ments. Most museums have the potential to answer such questions but few have the capacity to do so. The development of such a capability is one of the important projects now exciting the Smithsonian Institution's Museum of Natural History.

This museum is looking toward the computer sciences, not only as a means for more economical ways to process specimens and associated data, but also to provide an information system which will put in the hands of the scientists the capability of making valid correlations regarding population composition, distribution, habitats, and so forth, on the basis of a reasonably large sampling. From tests with source automation-data systems, it has been found at the Smithsonian that they increase productivity of a cataloger or data recorder by 70 percent or more. In addition, data can be recorded and encoded in such a way that they are machine-readable, thus making the exchange of information among a wide variety of users feasible and easy. By storing such data in ways which are readily filed and searched, queries involving the names of taxa, geographic distribution, species diversity, or faunal assemblages could be answered. By this means, the museums will reach their greatest fulfillment as repositories of information.

Squires believes that if museums do not undertake this role of actively accumulating complete information for analytic and synthetic use and thus become a library of factual and interpretative documentation their useful lifetime is limited. Whether or not data-retrieval systems are used, the museums must provide cross-linkage between their specimen holdings, their documentation, and the literature about objects in their collections. It is part of an experimental project of the Smithsonian Institution's Museum of Natural History to develop such ties.

With respect to technology, we are only a few years away from the potential of unlocking the future storehouses of documentation and entering into a direct dialogue with the scientific community. The identification of plants and animals, through the use of keys operated on an on-line, real-time basis in the conversational mode through computers is a reality in at least a dozen natural history establishments in the United States. A decade from now it may be possible to make plant or animal identification by voice interrogation directly through telephone lines to central computational facilities. Maps of species based on the holdings not only of one museum, but of the museums of the world should be an automatic output 25 years from now. Answers to complex questions about the associations of species and about the ecological settings from which they were taken, as well as changes in that setting should also be part of the repertoire of the museum of the future.

Thus, the museums' role as a communications link is a real and recognized one, reaching perhaps a broader range of users than any other kind of institution. Their long-stored, carefully developed fund of information is a continuously producing source of knowledge which is increasing in value and which will increase at a still more rapid rate with the use of modern communications techniques.

Note

1. The chairman of the session was S. R. Galler, assistant secretary (Science) of the Smithsonian Institution, and the panelists were: J. A. Oliver, director, American Museum of Natural History, New York; H. R. Roberts, director, Academy of Natural Sciences, Philadelphia; H. Friedmann, director, Los Angeles County Museum, Los Angeles; and D. F. Squires, deputy director, Museum of Natural History, Smithsonian Institution, Washington, D.C. Mrs. Ileen E. Stewart, National Institutes of Health, arranged the symposium as a feature of Section T, Information and Communications.

NEWS AND COMMENT

Lake Michigan: Salmon Help To Redress the Balance

Last September throngs of sports fishermen showed up on Lake Michigan suffering from "coho fever," a condition which is expected to return again this fall. Young coho salmon had been planted by the Michigan Department of Conservation in two Lake Michigan tributaries some 18 months earlier, and now they were due to return as heavy, mature fish. Return they did, concentrating by the thousands in the lake waters near the mouths of the rivers in which they had been planted, then starting their run upstream to spawn. True to its nature, the coho struck savagely at the anglers' lures, and some 60,000 of them were caught. These fish weighed an average of 12 pounds or better, and excited fishermen often displayed 20-pounders in triumph.

The coho, a native of the Pacific northwest, had not been introduced in Lake Michigan simply to produce a fever in fishermen, however. Besides being a magnificent sports fish, the coho is a voracious predator that is expected to help control the superabundant alewife, a type of herring which invaded Lake Michigan about 20 years ago and recently has become the lake's dominant and least-welcome fish species. The alewife has displaced several commercially important native species (such as the lake herring) and has caused distress because of massive die-offs that pollute beaches and drive away tourists. It is hoped that, through the stocking of Lake Michigan with the coho and other predatory sports fish, the alewife will be converted from a nuisance to a valuable forage species.

