

mistrust—of the rich that the poor will not cease growing in numbers and of the poor that the rich will not stop getting richer. Sane reason, however, invites us to recognize that the differential gradient between the poor and the rich nations is an evil in itself, and although closely connected with continuous population growth, it must be dealt with directly as well.

Because pollution is a surface phenomenon which also strikes the generation which produces it, we may rest assured that it will receive much more official attention than its inseparable companion, resource depletion. But since in both cases there is no such thing as the cost of undoing an irreparable harm or reversing an irrevocable depletion, and since no relevant price can be set on avoiding the inconvenience if future generations cannot bid on the choice, we must insist that the measures taken for either purpose should consist of quantitative regulations, notwithstanding the advice of most economists to increase the allocation efficiency of the market through taxes and subsidies. The economists' plank will only protect the wealthy or the political protégés. Let no one, economist or not, forget that the irresponsible deforestation of numerous mountains took place because "the price was right" and that it was brought to an end only after quantitative restrictions were introduced. But the difficult nature of the choice should also be made clear to the public—that slower depletion means less exosomatic comfort and that greater control of pollution requires proportionately greater consumption of resources. Otherwise, only confusion and controversies at cross-purposes will result.

Nor should any reasonable ecological platform ignore the basic fact that, from all we know about the struggle for life in general, man will probably not let himself down, when pressed for his needs, natural or acquired, by sparing his competitors (including future humans). There is no law in biology stating that a species must defend the existence of others at the cost of its own ex-

istence. The most we can reasonably hope is that we may educate ourselves to refrain from "unnecessary" harm and to protect, even at some cost, the future of our species by protecting the species beneficial to us. Complete protection and absolute reduction of pollution are dangerous myths which must be exposed as such (Section V).

Justus von Liebig observed that "civilization is the economy of power" [32, 304]. At the present hour, the economy of power in all its aspects calls for a turning point. Instead of continuing to be opportunistic in the highest degree and concentrating our research toward finding more economically efficient ways of tapping mineral energies—all in finite supply and all heavy pollutants—we should direct all our efforts toward improving the direct uses of solar energy—the only clean and essentially unlimited source. Already known techniques should without delay be diffused among all people so that we all may learn from practice and develop the corresponding trade.

An economy based primarily on the flow of solar energy will also do away, though not completely, with the monopoly of the present over future generations, for even such an economy will still need to tap the terrestrial dowry, especially for materials. The depletion of these critical resources must therefore be rendered as small as feasible. Technological innovations will certainly have a role in this direction. But it is high time for us to stop emphasizing exclusively—as all platforms have apparently done so far—the increase of supply. Demand can also play a role, an even greater and more efficient one in the ultimate analysis.

It would be foolish to propose a complete renunciation of the industrial comfort of the exosomatic evolution. Mankind will not return to the cave or, rather, to the tree. But there are a few points that may be included in a minimal bioeconomic program.

First, the production of all instruments of war, *not only of war itself*, should be prohibited completely. It is utterly absurd (and

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also hypocritical) to continue growing tobacco if, avowedly, no one intends to smoke. The nations which are so developed as to be the main producers of armaments should be able to reach a consensus over this prohibition without any difficulty if, as they claim, they also possess the wisdom to lead mankind. Discontinuing the production of all instruments of war will not only do away at least with the mass killings by ingenious weapons but will also release some tremendous productive forces for international aid without lowering the standard of living in the corresponding countries.

Second, through the use of these productive forces as well as by additional well-planned and sincerely intended measures, the underdeveloped nations must be aided to arrive as quickly as possible at a good (not luxurious) life. Both ends of the spectrum must effectively participate in the efforts required by this transformation and accept the necessity of a radical change in their polarized outlooks on life.⁶⁵

Third, mankind should gradually lower its population to a level that could be adequately fed only by organic agriculture.⁶⁶ Naturally, the nations now experiencing a very high demographic growth will have to strive hard for the most rapid possible results in that direction.

