Schistosomiasis control in the Dominican Republic: recommendations for appropriate course of action

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SCHISTOSOMIASIS CONTROL IN THE DOMINICAN REPUBLIC: RECOMMENDATIONS FOR APPROPRIATE COURSE OF ACTION
SCHISTOSOMIASIS CONTROL
IN THE DOMINICAN REPUBLIC:
RECOMMENDATIONS FOR APPROPRIATE COURSE
OF ACTION

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BACKGROUND TO SCHISTOSOMIASIS ASSESSMENT TEAM STUDY

On July 3, 1979, the Dominican Secretary of State for Public Health and Social Assistance, Dr. Jose Rodriguez Soldevilla, in a letter to the Acting Director of USAID/DR, described his intent to develop a major public health effort. He took particular note of the potential problem of bilharziasis -- localized and believed to be under close control, but capable of spreading to other parts of the country in view of existing and planned construction of dams to extend the practice of irrigated agriculture. He requested the Mission to provide grant funding to control and possibly eradicate schistosomiasis, the funding to cover technical assistance, overseas training of Dominican technicians, and essential supplies and equipment.

The Mission's response took note of GODR interest in developing a program to control bilharziasis, observed that no funding for support of such an effort was available at the time, but left open the possibility of consideration at a later date, when appropriate funding might become available.

To assist USAID/DR in assessing the importance of schistosomiasis as a public health problem, to explore the efficacy of the existing GODR program of schistosomiasis control, and to make recommendations concerning appropriate modification of the control effort, a team of scientists (epidemiologist/parasitologist, malacologist and physician) was provided (under IQC No. AID/SOD/PDC-C-0162 Work Order No. 5) to evaluate the present and potential threat. In support of the schistosomiasis assessment a sanitary engineer was provided by the San Juan Office of the Center for Disease Control; in addition,
USAID/DR provided the contract services of a financial/economic analyst to work with the SAT, to review the SAT findings, and to recommend an appropriate course of action to USAID/DR.

The report of the financial/economic analyst (referred to in this report as the Contractor) is under the terms of his contract keyed to the findings of the SAT but is an independent submission to USAID/DR and to AID/Washington (LAC/DR/HR).
1. *Schistosoma Mansoni* infection (bilharzia), which has been demonstrated to be widely prevalent in the municipalities of Hato Mayor, El Seybo and Higuey, would appear, from data provided by the Secretariat of State for Public Health and Social Assistance (SESPAS), to have declined sharply and steadily since the inception of the program for the eradication of bilharzia in 1970. Autochthonous *S. mansoni* infection is not known to have taken place outside the eastern provinces, where these municipalities are located.

2. The program, under the direction of the Center for Eradication of Bilharzia (CEB) in Hato Mayor, is keyed to two courses of action: drug treatment of detected cases of *S. mansoni* infection, without relation to or identification of the transmission points where infection took place, and attempted extermination of the intermediate host snail, *Biomphalaria glabrata*, through application of molluscicides to all identified *B. glabrata* populations in and around the three municipalities where *S. mansoni* infection was known to exist.

3. Neither aspect of this two-course approach has been fully successful -- the first because detection efforts have been restricted to treatment-seeking victims of all gastrointestinal complaints in the Centros and Subcentros de Salud in the three municipalities where autochthonous *S. mansoni* is known to exist, totally ignoring the possibility of such infection among the well; the second because *B. glabrata* is very difficult to control, even after its habitats are identified, because habitats exist widely throughout the area (and, indeed, throughout much of the Dominican Republic), and because there has been no effort to link habitat search and molluscicide treatments
to the transmission points where detected *S. mansoni* infections actually occurred.

4. In addition to its mollusciciding efforts, the CEB maintains a breeding pool for multiplying *Marisa cornuarietis*, a competitor snail which preys on both young snails and snail egg masses and also competes for aquatic vegetation. First introduced in 1963, *Marisa* is reported to be widely distributed in the eastern provinces, as is another introduced competitor snail, *Tarebia granifera*. The impact of these biological controls on *B. glabrata* prevalence and *S. mansoni* transmission is not known.

5. Examination of CEB records demonstrates that reduction of prevalence of *S. mansoni* infection has been measured only within a population sample of the clinical ill (normally of a disease other than *S. mansoni* infection) at three locations. Case treatment within this population sample may or may not have had a significant impact on prevalence of infection in the general population. The major contribution toward reduction of transmission (as evidenced by reducing prevalence within the sample population of treatment-seeking victims of gastroenteric complaints) is probably largely (but not necessarily completely) attributable to the program of mollusciciding. As noted above, mollusciciding has been hit-or-miss, not keyed to known transmission points. Further, mollusciciding has not been related to the volume of water to be treated.

6. The CEB started (in 1970) with a misconception of the magnitude of its task, and continues to labor under the misapprehension. The program is oriented toward case treatment rather than prevention of
further infection, and general killing of *B. glabrata* rather than focal mollusciciding at identified transmission points.

7. While CEB prevalence data (and the interpretation of such data) are subject to criticism -- as is the design of the current control effort -- the SAT concluded that the trend indicated by CEB figures might well be indicative of a true situation -- i.e., that the decline in prevalence and incidence in a highly selected clinical group might parallel a similar decline in the overall population.

8. The SAT field effort has shown *S. mansoni* infection to be present in each of three locations tested (one not previously identified as a focus of infection) within random sample populations of individuals not suffering from treatment-requiring gastroenteric complaints (i.e., the population in general).

