nedy conferences on these questions, Lederberg did offer a suggestion: "Let's stop torturing ourselves and perform the research necessary to correct fetal defects in utero. By really putting our shoulders to it, we can eliminate many of the ethical problems we are now facing." Unfortunately little evidence was presented at either the Hastings or Kennedy conclaves that scientists are exerting large efforts to provide defective fetuses with, say, drug or enzyme therapy via the amniotic fluid.

Yet even if, and when, fetal medicine becomes available, the more profound implications of the ethical questions raised by genetic counseling and prenatal diagnosis aren't liable to be dissipated. "Behind the horror at genetic defects," Callahan said at the Hastings conference, "lurks an image of the perfect human being"—as opposed to several other human ideals such as human individuality and diversity. Now that medical research has given man the power to play God, he isn't sure what to do with it; for once he starts, where does he stop? Said Robert Sinsheimer of the California Institute of Technology at the Hastings conclave, "Nature has no absolutes—only man, in his incompetence." Several scientists at that meeting suggested that there might be some things man would be better off not knowing, not achieving. Yet not one scientist present at either the Hastings or Kennedy meetings offered to turn in his or her electron microscope.

And as both conferences bore out, such nettling ethical questions are just arising with genetic counseling and prenatal diagnosis. In an interview at the Hastings meeting, for example, Cecil Jacobson, an obstetrician-geneticist at George Washington University Medical School, said that when he artificially inseminates patients he tries to use semen from men who have at least 12 years of education. Applying such a criterion might be considered a mild brand of eugenics, Jacobson admitted, "if education is any criterion of intelligence." Then expectations were voiced at the Hastings conclave that artificial inovulation of women might be accomplished within a year, as well as cloning of the first mammal (only amphibians so far). However scientists at that meeting tend to concur with microsurgeons close to the scene (SN: 9/4/71, p. 152) that embryonic gene engineering is a way off yet—and in spite of recent unprecedented success in using a virus to correct for a defective human gene in tissue culture (SN: 10/23/71, p. 276). If this is truly the case, it will give medical ethicists more lead time (between scientific achievement and widespread clinical application) to decide what to do about the double strand of human DNA which, against all odds makes humans what they are. □

Magnetic reversals and biological extinctions

An increase in cosmic-ray dosage when magnetic fields weaken is often proposed as the cause of extinctions, but there is now evidence of direct harmful effects of reduced magnetism on organisms

by Louise Purrett

A number of times throughout history life on this planet has been seriously and inexplicably disrupted. The fossil record of life on earth shows massive, sudden extinctions of marine species about 500 million and 250 million years ago and less serious periods of extinctions at the end of the Ordovician, Devonian, Triassic and Cretaceous periods (425 million, 345 million, 180 million and 65 million years ago, respectively).

The cause of these extinctions is one of the major unsolved mysteries of the earth sciences, but in many cases they appear to have some relation to magnetic reversals. James D. Hays of Columbia University's Lamont-Doherty Geological Observatory reports, for example, that during the last 2.5 million years eight species of radiolaria (microscopic marine animals) became extinct and six of these extinctions occurred directly after a magnetic reversal (SN: 11/21/70, p. 392).

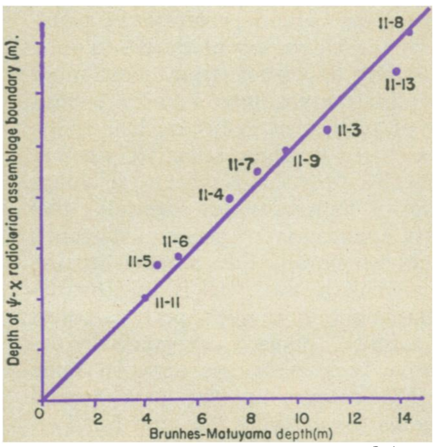
In 1963, Robert J. Uffen of the University of Western Ontario suggested that there may have been a causal relation between magnetic reversals and the extinctions. How magnetic reversals might affect terrestrial life has not been settled, however. During a reversal (SN: 4/10/71, p. 251) the magnetic field's intensity diminishes to zero and then builds up again. While the magnetic intensity is low, cosmic radiation that it normally shields out is allowed to bathe the earth's surface. This radiation, Uffen proposed, would have produced mutation rates many times greater than normal and thus be "a major influence in evolution in the presence of the environmental selection pressures of those times."

There were a number of problems with this theory, however. C. J. Waddington of the University of Minnesota demonstrated in 1967 that the increased radiation dosages experienced at sea level as a result of removal of the magnetic field's shielding effect would be too small to have a significant effect on population levels.

The thickness of the atmosphere, he says, would render cosmic radiation entering between the equator and polar regions relatively inefficient in producing sea-level cosmic-ray dosage. Further, some of the changes in radiolaria populations occurred in Antarctica. Because of the shape of the magnetic field, the poles are not shielded from radiation even when the field's intensity is at its peak, so that a magnetic reversal would produce almost no increase in radiation dosage.

