River Blindness: A Gamble Pays Off

International effort to stop the disease in West Africa has been a public health success; goal of opening depopulated river valleys to agricultural development is more elusive

As a small group of farmers gather around the irrigation engineer from AID outside the village of Nayé in northeastern Senegal, a middle-aged man stands apart listening to the talk, his eyes turned upward in the sightless stare of river blindness. In much of West Africa, new cases of the disease (onchocerciasis) are becoming rare, but that is not the case in Nayé on the banks of the Faleme River.

Asked about oncho, the village chief says that 20 of the 400 inhabitants of the village are blind. The youngest is a 7-year-old boy. He says Nayé is more fortunate than villages farther upstream where the disease strikes more heavily.

Nayé is at the edge of the area where oncho is endemic. It also lies outside the territory covered by a massive international effort to control oncho by killing the blackfly vector of the disease. Soon, however, Nayé and the rest of the villages on the Faleme are to be included in an extension of the Onchocerciasis Control Program (OCP), or oncho program as it is familiarly called.

The OCP is a rare example of the effective use of science and technology to combat a serious parasitic disease in Africa. In its first 11 years, the program has made major progress toward its primary goal of protecting people in seven West African countries against oncho.* It has also made it possible for numbers of people to move into fertile land in river valleys abandoned because of the disease.

Such is the OCP's success that international aid organizations have recently agreed to a 6-year, $133-million third phase of the program. An estimated 8 million additional people will be protected by the extension, bringing the total to some 25 million. The move is intended to end the disease as a serious threat in the region.

The program's performance is generally ascribed to its being well funded, well managed, and supported by a strong international R&D program. But it has not been all smooth sailing. At times, donor confidence in the program faltered. In fact, it seems fortuitous that it ever got started at all.

Developing Africa

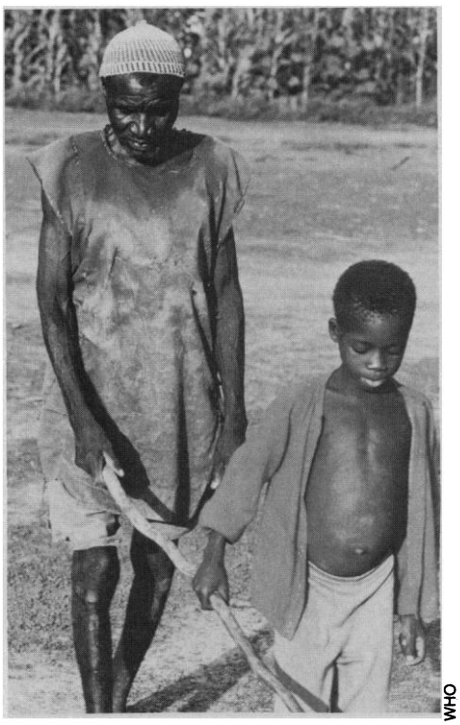
This is the first of two articles on science and technology in development in Africa. The reporting was conducted when the author was on leave from *Science* on a grant from the Carnegie Corporation. A second piece will describe efforts at economic development in the Senegal River Valley.

Joe L. Stockard, a USAID medical officer who has been involved with the oncho program since the beginning, observes that in the 1960's control methods had been successfully tested and a design for the program proposed, but no action was taken. Then, says Stockard, two things happened to convince the donors to form the OCP. "The drought hit, and McNamara put his personal prestige into getting support."

On a trip to West Africa in the early 1970's, Robert McNamara, who was then president of the World Bank, had a personal ecounter with victims of river blindness and put the bank behind the effort to organize the OCP. In addition to a clear humanitarian motive, the promise of an economic payoff through increased food production on reclaimed land in a region where famine threatened was viewed as justifying the investment.

The OCP was established with the United Nations' World Health Organization (WHO) as executing agency and the World Bank handling the financial side of things. USAID and other development organizations joined the bank as original backers; the number of donors has grown over the years to 19. OCP has a budget of about $20 million a year and regular staff of some 1000.

The OCP strategy is based on aerial spraying with pesticides of fast-running rivers and streams. The target is telltale white water produced by rapids and shoals where blackfly larvae, which require oxygenated water, filter nourishment from the water. The strategy was dictated by the technology available in the early 1970's when the program was organized. The target had to be the vector rather than the parasite, since no drug suitable for a mass treatment program was available. Previous spraying operations had shown that the fly is most vulnerable to insecticides at the stage when larvae are concentrated in the water.



