tural economist says.

Although it may be possible to engineer changes in the environment to at least partially compensate for natural limitations — such as by fertilizing fields to increase yields — a "law" of diminishing returns comes into play, Brown says. A point is reached at which each additional increase in fertilizer brings smaller increments of benefit, he says. At the end, the increased benefit of using more fertilizer is offset by the cost of the fertilizer or of applying it. This same law of diminishing returns applies, he says, to drilling for oil and gas, to mining raw materials, even to the ability of the environment to absorb pollutants. "Technological advances may more than offset declines in resource quality for awhile," Brown writes, "but at some point the most ingenious attempts to compensate for nature's limitations will no longer be adequate."

Ken Chen and Karl Lagler, in their 1974 book *Growth Policy,* further argue that policymakers exacerbate the problem by using technology to relax ecosystem constraints rather than to curb rates of growth and consumption. Technological answers generate many new problems, they say, because until now technology "has been able to wield its power primarily by bleeding natural resources and the environment."

Brown claims that scarcity-induced price hikes in resources are among "new inflationary forces" shaping the expanding world economy. The way to manage these new forces may not be to manipulate economic theory so much as to require simpler life styles among the affluent and new policies that stress sustainability rather than growth, he says.

One way nations have maintained "reasonable" unemployment rates with growing populations is by sustaining a growing economy, Brown writes. But as economic growth slows globally — and signs already indicate this is beginning, he says — the unemployment situation will loom more persistently. Coping with a permanently low- or no-growth economy will be a challenge, he predicts; society will have to change radically.

He foresees resource-conserving, labor-intensive societies that require resource recycling and energy conservation. Population planning will have to accompany economic planning, he thinks. And developing countries must detach themselves as much as possible from the economic state of developed countries, he says. Those developing countries may be able to maintain their economic growth — beyond the period or throughout the period that developed countries do — if they look to sharing resources and technologies among themselves, he says.

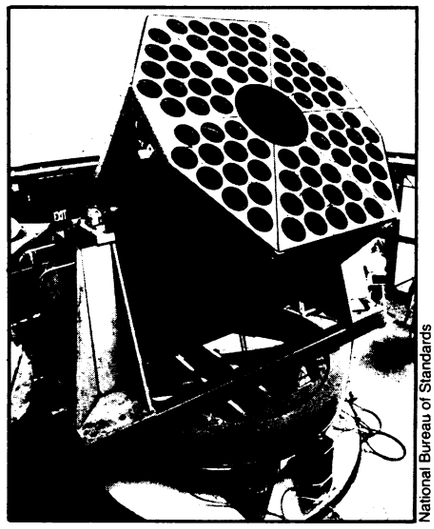
To tackle the difficult transition ahead, Brown says, economists must learn now to factor the state of biological systems into their forecasts and policies as they now factor in energy considerations. □

Seeing the sky through a fly's eye

People tend to think of a telescope as something to look through. Publicity drawings of even the largest and latest of astronomical telescopes tend to show a human figure bent over an eyepiece. Yet there is little or no actual looking through telescopes nowadays — except possibly for the hell of it. Pointing of modern telescopes is done by computer and the actual observing is done by various photomultipliers or solid-state photoregistration devices.

An eye at the eyepiece is even more superfluous when what the telescope seeks is a laser beam reflected from the moon. Better a device that can tell precisely where that came from. Also superfluous is the rather large field of view of the usual astronomical telescope. The Apollo 11 astronauts left the retroreflectors that receive the laser beams sent from earth and bounce them back in well-determined locations. What was desirable was a telescope that gathered a lot of light from a small and, by astronomical standards, extremely well-determined area. These considerations led James E. Faller, a physicist with the Joint Institute for Laboratory Astrophysics in Boulder, Colo., an organization jointly operated by the National Bureau of Standards and the University of Colorado, to design what is called for obvious reasons the fly's eye telescope.

Instead of the single fairly large aperture of the usual astronomical telescope, Faller combined 80 small ones, each 19 centimeters in diameter. Because of the small size of the apertures he could use lenses instead of the mirrors customary in ordinary telescopes. The 80 apertures all look at the same narrow area, and the light received by all of them is combined by further optical arrangements inside the instrument. The result is a fairly large total



National Bureau of Standards

aperture or light-gathering capacity concentrated on a narrow area of the target. The instrument looks ungainly, but is compact, light and portable. In fact, the fly's eye was driven to San Francisco, shipped to Honolulu, transferred by barge to the island of Maui and trucked to an observatory on the 3,000-meter summit of Mt. Haleakala.

