What did in the dinosaurs: Warm blood or soft eggs?

Nobody has ever seen a live dinosaur, so paleontologists must deduce what they looked like and how they lived from their anatomy and probable environment. Complete information on the life and times of dinosaurs may eventually allow scientists to explain their sudden extinction 65 million years ago.

Recently, two theories about dinosaurs, one concerning their system of temperature regulation and the other a change in their reproductive success, have recently gained ground. Both theories bear directly on the dinosaurs' ability to survive.

Anatomical similarities between dinosaurs and birds or mammals have led some scientists to surmise that though they were reptilian, dinosaurs might have been endothermic, or warm-blooded. Modern-day reptiles are ectothermic, or cold-blooded.

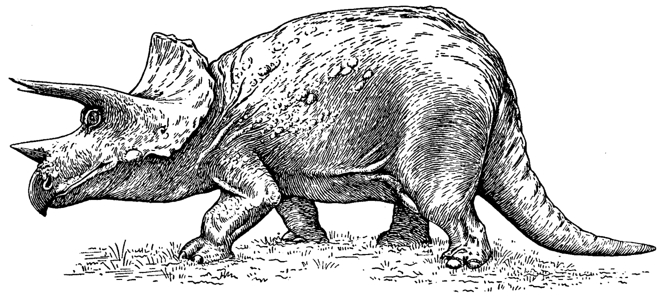
In the July 14 NATURE, Robert T. Bakker of Harvard University's Museum of Comparative Zoology combines anatomical and ecological evidence to argue that dinosaurs were indeed probably endothermic.

The amount of energy an animal must expend for locomotion increases with speed. The maximum energy output, and therefore the maximum speed, of a cold-blooded animal is much less than that of a warm-blooded animal of the same weight. Bakker estimates that if dinosaurs were cold-blooded a ten-ton tyrannousaur could run only 5.8 kilometers per hour. A good racehorse can do upward of 60 kilometers per hour. But fossil evidence indicates that dinosaurs were quite active. Some, such as hypsilophodonts, appear to have been capable of speeds of 50 to 80 kilometers per hour.

Another argument for endothermy is the sheer size of dinosaurs. The smallest specimens found must have weighed 50 kilograms when alive. An animal's ability to generate heat depends on the volume of its body; loss of heat is a function of surface area. As the size of an animal increases, volume increases more rapidly than surface area. Small endotherms thus lose a greater proportion of their heat through their skin than do large endotherms, and need insulation, in the form of hair or feathers to prevent excessive heat loss. Large tropical endotherms, such as elephants, can maintain a constant body temperature without skin insulation.

Fossilized impressions of dinosaur skin show that the animals were hairless. Endothermy is thus consistent with both the size and skin type of dinosaurs.

An endotherm must eat more than an ectotherm of the same size. In a balanced community, the ratio of predators to prey animals depends on whether the dominant predator is warm- or cold-blooded. Where the predator is cold-blooded, carnivores constitute about 25 percent of the total population. In a warm-blooded community they amount to less than 4.5 percent. In three Canadian rock groups, Bakker says, only 2.0 to 3.3 percent of the fossilized dinosaurs were carnivorous.



Smithsonian

Triceratops and his kin may have been warm-blooded.

Nicholas Hotten of the Smithsonian's National Museum of Natural History agrees that dinosaurs may have been endothermic. "We know they had doggone good heat control." He cautions, however, that conclusions based on predator-prey ratios must be tentative because of the sketchiness of the fossil record.

Bakker concludes that the combination of large size, endothermy and naked skin may explain the extinction of dinosaurs. About 65 million years ago there was a sharp drop in temperature. Bakker believes that dinosaurs, lacking skin insulation and too large to burrow underground, radiated away too much of their body heat under the colder conditions and could not survive.

Meanwhile, evidence has come from southern France that dinosaurs in that region underwent a change in reproduction that might have destroyed them. Last year researchers from Bonn University found fragments of dinosaur eggs in four successive layers of rock in Provence. The eggshells in the oldest rocks were two or more millimeters thick. In the younger rock layers, the shells became progressively thinner. Those in the youngest rock layer were thin enough to have been easily broken.

