actions in mixed stands is the most practical approach.

If a domain of applied science does not stimulate the fundamental research it requires, it must borrow the tools from other fields. The attempts to apply mathematical techniques to biology have usually been most disappointing when the methods created for physics have been transferred passively, and most successful when biology has stimulated the creation of the most suitable mathematics. Thus the relatively weak contribution of fundamental research to agriculture is not a critique of theory per se, but rather reflects the absence of the appropriate theory stimulated by the needs of agricultural practice. Where fundamental research was stimulated by agriculture, as in the development of biometrics at the Rothamstead Experiment Station or in Vavilov's gathering of the world seed collection and study of origins of cultivated plants, the practical significance was great.

Among the areas of agriculturally relevant fundamental research which are relatively lagging and which suggest themselves to a population biologist are:

1) Natural selection within communities. There is a suggestion that feedbacks within the community may result in a species selecting itself to local extinction. Manipulation of community parameters can harness selection to our ends.

2) The genetics of expanding species.

3) The study of the distribution of pests and their predators over a region within the framework of the extinction-migration theory of quantitative biogeography.

4) Host location in a heterogeneous environment.

5) The process of niche shift in the origin of pest species and the artificial selection of control organisms.

6) The community ecology of fine-grained and coarse-grained mixed plantings, both interspecific and at the level of polymorphisms.

7) The development of selection theory for coevolution.

8) The modeling of the cultivated field as an ecosystem in which the microbiological and cryptozoan communities are included.

9) Acclimation and adaptation in the widespread and narrowly restricted insect species.

10) Local race formation in low-mobility groups such as soil nematodes.

It is unlikely that any large-scale federal support will be forthcoming for work of this kind. (My own attempts to obtain small-scale support to cross over into this domain of fundamental applied research have been rebuffed both by agricultural and "basic" funding agencies.) Nor can we expect to alter the orientation of federal or state agricultural research programs. Rather the initiative will have to come from working scientists who go out deliberately to break the barriers between the "applied" and "fundamental" communities, between "applied" and "fundamental" research, between the state agricultural schools and agriculture research stations on the one hand and the urban "fundamental" biology departments on the other, building up a network of informal channels of discussion and cooperation that at least initially can be independent of administrators' approval.

Perhaps an informal committee for fundamental research in agriculture could meet as an adjunct of the meetings of one or more professional societies for this purpose.

References

1. N. Wade, *Science* **180**, 390 (1973).

NEWS AND COMMENT

Strip-Mining: House, Senate Gird for Renewed Debate

Close in the wake of a bitter contest over the future of the trans-Alaska pipeline, Congress is warming up for this year's second major debate in which the nation's appetite for fuel and the interests of the energy industry are matched against conservationists determined to preserve the American landscape. The subject is strip-mining, and pressures on Congress for some form of federal regulation are growing.

One reason is that nationwide coal production is accelerating, and so is a shift from underground mining to more economical, but damaging, surface operations, which, for the first time last year, produced more than half the nation's coal. Superimposed on these trends is a shift in stripping operations from Eastern states to the West, where more than 70 percent of the nation's low-sulfur coal lies relatively close to the surface of stupendous reaches of plains and desert, from the Navajo lands of northern New Mexico to the Canadian border.

Demands for low-sulfur fuel have been increasing in Eastern and Midwestern cites, and long "unit trains" of 100 coal cars and more are already plying to Chicago from newly opened coalfields in Montana. Higher levels of production have been encouraged by the Nixon Administration to offset the nation's reliance on foreign oil, but as stripping increases, so does the amount of ravaged land. The President's Council on Environmental Quality (CEQ) estimated in March that strip-mining, which began in earnest only after World War II, has dug up 4 million acres, mostly in Appalachia, only half of which have been reclaimed. Stripping operators have left behind some 200,000 acres of unrestored "orphan lands," for which owners cannot be found; several thousand miles of streams polluted by strip mine wastes; and 20,000 miles of exposed "highwalls." The Environmental Protection Agency (EPA) has estimated that stripping disturbs between 4000 and 5000 additional acres a week; environmentalists' opposition has grown apace.

In spite of the lateness of the season, congressional observers see some chance that the House and Senate will agree this session on a bill creating a permit system to regulate strip mine operators. The same law would probably establish a set of minimum environmental "performance" standards operators would have to meet, both in mining and in rehabilitating the land. Still to be settled, however, are working details of the permit system; the precise role of the federal government

versus the states in enforcing the law; and, of critical importance, the strictness and explicitness of the performance standards.

