



Basic Research and Public Support

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Letters

Animals from the Amazon Basin

History shows that precisely the resources and species thought to be inexhaustible are those in greatest danger of misuse and extinction. Laymen and scientists alike generally consider the flow of products from the "green sea" of the Amazon Basin to be limitless. It is not.

From 19 Sept.–12 Oct. 1966, I explored the forests near the Peruvian towns of Pebas, Santa Clara, Iquitos, and Pucallpa in order to survey the area for the study of primates. I flew over or boated through the intervening miles. Wherever I inquired, army officers, missionaries, and natives insisted that animals and good forest could be found "*en el centro*" (meaning directly away from the major waterway in the area). However, after half-day treks into forests of a type in which experience led me to expect many animals, I found none, even though I had been previously assured that I was in a "good" area. The sounds of the forests where I walked were chiefly those of insects. Visible were small birds, small lizards, and colorful tree frogs, joined only occasionally by a bird of medium size. Not once did I see any mammals or any large birds or reptiles. The usually common armadillo trails were extremely rare; feces or signs of feeding or resting were extremely scattered, and no nests were spotted. A colleague who has worked the Amazon from the Colombian border into Brazil and another who has worked the headwaters of the Pachitea River confirm these observations.

Wherever land is high enough to permit farming, slash-and-burn agriculture degrades the soil, completing the degradation of the forests which was begun by lumbering. In places the destructive trend has progressed to an "anticlimax" of pastureland. The second-growth forests, soon to be recut in their turn, are of poor quality and produce mainly wind-dispersed seeds. These are probably poor or inefficient food sources and can support little ani-

mal life in comparison with the original forests, though it is true that in slashed areas the collapse of the vertical stratification contributes to the abundance of a few species. Losses of forests to lumbering and farming, and animals to hunting practices are inevitable corollaries of the burgeoning populations along the river. (Not only dried monkeys but also fresh rat-sized rodents are for sale in the open meat market in Iquitos.) Road building will soon send colonizers into frontier areas which are now inaccessible.

However, the fur and live animal export markets threaten wildlife over a wider range. Demand always exceeds the fur traders' supply, though tens of thousands of skins are shipped from Iquitos every year. Select species such as tapir, peccary, ocelot, and jaguar are being severely depleted over truly vast regions because of the desirability of their hides. All animals must be sought further and further into the forests each year. The trends set in motion by agriculture and the fur trade are compounded by exportation. Many animal exporters are unable to fill their huge orders—mostly from the U.S.—and mainly for experimental animals. The methods of hunting and capture are those most devastating to the breeding populations. My experiences lead me to conclude that through human intervention many species' ranges are being truncated, perhaps irreversibly, over large areas.

Demographic and economic problems and the fur trade aside, the situation demands investigation of the extent of experimental animal resources currently available in the Amazon Basin. Most ecological parameters of our experimental animals are only vaguely known, if at all. My preliminary observations suggest that suitable habitats for ceboids may be much more restricted than is generally thought, and that seemingly insignificant modifications of the forests may make large areas uninhabitable. Committees of the International Biological Program should be encouraged to plunge into the vast and exciting prob-

lems of the Amazon Basin. Through their organizations scientists must urge and support the conservation and management of animal resources and the control of exports at the source of supply. We may also demand more care in the keeping and shipping of animals to eliminate death between forest and laboratory.

Conservation by scientists is most vital and practicable. Quite often an experimenter uses only a brain or some other organ and then disposes of the remainder of the animal. Cooperative and conservative use of experimental animals can and must eliminate this inexcusable waste in the laboratory. I suggest that the demand for experimental animals could finally drive some Amazonian species to extinction. It is time scientists acknowledge that the South American source of supply is exhausted.

