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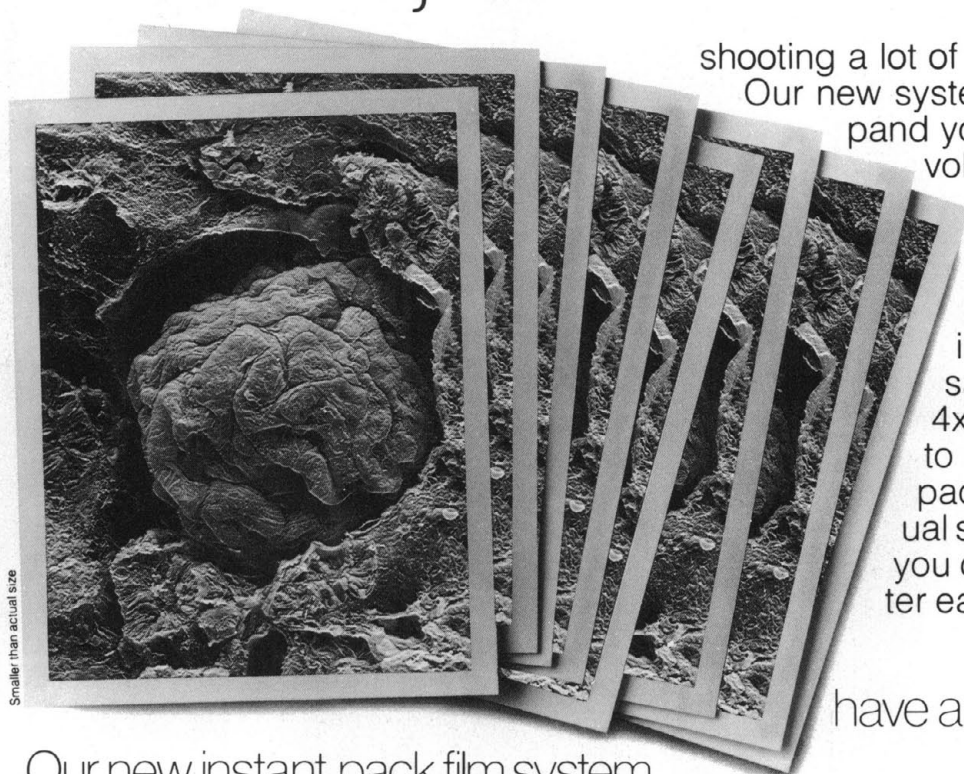
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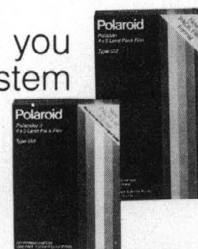
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COVER

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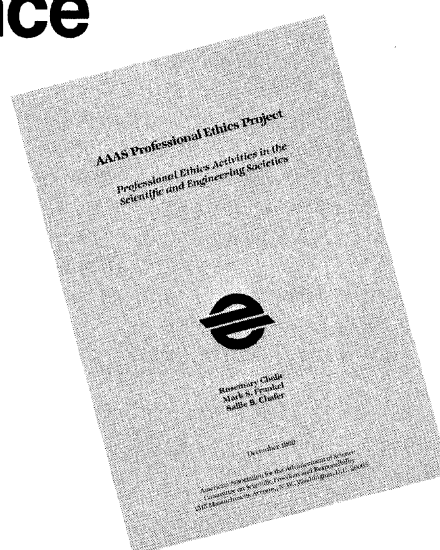
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Energy and Chemicals from Biomass

Economic forces and prospective future shortages of oil are inducing widespread interest in biomass as a source of energy and chemicals. A new *International Bio-Energy Directory** lists activities in 60 countries, including 1850 different projects. The majority of the less-developed countries obtain most of their energy from biomass. About 15 percent of the world's total energy is derived directly or indirectly from photosynthesis.

At the moment, there is a so-called oil glut, but this could be short-lived. If environmental problems, such as CO₂ or acid rain, connected with other energy sources become unbearable, biomass could quickly rise to importance. Exploitation of biomass is not without controversy, however. In the United States the increasing conversion of grain to ethyl alcohol creates an issue of food versus fuel. In many developing countries excessive use of wood is leading to deforestation and soil erosion.

For decades biomass and its products were relatively neglected, except for research to increase yields of food crops. But lately there have been expanded efforts to improve yields of nonfood plants and trees and to find better ways of obtaining fuels and chemicals from them.

Good forest management is already improving the yields of trees. This includes selection of superior stock in reforestation, thinning, and use of fertilizers. Considerable attention is being devoted to the coppicing of fast-growing trees. In the *Bio-Energy Directory* it is stated that hybrid poplar trees in Pennsylvania produce 20 metric tons per hectare per year (dry basis) when harvested on a 4-year coppicing cycle. Other claims include annual tropical growth rates per hectare of 88 dry metric tons of Napier grass, 85 tons of water hyacinths, and 300 tons of algae (grown under 100 percent CO₂). These numbers are probably atypical but in the future they may well be exceeded as a result of selection and genetic research.

