Letters

Biotic Energy Flows

Important aspects of the energy shortage are being ignored in both science and government. We tend to forget that most of the energy used by man is solar energy that has been fixed recently through photosynthesis. This energy provides food, fuel, fibers, and services that are essential for a habitable environment. Although the total amount of energy available as net primary production through this route has been estimated as 20 times the amount of energy in current use from fossil fuels, nuclear power, and hydropower, these flows of energy from the sun are being reduced (*1*). When the complex political, social, and economic systems of industrialized nations falter, as they appear to be doing at the moment, we turn immediately to biotic resources that are close to us. We substitute fish for beef, wood for fuel. Mounting world food shortages are contributing to the pressures on these resources. Shortages of both oil and food will get worse: worldwide demand is soaring, and supplies are limited. Reckless efforts to "solve" an energy problem that is unsolvable in the current context of growth threaten to speed destruction of renewable resources. Acid rains are a good example. Relaxation of air pollution standards for sulfur will result in continuation of the trend of rising acidity in rain in the Northeast. There is little doubt that a decade or more of precipitation with a *p*H of between 3.0 and 4.2 will reduce the net production of forests and agriculture. A 10 percent loss of net production in the New England states would be the equivalent of the power output of 15 1000-megawatt reactors. Would the people of New England agree to supply such a subsidy to the rest of the country if they had a choice?

There is no simple technical or social solution to the shortage of energy. Growth in energy consumption in the pattern of past years is over for the present. In addition, biotic flows of energy are now being lost, often irreversibly; the biota is being mined. Environmental problems are not simply those of adjusting techniques of energy production to reduce intrusions on the environment; they also include the preservation of the flows of energy—including food, materials, and services—through the biota to man. The shortage of fossil fuels presents a challenge to technologists to find more efficient ways of exploiting biotic energy flows on a renewable basis. The problem warrants, but does not have, major consideration in the President's energy program. Facilities comparable to those of a major national laboratory should be devoted to the problems generated by the worldwide spread of biotic impoverishment that is caused in large degree by current rates of exploitation of nonrenewable energy sources.

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Virus Cancer Program

As a contractor to the Virus Cancer Program (VCP), I am encouraged by the attention VCP has received in *Science* (News and Comment, 24 Sept. 1971, p. 1220; 14 Dec. 1973, p. 1110). I am glad to learn that at least I am part of a program that others feel is worth shooting at. It is, of course, unsettling to learn that John Moloney still feels there is room for improvement in the VCP.

Everyone knows that grants, peer group review, elucidation of basic mechanisms, motherhood, and the American girl are beyond reproach. Grant programs are directed by triannual review of the accumulated contents of the morning's mail. In such an impartial system, scientific bias and conflict of interest are impossible, and freedom of scientific inquiry is assured. On the other hand, contracts, targeted research, requirements for proposals, resources, and services are pedestrian and often uncouth. Clear identification and contractual control of such targeted programs permits everyone to keep an eye on us rascals.

If we assume that basic fundamental research will raise answerable questions, it seems reasonable to create targeted programs to attempt to settle matters. The answers may not be happy ones, but at least we will have tried. Arise goal-oriented pedestrians—you have only your tenure to loose!

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PCB's: Another Source?

The letter concerning the presence of PCB's (polychlorinated biphenyls) in microscope immersion oils (30 to 45 percent) from Bennett and Albro (14 Sept. 1973, p. 990) and the letter from Plimmer and Klingebiel (14 Sept. 1973, p. 994) indicating a novel method for PCB formation have served to stoke the fires of controversy and environmental concern. The validity of such concern is underscored by evidence indicating the possible manufacture of PCB's at waste treatment plants that receive textile mill discharges.

In November 1972, an investigation was requested of the suspected failure of a municipal sewage treatment plant using high-rate trickling filters. Three weeks of 24-hour sampling and analysis resulted in confirmation of failure (0 to 30 percent reduction of biochemical oxygen demand). Half the flow originated in a textile mill which was using at least 2 tons per week of commercial-grade biphenyl as a dye carrier for synthetic fiber. The waste treatment plant was using 150 to 190 kilograms per day of chlorine gas for influent odor control and effluent "disinfection," two procedures that are not at all uncommon. Filter rocks were scraped and flushed with 100 milliliters of distilled water. The PCB content of the resulting suspension, after suitable extraction, cleanup, and gas-liquid chromatography analysis, was 18 parts per million. This system at the same time was being subjected to significant concentrations of heavy metals contributed by another industry. This problem has since been eliminated, but the sewage plant continues to experience operating problems.

A full-scale investigation is in progress to determine the concentration of both biphenyls and PCB's in several water supplies and wastewater systems in the area and their effects on bacteria and protozoa.

