piece connecting the shaft to the point's socket), and limestone tablets with geometric or animal-shaped designs scratched into the surface. Both peoples also left caches of partly worked stone points, buried in red ochre, stored around the countryside.

Stanford admits that there are a couple of rather large apparent obstacles to the theory, namely the Atlantic Ocean and the at least 5000-year gap between the last Solutreans and the Clovis culture. But he argues that the Solutreans were being pushed toward the coast for survival as glaciers covered most of Europe. Long hunting trips along the southern fringe of the ice could have taken them farther and farther west—all the way to what is now New York, says Stanford. The seas would have been cold and thus relatively calm, so the trip could have been rapid—perhaps only 2 weeks, he says—and seabirds, fish, and marine mammals would have been plentiful on the edge of the ice.

As for the timing, Stanford points out several eastern Clovis sites that, although controversial, may be as ancient as the Solutreans. At Meadowcroft Rock Shelter in Pennsylvania, for example, deposits dated at 16,000 years ago contain unfluted projectile points that Stanford says "could represent a transitional technology between Solutrean and Clovis."

Even if the Solutreans crossed the Atlantic, Stanford agrees that Asians also must have discovered America, as DNA data show that today's Native Americans have Asian roots. But he notes that some Native Americans carry a mitochondrial DNA marker known as haplotype X, which has been traced back to Europe (*Science*, 24 April 1998, p. 520).

Reactions to the Solutrean solution often seem to depend on researchers' openness to alternatives to the Bering land bridge scenario. "I love it," says biological anthropologist Richard Jantz of the University of Tennessee, Knoxville, who has noted a few skeletal similarities between paleo-Indians and Europeans. Dillehay thinks the Solutrean link is at least as plausible as the idea of skirting ice sheets in boats along the Pacific coast to America. So does archaeologist Reid Ferring of the University of North Texas in Denton. "If we just pretended there were no oceans, we would immediately be drawn to Western Europe" as a likely point of origin for the Clovis people, he says.

But other anthropologists, including those skeptical of pre-Clovis ideas, tend to be wary of the Solutreans. The time gap alone makes it implausible, says archaeologist Stuart Fiedel of John Milner Associates in Arlington, Virginia, who authored a scathing critique of the Monte Verde work (*Science*, 22 October, p. 657) and also doubts the Meadowcroft dates: "It's an old idea that has been rejected at least twice." And some experts in European archaeology completely reject the idea. New Mexico's Straus says the Solutreans had a "vast diversity" of tools, most of which "don't bear any resemblance to Clovis." And they left "no evidence" of boating or deep-sea fishing, much less the ability to take 5000-kilometer cruises. He considers the similar tools a simple case of technological convergence.

Stanford admits that the Solutreans created many kinds of artifacts that aren't found in Clovis sites, but "there's very little in Clovis that is not found in Solutrean," he insists.

Despite the strong critiques, other researchers say that the lively interest in the idea is a sign of changing times, as anthropologists begin to consider alternative routes to the Americas. "If [Stanford] had gotten up 10 years ago and started talking about wandering Spaniards," says James Adovasio of Mercyhurst Archaeological Institute in Erie, Pennsylvania, lead excavator at Meadowcroft, "he would have been laughed out of the room." **–CONSTANCE HOLDEN**

RICE BIOTECHNOLOGY

Rockefeller to End Network After 15 Years of Success

The Rockefeller Foundation is closing the books on an ambitious $100 million effort to develop and disseminate new molecular tools to improve rice

PHUKET, THAILAND—Nobody threw rice. After all, it was the end, not the beginning, of a relationship. But tossing a few grains would not have been out of place as rice scientists from around the world gathered*—perhaps for the last time—to celebrate a 15-year effort by The Rockefeller Foundation linking the revolution in molecular biology to Asia's most important food crop and to mark the next phase of the venture. Most of the nearly 400 who met here recently were trained with Rockefeller money. But now they're on their own: The foundation has decided to shift its agricultural resources to problems facing subsistence farmers, with an emphasis on traits rather than specific crops and a focus on sub-Saharan Africa.

The International Program on Rice Biotechnology has disbursed $100 million since 1984 to foster cutting-edge genetics research aimed at helping rice farmers in the developing world. Its legacy: a community of rice researchers that has created more prolific, robust, and nutritious strains. "The Rockefeller Foundation rice biotech program is an outstanding example of a well-planned and -executed funding program," says Gurdev Khush, principal plant breeder at the International Rice Research Institute (IRRI) in Los Baños, the Philippines. "Other funding agencies could learn a lesson from [its] success."

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Rice colonels. Robert Herdt, left, and Gary Toenniessen manage Rockefeller program.

Rockefeller already had a track record in agriculture before it began the rice initiative, beginning with work in China in the 1930s and extending to IRRI's creation in 1960. But in the early 1980s, foundation officials began to worry that the increased yields and improved nutrition promised by the genetic engineering of plants were not going to be applied to rice. "At that time, there was essentially no research being conducted in rice molecular biology outside of Japan," says Gary Toenniessen, deputy director of the foundation's Agricultural Science Division. The foundation hoped to reverse that pattern by enticing leading plant science laboratories in advanced countries to work with rice, while building up the capacity of developing countries to carry out biotechnology research and integrate those efforts into national rice-breeding programs.

The two-pronged strategy was spectacularly successful in attracting the interest of topflight scientists. The foundation lured 46 labs in the industrialized world into the program, and by 1987 it was spending nearly $5 million a year on these ef-

* General Meeting of the International Program on Rice Biotechnology, 20 to 24 September, Phuket, Thailand.

forts (see graph). Investment in developing countries rose almost as fast. Rockefeller began sending promising Asian scientists to the labs it was supporting in the industrial countries, as well as putting money selectively into Asian facilities that could support their work once they returned home. From almost nothing in 1984, the foundation's investment in both training and capacity-building grew to nearly $4 million a year by 1989; it has remained at roughly that level ever since.

