sented a symposium on the biological effects of increased ultraviolet radiation at the annual meeting of the American Institute of Biological Sciences in Corvallis, Ore.

The researcher considered by them to be the father of photobiology, Arthur C. Giese of Stanford University, explained the seeming paradox between life in the existing ultraviolet shower and harm to life by a slightly hotter shower. "Organisms on earth live continually in an uneasy balance between ultraviolet light damage and repair of that damage." DNA, the cellular molecule most essential to the continuation of life, is also, Giese says, the most vulnerable to ultraviolet light, since there are only one or two copies of DNA in the cell compared with the many copies of other nucleic acids and proteins. Life has evolved several mechanisms for repairing damage to DNA from the levels of ultraviolet light that penetrate the earth's atmosphere. Therefore, any increase in the amount of ultraviolet light that strikes living organisms (particularly those which, unlike man, cannot hide from the sun), "might overwhelm life," Giese says.

Increased numbers of skin cancer cases are often cited most prominently among the negative results of such imbalance between ultraviolet input and evolutionary mechanisms for repairing ultraviolet damage. There seems to be little doubt that more skin cancer cases would be one effect, although attempts to quantify with predicted numbers of cases have been less than precise. ("To paraphrase Winston Churchill," says dermatologist researcher Frederick Urbach of Temple University, "never have so many said so much about something they knew so damn little about.") But skin cancer is probably not the most significant effect. "I personally," Urbach says, "am a lot more distressed by the effects on wheat and on phytoplankton."

NASA photobiologist Stuart Nachtwey outlined the potentially larger effects increased ultraviolet light would have on aquatic ecosystems—shorthand term "the phytoplankton." Speaking mainly about algae, perhaps the most significant effect, Natchwey says, would be reduced productivity due to decreased efficiency of photosynthesis, a decrease in the standing crop (the number of algae cells) and a slowing of cell division. A decrease in the amount of algae, a primary producer in the food chain, would undoubtedly cause a commensurate decrease in the rest of the food chain, he says.

But the effects of increased ultraviolet light would not stop there. A major function of protozoa, with their tiny cilia waving incessantly, is to help in the exchange of carbon dioxide and oxygen at the surface of the water. Interference with their survival or growth rate (and thus the exchange of gases necessary for plant and animal survival) even to a minor degree, would affect the entire food chain. Similarly, small effects on tiny zooplankton and phytoplankton could have major effects on nutrient sedimentation, nitrogen fixation and water purification, Natchwey says. All of these could combine to shift the community structure or reduce the diversity of life in the oceans and fresh waters. And this breakdown of natural order will affect all life in unknown ways.

Agricultural plants, too, would be negatively affected by increased ultraviolet exposure, R. Hilton Biggs of the University of Florida at Gainesville reported. He and his co-workers recently completed field and laboratory experiments in which agricultural crops were exposed to higher than normal levels of ultraviolet light. Corn, peas, tomatoes, cotton, rice, soybeans, lettuce and many of the other plants tested showed significantly decreased yields in proportion to the increase in exposure to the part of the electromagnetic spectrum, from 320 to 286 nanometers, that would increase with decrease in ozone levels. Plants, too, have evolved systems for repairing ultraviolet light injury, but are also susceptible to injury-repair imbalances. Also, Biggs says, water, oxygen, carbon dioxide, nitrogen, sulfur and other chemicals are cycled through biological systems, and any decrease in biological productivity would affect the recycling of these essential chemicals. □

Energy goal: 25 percent solar by 2020

The Energy Research and Development Administration (ERDA) has announced its plans for developing solar energy, saying that a quarter of the nation's energy in the year 2020 may come from the sun. The savings in conventional fuels would be equivalent to more than four million barrels a day. To begin, ERDA plans to spend some $89.2 million on solar R&D during the present fiscal year—up from a total Government expenditure of only $1 million just four years ago.

The program is based on cycles of demonstration projects, with most solar technologies reaching the demonstration phase in the mid-1980's. Solar heating and cooling and wind energy should come a little earlier.

The most developed technology is that of direct solar heating, with several demonstration projects in operation. As these come to a close, emphasis will shift in the late 1970's to combined heating and cooling applications and to projects involving higher temperatures (such as chemical processes). A separate thrust will be made in agriculture uses of direct solar heat, including crop drying, and heating animal shelters and greenhouses.

By the late 70's, ERDA hopes to work with industry to build a series of pilot plants to make fuels from biological materials. Using this indirect form of solar energy involves collecting agricultural wastes, logging by-products and possibly specially raised crops and converting them into useful fuels. Fermentation processes can be used to produce methane and alcohol, or pyrolysis can be used to convert waste to low-BTU gaseous fuels and oils. Both methods have been proved technically feasible.

Solar photovoltaic demonstration plants will probably have to wait until the mid 1980's, in order to reduce the high cost of collectors. Prior to that time, efforts will be concentrated on research into crystal growth (a key to manufacture of the solar cells) and to providing novel, efficient ways of concentrating the sun's rays on the photovoltaic collectors. When a one- to four-megawatt demonstration plant is finally built, the collector arrays will probably cost $500 per peak kilowatt of generated power—down a factor of 40 from present photovoltaic costs, and comparable to the cost of building a nuclear generating plant.

Generating plants of 5 to 50 megawatts, using conversion of solar thermal energy to electricity, will also probably be built by the mid-1980's. Cost reductions of one-third to one-half will be required. Later an ocean thermal conversion platform may be built—probably in the 25 to 100 megawatt range—but considerable component testing must be conducted first and a decision on building the demonstration plant can be expected by 1980.

Paralleling these research and development efforts will be a technology support and utilization program, which will include dissemination of information, assessment of projects and a proposed Solar Energy Research Institute. Already a technical information center has been established at Oak Ridge, Tenn. ERDA Deputy Assistant Administrator Donald A. Beattie says the agency is receiving 1,000 requests for information each week. Solar energy, he says, "has caught the imagination of the public."

Many problems remain in the development of solar energy. The cost of putting a 1,200-to-1,500-square-foot solar collector on a private home for heating purposes now runs from $3,000 to $8,000, depending on the part of the country and the type of house involved. Raymond Fields, assistant director for direct solar conversion, says that in the next five years these costs may be reduced 30 to 40 percent, but an awareness of "life-cycle costing" (spreading an initial expense over the life of an investment) will be necessary to demonstrate solar energy's value. Also, local architectural firms must be educated in how to incorporate solar collectors into their housing plans. Fields believes solar heating may be competitive with oil furnaces within five years (on a life-cycle basis). □