9. The SAT field effort has further demonstrated the presence of *B. glabrata* in habitats (not known to be infected) other than those previously identified. Some of these newly-discovered colonies are in areas of irrigated rice cultivation. The presence of a single infected human could render such habitats infective, thereby creating the possibility of a serious public health problem.

10. Internal migration patterns in the Dominican Republic show continuous movement of population. Schistosome parasites have an excellent chance of being carried out of the eastern provinces to other parts of the country where intermediate host snail populations exist -- including those where irrigated agriculture is planned.

11. Major reorientation of the present control effort is required, including a proper understanding of its functions, *if S. mansoni* is to be controlled adequately.
12. Many tools and resources are available for such a reoriented effort; they have not to date been mobilized for *S. mansoni* control. In most if not all cases, the use of these tools would not require substantial new or additional funding. They include but are not limited to:

a) Academic community capacity in delineation of foci of *S. mansoni* infection, malacological investigation and (as element in their training) graduate student manpower.

b) Basic village health services programs.

c) Potable water supply program.

d) Sanitary excreta disposal program.

e) Health education program.

13. The SAT investigation of *S. mansoni* infection in the Dominican Republic and of the present control efforts of the CEB came about as a result of a direct request from the Secretary of State for Public Health and Social Assistance; SAT recommendations would therefore seem assured of attention at the decision level.

14. To catalyze and provide guidance toward the application of the reoriented *S. mansoni* control program, USAID should recommend to GODR a survey more extensive in time and geographic coverage, to delineate the locations where *S. mansoni* infection is now to be found and to provide data on prevalence, intensity and incidence of infection in each area.

15. Dominican research capacity to conduct such a survey exists within the academic community. AID encouragement, recognition and partial support of such a Dominican research effort is fully consistent with the guidelines set forth in the 1980 AID Health Sector Policy Paper.

16. The SAT Report outlines the design of a more cost-effective program of control of *S. mansoni* infection, keyed to active case detection, identification of transmission points, treatment of
identified *S. mansoni* infection and focal mollusciciding of *B. glabrata* populations at transmission points.

17. Long-term control of *S. mansoni* infection is a Dominican responsibility, and should be carried out under Dominican leadership, using Dominican funds and employing Dominican resources. USAID/DR should be prepared to encourage reorientation of the CEB program and concur in the geographic realignment of existing AID-supported programs to permit their beneficial application to areas of *S. mansoni* infection, but should not assume responsibility for either the execution or the financing of the reoriented *S. mansoni* control program.
I. SCHISTOSOMIASIS IN THE DOMINICAN REPUBLIC

A. Human Infection

Schistosoma mansoni infection in the Dominican Republic is known to have existed for about forty years, since its positive identification by Ponce Pinedo in 1942. Autochthonous infection is known to have taken place in the eastern provinces of El Seybo and La Altagracia, and in particular, in the urban areas of Hato Mayor (where the infection was first detected), El Seybo and Higuey. While sporadic cases have been reported from Miches and Nisibon (both relatively close to the known infected area), it is not clear that they were autochthonous.

A 1950 population survey conducted in Hato Mayor produced evidence of wide-spread infection: of 243 stools of children aged 5-15, 21.4% were positive for S. mansoni eggs. Subsequent examination of skin test produced 30% positive reactions among Hato Mayor school children (1960). As recently as 1973, within a sample of 202 El Seybo children aged 3-12, 17% were found positive by skin test, and of 104 others aged 12-20, some 26.9% were positive. A sampling of 200 university students from Higuey, aged 20 and above, showed 23.5% positivity by the same test. Among 20 positive cases (as indicated by skin test), 19 were confirmed positive by the presence of S. mansoni eggs in their rectal mucosa, as detected by rectal biopsies.

In brief, S. mansoni infection is known to have been established in the Dominican Republic by 1942 (and, quite probably, much earlier); its presence and prevalence among children and young adults have been confirmed by statistically significant sample surveys in 1950,
1960, and 1973. All cases known to be autochthonous were found in the eastern provinces.

B. The Intermediate Host

*S. mansoni* infection among humans proceeds from invasion of the body by free-swimming cercariae, themselves released into water by an infected snail — which has in its turn been infected by miracidia released into water by *S. mansoni* eggs from the fecal deposit of a human host of the parasitic schistosomes. Thus, the chain from human to human cannot be completed in the absence of the intermediate host snail.

Although it may be possible under laboratory conditions to employ other kinds of snails as intermediate hosts, only one snail has been incriminated as the intermediate host under natural conditions in the Dominican Republic: *Biomphalaria glabrata*.

Since the presence of a single *S. mansoni*-infected human in an area with a *B. glabrata* habitat constitutes a threat of the creation of a focus of additional infection, the identification of *B. glabrata* habitats is a vital element in any program in control of the disease. *B. glabrata* is known to exist in many places throughout the country; its identified habitats include (but are not limited to) the locations where autochthonous *S. mansoni* infection has been found. No complete map of the habitats of *B. glabrata* has been prepared (although a snail habitat map for the Dominican Republic's neighbor, Haiti, is known to exist).