As the month-long August recess approached, the Senate Interior Committee was putting the final touches on a bill (S.425), sponsored by committee chairman Henry Jackson (D–Wash.), that would give state authorities primary control over strip-mining —an approach also favored by the industry and the Administration and strongly opposed by environmentalists, who cite a notoriously poor enforcement record for strip-mining laws already on the books in some 30 states.

In the House, two Interior subcommittees, working jointly on strip-mining legislation, faced the prospect of a sharp fight over a stringent new law proposed in July by committee Democrats. It would require states to set up regulatory agencies within 2 years, and would also create a special strip-mining enforcement office in the Interior Department to serve as a watchdog over the state agencies. As one committee staffer puts it, "The law would place federal authorities just a step behind the states," allowing them to close down mining operations and levy fines if a state agency fell down on the job.

NAS: Water Scarcity May Limit Use of Western Coal

A special panel of the National Academy of Sciences (NAS) has concluded that, unless the American public is willing to pay for massive new diversions of water into the burgeoning coalfields of the Northern Great Plains and the Southwestern deserts, water supplies will not be sufficient both to restore strip-mined lands and to support the large-scale gasification of coal.

In a report to be released later this month, the panel notes that, in most of the Western watersheds where immense mining, gasification, liquefaction, and power-generating complexes are envisioned, existing and potential water supplies are already heavily committed to present and future users; in some river basins, water resources are already overcommitted by 25 percent or more. Any system of dams and reservoirs large enough to improve this situation, the final draft of the report indicates, would bring environmental problems far greater—and considerably less predictable—than strip-mining itself.

The most immediate consequence of the academy report—assuming it passes internal NAS reviews intact—will be to cast a less-than-optimistic light on the practicality of "mine-mouth" gasification plants across the West. Such coal conversion plants are a key element of the emerging energy policies of the Nixon Administration. Indeed, all three of the President's messages on energy since 1971 have endorsed the expanded development of coal reserves, most of which are in the West, and each message has promised more and more money for coal gasification R & D. None of the President's energy messages, however, nor any of his messages on the environment, has broached the concurrent problem of water, a resource the academy panel regards as the "limiting factor" in Western energy development.

Yet water, in large amounts, is essential to coal gasification. By some estimates, a single commercial gasification plant turning out 250 million cubic feet of burnable gas a day would require upward of 20,000 acre-feet of water a year, in part to obtain hydrogen needed in the conversion process.

The academy report, some 200 pages long, is the work of the study committee on the Rehabilitation of Arid Lands, an ad hoc group organized 6 months ago to examine the special problems of restoring and revegetating the lands overlying coal deposits in Arizona, New Mexico, Utah, Colorado, Wyoming, Montana, and North and South Dakota. Headed by Thadis W. Box, the dean of natural resources at Utah State University, the committee is supported by a $53,000 grant from the Ford Foundation's Energy Policy Project in Washington, D.C.

One of the report's main conclusions is that the key determinants to success in healing mine-ravaged arid lands will not be the cost of rehabilitation, but, rather, meticulous advance study of each mining site and the availability of water.

"One of the surprising things to me," a panel member told *Science*, "was the relatively small amount of land you have to disturb in the West to get at a very large amount of coal." The panel concluded that, with so much coal from rather little land, a surcharge of only 3 to 4 cents for each ton of coal mined would cover even the most expensive land rehabilitation, including the shipping in of tons of new topsoil.

What pennies per ton will not buy, however, is water, especially rain. The committee's consensus is that for *most* of the Western coal lands, existing natural supplies of water—as indicated by annual rainfall—are probably adequate for both mining and restoring the land to something near its original condition.

But for the driest of the Western coal lands—as a rough general rule, those receiving 10 inches of rain a year or less—this is not the case. The NAS report concludes that any attempt to restore such lands to their original state will face extreme difficulties and may, in some areas, simply be doomed to failure. Most of these lands are located in the Four Corners area of Arizona, New Mexico, Utah, and Colorado, where strip-mining of Navajo lands helped to catalyze conservationists' resistance to Western coal development in the first place.

In these driest areas, the committee believes, the natural succession of plant life, once disturbed, will not restore itself for decades, perhaps for centuries. Efforts to rehabilitate arid lands by "artificially" replanting them will succeed only with what one academy official describes as "major, sustained inputs of water, fertilizer, and management" for periods of no less than 10 years and—for some regions of the Four Corners area—for perhaps as long as half a century.

The lesson, one panel member said in an interview, is that "without the most careful advance planning on a site-by-site basis, without using the most highly trained people and the most advanced methods, we will fail even at the best sites."—R.G.

This provision is a compromise with a strip-mining bill (H.R. 3) passed by the House last year, by a vote of 265 to 75, that would have given primary authority to the Interior Department.