Fourth, until either the direct use of solar energy becomes a general convenience or controlled fusion is achieved, all waste of energy—by overheating, overcooling, overspeeding, overlighting, etc.—should be carefully avoided, and if necessary, strictly regulated.

Fifth, we must cure ourselves of the

⁶⁵ At the Dai Dong Conference (Stockholm, 1972), I suggested the adoption of a measure, which seems to me to be applicable with much less difficulty than dealing with installations of all sorts. My suggestion, instead, was to allow people to move freely from any country to any other country whatsoever. Its reception was less than lukewarm. See [2, 72].

⁶⁶ To avoid any misinterpretation, I should add that the present fad for organic foods has nothing to do with this proposal, which is based only on the reasons expounded in Section X.

morbid craving for extravagant gadgetry, splendidly illustrated by such a contradictory item as the golf cart, and for such mammoth splendors as *two-garage* cars. Once we do so, manufacturers will have to stop manufacturing such "commodities."

Sixth, we must also get rid of fashion, of "that disease of the human mind," as Abbot Fernando Galliani characterized it in his celebrated *Della moneta* (1750). It is indeed a disease of the mind to throw away a coat or a piece of furniture while it can still perform its specific service. To get a "new" car every year and to refashion the house every other is a bioeconomic crime. Other writers have already proposed that goods be manufactured in such a way as to be more durable [e.g. 43, 146]. But it is even more important that consumers should reeducate themselves to despise fashion. Manufacturers will then have to focus on durability.

Seventh, and closely related to the preceding point, is the necessity that durable goods be made still more durable by being designed so as to be repairable. (To put it in a plastic analogy, in many cases nowadays, we have to throw away a pair of shoes merely because one lace has broken.)

Eighth, in a compelling harmony with all the above thoughts we should cure ourselves of what I have been calling "the circumdrome of the shaving machine," which is to shave oneself faster so as to have more time to work on a machine that shaves faster so as to have more time to work on a machine that shaves still faster, and so on *ad infinitum*. This change will call for a great deal of recanting on the part of all those professions which have lured man into this empty infinite regress. We must come to realize that an important prerequisite for a good life is a substantial amount of leisure spent in an intelligent manner.

Considered on paper, in the abstract, the foregoing recommendations would on the whole seem reasonable to anyone willing to examine the logic on which they rest. But one thought has persisted in my mind ever since

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I became interested in the entropic nature of the economic process. Will mankind listen to any program that implies a constriction of its addiction to exosomatic comfort? Perhaps, the destiny of man is to have a short, but fiery, exciting and extravagant life rather than a long, uneventful and vegetative existence. Let other species—the amoebas, for example—which have no spiritual ambitions inherit an earth still bathed in plenty of sunshine.