WHO

The young leading the blind. *A familiar scene in parts of West Africa.*

The basic strategy has proved sound. But the original planners underestimated the impact of the flies developing resistance to pesticides used in the program and of reinvasion by flies from outside the spraying area. These threats shook the donors' resolve. World Bank official Bilsel H. Alisbah concedes that "there were a couple of times when [the OCP] was close to being abandoned—when it was found that the wretched fly could travel long distances [and] when resistance to pesticides developed."

In the early 1980's, when expansion of the program area was being discussed, donor doubts were growing about the future of the OCP. Progress had clearly been made in controlling the disease. An epidemiological evaluation published in 1984† showed that

*The program originally covered the 700,000 km² Volta River Valley, which includes all of Burkina Faso and parts of Benin, Ghana, Ivory Coast, Mali, Niger, and Togo. Under the new plan, coverage will be extended to Guinea, Guinea-Bissau, Senegal, and Sierra Leone.

†*Onchocerciasis Control Programme in the Volta River Basin: Progress Report of the World Health Organization for 1984*. JPC.2 (OCP/PR/84), p. 12.

in 90% of the control area there was no significant infection of children born since the program began. However, skeptics questioned whether it was sensible simply to go on spraying indefinitely despite the substantial amount of development resources being claimed by the program. Stockard, who has long service on OCP's governing Joint Program Committee and this year is its chairman, recalls that in 1983 "the donors were dragging their feet. They were not about to expand with all the questions hanging."

OCP director Ebrahim M. Samba says that the donors concluded that for the program to be brought to a successful conclusion two conditions had to be met. "It was necessary to get a medicament that attacked the parasite in the human" in order to break the cycle of infection. It was also necessary to be sure that backup pesticides were available in case the flies developed resistance to the pesticides in use. "It would be foolhardy to go in unless we have sufficient alternative larvacides."

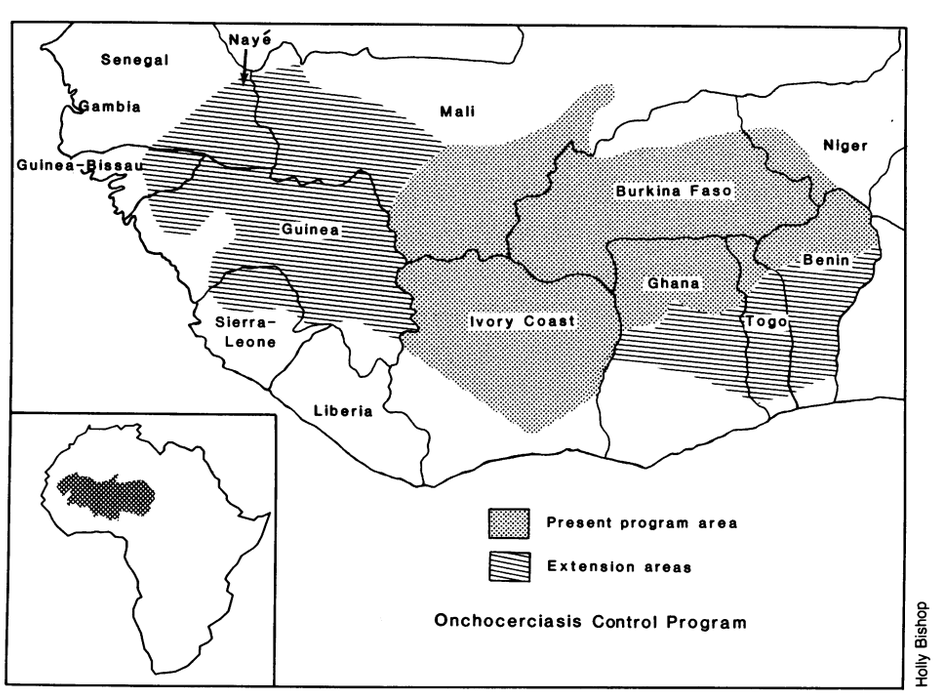
When the donors voted last year to underwrite the extension, they were satisfied that the conditions would be met. The quest for alternate larvacides was prospering. And promising results with new drug therapies had been reported; one effective drug for mass treatment could be available in 1987.

Samba and everyone else give credit for the turn of events to the international scientific effort carried out on behalf of the oncho program. WHO's Special Program for Research and Training in Tropical Diseases, TDR for short, which concentrates on seven major tropical disease groups, has achieved considerable success in proselytizing researchers and gaining the cooperation of chemical and pharmaceutical companies in industrial countries for an attack on endemic tropical diseases. But onchocerciasis might have received less attention in TDR's rather complex program if a special steering committee to focus on oncho had not been formed.