C. SESPAS Data

The program of bilharzia "eradication" of SESPAS, its techniques of human case detection and treatment and of snail habitat treatment are fully and accurately described in the SAT report.
In 1970, the Dominican Government mounted a program to eradicate bilharzia (schistosomiasis) as a function of the Secretariat of State for Public Health and Social Assistance (SESPAS), under the leadership of the Centro de Erradicacion de la Bilharzia (CEB) in Hato Mayor. Since that time, CEB has maintained records of *S. mansoni* infections found from stool examinations routinely performed on individuals who have sought attention for gastrointestinal complaints at the Subcentro de Salud in Hato Mayor and the Centros de Salud in El Seybo and Higuey. These records constitute the only consistently constructed and maintained series of data on *S. mansoni* infection in the Dominican Republic. Since they reveal positivity among a restricted population -- those sufficiently ill to seek attention at Centros and Subcentros de Salud for gastrointestinal complaints, and in a limited part of the country -- it becomes apparent that the overall prevalence of *S. mansoni* infection is not known. In fact, it is not even possible to determine from CEB data the prevalence of infection among the general population of the known infected communities.

The technique of stool examination employed at the Centros and Subcentros de Salud -- the Hoffman sedimentation method -- is relatively quick and easy; it suffers the disadvantage of low sensitivity, and may, therefore, fail to identify positive cases of low intensity. Consequently, the number of positive cases identified probably understates the actual prevalence among those tested.

Nevertheless, the records of the Centros and Subcentros de Salud (See Tables 1-3) show that over the course of a decade a minimum of 2019 cases have been positive; that the number of positive cases in
### TABLE 1: NUMBER OF POSITIVE CASES OF BILHARZIASIS (HATO MAYOR)

<table>
<thead>
<tr>
<th>Year Tested</th>
<th>Positive Cases</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>4,302</td>
<td>377</td>
<td>82</td>
<td>295</td>
</tr>
<tr>
<td>1971</td>
<td>4,256</td>
<td>170</td>
<td>38</td>
<td>132</td>
</tr>
<tr>
<td>1972</td>
<td>4,978</td>
<td>85</td>
<td>27</td>
<td>58</td>
</tr>
<tr>
<td>1973</td>
<td>7,801</td>
<td>96</td>
<td>31</td>
<td>66</td>
</tr>
<tr>
<td>1974</td>
<td>5,228</td>
<td>53</td>
<td>13</td>
<td>40</td>
</tr>
<tr>
<td>1975</td>
<td>4,463</td>
<td>19</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>1976</td>
<td>5,481</td>
<td>14</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>1977</td>
<td>3,106</td>
<td>12</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>1978</td>
<td>5,705</td>
<td>16</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>1979</td>
<td>4,093</td>
<td>12</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

### TABLE 2: NUMBER OF POSITIVE CASES OF BILHARZIASIS (HIGUEY)

1972-1978

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>528</td>
</tr>
<tr>
<td>1973</td>
<td>207</td>
</tr>
<tr>
<td>1974</td>
<td>64</td>
</tr>
<tr>
<td>1975</td>
<td>59</td>
</tr>
<tr>
<td>1976</td>
<td>88</td>
</tr>
<tr>
<td>1977</td>
<td>29</td>
</tr>
<tr>
<td>1978</td>
<td>18</td>
</tr>
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### TABLE 3: NUMBER OF POSITIVE CASES OF BILHARZIASIS (EL SEYBO)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>58</td>
</tr>
<tr>
<td>1973</td>
<td>62</td>
</tr>
<tr>
<td>1974</td>
<td>23</td>
</tr>
<tr>
<td>1977</td>
<td>29</td>
</tr>
</tbody>
</table>

**Source:** For above tables, SESPAS
Hato Mayor and Higuey has declined quickly to a low plateau (and, less markedly, in El Seybo). Positive cases have been increasingly restricted to older age groups. No cases among 0-4 age group have been reported since 1977, and in Hato Mayor only one positive case below age 15 has been reported since 1977.

Such data prove only that within the sample population (i.e., those treated for gastrointestinal complaints), *S. mansoni* infection is declining in prevalence, that new incidence is also declining, that intensity of infection is low and declining. The data are, however, based on prevalence among sick individuals. They reveal nothing about prevalence among individuals who may have asymptomatic infection or whose illness is so mild that they do not seek treatment.

D. Validity of SESPAS Records

The records of cases examined and confirmed *S. mansoni* positivity, as maintained by CEB/SESPAS, would at first glance appear to constitute a straightforward basis for calculation of percentage positivity within the CEB sample population (which, as has been noted, is not necessarily a representative sample population). CEB provided an unbroken series of records, 1970-79, of cases of *S. mansoni* infection identified in the municipality of Hato Mayor, compared with the total number of examinations. Less complete records, for selected years only, showing positive tests but not the number of examinations, were provided for the municipalities of El Seybo and Higuey.

Similar (but by no means identical) and more complete data, providing the estimated populations of the towns of Hato Mayor, El Seybo and Higuey (urban and rural combined), and for each location the number of examinations performed as well as the number of positive cases
identified, are to be found in another SESPAS document, the strangely titled "Annual Report Covering Eight Years of the Work of the Center for Eradication of Bilharziasis" by the former director of the Center, Dr. Brugal Montoya. It should be noted that the report itself was not made available to the team; despite a month-long search, it could not be located in the SESPAS library. However, the report has been extensively extracted by Drs. Sanchez Limardo, and Grullon Perez in a recent issue of the Revista Dominicans de Gastroenterologia (1980, Vol. 3). Their extracts of Dr. Brugal Montoya's report include all of the data noted above.