The new measure has drawn an intense and rather well-coordinated hail of fire from mining and utility lobbies, and environmental groups have managed to mount only a modest countercampaign. How the issue is decided, though, could have far-reaching effects on both the character and the timing of the final legislation.

Among its major differences with H.R. 3, the Democratic bill is broader in coverage—proposing environmental standards for underground as well as for surface mines—and its proposed standards are worded more explicitly, and in some ways more stringently. There are detailed requirements, for example, for such things as the care and storage of topsoil; prevention of pollution from spoil banks; the drafting of rehabilitation plans; and the designation of "fragile and historic" lands for protection from all mining.

Elaborate procedures for public notice, hearings, and appeals—and a provision explicitly allowing for citizen suits to bring court enforcement of the law—are also woven through the law.

Briefing

Train Moves Happily to EPA

President Nixon has nominated Russell Train, chairman of the Council on Environmental Quality (CEQ) since it was established in 1970, to be the new head of the Environmental Protection Agency (EPA).

Train, in a dazzling burst of candor in the context of the Nixon Administration, acknowledged that he had sought the job and was very pleased to have been chosen. He will be stepping into the shoes of William D. Ruckelshaus, who has been nominated for the post of Deputy Attorney General.

Senate confirmation should be no problem. Train has impeccable credentials as a conservationist and has gained considerable national status as CEQ chairman. A former tax court judge and president of the Conservation Foundation, Train joined the Administration in 1969 as Undersecretary of the Interior.

Train, a smooth and diplomatic type, has always been unswervingly loyal to President Nixon, despite the fact that the Administration has not always backed his views. Some environmentalists are concerned that this loyalty will get in the way of his forceful pursuit of EPA objectives, but Train insists he will be "my own man." He pointed out that EPA is beginning a new phase of implementation now that the flurry of major environmental legislation has subsided, and assured his listeners he did not intend to preside over the "piecemeal erosion" of the National Environmental Policy Act. (The Senate recently waived further application of the law to the construction of the trans-Alaska pipeline.)

But whither CEQ? The departure of the prestigious Train means none of its original members remain. The two latest appointees, Beatrice Willard and John A. Busterud, have remained virtually invisible, and some observers are concerned that the office will sink into oblivion. Journalists also wonder whether the CEQ, which under Train has been one of the most open and accessible among the President's executive offices, will remain so under his as yet unchosen successor.—C.H.

Schmidt Takes on FDA

Alexander MacKay Schmidt, dean of medicine at the University of Illinois, has been appointed commissioner of the Food and Drug Administration (FDA). He succeeds Charles C. Edwards, who is now assistant secretary for health in the Department of Health, Education, and Welfare (HEW).

At a recent briefing with the press, Schmidt surmised that he had been selected for the FDA post because of his interest in medical management and administration which, he said, is well known in academic circles. Thus, Schmidt joins the team of new HEW leaders who have all been chosen for their managerial expertise. Asked how he had come to the attention of HEW and White House recruiters, Schmidt said that a number of people, both within and outside government, had submitted his name.

Schmidt, 43, was born in North Dakota and got his medical degree from the University of Utah in 1955. During the 1960's he held various teaching posts at the University of Utah College of Medicine. In 1967 he came to the National Institutes of Health for a year and a half to serve as chief of the education and training branch of the Regional Medical Programs. In 1969 he moved to the University of Illinois, where he became dean and professor of medicine at the university's Abraham Lincoln School of Medicine.

An internist, Schmidt has served on a number of state and national task forces related to manpower, continuing education, and medical school affairs.

In 1968, the graduating class at the Utah College of Medicine gave him the "best teacher award."

Schmidt said the FDA staff is in good shape and he does not plan to make any drastic changes. But he emphasized the need for more in-house scientists—a perennial problem at FDA—and said there was a need to build "better bridges to the scientific world on a day-to-day basis." Schmidt wants to create "increasing openness" of the agency and its actions. "They must be able to stand the light of day," and if they don't, "we'll rethink it and do it over again." He said FDA was increasingly getting into areas that require moral and ethical judgments, and that the agency would increasingly be looking to the public for advice. By "public" he said he was referring to scientists and doctors: "We have been a little shy about having the practicing world on our committees."

Schmidt was reluctant to comment on specific FDA policies, but he said the controversial Delaney clause (which prohibits any level of carcinogens in food) would not be a problem if the public were well enough informed to make its own decisions on the risks it wants to take.

Schmidt does not see any need for FDA to be made an independent agency outside of HEW. "HEW is a massive organization, which means it is heavy, which means it has weight. I want to be able to use the weight of HEW."—C.H.

Another notable difference between H.R. 3 and the Democrats' bill is a provision in the latter bill that would require mine operators in the East to remain responsible for rehabilitated land for at least 5 years, and in the West for at least 10 years.