From the start of the spraying operations, the OCP had successfully used temephos, a biodegradable organophosphate with the trade name Abate. After resistance to the larvacide was observed, a second larvacide, chlorphoxim, was added. When resistance to chlorphoxim was also reported, the program added a biological control agent, *Bacillus thuringiensis* serotype H-14 (B.t. H-14), which is very effective against blackfly larvae and benign in ecological effect. The formulation available, however, was expensive and difficult to use efficiently in the spraying program.

Now, says Samba, energetic screening of existing pesticides coordinated by the vector control office of WHO's TDR has turned up several compounds that meet the stiff criteria on effectivness and ecological impact set by the program. Also, a new formulation of B.t. H-14 has made it easier and less expensive to use. Samba is emphatic. "Resistance is no longer a bogey, we are ahead of the bugs."

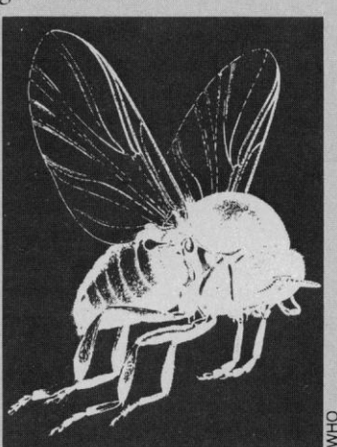
With respect to chemotherapy, there has been a similar surge in expectations. In the early 1980's, the OCP advisory committee framed a comprehensive research strategy for the program. The major aim was to eliminate the parasite in the human host.



Holly Bishop

Simulium damnosum

The vector for river blindness (onchocerciasis) in humans is the female blackfly *Simulium damnosum*. (The fly got its Latin name for the damnable itching it causes before the pathology of onchocerciasis was known.) Transmission occurs when infective larvae from the fly enter the skin of the victim through the bite when the fly takes a blood meal. Immature worms of the *Onchocerca volvulus* cluster in nodules in the skin where, as adult worms, they breed and produce millions of microfilariae which spread through the skin. When they reach the victim's head, the microfilariae invade the eye and the buildup of dead parasites there causes lesions that ultimately result in blindness. The cycle continues when a female blackfly, which must take a blood meal before oviposition, bites an infected human subject and ingests microfilariae.


WHO

The dangerous form of oncho is not, like malaria, transmitted by the single bite of an infected insect. Blindness in humans from oncho is a cumulative effect, the result of continued heavy exposure to infected flies and a product of the worm load. Total blindness or seriously impaired vision, however, are far from its only public health impact. Blackfly bites are painful and lead to tormenting itching as the microfilariae die in the skin and lesions occur. Serious secondary bacterial infections are common. People who suffer from oncho testify to its debilitating effects and there is evidence oncho has a synergistic relationship with other diseases. ■ J.W.

A Winning Combination

Why has the Onchocerciasis Control Program (OCP) worked when so many other health projects in Africa have gone awry? The explanation starts with OCP's field operations. To manage, as the OCP has, to deliver fuel and pesticides on time and in the quantities required to inaccessible landing sites scattered over a 700,000-square-kilometer area in seven countries entitles the organization to claim to have transcended West African conditions and norms.

Decision-making is centralized in OCP headquarters in Ouagadougou, the capital of Burkina Faso. A member of the technical staff, Pagnan Adama Kabore, explains that the organization runs on an unvarying routine. "Monday nights, the vector control people look at field reports on results from the past week and hear proposals from people in the field," he says. Vector control decides on what areas to treat, what insecticides to use, and which aircraft to send. (Fixed wing aircraft for wide rivers, helicopters for small rivers, and where tree cover is heavy.)

On the ground, the essential feedback of information to headquarters is provided by a well-developed network that covers all the breeding sites in the OCP area. The basic monitoring is done by a corps of "flycatchers," local people who patrol the breeding sites and trap the flies, using their bare legs as lures. At sector headquarters, flies are dissected by entomologists to establish whether they are infected.

To collect comprehensive epidemiological and ophthalmological data, survey teams from headquarters make visits periodically to villages in the control area. A benchmark assumption for the program was that the OCP would have to last longer than the life span of the parasite in humans. At the start of the program, the worm's life span was estimated at between 11 and 18 years so the term of the program was set at 20 years. Through research conducted within the program, the estimate of parasite life has been revised downward to about 11 to 12 years, a revision in OCP's favor.