The introduction of the coho is only part of a bold strategic intervention by the Michigan Department of Conservation in a lake ecology in which, for various reasons, a desirable balance has been lost. This intervention involves, in addition to the stocking of predatory fish, the rigorous control of commercial and sports fishing and an ambitious interstate and federal effort at pollution abatement. The Department of Conservation is, moreover, taking a leading part in efforts to curb the use of persistent pesticides—a particularly potent lake pollutant now suspected to have been the cause of heavy mortality of coho fry last winter in state fish hatcheries. In short, at the same time that this state agency seeks to establish a balanced and valuable new fishery, it is trying to save Lake Michigan.

The salmon-stocking program has grown steadily since the initial plantings in Lake Michigan and Lake Su-

NEWS IN BRIEF

● **FOGARTY INTERNATIONAL CENTER:** Funds for the John E. Fogarty International Center for Advanced Study in the Health Sciences have been appropriated. The center, which will be directed by Milo D. Leavitt, Jr., former director of the National Institutes of Health Office of Program Planning, will house an international conference and seminar program, a scholars-in-residence program, a foreign visitor center, and an international fellowship and exchange program. Named for the late Rhode Island Congressman John E. Fogarty who had long supported plans for the creation of an international health sciences study center, it will cost about $3 million and operate within existing NIH facilities until its construction is completed in 1972.

● **UNIFORM STANDARDS:** The National Bureau of Standards is supervising replacement of state weight and measure standards to improve measurement accuracy throughout the nation. Uniformity of measurement began in 1836 when the federal government was authorized by Congress to supply each state with a uniform standard of weights and measures. The new sets, which will be provided to about 10 states per year until all state standards have been modernized, will cost the federal government about $70,000 each.

● **NATIONAL SCIENCE BOARD:** Philip Handler, Duke University biochemist, has been reelected to a second 2-year term as chairman of the National Science Board, the 24-member policy-making body of the National Science Foundation. Also elected to the board's five-member executive committee are E. R. Piore, vice president of IBM, and Harvey Brooks of Harvard. They join committee members Robert Morison, of Cornell, and Leland J. Haworth, director of NSF.

● **HARVARD SCIENCE CENTER:** Harvard University President Nathan M. Pusey has announced plans for a new Science Center for undergraduate and graduate research and instruction. The new building, financed by an anonymous alumnus gift of more than $12 million, is the largest item in a $48.7 million program for developing science facilities at Harvard.

● **BUBONIC PLAGUE:** Colorado Department of Health officials have announced that recent tests reveal that 11 dead squirrels found in the Denver area all showed positive signs of bubonic plague. State and city officials are on the alert for further signs of the disease.

● **EDUCATION ASSESSMENT:** A major federal grant, totaling $370,000, has been given to the Committee on Assessing the Progress of Education (CAPE) by the Office of Education. CAPE, begun in 1964, has been supported in the past largely by the Carnegie Corporation and the Fund for the Advancement of Education, which together have contributed about $2 million to the project. The new federal grant will enable CAPE to continue plans for gathering census-like data on educational attainment, which may be used to judge the nation's educational system, levels of performance, and testing standards. The actual assessment, which will begin its first phase in 1969, will assess science, writing ability, and citizenship; it will take into consideration geographical location, socioeconomic status, sex, and urban-rural environmental factors.

● **NEW PUBLICATIONS:** The Society for the Experimental Analysis of Behavior has announced the publication of a new quarterly entitled the *Journal of Applied Behavioral Analysis*. Subscriptions for individuals may be obtained for $8 from Mrs. Mary Louise Sherman, Department of Human Development, University of Kansas, Lawrence 66044.

A new compilation of some 125,000 scientists and engineers, the *International Directory of Research and Development Scientists*, will be available next month for $60. An introductory offer of $47.50 is now in effect. For copies, write Institute for Scientific Information, 325 Chestnut Street, Philadelphia, Pa. 19106.

Government Patent Policy, an annual report by the Federal Council for Science and Technology, contains pertinent regulations regarding invention rights arising from government-sponsored research. Copies may be obtained for 25¢ from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

perior tributaries in the spring of 1966, and appears enormously successful. Several million young salmon, mostly cohos but also Chinook salmon (a larger, more slowly maturing fish) in substantial numbers, have now been planted in more than a score of Michigan streams.

As many as a third of the coho planted in Lake Michigan tributaries in 1966 survived and grew to maturity. Those not taken by fishermen were either allowed to complete their spawning run or were captured in weirs by the Conservation Department and stripped of their eggs, or sold for market. The coho also thrived in Lake Superior and, last fall, provided exciting sports fishing there.