Unlike the first-cited record series, which are devoid of interpretation, Dr. Brugal Montoya's report attempts to establish prevalence data for each community per 100,000 of population. The result is a statistical disaster; actual prevalence figures (as calculated from Dr. Brugal Montoya's own data) are understated by as much as 50 to one, with an average understatement of roughly eight to one. These figures are uncritically respected in the Sanchez-Grullon report cited above, and may have led to a general misunderstanding of the schistosomiasis situation in the Dominican Republic (and even among senior officials of SESPAS).

The magnitude of error is too gross to represent an intention to mislead; rather, it reveals basic flaws in data interpretation. The former director of CEB did not merely assume that the percentage of S. mansoni infection detected within a sample population of the clinically ill (of any gastrointestinal disease) within a community could be extrapolated to cover the entire population of the community
(however defined); he also appears to have assumed that detected
*S. mansoni* infection (at each Centro de Salud) constituted all *S. mansoni* infection within the community where the Centro was located. No other explanation can account for his conclusions.

Working on this assumption, Dr. Brugal Montoya then calculated percentages of positivity (expressed in "Cases per 100,000 of population") as if the entire population of the community had been his sample population.

This false assumption -- that detected positive cases among those being treated for gastrointestinal complaints constituted all *S. mansoni* infection in the entire community -- may help to explain at least part of the sharp drop in prevalence which would appear (from Dr. Brugal Montoya's report and from literature based on that report) to have taken place between 1950 (when Olivier *et al* found 21.4% of Hato Mayor children aged 5-15 to be positive for *S. mansoni* eggs in their stools) and 1970, when CEB records of experiences at the Hato Mayor Subcentro de Salud showed data indicating a positivity rate of only 10.83% (or 8.76%, depending on which CEB records are consulted).

E. Prevalence Comparisons

The following table compares *S. mansoni* infection data derived from the Olivier 1970 population sample survey among children in Hato Mayor; from Dr. Brugal Montoya's figures covering his experience at Hato Mayor for 1970 and 1978, as he interpreted them and as correctly interpreted; from currently available SESPAS records for Hato Mayor; and as implied by the Hato Mayor portion of the SAT field survey.
TABLE 4: *S. mansoni* INFECTION PREVALENCe RATES IN HATO MAYOR

<table>
<thead>
<tr>
<th>Year</th>
<th>Positive Cases Within Sample Population</th>
<th>Sample Population (Actual)</th>
<th>Sample Population Used by Reporter in Calculation</th>
<th>% Positivity (As interpreted by Reporter)</th>
<th>Actual % Positivity Within Sample</th>
<th>Cases per 100,000 Reported</th>
<th>Cases per 100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>52</td>
<td>243</td>
<td>4302</td>
<td>8.76</td>
<td>0.29</td>
<td>293</td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>328</td>
<td>3028</td>
<td>40,473</td>
<td>0.81</td>
<td>10.83</td>
<td>10,832</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>16</td>
<td>3929</td>
<td>42,245</td>
<td>0.038</td>
<td>0.41</td>
<td>407</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>12</td>
<td>4093</td>
<td>42,245</td>
<td>0.038</td>
<td>0.29</td>
<td>293</td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>1</td>
<td>49</td>
<td>49</td>
<td>2.04</td>
<td></td>
<td>2,041</td>
<td></td>
</tr>
</tbody>
</table>

1/ Olivier et al population sample restricted to children aged 5-15.

2/ Brugal Montoya: Informe anual sobre 8 anos de labor del Centro de Erradicacion

3/ SESPAS records provided to SAT.

4/ SAT representative population sample in a single barrio.

5/ Number tested.

6/ Estimated population of urban and rural Hato Mayor.
No explanation has been advanced as to why CEB records (as cited by Dr. Brugal Montoya's report) and the somewhat different CEB data provided by SESPAS to the SAT do not coincide, at least with respect to cases tested and positive cases identified.

The quantum drop in percentage *S. mansoni* prevalence within sample populations tested in 1950 and again 1970 -- a period when no effort to reduce prevalence was in effect -- is a function of several possible variables; test sensitivity, age of sample population tested, examination proficiency, and possibly fortuitous biological control of the intermediate host snail. The most significant difference, however, is that the 1970 sample population excluded any cases which were asymptomatic or insufficiently severe to require treatment at the Subcentro de Salud.

In fact, Dr. Brugal Montoya's report does a disservice to a record of relatively successful CEB performance. Within his questionable sample population -- the clinically ill of any gastrointestinal complaint -- the rate of *S. mansoni* infection per 100,000 population (Dr. Brugal Montoya's chosen extrapolation) in Hato Mayor fell dramatically -- not from 810.4 to 37.8, as he states, but from 10,832 to 407. (A more common measure would be a fall in percentage prevalence from 10.83 to 0.41). Nevertheless, the rates of *S. mansoni* prevalence in Hato Mayor at the time when Dr. Brugal Montoya left the CEB in 1978 were about 11 times what he believed them to be -- even within his sample population.

The SAT survey in 1980, using a more sensitive test than that available to the CEB, indicates that within a truly representative
sample population the prevalence would be 54 times higher than Dr. Brugal Montoya believed them to be in 1978 and five times the actual prevalence within the CEB sample population, as indicated by the test methods used by CEB.

