

BRAZIL'S SPECIAL SCHISTOSOMIASIS CONTROL PROGRAM: THE MODEL^{1, 2}

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A considerable portion of the present Brazilian population is afflicted with schistosomiasis. This article describes the unfolding of a major Government campaign against the disease. Employing a wide range of health education, basic sanitation, water supply, planorbiciding, and chemotherapeutic measures, it seeks to reduce the prevalence of schistosomiasis among schoolchildren to less than 4 per cent in all zones of operation. It is hoped that this will achieve effective short-term control over schistosomiasis throughout rural Brazil.

Background

Schistosomiasis, an endemic disease imported into Brazil along with African slaves, first established itself in the sugarcane-producing Northeast, where it found a favorable environment that offered the following advantages:

- the presence of planorbid snails;
- numerous bodies of water in the wetland and plains, where the growing of sugarcane began;
- human carriers clustered in small areas;
- a total lack of even minimal standards of hygiene;
- a hot, moist climate.

In 1920, foci of schistosomiasis began to spring up outside the initially infested region. The disease was spread by unskilled workers, who migrated out of the Northeast

to take employment being offered in other regions of the country. Also, large-scale projects proliferated. These invariably emphasized planning and engineering techniques, but made little provision for adequate health programs. The result was that whenever a cluster of carriers was superimposed on a significantly dense population of planorbid snails, new foci sprang up.

By analyzing the dates on which foci were detected, the establishment of a focus can be correlated with preceding large-scale construction projects. This correlation has been found in Belo Horizonte, the Doce River Valley, the Paraíba River Valley, the Santos Slope, and the Central Plateau. The emergence of these foci could have been foreseen and avoided (1).

Today a considerable portion of the Brazilian population is afflicted with schistosomiasis. The strictly economic loss to Brazil from this disease has not yet been quantified; and though the most important thing is the hazard to human beings, the economic losses are far from negligible. Hence it would be useful to estimate them for purposes of justifying an allocation of resources for preventive measures.

By striking in childhood and (in the overwhelming majority of cases) making its effects felt from adolescence on, schistosomiasis considerably diminishes the physical

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capacity of individuals at their most productive age. The cost of medical care in chronic cases, and of absenteeism and low productivity, imposes a heavy financial burden. In 1965 this was estimated by Louis Oliver at approximately 800 million cruzeiros.

More detailed studies have been carried out in other countries with WHO support (2), notably the work done in the Philippines by Farooq, who estimated the annual cost of schistosomiasis at 6.5 million dollars—more than the cost of malaria (3). The author also computed the annual cost per capita at as much as 15 dollars in Egypt, 24 dollars in Iraq, and 26 dollars in Japan. By treating infected workers in a factory, Khalid el Haddidy was able to reduce absenteeism by 37.5 per cent and defective production by 25 per cent.

Assuming Farooq's index for Egypt is applicable in Brazil, and estimating the cases of schistosomiasis at only 10 million, the annual loss to Brazil would be 150 million dollars, a most disturbing figure.

Since the survey by Pellon and Teixeira in 1949-1952, no data have emerged by which to gauge the number of carriers with any accuracy (4). Moreover, even the data of Pellon and Teixeira may be regarded as approximate: their scant resources, plus the fact that they only conducted the survey at the municipal level, were bound to limit the results of what was an important project carried out with scientific rigor in an admirable pioneering spirit. Our only data today are based on estimates of the total number of carriers that range from 8 million to 18 million.

Solely for resource allocation purposes, and without claiming to define prevalence, we have estimated the proportion of carriers in the neighborhood of a conservative 10 per cent, which would mean approximately 10 million carriers. A nationwide survey now in progress will provide precise data.

In view of the high prevalence of schistosomiasis in the Northeast, the large number of new foci outside the initially endemic

Table 1. Anti-schistosomiasis activities in Brazil, 1975.

Federal subdivision	Municipalities	Antiplanorbid measures			Coproscopic examinations			Patients treated	Drug used	
		Bodies of water		Molluscicide applied (kgs)	No performed	% positive	%		Specific	Adjuvants
		No. examined	Snails found							
Pará	7	—	—	—	16,866	177	0.7	—	—	—
Maranhão	4	152	39	—	10,269	277	2.7	—	—	—
Ceará	12	6,129	5,705	369	23,180	560	2.4	308	123	—
Rio Grande do Norte	30	73	—	—	61,719	1,934	3.1	—	—	—
Paraíba	5	193	141	355	37,118	3,063	8.3	2,097	1,593	248
Pernambuco	16	102	1	85	59,766	9,414	15.8	1,080	878	1,454
Alagoas	7	—	—	—	14,337	4,608	32.1	351	234	532
Sergipe	19	—	—	—	27,926	10,846	38.8	963	942	—
Bahia	19	8,282	6,268	85	12,604	2,856	22.7	50	50	—
Minas Gerais	19	1,716	358	135	79,248	4,903	6.2	1,403	8,773	—
Espírito Santo	14	—	—	—	11,864	294	2.5	1,994	1,244	2
Rio de Janeiro	17	3,822	2,539	48	298,398	4,518	1.5	2,329	2,008	128
São Paulo	1	—	—	—	1,250	7	0.6	—	—	—
Paraná	63	829	285	104	166,578	2,830	1.7	2,135	1,257	2,430
Mato Grosso	7	—	—	—	28,814	2	0.0	—	—	—
Goiás	5	1,474	1,295	—	1,606	56	3.5	—	—	—
Federal District	1	—	—	—	4,377	60	1.4	—	—	—
Total National	246	22,772	16,631	1,181	855,921	46,405	5.4	12,710	17,102	4,794

