits a date of either 900,000 or 1.6 million years, but not the intervening period—when the magnetic field was reversed.

Either date could make the new find of great significance, because of the scarcity of early hominid remains outside Africa. Although Java Man is a million years old, the oldest accepted hominid in Europe—the Mauer mandible—is only a half-million years old. But million-year-old stone tools have been found in France, and paleoanthropologists have long wondered who made them and what relation they had to humanity's African origins.

If the 900,000-year-old date for the Georgian jaw holds up, it would help answer the question of who made the ancient European tools. If the earlier date of 1.6 million years turns out to be correct, the jaw would throw light on even deeper questions—providing support for those who believe *Homo erectus* began migrating northward out of Africa not long after it evolved as a rival for an earlier human predecessor, *Homo habilis*, 2 million years ago. The older date, however, remains controversial—in part because the data from the German-Georgian team have not yet been published. Until they are, everything about the new find will no doubt be the subject of heated debate in the world of paleoanthropology. ■ ANN GIBBONS