Unfortunately, Dr. Brugal Montoya's choice of sample population has been continued by his successor, Dr. Amaury Mendez, the present CEB Director. Correctly calculated percent prevalence rates in the three areas of known autochthonous S. mansoni infection, as derived from the most recent SESPAS data from positive cases identified within a sample population of the ill were 0.29 for Hato Mayor (1979), 0.55 for Higuey (1978) and 0.53 for El Seybo (1977). SAT field studies suggest that 1980 positivity percentage rates within representative sample populations are many times higher than those derived from CEB data: 2.04 in Barrio Gualey in Hato Mayor, 6.06 in Barrio Ginandiana in El Seybo, and 3.13 in Batey Guayquía, an area midway between Hato Mayor and El Seybo.

While all CEB published records of S. mansoni infection are based on findings among the clinically ill, one major population-based survey was in fact undertaken. In 1975 and 1976 Dr. Brugal Montoya conducted a large population-based stool survey (using the Hoffman sedimentation method of analysis) of some 20,771 persons living in the Gulf and Western properties in the eastern provinces. Although Dr. Brugal Montoya's (unpublished) study of this survey was not available to the SAT for examination or further interpretation, he informed the SAT that the survey had produced only eight positives, all from the municipality of Higuey. This would indicate a very low prevalence in these areas.
II. SAT FIELD DATA

Initially, it must be recognized that the SAT field effort could not be, nor was it designed to be, an adequate basis for measuring the extent to which *S. mansoni* infection constitutes a major public health problem in the Dominican Republic. Neither does it fully delineate those places in the country where habitats of the host snail, *B. glabrata*, exist; which of these habitats have infected snails (and therefore represent an immediate threat of human infection); the locations where active human *S. mansoni* infection is now to be found; or the prevalence, intensity and new incidence of human infection in such areas.

Rather, the SAT effort confirms the existence of *B. glabrata* habitats in a number (but not all) of the previously identified locations; notes the disappearance (possibly temporary) of *B. glabrata* colonies from certain previous habitats, and identifies previously unknown habitats (not yet demonstrated to be infective, since the snails collected were found to be free of infection), some in rice-growing areas where infection would present a public health threat to workers. With respect to the disease in man, the SAT study confirms the existence of continued infection at two sites (Hato Major and El Seybo) where the disease has been endemic in the past (and, additionally, at a previously unidentified site midway between Hato Mayor and El Seybo), identifying within a random sample of the population at each site the prevalence and intensity of infection by age group and sex, and enabling at least for the very young, judgments with respect to new incidence.
Superficially, the SAT field effort lends a measure of support to the trend line shown by CEB records: that a decade of CEB activity (plus, possibly, one or more additional factors of as yet unassessed significance; *S. mansoni* infection has abated naturally on St. Kitts) has resulted in a major reduction in the prevalence and incidence of *S. mansoni* infection in those areas of the Dominican Republic known to have been foci of endemic infection as recently as 1973.

The SAT field effort can more accurately be compared with genuine population studies which preceded the inception of the PEB. Because the SAT effort (with respect to detection of human infection) employed a test different from and more sensitive than that used by CEB and was directed to a more representative population sample, it makes difficult a direct comparison with CEB data. Moreover, it demonstrates, as CEB data do not, the presence of asymptomatic *S. mansoni* infection among the well.

A. *S. mansoni* Infection in Humans

SAT's testing for human infection was carried out by a particularly sensitive method--the modified Ritchie stool examination--and because of the requirements for highly skilled technicians and technologically advanced laboratory facilities, the stool examinations were performed at the Center for Disease Control Laboratory in San Juan, Puerto Rico. CEB, in contrast, employs the simpler, quicker but less sensitive Hoffman sedimentation test.

The results of the SAT field study in all probability indicate intensities of infection higher than would have been revealed by use of the Hoffman test. Indeed, the SAT tests may have identified infections of low intensity which the Hoffman test would have missed
altogether. For these reasons alone, a direct comparison of SAT test results with CEB-derived prevalence data would not have full statistical validity.

Another factor—the significance of which may be inferred but cannot be measured—which distinguishes the SAT prevalence results from those derived from CEB data is the nature of the population tested. The SAT tests measure *S. mansoni* infection within a random sample of the population resident in areas known to have produced cases of infection over a decade or more, the random sample so selected as to cover the age-spread of the population in full. CEB case-finding records, in contrast, represent the sum of cases found to possess active infection among those individuals who were sufficiently ill (of any gastrointestinal complaint) to cause them to seek medical attention at the SESPAS Centros and Subcentros de Salud in Hato Mayor, El Seybo and Higuey, where discovery of *S. mansoni* eggs took place in the process of routine stool examinations. Thus, detection of *S. mansoni* infection has been almost a by-product; or to put it another way, CEB has followed a course of passive case detection within a population of the treatment-seeking ill.

CEB figures would, on the other hand, exclude any "well" individuals with asymptomatic *S. mansoni* infections, since the victims of such infection would not find it necessary to seek help at the Centros de Salud.

The SAT field study constitutes active case detection—a search for *S. mansoni* infection within three different random population samples—and might, other things being equal, be expected to produce
prevalence rates somewhat lower than those within a population sample selected by the presence of gastrointestinal complaints' (which frequently produce symptoms characteristic of acute *S. mansoni* infection). This did not prove to be the case. The SAT study identifies asymptomatic infections within the random population samples. Extrapolation of prevalence percentages within such sample populations to the entire population of the contiguous area is valid, although the sampling was too limited in geographic extent (a single barrio at each location) to enable a statistically reliable extrapolation to the entire municipality. But evidence of asymptomatic infection in each of the three sample populations is clear proof of a problem, the magnitude of which is not yet determined but the geographic extent of which is broad. Within these test populations the prevalence of infection averaged over 3.5%.

