they've dropped that term. Variations in the charged particles' pitch-angle distribution, he says, indicate that it could be a diffuse extension of the F ring — or it may not be a ring at all. The data show signs of what could be taken as a number of larger objects, perhaps tens of kilometers across, suggesting that the region might be better described as a collection of little moonlets. (Missing, however, are any signs of a much wider "E ring," hinted at by past earth-based data.)

Of the two clearly defined new satellites, says Van Allen, one — an object at least 100 km across — lies actually within the distinct portion of the F ring, some 80,580 km from the clouds (2.343 R_s from the center). The other, a 170-km object loosely known as Pioneer Rock and visible in one Pioneer photo, lies 92,040 km from the clouds (2.534 R_s from the center). A particle "dip" 91,320 km out (2.522 R_s from center) may be another satellite, or part of an eccentric wake of Pioneer Rock.

Conspicuously absent, Van Allen says, is any sign of Janus, Saturn's controversial "tenth satellite," expected by the astronomer who first reported it to be at about 2.65 R_s. Other researchers, however, have calculated that it could be at about 2.82 R_s, points out Van Allen, and there is a slight particle dip at that distance, some 109,200 km from the clouds.

Cameras on the Voyager 1 and 2 spacecraft, due at Saturn in 1980 and 1981, should help, though their paths will pass too far from Saturn for relevant particle data. □

Inbreeding harmful, even in the zoo

The last hope for the preservation of an increasing number of animal species involves breeding them in zoos or in small protected herds. More and more hoofed animals, for example, exist only in relatively small populations. But researchers at the Smithsonian Institution's National Zoo warn that inbreeding, which is generally permitted among hoofed animals in zoos and conservation parks, is detrimental to the offspring. After analyzing detailed breeding records covering more than 10 years, they conclude that inbred animals have a significantly higher death rate in the first 6 months of life than do non-inbred animals.

"The study has major implications, not only for the management of zoo breeding programs, but also for conservation and wildlife specialists who are responsible for managing small populations of hoofed species in reserves and in areas where species have been introduced back into their natural habitats," says Katherine Ralls, who directed the study. She points out, for example, that among the 25 roan antelope in a Kenya reserve, all young born since 1970 have the same father.

Many workers in conservation and wildlife management have been skeptical of the research on laboratory and domestic animals indicating that inbreeding leads to increased mortality in young animals. But Ralls and colleagues Kristin Brugger and Jonathan Ballou say in the Nov. 30 SCIENCE that the effects of inbreeding have not been previously recognized in exotic animals because most zoos have not maintained detailed breeding records.

Ralls and co-workers examined records of 16 species — the Indian elephant, zebra, pygmy hippopotamus, giraffe, four species of deer and eight species of antelope. Approximately 25 percent of the 559 young of non-related animals died before the age of six months; 50 percent of the 380 young of related animals died.

Inbreeding of such hoofed animals as sable antelope (above) and horned oryx (below) produces high juvenile mortality.

National Zoo, Smithsonian

A striking difference in the pattern of deaths was discovered for one species well represented in the sample. Among the Dorcas gazelles, non-inbred calves seldom died after the age of four days. Inbred calves continued to succumb to a variety of later medical problems.

The zoologists say that "the time has come to institute sound genetic management of small ungulate [hoofed] populations." They recommend that zoos exchange non-related animals for breeding and suggest maintenance and analysis of mating, birth and death records. □

Leg 68: Victory at a crossroads

A complete sedimentary record of the past 8 million years has been recovered by Leg 68 of the Deep Sea Drilling Project, marking a "new era in oceanography," according to co-chief scientist James V. Gardner of the U.S. Geological Survey in Menlo Park, Calif. The recent achievement also signifies another triumph for the newly developed Hydraulic Piston Corer (SN: 2/10/79, p. 85) as well as a crucial crossroads for the futures of the DSDP and the *Glomar Challenger.*

The Hydraulic Piston Corer (HPC), developed earlier this year by three engineers at Scripps Institution of Oceanography, enables ocean-going geologists to get undisturbed sediment samples from the sea floor (SN: 9/18/79, p. 118). Rotary drilling, routinely used by the *Challenger,* jumbles up soft sediments so badly that they are virtually useless to scientists who require a layer-by-layer record. And the HPC, because of its hydraulic design, can punch significantly farther into sediments than can other piston corers.