Now the Bonn paleontologists have found another batch of dinosaur eggs in the Corbières region of the Pyrenees in rock about the same age as the youngest layer in Provence. These eggs were likewise extremely fragile. In fact, the researchers believe the eggs were too fragile to support the growing embryo.

Such eggshell thinning would have been a result of hormonal changes in the animals. DDT is known to be causing similar thinning of bird eggshells. The Bonn scientists believe the hormonal change in the dinosaurs of southern France may have been triggered by overcrowding. But whether eggshell thinning could account for extinction of dinosaurs elsewhere remains to be seen.

Cryobiology: Cells on ice

Cryobiology, the study of the effects of low temperatures on living cells, is a research frontier. Probably no more than 400 scientists in the world are pursuing it. Nevertheless, probing the effects of low temperatures on cells is bringing benefits—better understanding of the behavior of normal cells under stress and the use of cold to destroy malignant tissue. At present single cells, such as blood and sperm, can be kept alive while frozen. Although efforts to revive frozen organs have been unsuccessful to date, banks for various tissues and organs are the goal of some cryobiologists. Cryobiology may also answer some esoteric questions, such as whether microorganisms from earth might contaminate other planets, or whether bodies frozen at death might be revived at a later date.

Two years ago, Peter Masur and colleagues Stanley Leibo and Robert H. Miller of the Oak Ridge National Laboratory in Oak Ridge, Tenn., reported in SCIENCE that successful freezing and revival of yeast cells depended on optimal freezing and warming temperatures. If these cells were cooled too rapidly, they turned into icebergs; if they were cooled too slowly, they became dehydrated and shrunken. If frozen cells were warmed rapidly, the effect was generally beneficial, if they were warmed too slowly, ice started to

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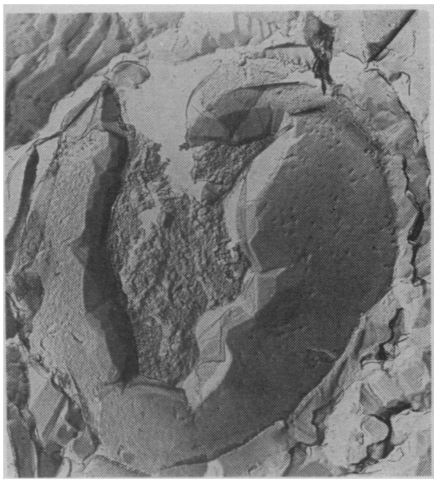

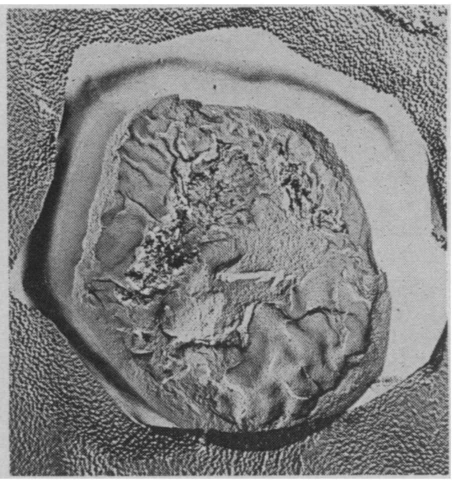

Harvey Bank, Oak Ridge

Cell frozen too rapidly turns into iceberg; cell frozen too slowly shrinks.

crystallize in their cytoplasm. Since then, the researchers have found that optimal freezing and warming temperatures vary depending on the kind of cell. The optimal temperature for yeast cells, for example, differs from that for bone marrow cells from mice, or for that for red blood cells from humans and cows. Harvey Bank, a graduate student on their team, has come up with conclusive visual proof that optimal cooling and warming temperatures are required for cell survival by cleaving cells that have been exposed to different temperatures and observing them with an electron microscope.

In recent months the Oak Ridge cryobiologists have also discovered that the membranes of cells are particularly vulnerable to too much cold, and that protection of cells against the deleterious effects of freezing probably occurs at the membrane, rather than inside the cell. Before sperm and blood cells are frozen in banks, they are usually immersed in glycerol to keep them from dehydrating. Masur and his colleagues placed cells in glycerol for varying periods of time before freezing them. They found that the survival of these cells was independent of how long the cells were allowed to absorb glycerol. So they concluded that glycerol protects the cells at the membrane level, rather than by passing into the cells.

