"Good's role [in the actual conduct of an experiment] was minimal, at least in my case," says one of his former staffers. "He reviewed what I was doing with me from time to time but not frequently."

Summerlin's experience was similar. "Bob and I were not really working together," he recounts. "In fact, it was often hard to get to talk to him. I used to have to get up at 4 or 5 o'clock in the morning to see him for a few minutes. But it did not matter too much then. The whole group there in Minnesota was very good, very friendly. There were a lot of people knocking heads together."

Summerlin's goal was to extend his observations about the transplantability of cultured human skin to animals and to other organs. He had to prove that what he observed about culture altering antigenicity was true and he wanted to explain why. By all indications at the time, his work was going extremely well, so well, in fact, that, when Good left Minnesota in January to head Sloan-Kettering, he asked Summerlin to come with him. Summerlin agreed.

On 30 March 1973, at the previously mentioned meeting of the American Cancer Society (a seminar for science writers), Summerlin reported that mouse studies confirmed his early clinical work. Using "well-defined inbred mice," he said he could show that skin maintained in culture for 7 to 10 days could be transplanted to genetically incompatible animals without being rejected.

. . . Lymphocyte cytotoxicity studies revealed that such grafts elicited no thymic-dependent lymphocyte response and no sign of blocking antibody production. Also, we now have both human and mouse data showing that the classical histocompatibility antigens, both H-LA in man and H-2 in the mouse, maintain their integrity during the organ culture process and persist after subsequent allogeneic transplantation without rejection. This phenomenon has been extended to xenogenic skin grafting after culture, using mice as recipients and human, pig, guinea pig, and rat skin donors.

Scientists Talk of the Need for Conservation and an

Wildlife conservation still retains some of the elitist cachet it had in the days before man's biotic resources began to be perceived as finite. Yet, as evidenced at a recent symposium of biologists, zoologists, and ecologists, the rapid extinction of plant and animal species the world over threatens to narrow down future choices for mankind.

Biotic impoverishment was the subject of the conference, which was sponsored jointly by the Smithsonian Institution and the World Wildlife Fund (WWF). It was in the nature of a brainstorming session to figure out how the WWF, as the largest private international organization concerned with world wildlife preservation, could best apply its limited resources. WWF, since its creation in 1961, has spent some $12 million on its mission, including a highly publicized $1 million campaign to save the Bengal tiger.

The picture, in view of the proliferation of population and economic activities over the world, is very grim. As Herbert Bormann of the Yale school of forestry said, people and their activities are spreading over the world like a "sheet of molasses," and the WWF is in the position of "scurrying around trying to fence off little areas" as the engulfment proceeds.

The only good news seems to be that, despite the relative ineffectuality of their efforts, both scientists and politicians throughout the world are developing a keener awareness of the urgency of the problem.

"Species-by-species" protection has long been recognized by conservationists as an insufficient approach. The U.S. Congress finally realized this in 1972 when it passed the Marine Mammal Protection Act, the first law designed to maintain the optimum population of a number of species within the health of their ecosystem. The rationale for conservation is no longer argued only in terms of esthetics or cost-benefit ratios, but on the far more fundamental grounds that the future viability and well-being of man are dependent on preserving as many species as possible from extinction.

Lee M. Talbot, ecologist at the Council on Environmental Quality, points out that, despite concern in the United States over pollution, it "is about the least important aspect of environment" because it is, in most cases, reversible. But changing land use, such as leveling forests or filling in wetlands, eradicates entire habitats and causes some species to be lost to the world forever. Plants and animals that may now be regarded as dispensable may one day emerge as valuable resources.

The eradication of species in tropical lands is seen as particularly alarming. If formations in the Amazon continue to be cut over, for example, it is estimated that some 1 million species of flora and fauna will disappear (the worldwide extinction rate up to now is estimated at about 10,000 species per century). This is only a guess, however, because scientists don't know how many species there are to begin with. One and a half million species are known; estimates of the total number have risen from 3 million a decade ago to somewhere near 10 million.

Population ecology is a science whose rules are only beginning to be adumbrated. So scientists face two equally urgent tasks: gathering data on which predictions and decisions can be based, and trying to persuade governments that it is in their interests to preserve habitats before they are erased by commercial and farming activities.

Since no amount of money is going to do the job, a major theme of the conference was the need to develop an "ethic of biotic diversity," in which such diversity is perceived as a value in itself and is tied in with the survival and fitness of the human race.

Scientists at the meeting advanced a number of ideas that might lead to more systematic efforts at preservation. Bormann noted that qualified leadership is in short supply and advocated the creation of some sort of training institute. Just as Sandhurst military academy was the seedbed of the talent that created the British Empire, so does the conservation movement need a "Sandhurst" which would bring together social, economic, and political as well as scientific disciplines for the creation of a sophis-

Summerlin went on to say that other organs, when cultured, also appear to lose their antigenicity. He specifically mentioned whole human and rabbit corneas and mouse adrenal glands.