Source: Superintendency of Public Health Campaigns (SUCAM).

area, and the inevitability of migrations to developing areas, we think there is every reason to search for means of checking the spread of the disease.

For years the Ministry of Health has been striving continually to check the spread of schistosomiasis. The operations conducted—diagnosis, treatment, and occasional use of planorbicides—have failed to check the progress of the endemic disease.

Considerable efforts were made in 1975. (see Table 1). However, the available drug (Etrenol), though highly effective, has many contraindications, and the special precautions required in its administration limited its large-scale use. Of the 12,710 carriers treated—a trifling figure in dealing with an endemic disease of such magnitude—practically all were exposed to reinfestation and were certain to be reinfested within 12 months. Hence, it is plainly necessary to find a new schistosomiasis control model that provides measures for elimination of the carrier state and reduces the risks of reinfestation.

Ecological Considerations

A considerable body of knowledge has already been accumulated on the taxonomy and biology of planorbid snails and schistosomes. Little, however, is known about the ecology of schistosomiasis.

Both the establishment of a new focus and the maintenance of the endemic disease are contingent on one event: the meeting up of a viable miracidium and a susceptible planorbid snail. This meeting is not a predestined event. The miracidium is short-lived and has a limited range of movement, which makes the encounter contingent on certain factors: environmental conditions propitious to the survival of the miracidium, the proximity of planorbid snails, the density of the snail population, and the number of miracidia.

It is common sense to expect some correlation between the number of miracidia and the density of planorbid snails, a correlation which determines the probability of encounters between them. But that correlation, subject to the influence of many factors, is not to be estimated by deterministic methods; rather, the indicated procedure is to develop a stochastic model.

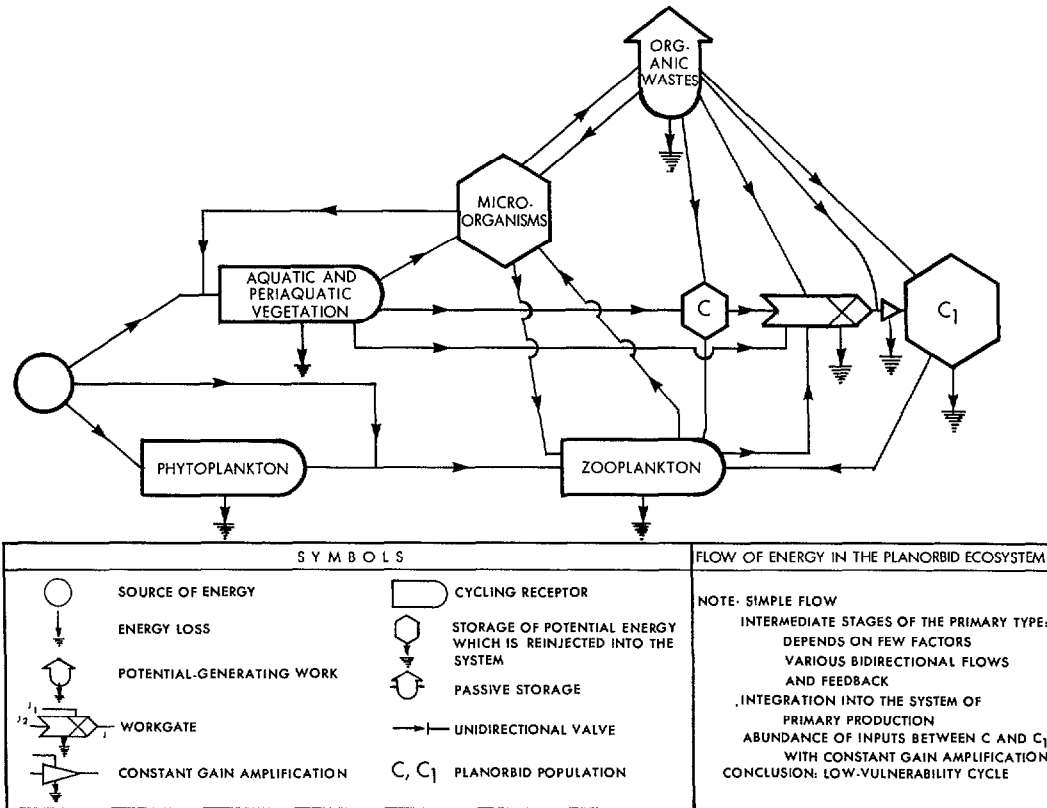
It is fair to expect, however, that effective treatment of all carriers at the same time will drastically reduce the number of miracidia. Hence a time will occur when the probability of planorbid infestation will drop significantly. It is certain that at that moment there will still be planorbids, particularly in populations of *Bulinus glabrata*, that were previously infected and are now discharging cercariae. Because of this, concomitant action must be taken against the planorbid population; and here the planorbicide must be used at the right juncture, so that its effect will enhance the natural drop in planorbid density at the moment when the density of the miracidia drops, thus minimizing the probability of reinfestation.