The Maui station collaborates in the lunar ranging program with another receiving station at the McDonald Observatory of the University of Texas. Maui was chosen after much discussion because it is on a different geotectonic plate — Hawaii is on the Pacific plate; Texas is on the North American — and it might be possible to detect the difference in plate motion between the two. In addition to the lunar ranging program, the fly's eye can also be useful in stellar spectroscopy, photometry and point-source astronomy. □

Commoner attack on Big Mac, et al

Is nothing sacred? Hamburgers may cause cancer, according to a report at the meeting of the American Society for Microbiology in Las Vegas. Barry Commoner and colleagues at Washington University in St. Louis have found that extracts from beef broth and pan-fried ground beef produce genetic changes in bacteria in the standard Ames test. Mutation-causing agents have been previously identified in meat that was charcoal broiled or cooked directly in a flame. But this is the first example of mutagens formed at ordinary (U.S.) cooking temperatures, researcher David Kreibel told SCIENCE NEWS.

"The cooking condition is essential to effect," Kreibel says. Mutagens are generally rated by the number of revertants, erally rated by the number of revertants, bacterial colonies on a laboratory plate that exhibit a specific genetic change. The beef substances, like many mutagens, had to be activated by enzymes from mammalian liver.

Beef stock cooked down to a paste gives 5,000 revertants per microgram, more than five times the potency of nitrosamine (900 revertants per microgram). A quarter of a well-done hamburger cooked in an electric hamburger maker gives 1,000 to 3,000 revertants, about 100 times the background level. A rare-cooked hamburger, however, shows only 10 percent as much mutagenic activity. No activity was found in hamburger broiled in an oven or cooked in a microwave oven.

The explanation for the various degrees of potency is totally a function of cooking temperature, Kreibel proposes. There is good heat transfer if a hamburger is placed

on a hot metal surface, such as a frying pan or the metal sheets used by McDonald's and many other fast-food franchises. The surface of the meat gets very hot. On the other hand, in an oven broiler the heat must travel through the air to reach the hamburger, or even a metal broiling pan, so the surface never gets above 150°C (300°F).

The researchers decided to look for mutagens in beef when they found that bacteria grown on media containing beef extract had an unusually high number of genetic changes.

So far the researchers have not tested other types of meat. They feel the most important immediate goal is to identify the mutagenic compound and the reaction that produces it. They have already isolated a "fairly pure" extract of the cooked beef and report that it appears to be among the most potent mutagens found. A chemical analysis (chromatograph) of partially purified material shows it is different than benz(a)pyrene, the mutagen from charcoal-broiled meat.

Identifying the mutagen is necessary before doing tests to determine whether the substance causes cancer in animals. About 90 percent of the known mutagens produce tumors in animal tests. "It may be that the mutagen is a known compound, and we'll be able to buy it, but that isn't likely," Kreibel says. He expects that they will eventually need to synthesize it.

The research group emphasizes that as yet the risk to human health is of unknown magnitude. But just in case, you may want to broil your burgers. □

Carcinogen hearing

A "comprehensive policy" for regulating potential carcinogens in the workplace is the subject of a two-month-long hearing that began in Washington this week. In its seven-year history, the Occupational Safety and Health Administration has been able to enact human-exposure standards for only 20 of the estimated 2,000 chemical carcinogens. As a result, the agency proposed last October to categorize all toxic chemicals into one of four groups until separate standards can be generated for each. Temporary standards would be set for entries in the top two categories.

The OSHA proposal — 100 pages long — would class chemicals by health risk. Those that caused cancer in humans, in two mammalian test species, or in repeated tests of one species, would enter "category I." Chemicals reported to be carcinogenic, but that lacked firm corroborative evidence, would make up category II. Two optional groups — III and IV — would contain chemicals requiring further "data development" and chemicals that are suspected carcinogens but not found in "American workplaces."

More than 150 public groups and 49 OSHA witnesses will testify this summer.