In brief, the relatively small size of the SAT-tested population sample and its geographic limitation (one barrio per community) would lay open to challenge any definitive conclusion concerning over-all prevalence which might be drawn from the test results. Had the stool examinations proved totally negative for *S. mansoni*, they would not have proved the absence of infection from the country or even from the areas where infection is known to have been previously endemic. Had the findings been heavily positive, however—especially among the very young—they would have cast serious doubt on the apparent conclusions to be drawn from CEB records; that prevalence in all known infected areas has declined sharply since the inception of the "eradication" program in 1970, and that there has been no new incidence among the 0-4 group since 1977 (and, in Hato Mayor, since
Actual SAT findings fall between these two extremes.

In fact, the SAT finding (within its sample populations) of low rates of prevalence of S. mansoni infection, as compared with high prevalence data from earlier population surveys, may negate CEB prevalence calculations but support CEB trend-line indications. But the SAT field effort at all three sites reveals appreciable prevalence of asymptomatic infection within the population at large, previously not revealed by CEB data, and strongly suggests the desirability of a major restructuring of the design of the CEB S. mansoni control program now in operation.

B. Malacological Field Survey

Snail surveys were principally concentrated in El Seybo province, but were also carried out in the provinces of La Altagracia, Azua, Duarte, Sanchez Ramirez and the National District.

B. glabrata colonies (or evidence of their recent presence) were found in eight localities in El Seybo province, two in La Altagracia, two in the National District and one in Sanchez Ramirez. Search of some foci reported in the literature did not reveal B. glabrata presence at this time.

From the present limited field survey and from the literature it is evident that B. glabrata is not only widely spread in the eastern provinces, but also extends its range into other parts of the country.

B. glabrata was not present in a number of previously identified habitats (although it may well still be present elsewhere in the same watercourse), possibly as a result of the activity of competitor
snails (e.g., *Thiara granifera, Marisa cornuarietis*), in some instances as a result of source reduction (environmental modification) but in some instances as a result of long-repeated, wasteful, mollusciciding practice. On the other hand *B. glabrata* was encountered in rice fields at La Cruz, not only in irrigation and drainage canals but also in cultivated plots. Shells in the excavated debris and sediment of canals and drains of rice fields near Miches give evidence that extensive populations of *B. glabrata* may be expected during wet seasons.

Other water bodies examined in the eastern and central parts of the country were free of *B. glabrata* but appeared to offer ideal habitats if the snail were accidentally introduced.

The limited SAT malacological survey produced no snails which were infected with *S. mansoni*. This may be a function of the relatively small numbers of snails collected, a low infection rate because of the season, or, in some instances, relatively low likelihood of human fecal contamination of the habitat.

C. **Significance of SAT Test Results**

The significance of the SAT test results should not be misunderstood. They reveal the presence (and suggest the prevalence) of *S. mansoni* infection among the "well" within three small test populations. They provide no definitive evidence of the place (or places) where the infection occurred, although inferences may be drawn from observed locations at each site where man-water contact is regularly made and where fecal contamination is evident. They identify a small number of individuals for treatment.
But most important, they reveal the presence of a human reservoir of *S. mansoni* infection which would, under current CEB practice, remained undetected and untreated.

It must be observed that individual case treatment is only incidentally concerned with relieving the infected individual of possible morbidity or mortality resulting from *S. mansoni* infection. The purpose of case treatment is to cut off a source of further transmission of such infection, i.e., to reduce the human reservoir of infection by one individual. Beyond treatment, however, it is important that the source of infection be identified by a search based on the activity pattern of the infected person; that other infected individuals who are contributing to the source be identified, treated and withdrawn from the human reservoir; and that the transmission point be cleared of host snails. There is no evidence that CEB has ever followed such a policy.

The SAT report points the way toward implementation of such a policy, but SAT test results do not provide adequate guidance for its full application.

Single barrios in Hato Mayor and El Seybo were tested; other barrios can be expected to produce similar evidence of infection, other transmission sites, and possible other patterns of exposure to infection; other locations outside the previously identified foci of infection can be expected to yield evidence of *S. mansoni* infection. Prevalence, intensity and incidence have not yet been adequately defined.

In sum, the percentage infection rates suggested by SAT test results do not demonstrate that *S. mansoni* infection is at present a major public health problem, although the infection prevalence
rates suggested by the SAT findings are higher by many times than the optimistic figures calculated from CEB data. They show, however, that *S. mansoni* infection, if not dealt with, could become a problem of major dimensions, particularly if it spreads to areas of irrigated rice cultivation, where the nature of the work assures infection--and reinfection--of agricultural workers. They make it clear that the ten-year effort of the CEB (which is, in practice, a program of control rather than of eradication), should be continued and restructured, with defined objectives and a modified pattern of operation which can deal with the problem more systematically with the assistance of a number of available tools not yet put to use.
III. EXISTING LEVEL OF GODR EFFORT

Existing GODR efforts to contain the impact of *S. mansoni* are, as is noted, a direct function of the Centre for the Eradication of Bilharzia, a branch of the SESPAS Division for Control of Transmissible and Non-Transmissible Diseases. Despite its name, the functions of the Bilharzia Control Section (as set forth in the GODR budget for 1980, page 207-43), are to "maintain a close control over existing foci of bilharziasis production, preventing their propagation in the rest of the country; standardize and administer required treatment to existing cases of this disease." Its annual objective, as stated in the same document (p. 205-7) is "to intensify the programs of ... bilharzia control which are concerned with the prevention of new foci and outbreaks."