It can be observed that all ecosystems throughout the world have metabolisms that are subject to annual variation (5). Planorbid populations should perforce be subject to such variation, and should display periods of maximum and minimum activity. In fact, seasonal variations in planorbid activity are known, having been recorded as early as 1955 (1). The risk of human and snail infestation should be greatest during the period of peak activity and least during that of minimum activity.

By taking action against the carrier population's schistosomes (through chemotherapy) and against the snail population (through planorbiciding) at the right times and places, it should be theoretically possible to influence the incidence and prevalence of schistosomiasis.

Analysis of planorbid ecology discloses a highly stable, relatively nonvulnerable

Figure 1. Energy flows in the planorbid ecosystem.



flow of energy characterized by bidirectional streams and many alternative pathways (Figure 1). In our environment, and at the present state of our knowledge, the planorbid snail is regarded as invincible. We will fail to eradicate it anywhere, except at very unusual isolated breeding sites. However, we can reduce its density temporarily and on a more significant scale if we operate on the basis of accurate knowledge of the natural fluctuations in that density.

Strategy

Figures 2 and 3 illustrate the energy flow of the schistosome ecosystem, identifying the points that are most vulnerable and

the actions that can be taken at those points.

The following procedures are practicable in Brazil:

- elimination of 90 per cent of the miracidia with chemotherapy—which in repeated experiments has cured 85 to 94 per cent of the carriers;
- temporary reduction of the planorbid density to less than 1 per cent of the initial density;
- coordination of these two actions in time and place in order to make the most of the period of spontaneous reduction in planorbid density (this would be the essential step);
- basic sanitation (sanitary improvements in every rural dwelling—including

Figure 2. Energy flows in the schistosome ecosystem.

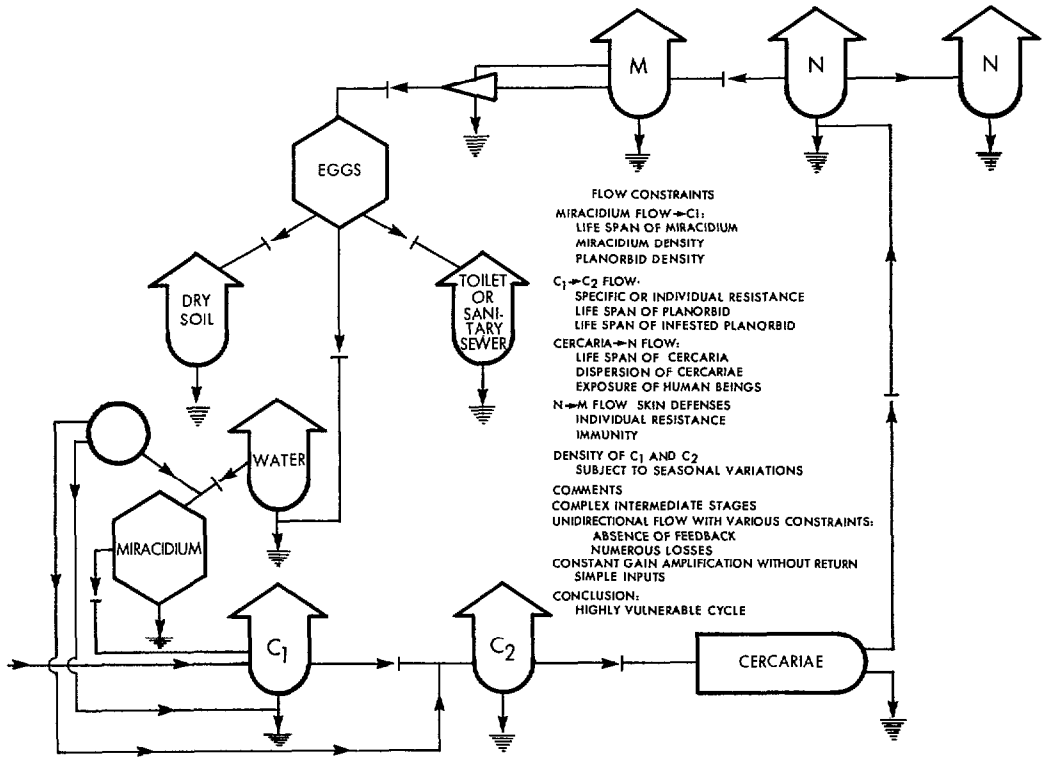
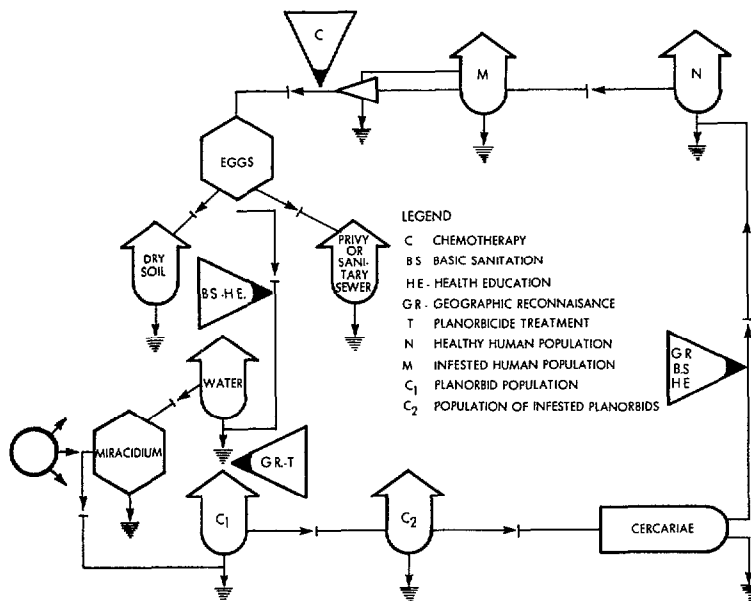