Why does Kabore think that the OCP is succeeding? "The routine [is followed] every day. It's exact in operation. Every unit does its job with discipline, punctuality. It is run like a military campaign."

World Bank official Bilsel H. Alisbah takes issue with the suggestion heard not infrequently that the program thrived because it has been an expatriate operation. "A cynic might say that the only reason it's working is that the African governments are not involved. The helicopters spray pesticides and the whole thing is run by a bunch of outsiders. That's unfair and oversimplistic. African governments played a critical role. They provided a lot of good people. And things got through customs." Regional programs typically inspire little enthusiasm among national governments in Africa. And African customs operations are renowned for delays and for levying duties not in regulations. The OCP "inspired the highest level of enthusiasm and cooperation," says Alisbah. "Those who might have sabotaged it didn't."

Member governments have permitted oncho staff to operate freely in pursuit of the fly, allowing them a mobility across national frontiers which is exceptional in the region. USAID's Joe L. Stockard agrees that high among the ingredients of success was that "The Africans themselves considered it important and sought assistance." Also essential, says Stockard, was that OCP was planned as a long-term effort. The organizers "recognized that it would require 20 years" and "we were able to get donor support for a long-term commitment." Another factor was that "good people came and stayed." He notes that "the WHO organization can recruit from the world market." This made it possible to attract capable scientists and other professionals to the OCP staff and also to win attention for oncho in the international scientific community.

OCP's director for the past 5 years has been Ebrahim M. Samba, a Gambian physician whose background includes studies at Edinburgh that earned him standing as a Fellow of the Royal College of Surgeons. Samba, a forceful personality, is sufficiently flexible to keep an international staff working in concert and diplomat enough to deal with member governments and donors. Africanization has proceeded to the point where 95 percent of the staff are from African countries and a training program has enabled African professionals to upgrade their technical competence and gain experience with a kind of management rare in Africa. ■ **J.W.**

The hope was to develop a drug that would kill the adult worm—a macrofilaricide. But work on microfilaricides was also urged since the absence of live oncho microfilariae in the skin could eliminate the human reservoir of infection. The donors accepted the proposal and began to fund projects, notably through contracts with pharmaceutical companies.

Prospects of a breakthrough brightened when Merck Sharp & Dohme approached WHO with the suggestion that its successful veterinary antiparasitic drug, ivermectin, might be an effective microfilaricide for oncho sufferers. Ivermectin is a semisynthetic drug derived from fermentation products from *Streptomyces avermitilis*, an organism found in soil.

Mohammad Aziz, a senior director of clinical research at Merck research laboratories, who has overseen clinical studies of ivermectin, says that, "To date, everything looks very good." The complete data on ivermectin should be ready for submission for registration by the end of this year. "Then it will be up to the regulatory agencies." says Aziz. If the drug wins approval, it should be available for use in the field sometime in 1987. Results of clinical trials indicate that a single ivermectin pill reduces the microfilariae in the skin by 90%. Aziz says that each dose affords protection for at least 6 months.

The OCP is well past the halfway point in its planned 20-year existence and member countries and donors readily reached agreement on a strategy for the balance. But could anything disrupt the program's march toward successful control of onchocerciasis (nobody connected with OCP uses the word eradication)? Some observers think that the potential for reinvasion will be hard to suppress completely. They note that many of the breeding sites that are sources of reinvasion are in the forest toward the coast rather than in the more open savanna of the present control area and that effective spraying operations are more difficult and much more expensive where the tree canopy is heavier. The working assumption now is that the forest fly carries a less dangerous form of the disease than the savanna type and would not pose a serious danger. But that case is not proven.

Discussion about the future of the program always touches on the issue of "devolution," that is, turning over control and financial responsibility in the mid-1990's to the African governments in the control area. If current plans are realized, a successor regional organization would be responsible only for monitoring operations. If a recrudescence of oncho occurred and a major control effort were required, chronic African

problems of regional cooperation, of paying recurrent costs, and of organizational effectivness could come into play.

The skeptics are in a minority. The program has already been able to stop spraying in Burkina Faso and expects to gain experience there that will allow a successful transition to a maintenance program throughout the region.

Now that achievement of the public health goals of the OCP seem reasonably assured, the question of the future of the organization is coming to the fore. Alisbah notes that one suggestion is to "take the expertise and apply it to the next disease." Another school of thought sees a role for the organization in spurring the economic development that was originally regarded as a corollary of the program.