REFERENCES

1. Abelson, Philip H., "Limits to Growth." *Science*, 17 March 1972, 1197.
2. Artin, Tom. *Earth Talk: Independent Voices on the Environment*. New York: Grossman Publishers, 1973.
3. Barnett, Harold J. and Chandler Morse. *Scarcity and Growth*. Baltimore: Johns Hopkins Press, 1963.
4. Beckerman, Wilfred, "Economists, Scientists, and Environmental Catastrophe." *Oxford Economic Papers*, November 1972, 327-344.
5. Blin-Stoyle, R. J., "The End of Mechanistic Philosophy and the Rise of Field Physics," in *Turning Points in Physics*, edited by R. J. Blin-Stoyle, et al. Amsterdam: North-Holland, 1959, pp. 5-29.
6. "A Blueprint for Survival." *The Ecologist*, January 1972, 1-43.
7. Bormann, F. H.: "Unlimited Growth: Growing, Growing, Gone?" *BioScience*, December 1972, 706-709.
8. Boulding, Kenneth, "The Economics of the Coming Spaceship Earth," in *Environmental Quality in a Growing Economy*, edited by Henry Jarrett. Baltimore: Johns Hopkins Press, pp. 3-14.
9. ———, "Environment and Economics," in [66], pp. 359-367.
10. Bray, Jeremy. *The Politics of the Environment*, Fabian Tract 412. London: Fabian Society, 1972.
11. Bridgman, P. W., "Statistical Mechanics and the Second Law of Thermodynamics," in *Reflections of a Physicist*, 2d ed. New York: Philosophical Library, 1955, pp. 236-268.
12. Brown, Harrison, "Human Materials Production as a Process in the Biosphere." *Scientific American*, September 1970, 195-208.
13. Brown, Lester R. and Gail Finsterbusch, "Man, Food and Environment," in [66], pp. 53-69.
14. Cannon, James, "Steel: The Recyclable Material." *Environment*, November 1973, 11-20.
15. Cloud, Preston, ed. *Resources and Man*. San Francisco: W. H. Freeman, 1969.
16. ———, "Resources, Population, and Quality of Life," in *Is There an Optimum Level of Population?*, edited by S. F. Singer. New York: McGraw Hill, 1971, pp. 8-31.
17. ———, "Mineral Resources in Fact and Fancy," in [66], pp. 71-88.
18. Commoner, Barry. *The Closing Circle*. New York: Knopf, 1971.
19. Culbertson, John M. *Economic Development: An Ecological Approach*. New York: Knopf, 1971.
20. Daly, Herman E., "Toward a Stationary-State Economy," in *Patient Earth*, edited by J. Hart and R. Socolow. New York: Holt, Rinehart & Winston, pp. 226-244.
21. ———. *The Stationary-State Economy*. Distinguished Lecture Series No. 2, Department of Economics, University of Alabama, 1971.
22. Daniels, Farrington. *Direct Use of the Sun's Energy*. New Haven: Yale University Press, 1964.
23. Einstein, Albert and Leopold Infeld. *The Evolution of Physics*. New York: Simon and Schuster, 1938.
24. "The Fragile Climate of Spaceship Earth." *Intellectual Digest*, March 1972, 78-80.
25. Georgescu-Roegen, Nicholas, "The Theory of Choice and the Constancy of Economic Laws." *Quarterly Journal of Economics*, February 1950, 125-138. Reprinted in [29], pp. 171-183.
26. ———, "Toward Partial Redirection of Econometrics: Comments." *Review of Economics and Statistics*, August 1952, 206-211.
27. ———, "Process in Farming Versus Process in Manufacturing: A Problem of Balanced Development," in *Economic Problems of Agriculture in Industrial States* (A Conference of the International Economic Association, Rome, 1965), edited by U. Papi and C. Nunn. New York: Macmillan, 1969, pp. 497-528.
28. ———, "Further Thoughts on Corrado Gini's *Delusioni dell' econometria*." *Metron*, 1966, 265-279.
29. ———. *Analytical Economics: Issues and Problems*. Cambridge, Mass.: Harvard University Press, 1966.
30. ———, "The Economics of Production," Richard T. Ely Lecture. *American Economic Review*, May 1970, 1-9.
31. ———. *The Entropy Law and the Economic Problem*. Distinguished Lecture Series No. 1, Department of Economics, University of Alabama, 1971. Reprinted in *The Ecologist*, July 1972, 13-18.
32. ———. *The Entropy Law and the Economic Process*. Cambridge, Mass.: Harvard University Press, 1971.
33. ———, "Process Analysis and the Neoclassical Theory of Production." *American Journal of Agricultural Economics*, May 1972, 279-294.