Figure 3. Vulnerable points in an energy flow diagram of the schistosome ecosystem.



installation of a toilet, shower stall, and laundering facilities);

- the provision of a potable water supply and the building of combined drinking water, toilet, shower, and laundering facilities for public use;
- sanitary education.

Carrying out these actions in a coordinated manner for all or virtually all of the population can considerably reduce the incidence and prevalence of the disease. However, none of these actions, by itself, can yield any lasting results. Only by carefully coordinating all of them can tangible effects be produced, and even then the gains can be consolidated only through constant and alert surveillance over a period of many years.

Methodology

The methodology worked out for Brazil's New Special Schistosomiasis Control Program (PECE) is based on the foregoing ecological concept, combined with:

- past experience in the planning and programming of campaigns for the control of malaria and Chagas' disease;
- logistical experience acquired and improved upon during the campaign against meningococcal meningitis carried out in Brazil in 1975, when 86 million people were vaccinated;
- experience acquired during the Caravelas Project (a 90-day sanitation project that provided 100 per cent coverage at the municipal level and in two small towns).

The PECE strategy involves three successive operational phases: a preparatory phase, an attack phase, and a surveillance phase.

Preparatory Phase

Defining the zone of operations. The task in this phase is to make a preliminary

determination of the zone of operations, which must be an unbroken and ecologically homogenous area where the disease is endemic.