Toxoplasmosis: Worse than thought

Toxoplasmosis is a common parasitic infection of humans and other mammals. Although the infection generally runs a mild course in children and adults, it can produce devastating effects on an unborn child's nervous system, resulting in mental retardation, hearing defects or visual loss (SN: 4/12/75, p. 242). The probability of a woman in North America having a child with congenitally acquired toxoplasmosis is one in 10,000.

One characteristic of toxoplasmosis is that it has never been known to seriously afflict more than one child in the same family. The reason, scientists believe, is that if a woman is infected with *Toxoplasma* while carrying one child, she will either build immunity against the infection that will protect any subsequent child in her womb, or she will not build immunity, and the latent infection will kill any subsequent children she conceives, resulting in miscarriages.

Now, two reports in the April ARCHIVES OF OPHTHALMOLOGY document for the first time the occurrence of toxoplasmosis striking not one but several children in the same family. That siblings of an afflicted child were infected can probably be explained by one of the following situations: The siblings acquired toxoplasmosis in the womb of a woman who had built sufficient immunity to *Toxoplasma* during her first pregnancy to protect them from miscarriage, but not enough immunity to protect them altogether from *Toxoplasma*'s ravages, or the siblings were infected by *Toxoplasma* some time after birth, and this infection was severe enough to damage their eyes. Regardless of which explanation is correct, though, the cases show that *Toxoplasma*'s ability to seriously hurt humans is more insidious than previously thought.

In the first report, Peter Lou, an ophthalmologist at the University of Toronto, and his colleagues describe three teenage siblings who have toxoplasmic-type eye damage. One, a 19-year-old girl, has perfect visual acuity, but shows a toxoplasmic-like scar on the retina of her right eye. Another, an 18-year-old boy, has a toxoplasmic-type scar on the retina of his left eye and for the past four years has suffered poor vision in that eye. The third, a 17-year-old girl, has a toxoplasmic-like scar on the retina of her right eye and has recently experienced a recurrence of blurred vision in that eye.

In an attempt to determine how all three of these siblings incurred toxoplasmic damage to their eyes — a probability of only one in a million — Lou and his coworkers used X-rays. But the X-rays did not reveal any skull calcification, a sign of congenitally acquired toxoplasmosis. The investigators then examined the eyes and measured the immune status of the afflicted siblings, their mother, father and three younger brothers. Only the afflicted siblings showed toxoplasmic-afflicted eyes and signs of toxoplasmic infection. So it looks as if the afflicted siblings neither got their infections in the womb nor acquired them after birth from other family members. So how did they become infected? Possibly from persons outside the family.

In the second report, George A. Stern of the Francis I. Proctor Foundation for Research in Ophthalmology in San Francisco and Paul E. Romano of Northwestern University McGaw Medical Center in Chicago report on two siblings with toxoplasmic-type scars of the retina. One, a 14-year-old girl, has had a history of poor vision from birth, is mildly retarded and was found by Stern and Romano to have toxoplasmic-like eye damage. Her six-year-old brother also has had poor vision from birth, shows moderate psychomotor retardation and was found by Stern and Romano to have toxoplasmic-type eye damage. That both children have had poor vision from birth and demonstrate some mental retardation suggests that their toxoplasmosis was congenitally acquired. So does the fact that both they and their mother show an immune reaction against *Toxoplasma*. In addition, their mother had five miscarriages between the births of the two children.

"We believe that the mother in our study probably acquired toxoplasmosis during her pregnancy with the child in case one," the researchers conclude, "and that her latent disease caused abortions in later pregnancies and the infection of the child in case two." □

Science fair gets grant

The General Motors Foundation has awarded Science Service, Inc., a five-year, $500,000 grant to help support the International Science and Engineering Fair.

The grant will be used to help provide awards through the ISEF's two-part system. All of the high-school-age students entering the competition (sometimes called "the Olympics of science fairs") are eligible for the General Motors Grand Awards, which honor first- through fourth-place winners in each of 11 categories. In addition, the schools of the first-place winners receive a cash award for the purchase of scientific equipment or books.

The first-place-winning students become eligible for the Nobel Prize Visit Award, in which two winners receive all-expense-paid trips to attend the Nobel Prize ceremonies in Stockholm, Sweden.

The ISEF is held annually in a different U.S. city, with more than 400 contestants picked from about 200 preliminary competitions in the United States and abroad. □