satellites in space. Describing his agency's new posture before the Senate subcommittee on strategic and theater nuclear forces earlier this year, Undersecretary for Directed Energy Weapons Major General Donald Lamberson said DOD currently expects to spend $900 million for research on space lasers during the next five years, prior to beginning expensive demonstrations in orbit. Roughly $600 million will go for programs to investigate the technical feasibility and cost effectiveness of using lasers in space. Three programs directed by the Defense Advanced Research Projects Agency (DARPA) — ALPHA, LODE, and TALON GOLD — will dominate these efforts.

Lamberson says ALPHA is investigating the prospects for high-powered mid-infrared-wavelength devices, though some shorter-wavelength laser systems are being looked at too. LODE is examining the feasibility of producing very large, precision mirrors to direct laser beams at their targets. It is also focusing on the difficulties of directing these beams at high brightness levels. TALON GOLD is concentrating on problems associated with locking a laser beam onto a moving target from space — a target that will likely be moving five or more times faster than the Sidewinders encountered in the recent Air Force tests.

The Army's role in the Space Laser Program is more modest. Focusing on ballistic-missile defense, it is chiefly investigating the extent to which missiles can be "hardened" (protected) against laser radiation. The Army is also concentrating on short-wavelength lasers, the type expected to prove most useful in space operations. For its part, the Air Force is studying the hardening of aircraft, satellites and other potential targets for their survival under an attack by enemy weapons, including lasers.

Responding to a growing public concern over the further militarization of space, DARPA Director Robert Cooper told the Congress on March 23 of this year, "We are conducting research and planning related to space weaponry, but I emphasize that no commitment has been made to acquire space-based weapons. And, we will proceed only if our national security is so threatened." —*J. Raloff*

Ozone: Selective force in plant evolution?

Scientists, spurred by the prediction that in the next decade stratospheric ozone may be partially depleted, are trying to learn how such a decrease might affect not only human health, but plant health too. One such study has led researchers to suggest that plants that originated at tropical and temperate latitudes display different levels of sensitivity to solar ultraviolet-B (UV-B) radiation, much of which is absorbed by the ozone layer before reaching the earth.

Earlier research also has shown that plants now living at different latitudes vary widely in their tolerance to ultraviolet-B radiation. The amount of UV-B that reaches the earth is linked to the thickness of the ozone layer because stratospheric ozone absorbs most of the invisible light before it touches the planet. Plants growing in tropical latitudes, where natural levels of UV-B are the highest on earth, are more resistant to the radiation than plants in temperate latitudes, where most of the world's food crops are grown. Botanists Alan Teramura of the University of Maryland in College Park, and Martyn Caldwell of Utah State University in Logan, report that the degree of tolerance to UV-B is related to the level of the radiation at the time specific plants evolved. The ozone layer and its effect on UV-B, they say, may have been a selective factor in plant evolution.

In field studies and controlled experiments, 90 agricultural plant species were exposed to UV-B. At first the researchers could not identify a common factor within plant families that makes the plants more or less resistant to the radiation. But when the researchers considered where the plants originated, they found that three times as many crops that evolved in temperate latitudes in the Near East, Northern China and Mesoamerica (roughly north central North America to Nicaragua) were adversely affected by the same level of UV-B as crops that evolved in tropical latitudes in mid-Africa, Southeast Asia and South America. Teramura and Caldwell assert that naturally occurring UV-B has been an "important selective force in the evolutionary history of these agricultural species."

The plants with low resistance to UV-B are particularly vulnerable, the scientists found, because increases in UV-B radiation inhibit their photosynthesis, result in smaller plant size and smaller leaf area, and reduce yield and yield quality. Soybeans, for instance, fare poorly when UV-B levels are too great. The crop is cultivated because its seeds contain high proportions of oils and proteins. Some varieties, Teramura says, produce less oil and protein when exposed to levels of UV-B that are outside the tolerance ranges of the plants.

It is estimated that the protective layer of stratospheric ozone may be depleted from 5 to 9 percent in the next decade, primarily due to human use of chlorofluorocarbons in refrigerants and other industrial applications (SN: 4/10/82, p. 244). The increase in UV-B radiation would be disproportionately large at temperate latitudes, scientists say, with a 19 percent increase in the amount of UV-B radiation capable of affecting plant biology.

—*C. Simon*

Sex switch stimulated by size

In the lonely hearts club of coral reef fish, when the going gets tough, the tough change sex. Many fish are hermaphroditic, but most species change sex because they lack a nearby mate. For the first time, researchers have now found at least one species that bases its sex on the relative size, not the sex, of its neighbors.

Female saddleback wrasse *(Thalassoma duperrey)* can change to male. While smaller fish of either sex stimulate a female to switch, larger fish inhibit such a change. "Basically, if you put two of these fish together, only the bigger one will become a male," says Milton Diamond of the University of Hawaii in Honolulu.

As a result, the larger fish are usually male, either by birth or by subsequent sex change. On the reef, a relatively small female is likely to encounter males. But if the proportion of larger fish drops, a female would find more mates if she changed sex. "Since fish are considered to be fairly highly evolved, this brings up a number of philosophical implications," says Diamond. "The social situation of these animals determines their sexual physiology and behavior."

Like most fish, the dull green saddleback wrasse has no detectable sex chromosomes, yet when it reaches sexual maturity, it produces either sperm or eggs. "The initial sex is probably determined by multiple sites on different chromosomes," says Robert M. Ross, of the Hawaii Institute of Marine Biology in Kaneohe. "This makes the wrasse very sexually labile." Females can later stop producing eggs and start producing sperm. This protogynous (female first) sex change takes two to three months and is non-reversible. Since the wrasse cannot produce both sperm and eggs simultaneously, it cannot fertilize itself. Says Ross, "Virtually all females eventually become males, given the right social conditions."

To determine those conditions the Hawaii group studied isolated females, and females placed with one to three smaller, sexually mature fish. As reported in the Aug. 5 SCIENCE, the lone females continued to produce eggs, as did those in pens with larger saddleback wrasse or smaller fish of another species. But females that were the largest of their species changed sex even if the smaller fish were male.

In species that live in Harems, removing the dominant male prompts the largest female to switch sex. But the social structure of the promiscuous saddleback, which breeds in temporary pairs or swarms, is less clear-cut. "You can't usually tell a male from a female by color," says Ross. "The size ratio of nearby fish may be the best clue to sexual strategy."

—*S. Steinberg*