Robert Herdt, Rockefeller's director of agricultural sciences, ticks off an impressive list of successes, including rice lines that are tolerant of high-aluminum soils and the identification and transfer of a gene associated with resistance to bacterial blight. The program's greatest achievement, however, has been support for work that incorporated the synthesis pathway for β-carotene, the precursor to vitamin A, into rice. Herdt says an estimated 400 million people dependent on rice suffer vitamin A deficiency, with its associated vision impairment and disease susceptibility.

Networked. Ingo Potrykus, above, and Qifa Zhang are Rockefeller grantees.

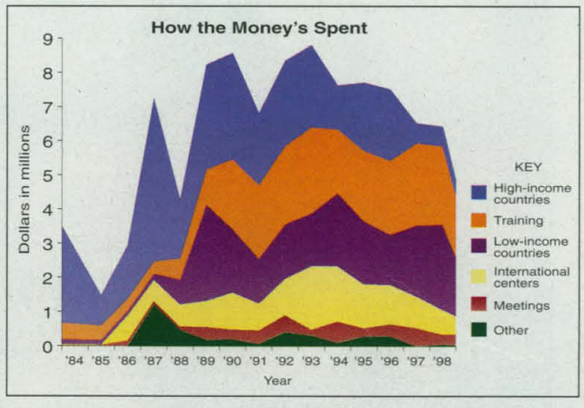
No one had ever transferred several genes into rice at the same time. The feat was finally accomplished this year by Ingo Potrykus, a plant molecular biologist at the Institute for Plant Sciences of the Swiss Federal Institute of Technology in Zurich, and his collaborator Peter Beyer of the Center for Applied Biosciences at the University of Freiburg in Germany (*Science,* 13 August, p. 994). "It's a tour de force," says James Peacock, a plant scientist from Black Mountain Laboratories in Canberra, Australia, and vice chair of The Rockefeller Foundation's Scientific Advisory Committee. "It has huge potential to reduce one of the [world's] most prevalent and serious nutritional deficiencies." Potrykus says the continued support from the rice biotech program allowed him to persist despite deep skepticism from colleagues and that its demise will make it harder to pursue such high-risk research: "Most funding agencies are very conservative."

The second leg of Rockefeller's support for rice biotechnology focused on graduate students and postdoctoral fellows, as well as training courses for scientists to learn such skills as transferring genes for specific traits. "The training is very, very important," says Qifa Zhang, a plant molecular biologist at Huazhong Agricultural University in Wuhan, China. Zhang notes, for example, that virtually all the techniques his team is using to understand what accounts for the increased vigor of hybrid rice plants "were developed within the framework of the [Rockefeller] program."

Over 400 researchers from developing countries have received some sort of training under the program, and at some institutes they make up a critical mass of talent. Of eight senior researchers on the biotech team at the Philippine Rice Research Institute in Maligaya, for example, five earned their doctorates with Rockefeller grants and one received a postdoctoral career development grant for collaborative research with an advanced lab. "Without the support of The Rockefeller Foundation, it would have been almost impossible for us to build this capability," says Leocadio Sebastian, the institute's deputy director for research.

As the skills of their scientists improve, developing countries have received an increasing share of program funding. Herdt says that the proportion going to advanced countries has fallen from 70% in the early years to 10% currently. International centers and labs in developing countries now get 60% of the funds, with the rest going for education.

Along with that increased funding came increased expectations, which Asian scientists appear largely to have met. Herdt says today's proposals have to satisfy the same standards as those from the United States and Europe. The results were obvious at Phuket, Peacock says: "This meeting has been as good as any scientific meeting we go to."



Moving target. Rockefeller's initial investment in industrial-world labs shifted to Asian scientists once the technology was developed.

And success is not confined to the laboratory. Herdt says that Chinese farmers are already using a disease-resistant rice variety produced using tissue culture, and other varieties genetically engineered for greater disease and pest resistance are being tested elsewhere. Several countries have improved local varieties by augmenting traditional breeding efforts with such biotech tools as molecular markers, which function as tags for traits and allow researchers to determine quickly if a target trait has been picked up by a crossbred plant. On a broader scale, he notes that China, India, and Korea have integrated biotechnology into their national rice research programs, and that the Philippines, Thailand, and Vietnam are moving in that direction. At the same time, Toenniessen admits that countries like Bangladesh have been unable to profit fully from the program because of the limited scope of their own research efforts.

The next step for Rockefeller, says Herdt, is "to focus on some of the most difficult traits and problems that face agriculture in the developing world." That change, part of an overhaul of the foundation's portfolio triggered by the arrival last year of agricultural ecologist Gordon Conway as president, puts a premium on "getting those [new] varieties down into farmers' fields," Herdt says. Instead of concentrating on one crop, the program will support work on traits, such as drought tolerance, that could be engineered into a variety of plants. A final component, he says, will be "doing something about building capacity in sub-Saharan Africa."

Educational programs will continue in some form, and much of the work now going on under the rice program may be eligible for support under the new guidelines. Strategic work on rice as a crop, however, will be phased out. Support for the biennial meetings might end, too.

That's an unhappy prospect for many of the rice researchers. IRRI's Khush says the linkages among rice researchers nurtured by the biennial meeting are "one of the payoffs of the program." But Rockefeller believes that it's time for the rice biotech community to stand on its own. Herdt hinted that Rockefeller might be willing to bankroll a future meeting, but he was adamant that the planning be done by others. Sounding like a proud but stern parent, Herdt left participants with this message: "If you want to have a meeting, organize yourselves."

–DENNIS NORMILE

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