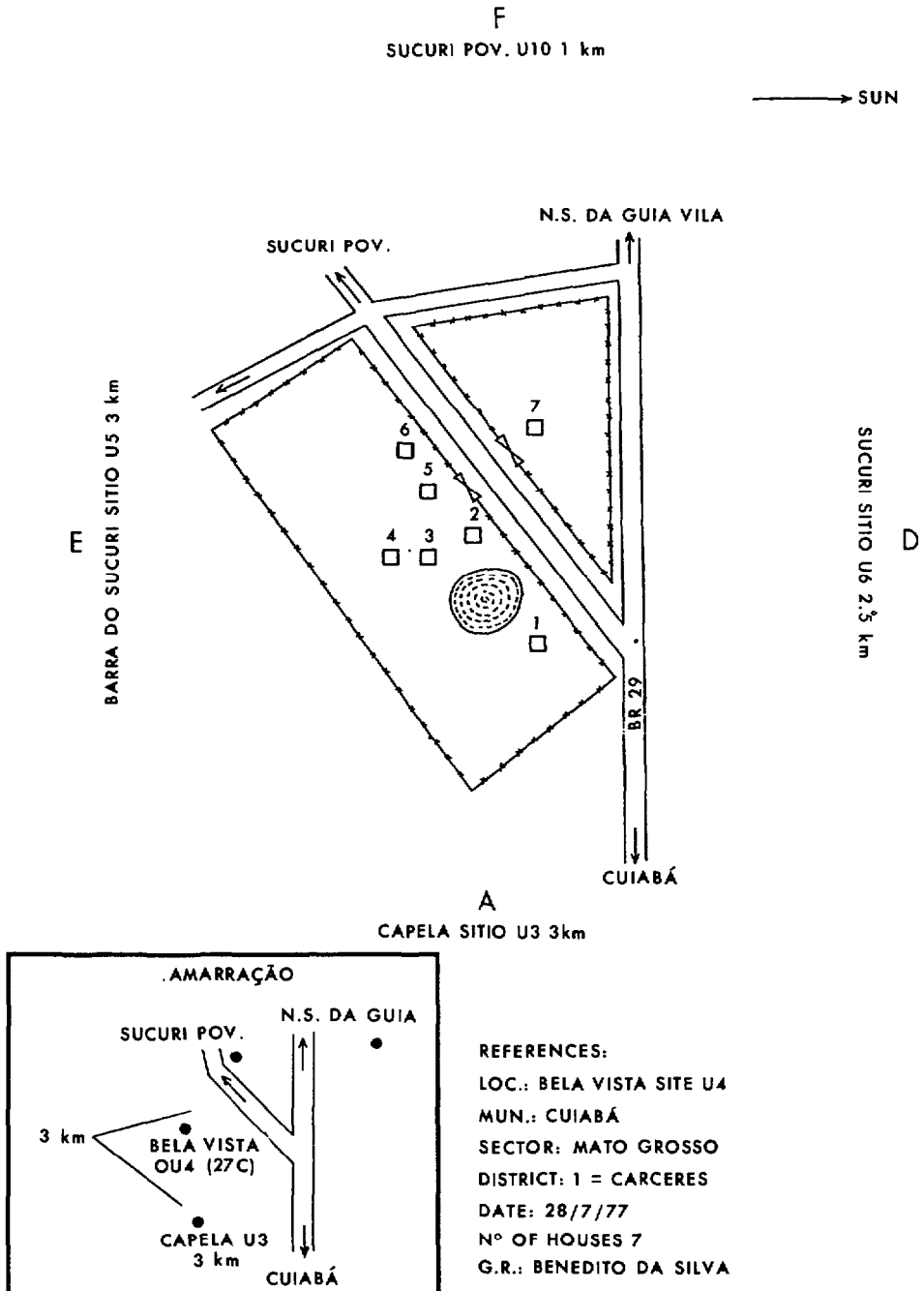
At first, the PECE will operate in the vicinity of an existing permanent installation of the Ministry of Health. As work progresses, the operational area will be extended to encompass whole municipalities and will spread out into the upper reaches of the hydrographic basin involved, its advance being limited primarily by ecological considerations and at times by physical geography, but not by state borders. Contiguity, continuity, and ecological homogeneity are thus the basic criteria for defining a zone of operations.

The operational headquarters of the Public Health Services Foundation (FSESP), such FSESP subunits as may prove necessary, and a temporary Superintendency of Public Health Campaigns (SUCAM) unit will be installed in the zone of operations. The FSESP operational headquarters and subunits will carry out the basic sanitation work and may also house the multiagency sanitary education team. It will be up to SUCAM to perform a geographic reconnaissance of the area, to locate all dwellings on a map (Figure 4) and to collect data on the population, roads and trails, water bodies, breeding sites, and snails (Figure 5). SUCAM will also have to set up a temporary laboratory and conduct a coprologic survey of schoolchildren between the ages of 7 and 14, in addition to monitoring the surveillance phase.

In carrying out the geographic reconnaissance, SUCAM teams will identify and locate existing and potential planorbid breeding sites, identify planorbids, and determine their density and the percentage of infested snails (by maceration). If infested planorbids are found, the breeding site involved will be designated as a focus.

At every actual and potential focus a capture station will be set up, from which

Figure 4. Site maps for geographic reconnaissance.