It was all very exciting. Transplantation between unrelated individuals is a terrible problem, and here was someone suggesting a potentially simple way around it. Good, who was at the meeting briefly, enthused over the work.

Several weeks later, at the meeting of the American Society for Clinical Investigation, Summerlin was one of the lead speakers. His presentation was lucid and convincing. The audience was impressed. Good was excited, pleased, proud. Everybody looked good, including Sloan-Kettering, whose reputation as a place of scientific excellence Good was trying to rebuild.

In spite of the public displays of success, there were reasons to believe there was a long way to go before the tissue culture phenomenon could be said to stand on solid ground. Several immunologists were skeptical. It seemed too easy; they needed to be convinced. According to some of Good's colleagues in immunology, he himself tried to reassure them, putting the strength of his own very substantial reputation behind his words.

But there was another problem. Unknown at the time to the scientific community at large, there were investigators who, try as they might, could not repeat Summerlin's experiments. The ultimate test of proof in science, repeatability, had not been met. But Summerlin and Good were not emphasizing that.

Barbara B. Jacobs of the American Medical Center in Denver is among the investigators who has tried to duplicate Summerlin's work. In work that preceded Summerlin's, she demonstrated that cultured mouse tumors can be successfully transplanted to incompatible mice; however, her work differs from Summerlin's in several major respects (*Science*, 7 September 1973). In 1964, she says, she tried to extend her mouse tumor work to skin but

Ethic of Biotic Diversity to Slow Species Extinction

ticated and influential cadre of leaders. In the shorter term, Bormann also suggested that the WWF put some money into the creation of an institute, in a fast-growing country such as Nigeria, that would be staffed by natives and would take stock of the country's resources and make decisions on what needs to be saved at once.

Daniel Janzen, tropical biologist at the University of Michigan at Ann Arbor, observed that "the only way to fight the loss of a habitat is with the same power that is destroying it." Costa Rican rain forests, for example, are being decimated by a combination of foreign businessmen. Why not approach similar businessmen, suggested Janzen, and offer to sell them areas of valuable habitat on the same basis one would sell a valuable painting. In this way they could combine a good deed with a good investment. Thus, said Janzen, could be created a "museum of natural habitats." Roger Payne of the New York Zoological Society sprang to this idea. The best way to sell a new concept is to put it in an already accepted form, he pointed out. A natural habitat museum could be just that—with a board of directors, trustees, curators, and guards. Some of the collection would be privately owned, some would be on display, and some could be withdrawn from display. "Guards" could be altruistic adventurous types like Peace Corps volunteers who could live on the land for a certain period.

Talbot later told *Science* that none of the ideas advanced were new, novel as they may have sounded. This was not to denigrate the conference; rather, he said, it proved once again that people all over the world concerned with conservation all tend to come up with the same basic approaches. "What came out was really an independent endorsement of what we have been doing for a long time," says Talbot, who has been engaged in international conservation activities during the past 25 years. "It also shows that while we have been right we haven't been all that successful." Some of the approaches to which Talbot was referring are intensive lobbying of governments, which is a specialty of the International Union for Conservation of Nature and Natural Resources, a nongovernmental organization that acts as consultant to the United Nations; the idea of creating natural habitat museums; and campaigns to save a single species such as whale or tiger as a means both to attract public attention and to save an entire habitat, of which the publicized species is only a small part. Also a part of world conservation philosophy is the need to preserve "spectacles" such as the migration of wildebeests across the Serengeti Plain or the accumulation of flamingos around Lake Nakuru in Kenya, even when the species involved are not endangered. This, too, involves protection of vast areas and all their attendant biota.

Talbot's own belief is that if more effective approaches exist, conferences won't uncover them. What we need is to get some smart people from a mix of disciplines into some sort of think tank, he believes, people free from day-to-day concerns of conservation who can back off and take a hard look at the total picture.

Meanwhile, conservationists see a desperate need for immediate action. For the most part, they must stand by helplessly watching Bornean rain forests being flattened for pasture land and Costa Rican rain forests being turned into Swedish cabinets. Janzen predicted that within the next century only a few dozen tropical areas will have escaped the heavy hand of man, and these will be saved not as a result of any policy but from quirky circumstances in these areas.

The conservation movement has moved far beyond concern about furry creatures with warm brown eyes. However, until someone comes up with a better idea, the furry creatures will be used as the selling point to the general public (WWF's symbol is the panda). As one Indian official is quoted as saying, ". . . we are going to preserve the whole biological pyramid with the tiger on top." Conservationists are well aware that the real problem is the salvation of countless other species, some known and some not, the silent majority, as it were, upon whose continued survival the quality of future human life depends.—C.H.