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Basic Research and Public Support

Greenberg's article ("Money for research: LBJ's advisers urge scientists to seek public support," 19 May, p. 920) reminds me of a conversation I had recently with three engineers over a game of bridge. One was describing his work with satellites, and the discussion got into navigational problems. I found myself explaining some of the recent work on honeybee navigation, and speculations concerning honeybee brain function. Ultimately one of them asked if this work had some special significance or was being conducted merely on an academic basis. I was sufficiently so taken aback for the moment that my answer was lame. Subsequently discussion resumed on satellites, and glowing descriptions were given of the variety and complexity of gadgetry on some of them. When I innocently inserted the question whether information being received from these gadgets had any practical application or just represented somebody's whim, I received three amazed stares. One engineer said in polite exasperation: "Hell, man! We're exploring the universe!" I replied, "So are those fellows interested in honeybee brains." George Gaylord Simpson has said that Darwin's book was the most important one of the last few centuries

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because it changed man's attitude toward himself. I wonder if this is a practical application?

Supporters of democracy share the opinion that scientists ought to feel obligated to explain to taxpayers (and, even more important, to themselves) why their work should go on. But Greenberg's peculiar twists of the subject suggest to me that he may not yet know what basic research is all about. DuBridges' remark that adequate support for research can be nothing less than that which gives every competent researcher adequate support can only be qualified in terms of societal affluence. Such qualification becomes complicated only when it becomes divorced from adjusting standards of competence. Is there an imaginative person anywhere who would not be depressed that growing societal complexity might foster increasing bureaucratic tendencies to look askance at scientific endeavors just because they lack visible technical applications at their inception?

When Greenberg speaks of "the profession" of science, I wonder if he knows what is conveyed by the singular? I would suggest, incidentally, that democracy, in which education, citizen participation, and therefore communication (as between scientists and nonscientists) and self-correction, are at their best, is probably as close to science as one can get in politics. Paraphrasing George Simpson again, science is just a self-correcting method of learning about the universe, and the data of science are observations that any normal person can understand. I certainly include in that understanding the why as well as the what and how. When Greenberg intimates, as many scientists also have, that the American public cannot understand basic research, and therefore when we go to the public for support we must define basic research by making it "mission-oriented," this is an insult, a dismal prospect, and a step backward, both politically and scientifically. There is no "issue of whether too much basic research is disengaged and remote from practical application," for basic research is not defined in terms of its proximity to practical application.

Bennett is quoted as saying that when nonscientists argue that too much basic research is disengaged, this cannot be labelled as "special pleading." For the very reason that they are taxpaying nonscientists, it can be labelled as special pleading. We have indeed been reluctant, in basic research, to "make

qualitative judgments," "set priorities," or "jettison excess baggage." The only error in this is when it has taken the form of reluctance to identify individual incompetence. Priorities cannot otherwise be imposed appropriately or profitably from the outside. Can biochemists decide about the competence of people in biological systematics (or vice versa)—or can either group decide that the whole field is a waste of time, and therefore, *by definition*, no one in the field is competent? The best we can do to accomplish proper focus in basic research is to make absolutely certain that we are doing the best possible job of selecting and promoting competence in every field. The best "selective mechanism" is then automatically operative, for trivial questions are identified and effectively put aside by competent investigators.

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Greenberg's article notes that various scientific bodies now have formed or are considering forming committees on public affairs. The American Society for Pharmacology and Experimental Therapeutics has had a very active committee on public affairs since August 1965.

It is worthy of notice, however, that if such committees concern themselves only with public relations and the matter of research support that should be available for the disciplines they represent they will not be performing their proper role. A public affairs committee of any scientific, or other organization, should be cognizant of, study, and then provide advice and counsel on all types of legislative proposals falling within its realm to the legislative and executive branches of government, whether on the federal, state, or local level. The committee on public affairs of the Pharmacology Society has functioned in this way. Once the usefulness of a scientific discipline in this realm is recognized, I do not think it will be difficult to convince those responsible for appropriating public funds that it is in the public interest to support research at a respectable level. After all, it is the proper function of government to promote the general welfare of its citizenry.