Devoting Leg 68 entirely to the HPC, co-chief scientists Gardner and Warren L. Prell of Brown University and co-workers drilled in the Caribbean Sea 100 miles north of Panama and in the Pacific Ocean about 200 miles west of Galapagos. The relatively short voyage (35 days from August to September) was the first DSDP leg to obtain a continuous record of magnetic and biological events in a single column. According to Prell and Gardner, the 200-meter long, 8-million-year record (which goes back about 7.5 million years further than the previous record piston core) contains every known magnetic field reversal and has a resolution two times better than any other such core. Now, the researchers suggest, scientists may be able to distinguish oceanographic events that occurred as little as 1,000 years apart.

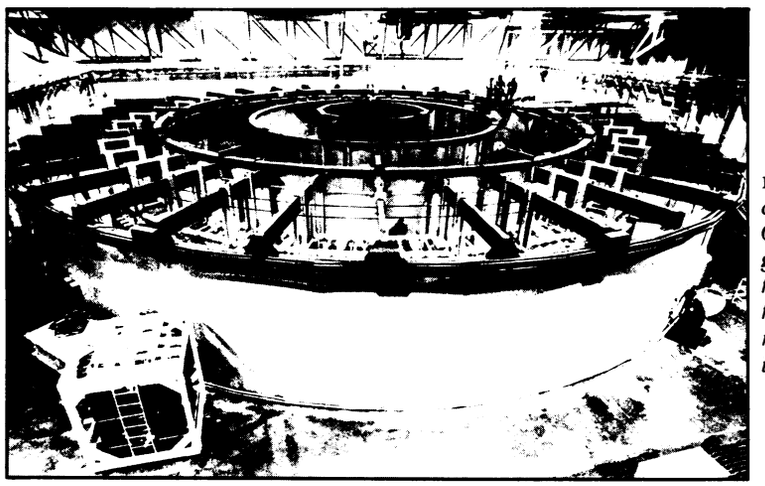
The record-breaking core is a scientific windfall for a variety of disciplines. For climatologists, the 8-million-year core will provide the longest record yet of climate changes. The best core samples available to climatologists have been only 200,000 to 400,000 years long; longer piston cores could not be obtained or were pieced together with substantial gaps. For biologists, the core will be a continuous evolutionary scale — more complete than any land or sea fossil record — and will allow precise dating of fossils. For geologists, the sample may help solve problems such as nuclear waste disposal. Previously, no piston core was long enough to assess the permeability and seismic history of the ocean bottom.

By its ability to reach such depths, the HPC has created "not just an extension, but a whole new area" of very precise, "quantitative" paleooceanography, say re-

searchers such as climatologist James D. Hays of Lamont-Doherty Geological Observatory. But Hays and others fear that future may soon be snatched from their hands. The *Challenger*'s funding has nearly run out and the much larger *Glomar Explorer* is scheduled to take its place, although even that possibility is under intense debate. If the *Explorer* is funded, it will concentrate on deep ocean drilling, often sitting over one hole for as long as a year. Because the deep ocean has little sediment, the HPC would be moot. If *Challenger* funding is halted — as in the current plan — the HPC "could die with it," says Hays. He and others, backed by the DSDP's scientific advisory panel, have proposed a two-year extension of the *Challenger* to sample the world's ocean bottoms with the HPC.

But the bureaucratic machinery is already rumbling along one track and the researchers fear the momentum may be too much to switch it to another. And the current attitude toward funding "big science" makes the researchers less than optimistic. Scientifically, however, they believe the choice is clear. Says Hays: "If we lose the HPC, paleooceanography will stagnate." □

Fusion switch: Ions for electrons



Sandia Labs

PBFA *under construction. One of 36 generators for the 100-ft-diameter machine is inset.*

There is no question that thermonuclear fusion can be induced by imploding a mass of fuel. That was proved long ago at a place whose name has become a common noun for bathing suits and underpants (because almost all the substance of the garments has been blown away?). The modern question is whether this kind of thing can be made to work efficiently and economically with small pellets of fuel in a reactor to produce electricity.