These and other findings, Masur told SCIENCE NEWS, are but a beginning toward understanding the microscopic effects of different temperatures on different types of cells. "Such understanding," he asserts, "is essential before tissues and organs can be frozen and successfully revived."

As far as earth organisms contaminating other planets—Mars, say, when the Viking spacecraft lands there in 1976—Masur says it is possible but unlikely. "Microorganisms might be able to survive the cool temperatures at Mars' poles," he explains, "but not the intense solar radiation that penetrates Mars' thin atmosphere." Of course the possibility of each bacteria reaching Mars is remote in the first place, since Viking will be sterilized.

Cryobiologists generally find discussion of reviving bodies frozen at death distasteful, since such revival is far beyond the competence of present-day scientists. Masur contends, though, that bodies frozen by present methods would probably not be able to be resuscitated. They are frozen at one temperature rate, and organs require different freezing temperatures to survive. □

Upward and onward: NAL at 300 GeV

When the National Accelerator Laboratory was originally planned, it was designed to accelerate protons to a maximum energy of 200 billion electron-volts (200 GeV). While construction was under way at the Batavia, Ill., site, improvements in the design of magnets and the technology of power supply made possible an improvement of the design so that energies up to twice the original maximum could be contemplated without increasing the size or cost of the machine.

Early this year the accelerator was completed far enough to begin running. On March 1 it reached the original design energy of 200 GeV. Now it is beginning to fulfill the promise of the improved design. At 9:13 p.m. CDT July 16 the accelerator produced its first beam at 300 GeV amidst great rejoicing by the staff. It had been a weekend of thunderstorms that knocked out the laboratory's power several times, but at the critical moment all worked well. Engineers from the Commonwealth Edison Company were on hand to measure the drain that operation at 300 GeV put on the company's grid. The size of that effect may determine at what times of day and for how long operation at such high energy will be possible.

The physicists are now hastening to extract a 300-GeV beam from the accelerator itself and run it into a 30-inch bubble chamber in order to measure what happens when probes of this energy strike stationary protons in the hydrogen. With higher energy probes than anywhere else in the world (the nearest competitor is a 76-GeV machine at Serpukhov in Russia) the NAL physicists expect to be able to resolve finer details of the structure and interactions of subatomic particles and hope to come nearer to an understanding of the fundamental structure of matter. □

Interplantary gases in lunar UV photography

The lunar surface is a nearly ideal place for astronomical observations. So most astronomers have believed and a preliminary report issued last week on the Apollo 16 ultraviolet camera/spectrograph results confirms it. About 190 frames of ultraviolet film were exposed while the Apollo 16 astronauts were on the lunar surface (SN: 7/1/72, p. 12).

"One of the most important results so far," says George Carruthers, principal investigator for the camera at the Naval Research Laboratory, "is the first spectrographic identification of the 584-angstrom line of helium in interplanetary space." The helium-line intensity is about one percent of the Lyman-alpha-line intensity, confirming that helium is present in about the expected proportions in interplanetary gas—somewhere between six and eight percent. It is thought the helium is produced by the interaction of interstellar gas with the solar wind and solar ultraviolet radiation. Helium was also identified for the first time in the earth's upper atmosphere as were ionized oxygen and ionized nitrogen.

Ultraviolet photographs show the spectral lines of atomic oxygen at 1,305 and 1,356 angstroms in the earth's night glow. The diffuse ultraviolet glow due to atomic hydrogen in space was observed in all directions from the lunar surface at about one-fifth the minimum intensity seen previously from earth orbit.

"Further analysis of the camera results may also shed some light on the major source of oxygen in the earth's atmosphere," says Carruthers. Some scientists think this source is from photodissociation of water vapor by solar ultraviolet radiation rather than photosynthesis by green plants. The hydrogen in the geocorona is believed to be the result of the same process. The hydrogen escapes to the geocorona and eventually into space, while the heavier oxygen remains in the atmosphere. □