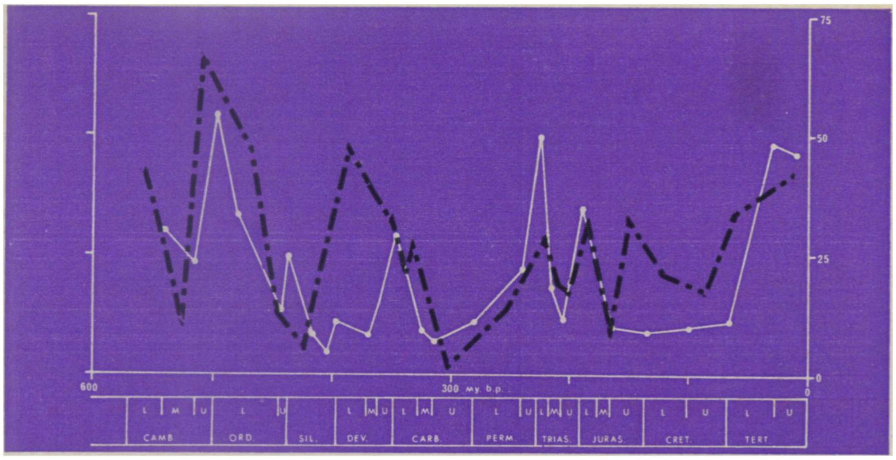
The summary effect of removing the field, he says, is to increase the radiation dosage due to cosmic radiation by no more than six millirads (a measure of absorbed dosage) per year and to increase that taken up by organisms by no more than two millirads per year. "These values are so small, particularly in comparison with the general background radiation levels always present, that it seems inconceivable that they could appreciably affect the evolution of any organisms."

Finally, says Ian K. Crain of the Australian National University, the radiation hypothesis fails to explain how marine life, which is shielded from cosmic radiation by the sea water, can be affected by increases in radiation in the atmosphere.



Science

A polarity change and radiolarian extinction: Strong correlation.



GSA Bulletin

Magnetic reversal rate (broken line) and biological extinctions (solid line).

Another explanation frequently advanced is that magnetic reversals cause climatic changes which in turn influence evolution. Three Lamont-Doherty scientists have correlated variations of magnetic intensity and climatic change for the past 1.2 million years. Goesta Wollin, David B. Ericson and William B. F. Ryan measured the abundance of planktonic foraminifera in deep-sea sediment cores from the North Atlantic, North Pacific and Caribbean. These marine animals proliferate in warm climates.

On the basis of their evidence the three suggest that a "cause and effect relationship links changes of the earth's magnetic field and climate," with higher magnetic intensity bringing colder climate. Magnetism may modulate climate, they believe, by providing a shield against certain types of solar radiation.

But once again, points out Crain, in the September Geological Society of America Bulletin, the thermal inertia of the oceans, which may require a century for a change in atmospheric temperature to produce even a change of a few degrees in the ocean, protects marine life from sudden climatic change.

Crain believes that a much simpler mechanism is responsible for the relation between magnetic reversals and extinctions: "Mass extinctions are caused directly by the deleterious effects on organisms of the reduced magnetic field during a reversal." Hays had made a similar suggestion last year at the annual Geological Society of America meeting.

There are few published experimental results on organisms living in magnetic fields of intensity below that of the earth, but, says Crain, the few conducted to date are consistent and show gross behavioral and biochemical abnormalities associated with life in a reduced magnetic field.

After 72 hours, bacteria kept in a low magnetic field suffered a 15-fold reduction in reproduction. Locomotion of flatworms, protozoans and mollusks was found to be affected, and birds also showed significant changes in motor activity. Experiments on mice showed drastic changes in enzyme activity, and prolonged exposure produced a shortened life-span, significant tissue changes and infertility. The effects of low magnetic fields, says Crain, are thus "potentially lethal."

"Infertility, changes in locomotion (hence, feeding), and the incalculable effects of enzymal alterations could conceivably have had a lethal effect on many species," he adds. Magnetic fields, he points out, would operate with equal effectiveness on marine and terrestrial organisms, since sea water provides no barrier against them. Their effects would have been more significant than cosmic-ray dosage and at least as significant as climatic change in causing extinctions.

Two basic explanations have been offered for the observed effect of magnetism on life. One is that the magnetic field displaces or aligns paramagnetic (partially susceptible to magnetism) or diamagnetic (magnetically repellant) biological molecules. M. M. Labes has pointed out that the rod-like molecules in liquid crystals (SN: 9/25/71, p. 215), which occur in many biological systems, can orient themselves in a magnetic field and that fields of certain strength markedly influence the properties of liquid crystalline materials. The complex lipids present in various organs of the body, such as the adrenal cortex and ovaries, exist as liquid crystals.

The second explanation for biomagnetic effects suggests electromechanical interactions between the magnetic field and moving charged ions in cell membranes.

The low field effects, Crain concludes, would have been supported by climatic changes and the increased, though small, cosmic-ray flow. "The total effect could easily have been as catastrophic as the fossil record indicates." □