The fuel pellets would be imploded by energy delivered from several sides by beams of something: laser light, electrons or ions. Lasers got the first start and continue to enjoy a heavy research effort, possibly because the technology of lasers was immediately available and also possibly because the bomb — at least according to what we have read in judicially sanctioned press reports — employs gamma rays, which are a form of light. Electrons seemed the next best bet. Ions appeared to be a long shot. Now the latter situation reverses. Sandia Laboratories of Albuquerque, the major U.S. center of such particle-beam fusion experimentation, has announced that its forthcoming major experiment, the Particle Beam Fusion Accelerator (PBFA) will use beams of light ions (elements of low mass like carbon or oxygen) rather than the electrons it was originally intended for.

The change comes about because of the success in producing and accelerating ions in another apparatus, PROTO I. This work was led by David J. Johnson of Sandia, and it was stressed last spring by Gerald Yonas in a public report on the promise of light ion fusion (SN: 3/31/79, p.197). That work, which produced ion beams with a current density of 400,000 amperes per square centimeter, is now coupled to theoretical modeling of ion beam transport (another serious problem) by J.P. Quintenz and J.W. Poukey, to form the basis of the laboratory management's decision to change PBFA to ions.

From the point of view of the target, ions have seemed a more efficient way of making the implosion happen. The difficulty of producing and transporting them, compared with light or electrons, led to their being kept on the back burner until now.

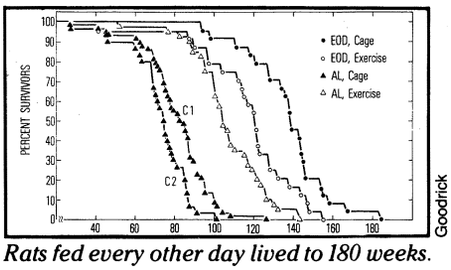
The first stage of PBFA, which is scheduled to start operating next fall, will consist of 36 units, each producing a particle beam to drive at the target, delivering a total power of 30 trillion watts in 40-nanosecond pulses. In 1983 it is planned to add another 36 modules to raise the power to 100 trillion watts. A similar machine in the Soviet Union, Angara-5, recently operated its first unit (SN: 10/27/79, p. 277) with electrons, which seem for the moment the continuing Soviet choice. □

Fasting fosters longevity in rats

The advantages of moderate eating habits extend far beyond the cosmetic; numerous animal studies have demonstrated that caloric restrictions early in life lead to an increased life span and reduce the risks of certain diseases, cancer and diabetes among them. But evidence for the health-promoting effects of periodic fasting has been less convincing. Some experiments have shown a modest increase in life span, while others have arrived at conflicting and confusing conclusions. Now, recent experimental findings suggest that periodic fasting not only promotes a longer life, but encourages more vigorous activity later in life. These findings were presented by Charles L. Goodrick of the Gerontology Research Center in Baltimore at the recent annual meeting in Washington of the Gerontological Society.

Goodrick's research focused on the effects both of fasting and of access to an exercise wheel on five groups of paired male rats, one control group and four experimental groups. One of the experimental groups was placed on an every-other-day feeding schedule and given free access to the exercise wheel; a second group was also fed every other day but denied use of the wheel. Two other groups of rats were allowed to eat at will, but only one of these "ad lib" groups had the exercise wheel available.

Goodrick found that the fasting rats lived significantly longer than the rats that were permitted to eat ad lib. He also discovered that the ad lib rats that exercised lived significantly longer than those that ate freely but did not exercise. Among the fasting rats, Goodrick found, exercise did not further increase their life span.



Goodrick

Rats fed every other day lived to 180 weeks.

The fasting rats not only lived longer, they remained more active later in life than the ad lib rats. "The amount of voluntary wheel exercise was significantly increased for the rats fed every other day when compared with the voluntary wheel exercise of controls, and these differences were especially impressive and consistent late in the life span," Goodrick said.

According to Goodrick's evidence, "Health, vigor and a long life may be maximally promoted by a reduction of daily food intake or by periodic fasting." □