34. Gillette, Robert, "The Limits to Growth: Hard Sell for a Computer View of Doomsday." *Science*, 10 March 1972, 1088-1092.
35. ———, "Nuclear Safety: Damaged Fuel Ignites a New Debate in AEC." *Science*, 28 July 1972, 330-331.
36. ———, "Reactor Safety: AEC Concedes Some Points to Its Critics." *Science*, 3 November 1972, 482-484.
37. Glaser, Peter E., "Power from the Sun: Its Future." *Science*, 22 November 1968, 857-861.
38. Goeller, H. E., "The Ultimate Mineral Resource Situation." *Proceedings of the National Academy of Science, USA*, October 1972, 2991-2992.
39. Gofman, John W., "Time for a Moratorium." *Environmental Action*, November 1972, 11-15.
40. Haar, D. ter, "The Quantum Nature of Matter and Radiation," in *Turning Points in Physics*, [5], pp. 30-44.
41. Hammond, Allen L., "Solar Energy: A Feasible Source of Power?" *Science*, 14 May 1971, 660.
42. Hardin, Garrett, "The Tragedy of the Commons." *Science*, 13 December 1968, 1234-1248.
43. Hibbard, Walter R., Jr., "Mineral Resources: Challenge or Threat?" *Science*, 12 April 1968, 143-145.
44. Holdren, John and Philip Herera. *Energy*. San Francisco: Sierra Club, 1971.
45. Hotelling, Harold, "The Economics of Exhaustible Resources." *Journal of Political Economy*, March-April 1931, 137-175.
46. Hubbert, M. King, "Energy Resources," in [15], pp. 157-242.
47. Istock, Conrad A., "Modern Environmental Deterioration as a Natural Process." *International Journal of Environmental Studies*, 1971, 151-155.
48. Jevons, W. Stanley. *The Theory of Political Economy*, 2d ed. London: Macmillan, 1879.
49. Johnson, Harry G. *Man and His Environment*. London: The British-North American Committee, 1973.
50. Katchalsky, A. and Peter F. Curran. *Nonequilibrium Thermodynamics in Biophysics*. Cambridge, Mass.: Harvard University Press, 1965.
51. Kaysen, Carl, "The Computer that Printed Out $W \cdot O \cdot L \cdot F$." *Foreign Affairs*, July 1972, 660-668.
52. Kneese, Allen and Ronald Ridker, "Predicament of Mankind." *Washington Post*, 2 March 1972.
53. Laplace, Pierre Simon de. *A Philosophical Essay on Probability*. New York: John Wiley, 1902.
54. Leontief, Wassily, "Theoretical Assumptions and Nonobservable Facts." *American Economic Review*, March 1971, 1-7.
55. "Limits to Misconception." *The Economist*, 11 March 1972, 20-22.
56. Lovering, Thomas S., "Mineral Resources from the Land," in [15], pp. 109-134.
57. MacDonald, Gordon J. F., "Pollution, Weather and Climate," in [66], pp. 326-336.
58. Maddox, John, "Raw Materials and the Price Mechanism." *Nature*, 14 April 1972, 331-334.
59. ———. *The Doomsday Syndrome*. New York: MacGraw Hill, 1972.
60. Marshall, Alfred. *Principles of Economics*, 8th ed. London: Macmillan, 1920.
61. Marx, Karl. *Capital*. 3 vols. Chicago: Charles H. Kerr, 1906-1933.
62. Meadows, Donella H., et al. *The Limits to Growth*. New York: Universe Books, 1972.
63. Metz, William D., "Fusion: Princeton Tokamak Proves a Principle." *Science*, 22 December 1972, 1274B.
64. Mill, John Stuart. *Principles of Political Economy*, in *Collected Works*, vols. II-III. Edited by J. M. Robson. Toronto: University of Toronto Press, 1965.
65. Mishan, E. J. *Technology and Growth: The Price We Pay*. New York: Praeger, 1970.
66. Murdoch, William W., ed. *Environment: Resources, Pollution and Society*. Stamford, Conn.: Sinauer, 1971.
67. Novick, Sheldon, "Nuclear Breeders." *Environment*, July-August 1974, 6-15.
68. Pigou, A. C. *The Economics of Stationary States*. London: Macmillan, 1935.
69. *Report on Limits to Growth*. Mimeographed. A Study of the Staff of the International Bank for Reconstruction and Development, Washington, D. C., 1972.
70. Revelle, Roger, "Food and Population." *Scientific American*, September 1974, 161-170.
71. Schrödinger, Erwin. *What is Life?* Cambridge, England: The University Press, 1944.
72. Silk, Leonard, "On the Imminence of Disaster." *New York Times*, 14 March 1972.
73. Solo, Robert A., "Arithmomorphism and Entropy." *Economic Development and Cultural Change*, April 1974, 510-517.
74. Solow, Robert M., "Is the End of the World at Hand?" *Challenge*, March-April 1973, 39-50.
75. ———, "The Economics of Resources or the Resources of Economics," Richard T. Ely Lecture. *American Economic Review*, May 1974, 1-14.
76. Spengler, Joseph J., "Was Malthus Right?" *Southern Economic Journal*, July 1966, 17-34.
77. ———, "Homosphere, Seen and Unseen; Retreat from Atomism." *Proceedings of the*