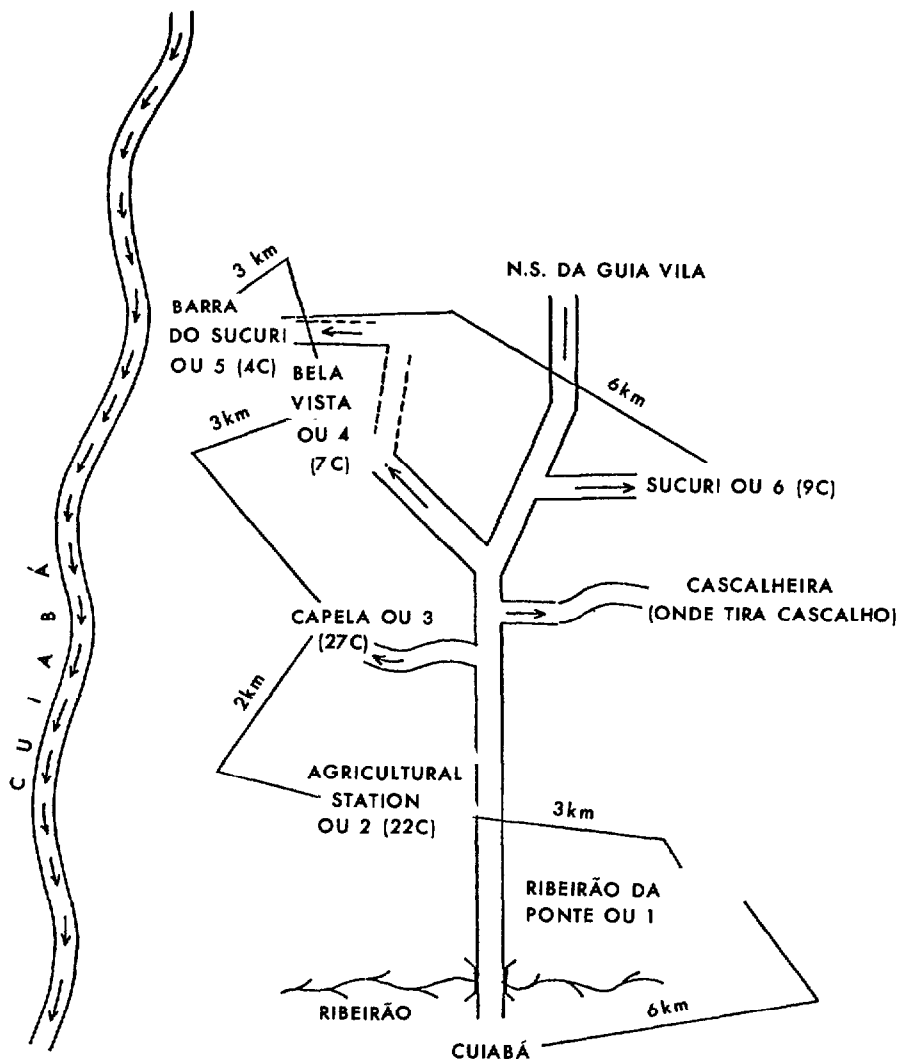


the focus will be kept temporarily under observation. On the basis of the observed frequenting of the focus by the local inhabitants and the proximity of breeding sites to foci, both breeding sites and foci will be classed in terms of their epidemiological significance.

Depending on the epidemiological significance of a breeding site, its ecological

representativeness, and the closeness of the resemblance between its behavior and that of breeding sites watched by capture stations in the same area, at least one capture station will be converted into an experiment *control station*, and the capture stations of which it is representative will be phased out. Planorbid populations will continue to be monitored every 30 days at the control

Figure 5. Site location map.



stations, following a standard procedure, until the end of the program. The number of control stations will be the smallest capable of supplying representative data for each different ecotope found in the area. Rainfall data will also be recorded in each zone of operations.

In the preparatory phase, the FSESP will carry out basic sanitation work, build water supply systems, and extend existing distribution networks in an effort to bring potable water to the entire population. The work will be done not only in municipal centers, but also in all other towns and settlements of more than 400 inhabitants.

At the same time, the National Sanitary Education Division will coordinate the health education activities of the FSESP and SUCAM for purposes of (1) providing refresher training for and obtaining the participation of local teachers, (2) mobilizing community leaders, and (3) establishing health patrols made up of especially selected and trained schoolchildren. Social communications aids will be used for rapid mobilization of the community, and a methodical, persistent, and continuing health education campaign will be launched forthwith. Health education activities will be influenced by data collected through surveys of community attitudes, superstitions, values, and mores in each zone of operations.

In addition to using quantitative methods to evaluate health education activities, constant efforts must be made to improve methods for evaluating results by endeavoring to state them in mathematical terms, in order to avoid subjective assessments.

Poster contests among schoolchildren will be particularly useful as a means of encouraging community participation, in motivating schoolchildren to study the problem, for eliciting individual opinions that reveal attitudes and values, as a device for collecting material that can shed light on predominant speech patterns and ideas, and as a resource for the improvement of health

education activities in the zone of operations.

Attack Phase

The attack phase will be subject to the following conditions: The area of attack will be an entire zone of operations, with no untreated enclaves; and the time of attack will be the start of the period when the density of the planorbid population drops steadily, as determined from examination of the data provided by 12 months of observation at the control station.

Prerequisites for entering into the attack phase will be adequate coverage by basic sanitation services; health education—after completing the preliminary contacts and organizing the health patrols; presence of trained medicators with established routes and stocked local supply posts; availability of medical supervision for the detection of contraindications, overseeing of dosages, attending to possible side-effects of the medication, and appropriate referral of cases that can be treated only under high-level medical supervision; presence of adequate stocks of drugs distributed at strategic spots in the zone of operations; sufficient planorbicide stocks in the zone of operations; and formal written authorization from the General Coordination Group, given in the light of information on all the above.