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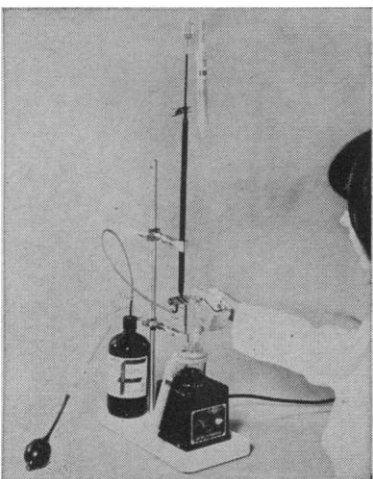
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The purpose of the article in question was to *describe* a significant change of opinion among persons who occupy influential positions in the federal government's dealings with the scientific community. I believe it is desirable for scientists to be informed of such changes, and I also believe it is important for them to recognize a distinction between description and advocacy.

—D.S.G.

Exporting Ph.D.'s: Is It Profitable?

If the process of growing brains were put into the same category as a tree crop such as nuts or oranges, I think we would find that the export side of the industry, properly planned and managed, would have an attractive economic potential for a number of underdeveloped countries. These overpopulated areas traditionally seek new industries which use lots of labor, very little land, and which can cater to the export market. The education industry meets all three criteria. An educational institution is extremely labor intensive, with perhaps 80 percent of the total costs going directly into payroll while the remaining 20 percent stimulates rather directly such labor intensive industries as building and publishing. As for the exportability of the products, markets seem to be expanding in Europe and North America for mathematicians, scientists, engineers, and medical personnel. Unlike nuts or oranges, we have to consider the desires of the product—whether or not significant numbers of degree holders wish to be exported. Ample evidence indicates they do.

By producing such educational products for both domestic consumption and export, the country could benefit from a good return on its investment in the export side of the industry, and from economies of scale, that is, cheaper unit costs on the domestic side. To estimate a proper return on the investment, an accountant would use much the same procedures as he does for a tree crop. He would include in the cost everything which the family and the community spend on a young person between the completion of compulsory education and the bestowing of the degree. He would also include an allowance for income foregone (on a monetary investment that might otherwise have been drawing interest), for

crop insurance (for those students that fall by the wayside), for income tax foregone (had the young man started working in his early teens), and so forth.

A rough calculation indicates that it might cost about \$4000 to produce a Ph.D., f.o.b., at the international airport in Taipei or Bombay. Given suitable employment in the United States, it ought to be easy for him to pay back the \$4000 plus interest and profit at a rate of at least \$500 to \$750 a year within 10 years.

It would not be surprising to discover that most of the students already send home this much money without any compulsion. Perhaps the problem is that they pay it all to the family, ignoring the government's investment. In a properly managed education-for-export industry the returns on the investment could be allocated rationally. And the employer of our Ph.D. might be persuaded to contribute.

If returns on investments were very good, foreign capital might wish to invest in the education-for-export industry. Parents of potential exportees would be willing to invest more of their own money in their advanced education. Such investors would then worry lest their products could not be exported, and, like surplus oranges, rot. The main problem is not that a brain drain is innately uneconomic for the underdeveloped country, but that it is uneconomic if badly managed.

The complaints most frequently heard relate to the exportation of brains which are not surplus to domestic requirements, a serious form of bad management. Just how uneconomic this is can be comprehended by considering the cost of an imported expert. To replace an essential Ph.D. in Taiwan or India, earning about \$1000 to \$3000 a year, by an expert from the United Nations, might cost about \$25,000 a year in terms of salary, travel, allowances, and U.N. overhead. (Much of this amount would come ultimately from the developed countries which contribute heavily to the U.N.) Some other foreigner might be found who would cost less.

If our essential Ph.D. who emigrates is not replaced and, as a result, a power plant cannot operate or the Prime Minister gets bad advice, the economic loss would be much greater than the cost of his replacement; exactly how great we have no way of knowing.

Too much discussion on the economics of the brain drain seems to