Ozone Depletion: Early Evidence Comes In

Since 1974, when scientists first voiced their suspicions that chlorofluorocarbons attack the ozone layer of the stratosphere, heated controversy has marked use of the chemicals. Now the debate continues: NASA's Goddard Space Flight Center reports the first experimental evidence that the ozone layer gradually is being depleted.

Stressing the word "preliminary," Donald F. Heath cites findings based on satellite data that stratospheric ozone about 40 kilometers above the earth's surface (within the ozone-rich layer between altitudes of 25 and 54 kilometers) decreased at a rate of half a percent a year between 1970 and 1979. The findings reflect a very slight depletion at the 40-kilometer altitude and would represent an even smaller change, if any, in ozone in the total column. The depletion is significant, however, because it occurs at the precise altitude where chlorine released from chlorofluorocarbons is thought to be most effective in destroying ozone. Further measurements are underway to augment and verify the data.

Chlorofluorocarbons are synthetic chemicals used in industrial processes, in the manufacture of plastic foams, in refrigerants and, to a diminishing extent, as spray propellants. Chemically stable at ground level and in the lower atmosphere, over several decades chlorofluorocarbons diffuse and rise to the stratosphere where solar radiation causes them to break down. Chlorine is released, which reacts with and destroys the ozone, the earth's shield against ultraviolet rays that damage fish and crops and cause skin cancers.

Using data from the NASA satellite, Heath determined the amount of ozone in the total column and its vertical distribution between 25 and 54 kilometers. Measurements of vertical distribution of ozone made from a satellite far above the stratosphere are more precise than similar measurements taken from the ground. Instruments on earth cannot detect ozone depletion of less than two to four percent and so cannot be expected to measure a loss, for example, of one percent from the total column to date.

In 1979 the National Academy of Sciences reported that ozone depletion could reach 16.5 percent over the next 100 years if chlorofluorocarbon releases continue at the 1977 rate (SN: 11/17/79, p. 340). Many scientists now predict slower depletion—between five and eight percent in the next century. World production and sales of two chlorofluorocarbons thought to be most damaging to the ozone, CFC-11 and CFC-12, have decreased a total of 18.3 percent since peak production in 1974, the Chemical Manufacturers Association reports. Internationally, nations are agreeing to curtail aerosol uses of CFC-11 and CFC-12, and not to increase production capacities for the chemicals.

As the debate continues, so does research. The next step is to establish a firm causal relationship between the breakdown of chlorofluorocarbons and depletion of stratospheric ozone. In April 1982, James G. Anderson, an atmospheric chemist at Harvard University, plans to launch in New Mexico a giant helium balloon 100 times larger than the Goodyear blimp. From its 45-kilometer altitude, the balloon will lower an instrument package 20 kilometers through the ozone layer, taking measurements along the way. Because ozone levels may vary according to altitude, season, time of day and sunspot activity, the balloon is equipped, yo-yo-style, to hoist up the instrument package and send it back down for additional rounds of measurements.

"We're studying whether the presence of chlorine and the decrease of ozone can be observed simultaneously. Preliminary indications [such as the NASA satellite findings] are that this is happening, although it would be premature to jump to a firm scientific conclusion," Anderson says. He anticipates initial results from the balloon tests, which will be funded by a $150,000 grant from NASA, within a year after the launch.