A number of bilateral aid projects, mostly for agricultural development, have, in fact, been funded for resettled land, but no comprehensive data on the socioeconomic effects of the program are available. In Burkina Faso, which had a larger percentage of land affected by oncho than any other OCP country, some 240,000 hectares were reported to have been reoccupied by last year. Some successes have been reported with cultivation of export crops, but efforts to obtain increased yields with food crops for domestic use have so far been disappointing.

There is increasing awareness that "development hasn't worked as well as the [OCP] program," says Stockard. And at recent meetings of the Joint Advisory Committee the question has been raised, "Shouldn't the Joint Program Committee play more of a role? Are they prepared to alter the mandate, expand it to cover economic development?"

Alisbah, director of West Africa Country Programs for the World Bank, acknowledges that "Now that [the OCP] is succeeding, there is donor pressure for economic follow-up." He says the bank plans to focus a major effort on the OCP region next year "to explore the proper economic follow-up." The aim is "to determine whether there is an effective role for an international group or it is best left to bilateral action."

If consensus is lacking on the future of the organization, there is no serious question of its having improved the lives of millions of people at risk. A point that should not be forgotten is that the oncho project was a gamble. Those present at the creation recall that, despite initial confidence in the technology, there were many uncertainties. A World Bank official remembers that there were even doubts about "whether the valleys were really so green. What other diseases kept people out of the valleys? There was not a terrific database. In the absence of convincing scientific evidence, they went by the passions of Africans speaking of the effects of the disease." He says "it was a matter of emotion." For anyone who travels to a village like Nayé, it still is. ■

JOHN WALSH

Soviet–U.S. Fusion Pact Divides Administration

Afraid the Soviet military will benefit from a world ignition machine, DOD wants Reagan to drop his summit pledge

Six weeks before the Reagan-Gorbachev summit in Geneva last fall, Soviet Foreign Minister Eduard Shevardnadze met with Secretary of State George Shultz in New York. The Soviet official wanted to put nuclear fusion research on the agenda for the November summit talks. Shultz, a former executive of Bechtel Group, Inc., an engineering and energy technology company, took the proposal to President Reagan. A few weeks later Shultz told Kremlin officials in Moscow that Reagan was willing to explore broadening ongoing work with the Soviets related to developing a fusion power reactor.

By the end of the 3-day summit, Reagan and Soviet General Secretary Mikhail Gorbachev were calling for the "widest practicable development of international cooperation" in magnetic confinement fusion. Negotiators at Geneva were not able to agree on a specific mission. Nevertheless, the statement issued by the two leaders has been interpreted by the Soviet and U.S. fusion communities to mean multilateral construction of a major new device—the so-called Energy Test Reactor (ETR).

But 5 months after the summit, the idea of the United States constructing a new test reactor with the Soviets is in trouble. The merits of the Gorbachev-Reagan communique on fusion are heatedly being debated within White House agencies, as well as the Defense, Energy, and State departments. Budgetary impacts, but especially concerns about transferring technology to the Communist Bloc, are fueling a campaign in parts of the Administration to kill or sharply curtail any new fusion project that includes the Soviets.

Seen as the key to reenergizing waning fusion programs in the United States and Soviet Union, this reactor is needed to reach the next frontier in magnetic confinement fusion: the study of burning plasma and the testing of materials eventually to be used in a commercial power reactor. Fusion energy derived by the combination of hydrogen atoms to produce helium has been heralded as potentially providing a limitless supply of energy that is safer and environmentally more acceptable than fission technology.

The challenge facing fusion researchers has been to produce within the confines of a magnetic field a hydrogen plasma with sufficient density and temperature to ignite and burn. Steady progress toward this goal has been made over the past decade, but the cost of major experiments also has increased. The next experiment could cost as much as $4 billion, a burden that neither the United States nor the Soviet governments appear willing to shoulder alone. With the participation of Europe and Japan, though, the cost would fall to about $1 billion per country.

The Soviet Union's Chernobyl power plant disaster, however, may have provided Administration naysayers with a graceful way for the United States to back away from working with the Soviets on an international ignition experiment. According to Stephen Bryen, DOD's deputy under secretary for trade security policy, Defense Secretary Caspar Weinberger will shortly propose to Reagan that the United States substitute an international collaboration on fission power plant safety in place of cooperating with the Soviets in a multilateral fusion experiment.

The Department of Defense is not opposed to the United States jointly building a new test reactor with the Japanese and Europeans. But the department strongly op-