The Democrats' bill, and to some extent the Senate bill, have benefited from an unusual liaison with the National Academy of Sciences' study panel on arid land rehabilitation (see page 525). At the panel's request, NAS staff officers have briefed House and Senate staff on the panel's deliberations, a rare departure from the secrecy that usually surrounds NAS studies. The usefulness of this liaison has been limited by the fact that congressional staff have not been allowed to read the report (due to be released this month), but its main public policy implications were spelled out in a 23 July letter to Representative Morris Udall (D–Ariz.), chairman of the Interior subcommittee on environment.

The letter, from Ralph A. Llewellyn, an NAS staff officer, emphasizes in part that:

> We find that most state laws governing surface mining and rehabilitation in the West do not provide for adequate planning, monitoring, enforcing, and financing [of] rehabilitation. . . . For these reasons it is apparent that a strong federal "floor" must be provided for regulating rehabilitation. . . . It is also very desirable to provide for substantial public participation in the entire rehabilitation program, from evaluation of pre-plans through the decision regarding success of the results.

In the letter, Llewellyn said the panel also felt strongly that areas of special historic, scenic, archeological, or biological interest should not be mined if the resulting damage could not be undone.

Backers of the Democrats' bill think their measure better reflects such concerns, and some members of the academy panel privately agree. The mining industry and Western utilities, however, seem to regard the bill as an unmitigated disaster. Using identical phrases in separate telegrams to the House Interior subcommittees, the American Mining Congress (which represents the mining industry) and the National Coal Association have declared the Democrats' bill "so unworkable" that it would "virtually prohibit surface mining of coal . . . at the very time the nation is looking to coal as a solution to the energy crisis."

One of the most detailed industry critiques of the bill comes from the Western Systems Coordinating Council (WSCC), representing 42 Western utilities. Among other things, the WSCC objected to provisions that might be used to bar mining from "historic, or fragile, or a natural resource area," and urged instead that such decisions be left to "long-term land use planning" by individual states. The WSCC also objected to a section of the Democrats' measure that would give Indian tribes the same rights and responsibilities as states in regulating mining on reservations, and requiring tribal consent for working both new and existing mines. The council complained that Indians might use this as leverage to make "exorbitant demands" on utilities. A similar provision was deleted from the Senate bill.

Oddly enough, the industry now seems to favor H.R. 3 as the starting point for legislation in the House, even though it fought the bill tooth and nail last year. It may be that industry senses an inevitability about strip-mining legislation, but the choice of H.R. 3 as the "markup" bill would clearly be to its advantage. Interior Committee Democrats would likely respond with a long series of amendments, and the ensuing delays could leave the 93rd Congress closing shop without a strip-mining law on the books.—ROBERT GILLETTE

A Conversation with Eugene Wigner

Eugene Wigner is one of the scientific emigrés who left Europe in the 1920's and 1930's and settled in the United States, providing a crucial leavening of American science. Wigner is now 70 and living in active retirement in Princeton.

His association with the university goes back more than 40 years, spanning an era in which physics and the world changed profoundly. Wigner has been a close observer of and, as a physicist, a major contributor to those changes. His generation reached maturity near the close of the heroic age of physics, dominated by figures such as Bohr and Einstein; Wigner himself played a leading role in establishing the foundations of nuclear physics. He became involved in a fateful scientific decision when, at the start of World War II, he joined with other scientists in conveying the information which persuaded Einstein to write the now famous letter to President Roosevelt which alerted him to the implications of German research in atomic physics. This started the train of events which resulted in the American atom bomb project. During the war, Wigner headed the theoretical physics section at the Metallurgical Laboratory of the University of Chicago, where the first chain reaction was achieved. At the end of the war, he was active in organizing atomic scientists in the successful lobbying effort for civilian rather than military control of atomic energy. After the war, Wigner served for a year as codirector of the Oak Ridge laboratories when serious work on power reactors was begun. He then returned to Princeton, where he continued the research for which he shared the Nobel Prize in 1963. Over the years, a great many of the principal honors and offices that government, universities, and professional societies bestow have come his way.

Wigner did not become a public figure in the way that his Hungarian-born colleagues Edward Teller and the late Leo Szilard did, but this does not mean that he has avoided controversy. Since World War II, American scientists who worked on military projects have tended to identify with one of two general attitudes toward nuclear policy, and especially toward relations with the Soviet Union. The two groups might be labeled conservatives and liberals. The former, generally, have felt that national security depended on the United States maintaining at least comparable nuclear strength, while the latter group put less stress on a strict nuclear balance and more on effective arms control agreements and political détente. Wigner has sided consistently with the conservatives and has expressed his views most vigorously in advocating a stronger civil defense program.