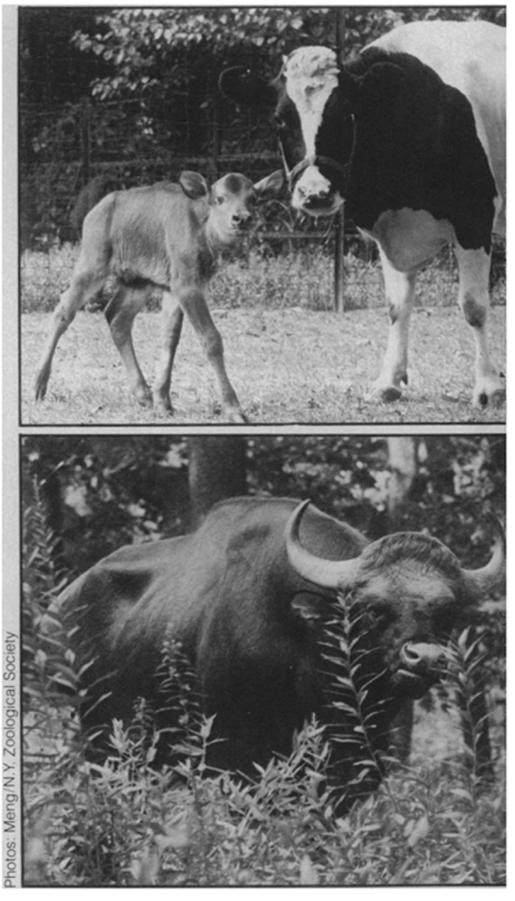
Whether new evidence will lead to greater regulation of chlorofluorocarbon production is unclear. An advance notice of proposed rule-making issued by the Carter administration in October 1980 drew more than 2,000 public comments, but so far, the Environmental Protection Agency has no proposal in the works that would regulate non-aerosol uses of the chemicals. While it is clear that chlorofluorocarbons do destroy ozone, estimates of the magnitude and implications of depletion are highly speculative, says Herbert Wiser, principal science adviser in EPA's Office of Research and Development. "There will be damage, and there is damage being done now," he said. "What we don't know is the magnitude of the effect. If the magnitude is large, we need regulatory action. If the magnitude is small, we may do nothing." □

Rent-a-womb at the zoo

A common dairy cow gave birth to a rare wild ox at the Bronx Zoo last week in the fruition of an experiment with embryo transplants that may eventually brighten prospects of survival for several endangered species. The transfer of the the several-day-old embryo from a gaur, a large ox native to remote forests of India and Nepal, to the uterus of a Holstein cow, resulted in the first successful use of a domestic animal as a surrogate mother for a member of a vanishing wild species.

Janet Stover led the researchers from the New York Zoological Society who primed several Holsteins last autumn with prostaglandin injections, hormones that synchronized the cows' reproductive cycles so they would be receptive to housing gaur embryos when fertilized eggs became available. (Its similar reproductive system, gestation length, and comparable size at birth made the Holstein, another member of the genus *Bos*, a promising surrogate for the gaur, Stover says.)

Next, the scientists selected a female from the zoo's herd of 16 gaurs and administered hormone injections that stimulated her to superovulate, releasing several ripe eggs, instead of the usual one per cycle. Of the five fertilized eggs flushed



Photos: Meng/N.Y. Zoological Society

Wild ox calf (above) born to Holstein cow may stand 2 m high and weigh 1,000 kg as a 5-year-old adult (below).

from her uterus and implanted in Holsteins, only one resulted in a live birth. If and when perfected, however, the embryo transfer technique could produce up to six or eight gaurs per year from a single mother, researchers assert, as opposed to the gaur's natural rate of one each year.

"Manhar," the infant ox whose name translates to "one who wins everyone's heart," boosted the hopes of zoo researchers around the world who worry about maintaining both numbers and genetic variety in animal species near extinction. As a burgeoning human community encroaches upon the specialized habitats of more and more animal species, zoos and animal preserves must assume a greater responsibility for maintaining healthy, representative populations of animals, says Richard Schultz, director of the St. Louis Zoological Park.

"I may sound pessimistic [about the preservation of endangered species in the wild], but I am very optimistic about the roles a zoo can play today," Schultz told SCIENCE NEWS. While the Bronx zoo focused on improving the reproductive success of a rare species with the embryo transfer technique, scientists at the St. Louis zoo concentrated on developing a reliable method of artificial insemination in a rare variety of antelope. A current recourse to inbred zoo populations is exchanging adult animals, Schultz says, a procedure that is costly, time consuming, and sometimes dangerous to both transported animals and their human handlers.

The accumulation of sperm banks, *in vitro* fertilization of ova, and intraspecific transfer of frozen embryos are other reproductive methods currently under research at various U. S. zoos. Although Bronx zoo researchers say they hope next to transplant embryos from the endangered Arabian oryx to the gemsbok, a more common antelope, further knowledge of the endocrinology and reproductive cycles of exotic species must be gained before cross-species transplants can come into common use.