These statements precede actual budget provisions of DR $56,000, of which $40,200 represent salaries, $3,168 travel expenses, $6,000 vehicles, $3,344 chemicals, and $3,728 all other items (all figures in Dominican pesos, which are, officially, equivalent to U.S. dollars).

It is to be noted that these figures are budget provisions, not expenditures. More significantly, they exclude the salaries and other costs of the medical side of the CEB staff, covering only the molluscicide team. In fact, no data are available concerning either budgets or actual expenditures for 1978 or 1979; all costs for prior years are buried, possibly in the figures for the Division of Transmissible and Non-Transmissible Diseases. That such costs existed is evident; the CEB has continued to function without interruption since 1970, apparently without need for a line-item budget.
It is reasonable to assume that the 1980 budget provision was derived from the actual (if unidentified) operating costs of prior years. It is improbable that the 1980 budget covers the anticipated costs of molluscicide, since existing supplies (purchased in 1975) are sufficient to cover needs (at present rates of use) for at least another year.

In brief, neither past, present or future costs of CEB operations are available.

SESPAS has in 1980 demonstrated its concern over the problem of a potential spread of *S. mansoni* infection by:

1. Establishing a line-item budget for at least part of the Bilharzia unit within the budget for the Division for Control of Transmissible and Non-Transmissible Diseases.
2. Defining the function of this unit in terms of control rather than eradication.
3. Expressing as an annual objective a program intensification to prevent the establishment of new foci of infection and outbreaks of infection at any point.

The functions and objectives of the program, then, have been properly identified on paper.

The extent to which SESPAS (and the GODR) is supporting and may be prepared to support an augmented control effort is not known.

At the field level, the CEB shows no recognition that its functions have been redefined, or that its program, as presently conducted, is unlikely to achieve its stated objective. To cite the SAT conclusion: since 1978, the work of the CEB has been done more or less by inertia, the personnel repeating established routines without much direction (and) without fixed goals.
IV. COSTS, BENEFITS AND EFFECTIVENESS

Although *S. mansoni* infection unquestionably exists in the Dominican Republic, and all identified cases are both recorded and sent to the Hato Mayor Subcentros de Salud for treatment, *S. mansoni* infection is not currently a recognized cause of morbidity. Since his appointment to head the CEB in 1978, Dr. Amaury Mendez has seen no cases of enlarged liver or spleen associated with *S. mansoni* infection. In contrast, his predecessor, Dr. Brugal Montoya, indicated (but did not have written data) that he has seen *S. mansoni*-related hepatosplenic disease during his tenure as CEB director, and Dr. Ponce five Pinedo in 1942 documented cases (of six cases identified) with signs and symptoms of advanced hepatosplenic disease.

The current absence of recognized cases of disease secondary to *S. mansoni* infection is not inconsistent with the decrease in the number of cases reflected by CEB data (which, as is elsewhere noted, may be reliable with respect to trend if not to actual reduction in prevalence). However, it is equally likely that detected hepatomegaly and splenomegaly secondary to *S. mansoni* infection were mistakenly attributed to malaria, which is also endemic in the *S. mansoni*-endemic areas and which has been increasing in prevalence in recent years.

Acute schistosomiasis, a form of the disease often found in people about 30 days after their first exposure to schistosome cer-carcise, is similarly unrecognized as a cause of morbidity in the Dominican Republic. Since this syndrome has the symptoms of other acute febrile illnesses, including malaria, it may easily have been misdiagnosed.
Undetected *S. mansoni* infection, which the SAT field effort has shown to exist, has by definition not entered into national data on morbidity.

In sum, it is quite clearly impossible to cite data on the costs to the economy inherent in *S. mansoni* infection—loss in earnings on the part of the worker, for example, or an imputed value for human suffering. In the case of asymptomatic infection, the victim may be unaware of discomfort.

Because of the unexplained bookkeeping techniques of SESPAS, it is not possible to cite data on the present costs of controlling *S. mansoni* infection. No expenditure data are to be found for 1978 and 1979, for example, and the only cost figures available are included in a budgeted RD $56,440 for 1980. It may be hypothecated that in the absence of the present control effort *S. mansoni* infection might have spread throughout the eastern provinces and their 650,000 population, or conversely, that the present program, whatever its actual monetary dimensions, had provided a substantial measure of protection against *S. mansoni* infection for some 650,000 people. Following this line of reasoning, it is possible to infer that an incremental input—from whatever source—would improve the measure of protection not only in presently endemic areas but also in other parts of the country where the presence of *B. glabrata* populations opens the probability, imminent or ultimate, that *S. mansoni* infections may be carried by infected migrants. This line of reasoning would be accurate, but would not constitute a plausible economic justification of the program.
The Contractor does not believe that, given the present status of *S. mansoni* infection in the Dominican Republic, the benefits of the present or prospective efforts can be measured in purely economic terms. In none of the literature examined has any attempt been made to do so. Even in countries where the impact of schistosomiasis is far heavier—{}and far more precisely measured—{}efforts to produce a control program justification based on benefit-to-cost analysis have not yielded satisfactory results. The Edna McConnell Clark Foundation, which has supported schistosomiasis research for many years, has concluded that an economic justification for schistosomiasis control has never been developed, that the development of such a justification would be extremely difficult, but that further research of a significant categorical disease deserves support.