However, the Lake Superior coho were much smaller than their brothers in Lake Michigan, and the percentage surviving from the 1966 planting was substantially lower. Chiefly, this is because, in Lake Superior, alewives have not attained the abundance they have in Lake Michigan. The Lake Michigan coho feeds largely on alewives, although some authorities suspect that his diet also includes lake trout, perch, and other desirable species.

Thirty years ago Lake Michigan had a well-balanced and highly productive fishery from which the alewife was totally absent. The lake trout and the burbot (a freshwater fish allied to the cod), both abundant and widely distributed, were the principal predators. Other lake fish included yellow perch and several species of chub, as well as smelt, lake herring, and other forage fish.

This fishery ecology was upset by the alewife and an earlier invader, the sea lamprey. The lamprey, a predator which attaches itself to its victim by means of its sucker-like mouth and feeds on the blood of the host fish, has inhabited Lake Ontario since postglacial times. The opening, in 1829, of the Welland Canal, which provided a bypass around Niagara Falls, gave the lamprey access to Lake Erie and the upper Great Lakes. By the 1930's the lamprey had reached Lake Huron and Lake Michigan, and by the end of the 1940's it had nearly destroyed the lake trout and other predatory fish of both lakes. In the early 1950's the lamprey became well established in Lake Superior, again having a catastrophic effect on the lake trout and other large fish.

Significantly, the alewife, an anadromous species native to the Atlantic,

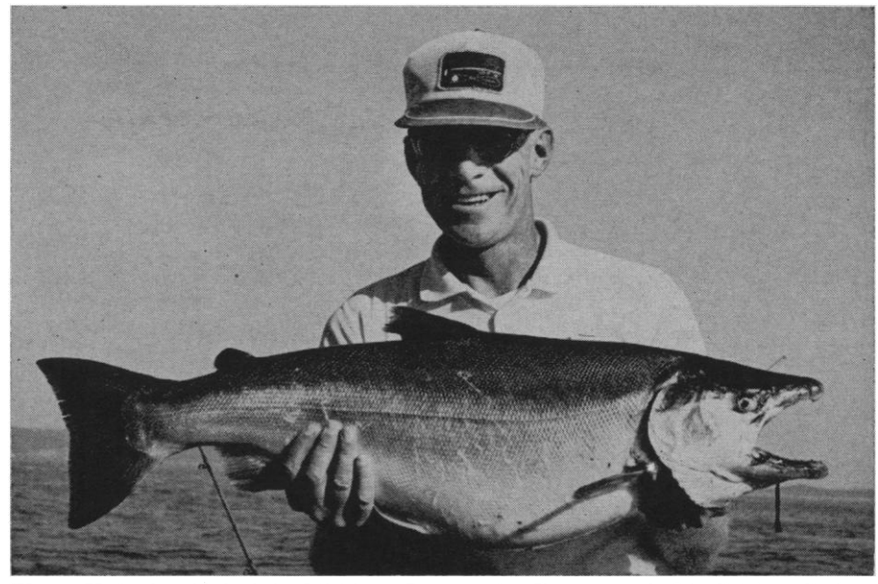
was not discovered in Lake Michigan until 1949, when the predators that probably would have controlled it were nearly gone. In these favorable circumstances the alewife multiplied rapidly, its proliferation seemingly unchecked except by periodic die-offs which sometimes (as in 1967) left windrows of rotting fish along Lake Michigan beaches. The alewife has some commercial uses, as in pet food and fish meal, but the market for it has developed slowly and has been unstable.

Restoration of predatory species and a better balanced lake fishery could not have succeeded before the sea lamprey was brought under control. Such control has been achieved in Lake Superior and Lake Michigan, however, by the Great Lakes Fishery Commission—principally through treatment, with selective poisons, of the streams in which the lamprey spawns.

Decline of the lamprey has allowed Michigan's fish-stocking program to make a promising start, but continued success will depend on whether other threats are overcome. Persistent pesticides, especially dieldrin and DDT, are an immediate danger. Howard Johnson, a fishery biologist at Michigan State University, has concluded that DDT residues were the "most probable cause" of the mortalities of the coho fry. These hatchery fish were produced from eggs taken from Lake Michigan coho; the eggs had DDT residue levels from two to five times higher than the levels found in eggs taken from fish recovered in Lake Superior.

