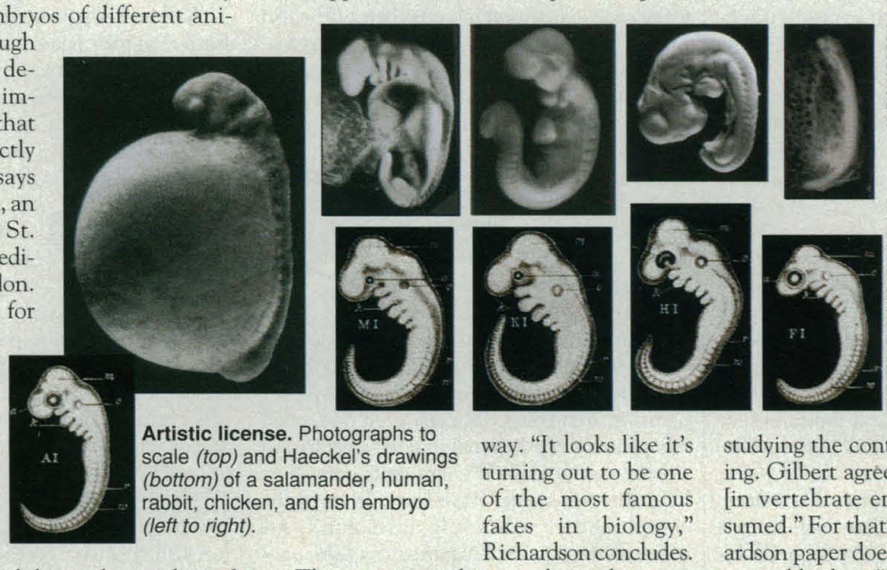
DEVELOPMENTAL BIOLOGY

Haeckel's Embryos: Fraud Rediscovered

Generations of biology students may have been misled by a famous set of drawings of embryos published 123 years ago by the German biologist Ernst Haeckel. They show vertebrate embryos of different animals passing through identical stages of development. But the impression they give, that the embryos are exactly alike, is wrong, says Michael Richardson, an embryologist at St. George's Hospital Medical School in London. He hopes once and for all to discredit Haeckel's work, first found to be flawed more than a century ago.



M. RICHARDSON, THE BODLEIAN LIBRARY, OXFORD

Artistic license. Photographs to scale *(top)* and Haeckel's drawings *(bottom)* of a salamander, human, rabbit, chicken, and fish embryo *(left to right)*.

Richardson had long held doubts about Haeckel's drawings because they didn't square with his understanding of the rates at which fish, reptiles, birds, and mammals develop their distinctive features. So he and his colleagues did their own comparative study, reexamining and photographing embryos roughly matched by species and age with those Haeckel drew. Lo and behold, the embryos "often looked surprisingly different," Richardson reports in the August issue of *Anatomy and Embryology*.

One striking deviation from reality, Richardson says, appears in Haeckel's drawings of embryos in the "tail bud" stage, which he depicted as identical for different species. While real embryos do share many features at this stage, such as a tail and identifiable body segments, they also have key differences. Human embryos, for example, have tiny protrusions called limb buds, says Richardson, particularly if they have developed to the point of having as many body segments as Haeckel gives them. But Haeckel did not include limb buds. And in his drawings, the chick embryo eye is blackened, like a mammal's, "but it wouldn't be pigmented this early," Richardson says. He adds that Haeckel has given the bird embryo a curl in the tail that resembles a human's.

Not only did Haeckel add or omit features, Richardson and his colleagues report, but he also fudged the scale to exaggerate similarities among species, even when there were 10-fold differences in size. Haeckel further blurred differences by neglecting to name the species in most cases, as if one representative was accurate for an entire group of animals. In reality, Richardson and his colleagues note, even closely related embryos such as those of fish vary quite a bit in their appearance and developmental pathway. "It looks like it's turning out to be one of the most famous fakes in biology," Richardson concludes.

This news might not have been so shocking to Haeckel's peers in Germany a century ago: They got Haeckel to admit that he relied on memory and used artistic license in preparing his drawings, says Scott Gilbert, a developmental biologist at Swarthmore College in Pennsylvania. But Haeckel's confession got lost after his drawings were subsequently used in a 1901 book called *Darwin and After Darwin* and reproduced widely in English-language biology texts.

The flaws in Haeckel's work have resurfaced now in part because recent discoveries showing that many species share developmental genes have renewed interest in comparative developmental biology. And while some researchers—following Haeckel's lead—like to emphasize the similarities among species, Richardson thinks studying the contrasts may be more interesting. Gilbert agrees: "There is more variation [in vertebrate embryos] than had been assumed." For that reason, he adds, "the Richardson paper does a great service to developmental biology."

–Elizabeth Pennisi

GEOSCIENCE

Ring Laser Senses Earth's Spin

The sun will surely rise tomorrow, but it may not rise exactly on schedule. Because tides, atmospheric changes, and perhaps movements in Earth's core are constantly shifting the planet's mass, the time it takes to make a full turn fluctuates by a few milliseconds per day. And milliseconds matter, at least to researchers trying to understand the fluctuations and people wanting to get a fix on their exact position by comparing precise time signals transmitted from global-positioning system satellites. Now a square block of glass 1.2 meters across in a cave in New Zealand may help keep track of Earth's vagaries.

UNIVERSITY OF CANTERBURY

Ring of glass. Scientists fine-tune C-II, the world's largest ring laser gyroscope.

The device is the world's largest ring laser gyroscope, similar to the laser gyros used in the navigation systems of aircraft but very much more accurate. "We believe it is the most stable gyro that has ever been produced," says theoretical physicist Geoffrey Stedman of the University of Canterbury in Christchurch, New Zealand. Built by scientists from the Federal Office for Cartography and Geodesy in Frankfurt, Germany, the Technical University of Munich, and the University of Canterbury, the $1 million gyro, dubbed C-II, should be up and running by late fall. When it reaches its peak sensitivity, it should be able to detect changes as tiny as a few milliseconds per day.

Earth scientists can already detect such minute fluctuations using very long baseline interferometry, in which two or more radio telescopes separated by thousands of kilometers monitor slight changes in the apparent position of beacons in the distant universe, called quasars. But analyzing the measurements involves sending tapes to a processing center where readings from the telescopes are compared on a single computer. A faster alternative is satellite tracking, in which the movement of a satellite relative to the spinning Earth is tracked by reflecting laser beams off it.