Arctic evolution for land plants, animals?

A group of paleontologists working in the northernmost reaches of the Arctic proposes that some land animals and plants assumed to have evolved in mid-northern latitudes in fact evolved in the Arctic millions of years earlier. The finding suggests that some plants evolved as much as 18 million years sooner, and some animals 2 to 4 million years earlier than widely believed. The suggestion is a reversal of many existing scenarios for plant and mammal evolution that hold that many species developed in the south and eventually wended their way toward the cooler northern climes.

The finding — already being challenged by at least one paleontologist — was reported in the Sept. 16 SCIENCE. The results are an outgrowth of 10 years of research, the goal of which was to establish a geographic link for migration of life forms between North America and northern Europe. In the last decade, fossil evidence from Ellesmere Island, the northernmost Canadian island, has lavishly demonstrated that a diverse array of animals and plants lived in the Arctic during the warmer period starting 55 million years ago, and that at that time the continents were, in fact, connected. The recent finding that a variety of mammals and plants *evolved* there as well came about when the researchers applied a revised time-scale for magnetic reversals, the irregular changes in the earth's magnetic field that are recorded in the rocks. The fossils in the Arctic closely resemble those found at lower latitudes but the rocks in which they are found, the authors write, are millions of years older than their southern counterparts.

The finding is reported by Leo J. Hickey, director of the Peabody Museum of Natural History at Yale University, Robert M. West, director of the Carnegie Museum in Pittsburgh, Mary Dawson, also of the Carnegie Museum, and Duck K. Choi of Pennsylvania State University, University Park.

Incongruous dates for a range of fossil plants and animals from the Arctic had been known but not explained, Hickey says. The researchers arrived at their recent conclusion when they plotted the revised magnetic zones against the stratigraphic ranges, or locations of the Arctic animals and plants within the geological time scale. Biostratigraphy is the traditional fossil-dating method. Some vertebrates, such as some primitive tortoises and turtles, occur 2 to 4 million years earlier in the Arctic than at southern latitudes, the authors note, and some pollen forms and plants show a "drastic" disparity in time of appearance. The authors also write that some kinds of perissodactyls, or early horses, made their evolutionary appearance not in the subtropics, as has been suggested, but in the Arctic.

Such biological largess might be attributed to the Arctic climate, which was warmer than today at intervals about 65 million years ago and from 55 to 45 million years ago. But the Arctic as a locus of evolution raises questions that will require extensive scrutiny by biologists. Today most Arctic animals simply hibernate during the annual interval when no sunlight touches the high latitudes. If an animal is "living at 70° to 75°N and temperatures are pretty warm, what do you do for the six months when there is no sunshine at that latitude?" asks Leonard Radinsky of the University of Chicago. "What do you do if you're a plant and can't undergo photosynthesis? That may be one of the most interesting questions that comes out of this research."

At least one vertebrate paleontologist, Malcolm McKenna of the American Museum of Natural History in New York, is highly skeptical of the assertion that the animal forms cited in the article evolved in the Arctic. He says the paleomagnetic data are drawn from another researcher's unpublished master's thesis and "leaves much to be desired. ... They're throwing out biostratigraphy and accepting [this] paleomagnetic data, which I think is a very dangerous thing. ... In this case they've stuck their necks way out, and they're going to have various sharp axes wielded in their general direction. I think we've got a major clean-up job on our hands."

— *C. Simon*

A possible X-ray lasing transition

Lasers began in the infrared, following the success of masers, which had pioneered the application of the principle of amplification by stimulated emission of radiation in the radio wavelengths. Over two decades, lasers have moved gradually to shorter and shorter wavelengths. The frontier now is in the extreme ultraviolet (XUV) and X-ray range. The last two years have seen significant progress toward a laser in that range, reports R.J. Dukart of Physics International Company in San Leandro, Calif.

The experiments to which Dukart refers took place in the context of a widespread effort to use plasmas — ionized gases — energized by high-power accelerators to produce high intensity bursts of this radiation for investigations in materials science, biology and other disciplines. At last week's Beams '83, the Fifth International Conference on High Power Particle Beams, which met in San Francisco, representatives of various laboratories — Maxwell Laboratories of San Diego, the Ecole Polytechnique in Palaiseau, France, Sandia National Laboratories in Albuquerque, N.M., and Physics International — discussed various ways of making and shaping such plasmas for best effect.

The high power accelerators that energize the plasmas store up large amounts of electrical energy in huge banks of capacitors or induction coils and then release it in short high power pulses. This contrasts with the high energy accelerators used in ordinary particle physics experiments, which deliver high energy continuously to particle beams that represent minuscule currents, typically milliamperes, for a very low power rating. The high power accelerators deliver currents in kiloamperes or megamperes, up to a billion times as much.

Of the laboratories working on X-ray and XUV radiation, Physics International seems the most intent on producing a laser. Even without a laser, interesting things can be done with this radiation and a pinhole camera. "We have seen [biological] cells lying under other structures," Dukart says. The advantages of a laser would be concentration of energy into a narrow wavelength and the possibility of tuning. "If you can tune the radiation and look at surfaces, you'll have a very powerful tool," Dukart says.

To get a laser requires a population inversion, a reversal of the usual statistics of energetic atoms. Normally in a large sample most of the atoms will be in the lowest possible energy state. The higher the energy state, generally the fewer the atoms in it. An inversion is a gross overpopulation of some high energy state. Getting this inverted population to release its energy by radiation all at once is the basic condition for a laser. In the main achievement of the recent experiments, researchers have found some energy levels of neon-like krypton that seem to be candidates for this process. (Neon-like krypton is a krypton ion that has lost all but 10 electrons, so that it has the nucleus of krypton but the electronic structure of neon.)

So far the experiments have been aimed at a single-pass laser, one in which the radiation goes through the lasing material only once. To get a high gain — a high concentration of energy — means making a long narrow plasma and so putting large numbers of ions in the way of radiating as the radiation pulse goes by. Visible light lasers have mirrors that make the radiation go back and forth many times and so multiply the gain. Until recently it was generally impossible to reflect X-rays specularly, at angles nearly perpendicular to the surface of the mirror. Now, however, there are materials that will do it for this spectral range. If mirrors can be applied, the gain of an X-ray laser could be tremendous.

The next few years will see whether these energy levels are useful for a laser, and, if it works, whether it represents a practical energy advantage.

— *D.E. Thomsen*