A longer-term threat is that the over-enrichment of Lake Michigan waters by phosphates and other nutrients will lead to accelerated eutrophication, similar to that found in Lake Erie where, in some areas, heavy algal growth covers the surface and washes up along the shore.

Stanford H. Smith, of the U.S. Bureau of Commercial Fisheries Biological Laboratory at Ann Arbor, believes that Lake Michigan's coho and other salmonid species might have difficulty surviving under eutrophic conditions. Such conditions have inhibited the natural reproduction of Atlantic salmon and lake trout in Lake Ontario and Lake Erie, he observes. As to how a Lake Michigan salmon fishery largely dependent on hatchery reproduction would fare under eutrophic conditions, Smith is uncertain. But he is convinced that to allow the present over-enrichment to continue is a poor gamble.



Wayne H. Tody, chief of the Michigan Conservation Department's fish division, displays a big coho—grown up after an 18-month diet of alewives.

Michigan's coho-stocking program faces another uncertainty, both in the short- and long-term, in that its success depends on the continued availability of a highly abundant forage fish. It is possible that the coho, along with the lake trout and other predators which have been coming back since the decline of the lamprey, will succeed all too well in reducing the alewife population. Commercial fishermen also take significant quantities of alewives. As state fishery biologists well know, the effect on the alewife of these two factors—heavy predation and a substantial commercial catch—will have to be closely watched.

The Department of Conservation is, in fact, moving on a wide front to attack all the problems, actual and potential, facing the new coho fishery. It is a large, scientifically oriented department, and fish, game, parks, forests, and water resources are all under its jurisdiction. (Its name soon will be changed to "Department of Natural Resources," a designation deemed more suggestive of the agency's broad mandate.) The one major natural-resource area outside the Department's ambit is agriculture. The Department has, in trying to discourage use of "hard" pesticides, clashed with agricultural interests—with people who, understandably, are more concerned about protecting crops than about protecting Lake Michigan salmon.

Ralph A. MacMullan, Director of Conservation, supported a bill introduced in the Michigan legislature this year to establish a powerful state pesticide control committee, which he would chair. If this potent body decided that a particular pesticide was too hazardous, it could not only ban use of the pesticide but also forbid its sale in Michigan —even though the pesticide had been registered and approved by the Michigan Department of Agriculture (MDA).

Opposition to this measure by MDA officials and others was sufficient to delay action, and the bill did not come to a vote. A similar bill will be introduced next year, however, and it is expected to receive strong support. Warnings by MacMullan, prior to the losses of coho fry, that pesticides posed a threat to the new salmon fishery aroused public interest last year. Following the advice of entomologists at Michigan State University, MDA later withdrew its recommendation to municipalities that DDT be used to combat Dutch elm disease and recommended that other control methods, involving some use of methoxychlor (a less persistent pesticide), be used instead.

Awareness of the pesticide problem is growing in the upper Great Lakes region generally, and, on 31 July, conservation officials of Michigan and the three other Lake Michigan states—Indiana, Illinois, and Wisconsin—pledged to seek better control of pesticides through research and other means, including the adoption of new laws and tighter water quality standards. They noted the mortalities of coho fry and warned that, unless use of pesticides is soon controlled, the consequences for Lake Michigan will be disastrous. The Michigan Department of Conservation was a prime mover behind this new four-state agreement.

M. P. Rebuked for CBW Disclosure

London. When it comes to withholding information, the U.S. Congress is as tight as a wormy canoe, and, though it is routine for offended parties to protest raucously, steps are rarely ever taken to punish the passers or recipients of embargoed material. It's different here; and as evidence of this, we can consider the case of Tam Dalyell, a young Labor M.P. from Scotland, who, as a member of the Select Committee on Science and Technology, has achieved distinction for persistent inquiry into the mysteries of research policy making. Often, this has been to the embarrassment of the government, which, as is the case in the United States, generally takes the position that everything either is fine or is in the process of becoming so.