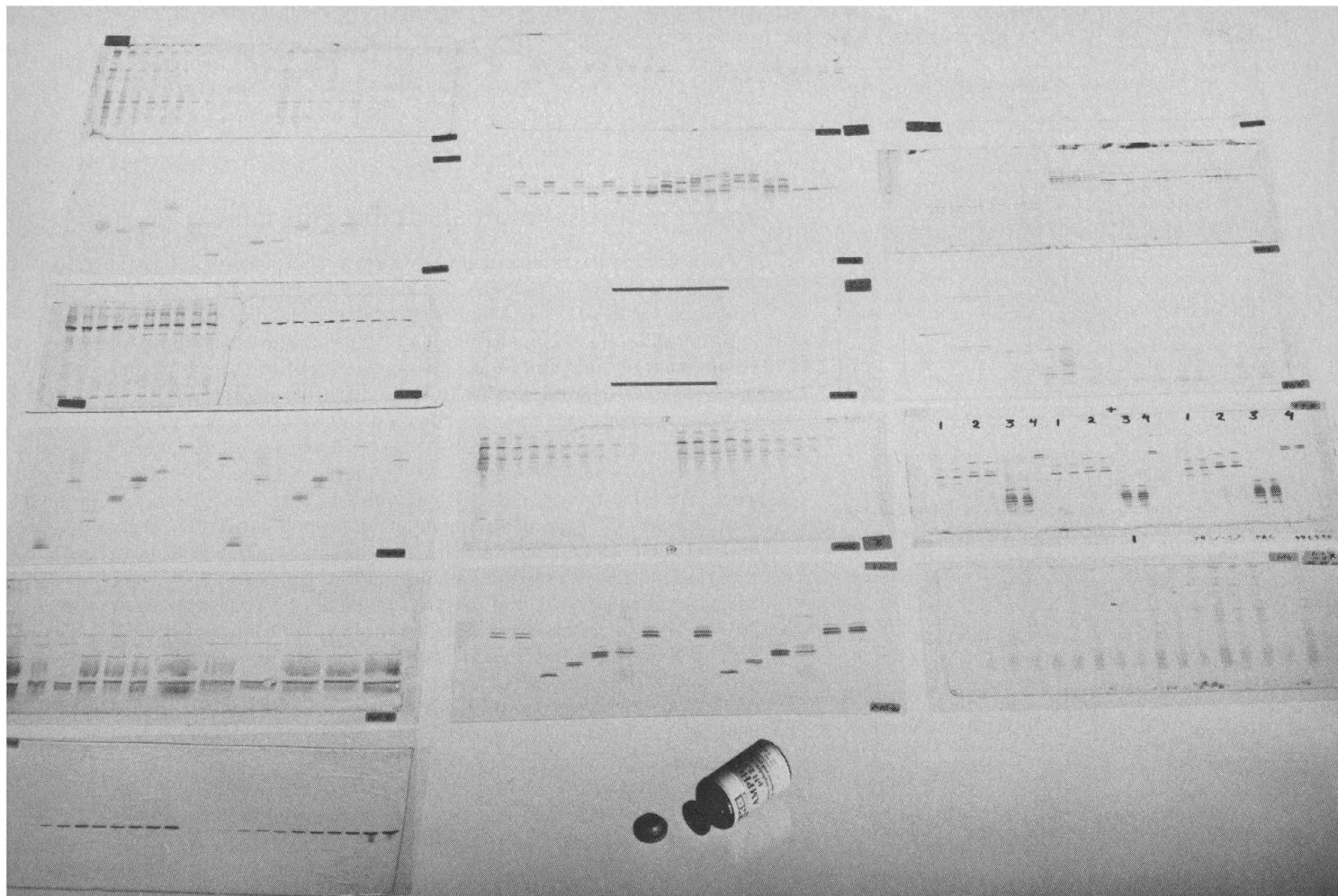
Work on the utilization of biomass is also active. Of special importance is research aimed at unlocking the values inherent in cellulose, which is a polymer of glucose. Glucose is a feedstock for many fermentation processes besides that yielding ethyl alcohol. Were glucose sufficiently inexpensive in comparison to petroleum, most of today's tonnage of petrochemicals would be derived from it.

Until recently, there were two principal approaches to breaking the lignocellulose complex and making glucose available. They involved microbial enzymes or treatment with aqueous mineral acids. Yields were not good or the digestion was slow. A technique that employs anhydrous hydrogen fluoride is now drawing attention. The chemical splits cellulose rapidly at 0°C with high yields. Other approaches to the use of wood include subjecting it to gasification or rapid pyrolysis. Wood is much more easily gasified than coal, being converted to gases at 700°C. Fast pyrolysis yields substantial quantities of ethylene.

Use of energy and chemicals from biomass in the United States is likely to increase slowly at first. But substantial research activity here guarantees more efficient production of biomass, and better, innovative processes for using it. One can visualize a possible gradual transition in which biomass replaces an increasing fraction of petroleum as an energy source and feedstock. The process is likely to begin with increased use of ethyl alcohol and with production of some chemicals that can be readily derived by fermentation of glucose. In addition, functions now being served by products derived from petrochemicals may be served in new ways by items made from processed biomass.

In looking toward the future and planning our research activities, we should also consider possible international applications of our work; and should be alert to new results elsewhere. As the developed countries join the less-developed countries in a greater dependence on biomass we shall have much to learn from each other.—PHILIP H. ABELSON

**International Bio-Energy Directory*, Paul F. Bente, Ed. (Bio-Energy Council, Washington, D.C., 1981). \$90.



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Although it is too late to submit suggestions for symposia for this Annual Meeting, contributed papers can be sent in up to 4 September 1981. Instructions for abstracts are given below and a sample is shown.

The contributed paper sessions are of the POSTER type. In such sessions each contributor will have a bulletin board on which to place text and graphic material (of an oversized nature) for an extended period of time so that the work can be discussed with all interested parties (see *Science*, 28 June 1974, page 1361).

Please note that all contributions must be submitted and signed by a AAAS member or fellow, although this person need not be one of the authors.

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