- "Theoretical Assumptions and Facts." *American Economist*, March 1971, 1-7.
- "Option." *The Economist*, 11 Feb. 1971, 2.
- "Mineral Resources from the Sea." pp. 109-134.
- J. F., "Pollution, Weather and the Price of Materials and the Price of Energy." *Nature*, 14 April 1972, 331-332.
- Day Syndrome*. New York: Basic Books, 1972.
- Principles of Economics*, 8th ed. William McMillan, 1920.
- 3 vols. Chicago: Charles Scribner's Sons, 1933.
- H., et al. *The Limits to Growth*. New York: Universe Books, 1972.
- "Fusion: Princeton Tokamak." *Science*, 22 Dec. 1972, 115-116.
- Principles of Political Economy*, vols. II-III. Edited by J. M. C. Brown. Toronto: University of Toronto Press, 1955.
- Technology and Growth: The Limits to Growth*. New York: Praeger, 1970.
- V., ed. *Environment: Resources and Society*. Stamford, Conn.: JAI Press, 1974.
- "Breeder Reactors." *Environmental Science*, 1974, 6-15.
- Economics of Stationary States*. London: Macmillan, 1935.
- Growth*. Mimeographed. Staff of the International Labour Office, 1972.
- "Growth and Population." *Science*, 1974, 161-170.
- What is Life?* Cambridge: Cambridge University Press, 1944.
- "The Imminence of Disaster." *Science*, 14 March 1972, 115-116.
- "Arithmorphism and Economic Development and Cultural Change." *Science*, 1974, 510-517.
- "The End of the World at the End of the World at the End of the World." *Nature*, March-April 1973, 39-40.
- "Limits of Resources or the Limits of Growth." Richard T. Ely. *Economic Review*, May 1972, 115-116.
- "Was Malthus Right?" *Journal*, July 1966, 17-18.
- "Seen and Unseen; Remembered and Forgotten." *Proceedings of the Nineteenth Southern Water Resources and Pollution Control Conference*, 1970, pp. 7-16.
78. Sprout, Harold and Margaret Sprout. *Multiple Vulnerabilities*. Mimeographed. Research Monograph No. 40, Center of International Studies, Princeton University, 1974.
79. Summers, Claude M., "The Conversion of Energy." *Scientific American*, September 1971, 149-160.
80. Wallich, Henry C., "How to Live with Economic Growth." *Fortune*, October 1972, 115-122.
81. Weinberg, Alvin M., "Breeder Reactors." *Scientific American*, January 1960, 82-94.
82. ———, "Social Institutions and Nuclear Energy." *Science*, 7 July 1972, 27-34.
83. ——— and R. Philip Hammond, "Limits to the Use of Energy." *American Scientist*, July-August 1970, 412-418.