Implementation of the attack phase will include planorbiciding as frequently as required to maintain the density of planorbids at a level below 1 per cent of the lowest original density. The planorbicide will be used in the epidemiologically important breeding sites and in the foci. Whether or not planorbiciding is done will depend on the results of a prior examination of the effects on local food resources. The application will be followed by weekly checks of planorbid density, and will be repeated as many times as needed to keep the low planorbid density stable for six months.

The attack phase will also include the administration of oxamniquine, in a single standard dose, to all members of the population to be treated, within a period of not more than 10 days, once the planorbid density has dropped to less than 1 per cent of the original density. The population to be treated will consist of all schoolchildren 7 to 14 years old where the survey shows a prevalence of less than 20 per cent, or the entire population where the survey shows a prevalence of more than 20 per cent. Treatment will not be administered to alcoholics, patients on psychotropic or narcotic drugs, cases on encephalopathy, uncompensated cases of enlarged liver and spleen, or severe cachectics.

Our current knowledge is not sufficient to warrant authorizing the administration of oxamniquine to pregnant women and epileptics. But cases of serious hepatosplenomegaly, even if in the compensation phase, will be treated if they are assured of close medical supervision backed up by hospital facilities and adequate resources for the control of liver and kidney functions.

In areas subject to flooding, which disperses the planorbid population, chemotherapy will be applied when the flood reaches its peak stage. Planorbicides will be applied as soon as the waters revert to their normal levels.

Surveillance Phase

Experience acquired at Touros in the state of Rio Grande do Norte has shown it possible to start the surveillance phase 180 days after the attack phase. The surveillance phase includes the following activities:

- monthly determinations of the snail population and the percentage of infected snails (the control stations continue in operation without interruption);
- monitoring of the maintenance of basic sanitation facilities;
- conducting coproscopies of schoolchildren every six months until the prevalence levels off below 4 per cent;
- treatment of new cases; and retreatment of resistant cases and reinfested persons;
- continuation of health education activities.

Structures to be used include the existing health network, a chain of health units at different levels of complexity now being set up (PIASS), the National System of Public Health Laboratories, SUCAM district offices and field laboratories, and FSESP regional offices.

Supervision and Evaluation

Execution of the program will be subject to ongoing supervision and evaluation at three levels: at the local level by the local SUCAM and FSESP offices, at the state level by the competent SUCAM and FSESP agencies, and at the national level by the General Coordination Group.

The General Coordination Group will be chaired by the Minister of State for Health and will have an Executive Secretary chosen by the Minister. Its other member will be the President of the FSESP, the Superintendent of the SUCAM, the Director of the National Health Education Division, and the Director of the Division of Schistosomiasis Control.

The General Coordination Group will meet every 30 days whenever possible, in Brasília or (preferably) in a zone of operations. During these meetings the General Coordination Group will discuss reports received on the work done by the executing agencies (the FSESP, SUCAM, and the National Health Education Division), which will be presented as summaries in a standard form. These reports will cover the work done in quantitative terms, the goals for the reporting period, the percentage accomplishments to date, a summary of the

difficulties encountered, and suggestions for improving the work.

The General Coordination Group will also decide when research is needed to improve the conduct of the Program, will identify possible executing agencies, may invite prominent specialists to participate in its meetings, will enlist the cooperation of universities and research agencies, and will have the GAPP—the Research Project Support Group in the Ministry of Health—support projects designed by third parties at the Group's invitation.

The General Coordination Group must improve the flow of information, which must not stop short at the top but must return to the bottom—so that all those involved in execution will be continually informed about the progress of the program. To this end, the Executive Secretary will have a report drawn up after each meeting and will have copies made for distribution at the state level for all implementing staff members.

Experimental Areas

Experimental areas will be chosen by the General Coordination Group. In these areas more rigorous and detailed methods for data collection, monitoring, and evaluation will be used—methods that are highly complex and costly, and that would be impractical to apply throughout the program. Findings in the experimental areas will be discussed and evaluated, and may result in changes being made, including possible introduction of new tactics and even improvements in strategy.

The program is not regarded as a hard and fast arrangement. It is essentially dynamic and must evolve through a process of continual improvement. However, any changes must be approved by the General Coordination Group, the only agency with this authority.

In choosing experimental areas the criteria have been:

- The area must be small enough for each inhabitant to be individually monitored; under present conditions, this means the area must have a population of less than 2,500.

- The community must be a stable one not significantly affected by migrations.

- It must have well-defined ecological conditions that are representative in some way.

- It must offer possibilities for implementing one or more of the main activities of the program (chemotherapy, sanitation, planorbiciding, and health education).

In all circumstances, the experimental areas will be run with full respect for the right of the population to enjoy all the benefits that the PECE can offer, and the various measures implemented will be so conducted as to minimize the risks to the community.