"We're still learning a lot about just the basic reproductive physiology in these animals," says Janet Ott, a researcher specializing in reproduction in exotic animals at the Brookfield Zoo in Chicago. Before embryo transplants or artificial insemination can be useful reproductive tools, scientists need to understand each female's fluctuating hormonal cycles to be able to predict when fertilization and implantation are most likely to be successful. Conventional mapping of the cycles involves assaying the hormone levels in daily blood samples — a technique that is detrimentally stressful for most wild animals, Ott says. By developing a technique to measure the hormonal levels in urine samples instead, Ott can now unobtrusively map reproductive cycles of rare okapis, short-necked African relatives of the giraffe. She hopes to expand the technique's use to other species soon. □

Bell's theorem: Still not ringing true

It's difficult for many scientists to know just how to feel toward quantum mechanics. On the one hand, it has this reputation for predicting with unrivaled accuracy the outcome of experiments involving a comprehensive range of submolecular phenomena including elementary particles, atoms and electromagnetic radiation. On the other hand, it suggests, heretically to some, that our universe may be nondeterministic, that is to say, statistical in its basic structure. This seemingly is the concept being borne out by experiments done since 1972 and recently upheld by yet another similar experiment, noteworthy for its statistical significance.

Reported in the Aug. 17 PHYSICAL REVIEW LETTERS, this latest experiment, in some respects like others before it, employed visible photon pairs emitted by the energized calcium-40 isotope. In each such pair, the two photons emerge from the isotope with mutually opposite polarizations and in opposite directions. The ostensible object of this experiment was to record the number of coincidences, the number of occasions one detector was hit by a photon at the same time the opposite detector was hit by another photon, presumably the other member of the pair.

Experiments of this sort aim to test theoretical and philosophical developments that stem from a 1935 suggestion by Albert Einstein, Boris Podolsky and Nathan Rosen. They advocated the preservation of the determinism characteristic of classical physics and proposed a way to save it by introducing the notion of "hidden parameters." In short, they argued that the reason a particle's trajectory is ill-defined in quantum mechanics is not that it is ill-defined in reality, but because quantum mechanics does not take into account the existence of certain unobserved parameters that influence the particle's trajectory. Were we only to take account of these parameters, they argued, the uncertainty attached to the particle's movement would disappear.

In 1963, John S. Bell of the CERN laboratory in Geneva discovered that an empirically testable distinction exists between quantum mechanics and deterministic hypotheses, generally referred to as local realistic theories (these include, but are not limited to, the hidden-parameter theories). Specifically, this distinction relies on the discovery of a mathematical inequality, now named after Bell, that expresses a limitation on the number of coincidences that can be expected between correlated objects separated by a large distance, such as the calcium-40 photons, if any of these local realistic theories holds.

The recent experiment, carried out by A. Aspect, P. Grangier and G. Roger at the Optics Institute of the University of Paris, found that Bell's inequality was violated, and resoundingly so (the discrepancy exceeded 13 standard deviations), thus upholding quantum mechanics. The majority of previous experiments have come to the same conclusion, but this latest experiment further dispells lingering uncertainties by improving the statistics. □

Monoclonal antibodies tackle human cancer

A new immunotherapy against cancer is flexing its muscles: monoclonal antibodies — large batches of antibodies primed against a single enemy molecule (antigen). Last year monoclonal antibodies were used against tumors in animals and selectively targeted drugs against cancer cells. Now, for the first time, they have made cancer regress in humans, Richard Miller, Ronald Levy, James McKillop and David Maloney of Stanford University Medical Center in Stanford, Calif., report in the Aug. 1 LANCET and in the July BLOOD.

In 1975 George Köhler and Cesar Milstein of the Medical Research Council Laboratory of Molecular Biology in Cambridge, England, devised a means of mass-producing antibodies reactive against the same antigen (SN: 12/30/78, p. 444). They fused mouse cells making antibodies against a specific antigen to mouse tumor cells, creating new cells called hybridomas. The hybridomas inherited the quality of immortality from their cancer-cell progenitors and also the ability to produce antibodies from their antibody-producing cell ancestors. The hybridoma cells were then screened, and only those making antibody against the desired antigen were put into a test-tube to continue to multiply. The result: vast amounts of hybridomas making vast amounts of antibodies all directed against a desired antigen.

Miller and his co-workers then applied Köhler and Milstein's technique in order to make lots of mouse antibodies that react against a particular antigen that is much more plentiful on the surface of cancerous white blood cells than it is on the surface of healthy white blood cells. They injected the antibodies into six patients with leukemia or lymphoma (both white blood cell cancers) who had not responded to conventional cancer therapies. All six patients tolerated the antibodies without difficulty. The researchers had not been sure whether they would, since mouse antibodies are foreign proteins in the eyes of the human immune system, and the patients' immune systems could have triggered serious allergic reactions against the antibodies. The antibodies