In 1966, the wisdom of using chlorine in waste treatment processes was seriously questioned (*1*) after an investigation revealed the presence of halophenols in waste-water systems. Reynolds (*2*) has stated: "The means by which PCB's enter the ecosystem to contaminate fish and wildlife are still not clearly understood." Answers will come only from research.

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Instability of N-Nitrosamides

The letter from A. H. Sparrow (24 Aug. 1973, p. 700) telling of an accident with nitrosomethylurea comes as no surprise to a chemist familiar with the properties of *N*-nitrosamides. Some time ago, I received a call from another institution telling of a similar accident with a much smaller quantity of nitrosomethylurea.

The instability of *N*-nitrosamides, particularly of nitrosoalkylureas, is well know. These compounds must be kept in a freezer, not merely under refrigeration. Not only do they decompose rapidly on occasion, but they can also decompose slowly and polymerize, as I discovered once in carrying some deuterium-labeled nitrosomethylurea across the Atlantic. Because of this instability, quantitative biological or biochemical studies in which improperly stored nitrosamides are used can have little meaning. Without making a chemical analysis before use, the investigator will not know how much of the undecomposed compound is present.

Two conclusions can be drawn from these episodes. First, the storage of a large quantity of a biologically potent compound such as nitrosomethylurea is inadvisable, particularly when the amounts needed for any experiment are measured in milligrams. Second, the shipping of such unstable compounds (with possible hazards to postal workers and other unwitting handlers of the materials) should be stopped.

When I have been asked by scientists to supply nitrosoalkylureas, my solution to the problem has been to provide a recipe for small amounts of these compounds. Their preparation is extremely simple and can be carried out by someone with a minimal knowledge of chemistry in an afternoon. The starting materials are safe, cheap, and readily available.

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Human Ecology

Amos H. Hawley's critique of ecology (23 Mar. 1973, p. 1196) makes some telling points. Few scientists would disagree with the implication that environmentalist and conservationist extremes are characterized by emotional overstatements and clichés, without objective basis, that fail to qualify as ecology or as any other science. Hawley, furthermore, puts his finger unerringly on the weaknesses inherent in "The scaling down of ecology to manageable proportions. . . ." The study of "relations between given species and particular environmental features" is indeed not so broad as a systems approach (exemplified by the ecosystem concept). And even ecosystem studies suffer unavoidable difficulties stemming from necessary size limitation and (not mentioned by Hawley) their eventual dependence upon all of the mechanisms of species-environment interaction. Hawley is therefore clearly correct in calling attention to the supplementary value of holistic and mechanistic studies. It is regrettable that these insights are progressively forgotten in the remainder of the article.

The professional ecologist's inclusion of man in ecological studies is totally dependent upon *Homo sapiens* being subjected to the same treatment as that accorded every other species. Should it prove inconsequential that bald eagles are exterminated, is it necessarily more tragic to the biosphere if man is the next victim of extinction? If it is "bad" that beavers cut more trees than they can use, are Hawley and I to be forgiven for the waste of boreal fibers on which we print our differences of opinion? If Garrett Hardin's cows demolish their pasture by being too numerous, does man have some unique quality that guarantees that he will suffer no hunger, whatever the density of his population per unit of space-energy? It would be difficult to support an affirmative answer to any of these questions.

Hawley bases his opinion upon two closely related biases. While it is not denied that Hardin's cows are subject to the Malthusian principle, Hawley excuses man from a comparable fate on the grounds that man has a technology, the product of which increases more rapidly than does human population. It is quite true, as Hawley points out, that this was not anticipated by Malthus. There issues from this disproportion the not very surprising consequence that production comes to exceed the labor force, both quantitatively and in terms of labor's capacity to buy. In the face of this, Hawley argues that "A decline in the relative size of the labor force does not, however, contradict the need for large numbers of people in an industrially advanced society. While such a society needs comparatively few workers, it needs relatively more consumers." (What we really need is more beavers to consume all those wasted trees.)

Totally lacking in Hawley's analysis is any correspondence between his view of the organizational society he wishes to call "human ecology" and the ecosystem approach he seemed to find largely worthy. The material and energy input of the industrial society is not mentioned. While exponential technological development might well have confounded the Reverend Malthus, that worthy gentleman gets the last laugh. Technology suffers from its own Malthusian malaise in the form of diminishing reserves of fuel, strategic materials, and soil, as well as the accumulation of wastes. Meanwhile, its Madison Avenue search for more consumers guarantees ever greater demand for ever scarcer commodities. The first research effort of the new "human ecology" should be a search for just one example of material infinity in nature.

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