Of late, Dalyell has been particularly interested in the politically volatile subject of chemical and biological weapons (CBW) and has been campaigning to eliminate secrecy at the Porton Down research facilities, some 80 miles southwest of London, where the Defence Ministry carries on work in these fields (*Science,* 21 June). Last week, Dalyell's campaigning brought him further distinction when the House voted, 244 to 252, that in the zealousness of his antisecrecy campaign, he had violated venerable rules of parliamentary conduct last spring by handing a copy of an unpublished Select Committee document on CBW to an inquiring reporter from the *Observer.*

"Breach of Privilege and Gross Contempt"

Dalyell humbly pleaded guilty, though explaining that he had passed the document—a transcript of the Select Committee's hearings into what goes on at Porton—in the belief that it was to be published without change within a few days. The House then reprimanded him for "breach of privilege and gross contempt," and the matter ended there, amidst a good deal of private talk, however, to the effect that Dalyell had offended more by making a nuisance of himself on the politically volatile subject of CBW than by transgressing Parliament's publication procedures. Prior to the vote, there was speculation that a severe reprimand might force him to resign his seat, but, by and large, there was more sympathy for Dalyell than is suggested by the vote; and the press, of course, generally took the position that there is nothing wrong with slipping papers to the press. (The *Guardian* headlined its account, "Medieval rebuke for Mr. Dalyell," and noted that, prior to delivering the reprimand, the Speaker donned a three-cornered black hat "which he keeps under his seat for such rare occasions.") This was the first time such a case had come up in 21 years.

The committee on privilege, which conducted a hearing into the matter also concluded that both the author of the article and the editor of the *Observer* had committed contempt of the House, but the committee recommended that no action be taken against them.

The *Observer* article, published 26 May, did not contain any information that was deleted from the published version of the Select Committee transcript. But having gotten a good scoop, the *Observer* made the most of it. What it took special note of, in a front-page story headlined, "Biological Warfare: Dons Named," was that the chemical and microbiological establishments at Porton had contracted for research to be conducted at some 25 universities and research centers throughout Britain. Though individual researchers were not named in the transcript, there were sufficient leads for identifying a good number by name, and, once this was done, the usual barrages and counter-barrages began to fly on the subject of the propriety of academics engaging in CBW research. It is said by some who are in a position to know that, at that point, the Defence Ministry proceeded to offer encouragement for the House to take disciplinary action against Dalyell.—D. S. GREENBERG

However lax they may have been in the past, the Lake Michigan states now approach pollution problems with greater urgency. The agreement reached in a four-state pollution abatement conference held in Chicago early this year included a provision especially significant for the lake's fishery ecology. By the end of 1972, all cities in the watershed are to start removing from their wastes at least 80 percent of the phosphorus—a nutrient which plays a key part in the eutrophication process. Other forms of municipal and industrial pollution also are covered by the agreement, and, according to Murray Stein, chief of enforcement for the Federal Water Pollution Control Administration, abatement schedules are being followed in good faith. The Michigan Department of Conservation is campaigning for a $335-million "clean water" bond issue proposal, which is to be voted on this November. The bonds would help finance municipal sewage treatment facilities.

Remedies far more radical than anything now planned are being advocated by some, however. For instance, the Bureau of Commercial Fisheries has taken the position—in a paper prepared by Stanford Smith of its Ann Arbor laboratory—that, ultimately, all wastes must be diverted from the Lake Michigan drainage into the Mississippi drainage. Otherwise, the Bureau says, accelerated eutrophication will be inevitable. Yet diversions from the lake on the scale suggested would affect water levels, and, as the 30-year history of Chicago's diversion of Lake Michigan water into the Illinois River attests, major political and legal problems involving all the Great Lakes states and Canada would be unavoidable.

Even though the future is clouded with uncertainty by pollution problems, the Michigan Department of Conservation is going all out in a program of fishery management believed to be unprecedented in scope and complexity. In addition to its rapidly expanding hatchery operations, the Department will improve stream habitat and build fishways for coho and other lake-run species. Further, it is trying to manage the lake fishery so as to keep a balance between predator and prey. The Department has just been given regulatory powers which, in their comprehensiveness, can be matched in only one other state (Minnesota, which has no large fishery).

A new state law authorizes the Department to limit the number of commercial fishing licenses issued; fix catch quotas; prescribe when, where, and how catches may be made; and recover up to 5 percent of the value of the catch. Moreover, several years ago the Department stood tradition on its head by deciding that development of the sports fishery, rather than the commercial fishery, was to be its primary task. This new emphasis is reflected in a variety of ways. For example, to protect the young coho, severe restrictions have been placed on the setting of gill nets. And, for the moment, commercial fishing for coho is not allowed.