The goals to be attained are as follows: In the first stage, the program must cover the schistosomiasis-infected area of Maranhão, Ceará, Rio Grande do Norte, Paraíba, Alagoas, and Sergipe. The projected date for the entire area to be in the surveillance phase is 1979. In each locality of the area prevalence should have been reduced to 4 per cent or less, using the percentage obtained in the survey of schoolchildren as a reference. If that prevalence can be sustained, it can be expected that the disease will be eradicated in the long run.

The program will not cover capital cities, where water supply services and basic sanitation are not the responsibility of the Ministry of Health/FSESP. But so long as one single dwelling is not supplied with water, the basic sanitation problem is not solved; so long as polluted streams and lagoons have not been drained or filled in it will be virtually impossible to control schistosomiasis in those cities; and hence the disease can be exported from the cities to the countryside all over again. Control of the endemic disease in the countryside is already viewed as feasible in the short run.

Ultimate eradication is unlikely, however, because of the possibility of reinfestation through carriers migrating from cities to rural areas.

Research

To be supported by the Ministry of Health, schistosomiasis research must meet the following conditions: (1) it must be presented in the form of a technically sound project; (2) it must have well-defined objectives that mark it as original research, for funds must not be dissipated in duplicate research; (3) it must be conducted by researchers who are prepared to do the field work themselves and not leave it to others; (4) a performance timetable consistent with the requirements of the PECE must be presented; (5) researchers must be willing to accept monitoring and periodic discussion of their work by the General Coordination Group; and (6) the research must relate to subjects of interest to the PECE.

Subjects of priority interest to the PECE are:

- Planorbid ecology, defined as the interaction between the planorbid and the environment as expressed by fluctuations in the population dynamics (reproduction, migration, and relocation) of the snails.

- The ecology of schistosomiasis—interactions between the environment and schistosome eggs, miracidia, and cercariae, expressed in terms of their survival, range of movement, and infectivity.

- Effects of chemotherapy on the adult schistosome and description of these effects on the adult organism, particularly with regard to reproductive activity.

- Survival of the infected planorbid under natural conditions.

- Behavior of communities in endemic areas (before and during implementation of the PECE).

- Residual action of planorbicides.

- Effects of planorbicides on aquatic flora and fauna.

- Development of mathematical models.

- Standardization of monitoring procedures.

- Methods for diagnosing human infestation.

SUMMARY

Today a considerable portion of Brazil's population is afflicted with schistosomiasis. This article describes the basic approach and concepts of a new antischistosomiasis program in that country.

The program seeks to simultaneously reduce the miracidia and planorbid snail populations of predefined areas through appropriately synchronized chemotherapy and planorbiciding work supported by health education, improvement of basic sanitation, and provision of potable water. This undertaking—known as the Special Schistosomiasis Control Program, has been divided into preparatory, attack, and surveillance phases.

The preparatory phase involves defining ecologically homogeneous operating zones; collecting data on local human population, roads and trails, water bodies, snail breeding sites, and

snails; determining prevalence of human schistosomiasis; setting up snail monitoring facilities; and implementing basic sanitation, water supply, and health education activities.

These steps are followed by the attack phase, in which suitably prepared areas are given enough planorbiciding to reduce the local planorbid snail population to less than 1 per cent of its original level. Once this has been accomplished, the eligible human population receives a single standard dose of oxamniquine within a 10-day period.

This leads into the surveillance phase, during which health education activities and treatment of newly detected or resistant cases of schistosomiasis continue; the maintenance of basic sanitation facilities is monitored; snail population levels, as well as the extent of schistosomiasis within these snail populations, are measured;

and schoolchildren are given coproscopic examinations every six months to monitor levels of schistosomiasis in the human community.

Initially, schistosome-infested areas in the states of Alagoas, Ceará, Maranhão, Paraíba, Rio Grande do Norte, and Sergipe are to be included in the program. Many large cities will not be included, however, because the Ministry of Health and Public Health Services Founda-

tion lack jurisdiction over water supply services and basic sanitation in these areas. It is felt at present that control of endemic schistosomiasis in rural areas is feasible in the short run through this program—but that ultimate eradication is improbable because of the likelihood that migrating carriers from the cities will reintroduce the disease.

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PAHO EXPERT ELECTED TO HEAD ENGINEERING ACADEMY

Frank A. Butrico, Chief of the Division of Environmental Health of the Pan American Health Organization, has been elected president of the American Academy of Environmental Engineers. The Academy is an organization of registered professional engineers which aims to improve the standards of environmental engineering and public recognition of this profession by board certifying those with established competency.

Mr. Butrico has been with the Pan American Health Organization since 1974. For nine years prior to that date he was Director of the Environmental Sciences Institute. Mr. Butrico also served for 21 years in the U.S. Public Health Service.