Clearly, the Department is operating on a level of sophistication beyond that of the fish and game agencies in most states. MacMullan, its director since 1964, is a trained biologist who has given greatly increased emphasis to research and development. The Department's fishery research stations and laboratories, which have a reputation for scientific competence, are playing an important part in the new coho program.

The stocking of coho was preceded by a thorough review of available information about the characteristics of this salmon and its adaptability to freshwater environments. The program is nevertheless in many respects a venture in the dark, involving as it does the introduction of an alien species into a huge inland sea of which the physical dynamics and biology are but dimly understood.

This venture is taking place, however, when Great Lakes research is in vogue. For example, scientists from Big Ten universities and elsewhere have been exploring, with the support of the Department of the Interior's Office of Water Resources Research, the possibility of developing water-quantity and water-quality models of Lake Michigan and the other Great Lakes.

But while such investigations may not produce significant results for years, the pressing nature of Lake Michigan's fishery problems are evident, spectacularly so when a massive and revolting die-off of alewives occurs. Hence, the Department of Conservation must try to cope by manipulating nature in the raw, and in the large.

—LUTHER J. CARTER

Protein Supplements: AID Focuses on Background Problems

In many parts of the world, diet deficiency, rather than shortage of food, is a severe cause of malnutrition. When the United States responded to this situation by supporting extensive research in food fortification, it found itself involved in a whole array of problems, beyond simply developing a supplement.

Universities such as M.I.T., Harvard, Cornell, and Purdue have been working for some time, under government contract, on development of high-protein food. But allied problems, such as difficulties of marketing and distribution, rejection by intended consumers, and resistance from competing food companies have been pushed into the background.

Now, with the growing realization that development of low-cost, high-protein foods is of little use if people don't eat them, a more thorough evaluation of a whole complex of problems is being attempted.

An unusual program developed by the Agency for International Development (AID) does just that, and involves private industry as well. In collaboration with the Agriculture Department, AID encourages private companies to investigate the possibilities of developing new foods and marketing them where protein deficiency exists. The plan incorporates the use of sophisticated marketing-research techniques for determining the food preferences in underdeveloped economies.

The experimental 3-year AID plan provides $60,000 each to private companies to study foreign markets and distribution systems, to develop food prototypes, and to make investments abroad. Nine federal grants have been awarded thus far, to Monsanto, Swift, and General Foods, among others, to develop and market such products as soybean beverages and cottonseed concentrates.*

After a year, the AID program continues to look promising on paper, but the individual projects face a number of major problems. A typical case is that of the Pillsbury Company, which was awarded a grant to develop a new protein beverage for El Salvador; Pillsbury was the first company to receive an AID grant, and its project is the most advanced. Planning began some 15 months ago, when Pillsbury signed the government contract for a test marketing development.

Besides the $60,000 provided by the government, Pillsbury has invested about $300,000 of its own money in product development, and a powdered beverage called "Frescavida" is ready for marketing. The company expects that its initial investment will allow it to develop other products as well. Pillsbury selected wheat germ as the protein concentrate for the beverage because it was readily available.

El Salvador is an agricultural nation with a dense population and severe problems of malnutrition. Because consumption of soft drinks is quite high there, preliminary research indicated a marketing potential for Frescavida. Howard E. Bauman, Pillsbury's corporate research director, told *Science* that the company anticipates a profitable future for the product, but Pillsbury faces some problems.

It will be necessary to create an effective distribution system, with emphasis placed on reaching a large number of people at relatively low cost. Initially, Frescavida will be marketed

* For the calendar year 1967, the Agency for International Development signed contracts with the following firms: Pillsbury, a protein beverage called "Frescavida" for El Salvador; Monsanto, a soy beverage called "Puma" for Brazil and Guyana; Swift, a soy-milk beverage for Brazil; Krauss Milling, a fortified corn product for Brazil; International Milling, a fortified wheat product for Tunisia. In 1968, the following contracts were signed: Dorr-Oliver, a cottonseed protein product for India; Swift, a protein beverage for India; General Mills, a soy and cottonseed product for Pakistan; and California Packing, a protein beverage for East Africa. There are a number of projects still pending.