*S. mansoni* infection in the Dominican Republic is a locally prevalent and potentially more widely prevalent "end of the road" disease, primarily of the rural population but not exclusively so, and one to which the GODR is proposing to devote more attention than it has been received heretofore. No precise measurement can be made of what might be considered the negative socio-economic effects of this chronic parasitic infection. The GODR has indicated concern for the expansion of *S. mansoni* infection which may accompany development activities, but impairment of tourism and the political overtones of expanded prevalence of a categorical disease are additional considerations which may influence GODR's interest in an augmented control effort.

The SAT has suggested a technique for *S. mansoni* control, which, if adopted, will prove more effective (and more cost-beneficial)
than the existing control effort. To the extent that USAID should decide to support the implementation of this technique, the USAID inputs (and, indeed, the total control effort) should be considered as justifiable not on the basis of an absolute return on investment but on the basis of the probability of a higher degree of protection to the population now at risk (and, in addition, at potential risk) as a result of a better-designed program operating on the basis of reliable base-line data.
V. JUSTIFICATION REQUIRED FOR USAID SUPPORT

AID policy concerning support of disease control programs has normally been keyed to the following considerations:

A. The extent to which the disease constitutes a major problem.
   Aid has normally been prepared to consider assistance to disease control programs in instances where there is need to protect a substantial investment in terms of gains already made or a need to prevent the disease from becoming a deterrent to other country development programs.

B. The nature of preliminary preparation.
   As a precondition for consideration of disease control assistance, AID normally requires that the country demonstrate its own interest in and concern about the disease through the development of an appropriate plan to control the disease and the provision of an adequate budget and staff to carry out the country program. However, AID has frequently provided assistance in the development of a plan of control which meets the requirements of technical and administrative soundness.

The plan should describe:

1. The broad strategy to be adopted to control disease prevalence and prevent its spread.

2. The organization through which the plan is to be implemented, including staffing requirements.

3. The nature of and provision for meeting national training and research requirements.

4. The extent of national budgetary support for the effort.

5. External assistance requirements, and

C. The extent of internal resource mobilization.

In addition to country budget and staffing preparation, AID has also taken account of the extent to which other national efforts, not limited to efforts of the government, have been or are planned to be brought to bear on the disease control program. This will include the activities of other sectors which can influence or be influenced by the prevalence or spread of the disease.

D. Exploration of resources of external support.

AID has taken account not only the mobilization of available internal resources but also the exploration of external sources of assistance. Such assistance would include (but would not be limited to) technical guidance (normally WHO/PAHO) and financial assistance.

E. The nature of AID support.

AID has not restricted itself to a particular input or class of inputs, but normally seeks to provide those kinds of support which, taken together with other inputs, can make possible the successful implementation of the plan. In some instances this has been limited to support of in-country research and provision of external training.

To the Contractor, it appears that some (but not all) of the essential preconditions of AID assistance have been met. The SAT, on AID's behalf, has confirmed the existence of the problem of \textit{S. mansoni} infection (in a dimension greater than had been recognized by GODR officials), has suggested the directions to be taken to make the present GODR program more effective in meeting its announced targets and has identified existing additional resources upon which
GODR can draw in implementing a reorientated schistosomiasis control effort. The need for additional inputs of AID resources (i.e., beyond the contribution of the SAT) appears to be minimal:

1. Support of in-country research by the Dominican academic community.
2. Offshore training of key senior personnel, in Puerto Rico or elsewhere.
3. Application to *S. mansoni* control of existing USAID-supported programs.

Whether the widely publicized offers of Gulf and Western (to provide large-scale financial support to GODR's efforts to improve and increase the availability of health services in the Dominican Republic) can be brought to bear on the reorientated *S. mansoni* control program is not known; it would appear to warrant GODR exploration.

Failure to provide such support to a redirected *S. mansoni* control program could have the effect of permitting further expansion of the areas of endemic *S. mansoni* infection, not only within what are believed to be its present marginally damaging confines but also to the areas of present and potential irrigated agriculture, in the eastern provinces and in other parts of the country where the intermediate host has or may be found to have established populations. Establishment of endemic *S. mansoni* infection in such areas would be more difficult to control, would involve a quantum jump in control costs, and would create, for the first time, a level of *S. mansoni* infection sufficiently high to represent a serious public health problem.
VI. CONTRACTOR'S RECOMMENDATIONS

Under the terms of contract No. AID/LAC-C-1401, the Contractor is required to make "recommendations for appropriate course of action for USAID/DR." To the Contractor, it appears that while USAID/DR can be of assistance, the major decisions concerning the control of *S. mansoni* infection rest with the GODR, and in the absence of assurance of favorable action on such decision, no USAID action is required, or, indeed, warranted. Emphatically, the Contractor does not recommend that the USAID should assume the responsibility for control of *S. mansoni* infection in the Dominican Republic.

To the Contractor, it appears that a number of steps should be taken without delay. These steps are outlined below, in the approximate sequence of action.

It should be noted that while the steps outlined are consistent with the conclusions of the SAT report, the recommended course of action does not fully mirror the SAT's recommendations.

Since the initial action leading to the SAT study was a written request from the Secretary of State for Public Health and Social Assistance for USAID grant support for an enhanced program of control over *S. mansoni* infection and its spread, the first step following the SAT study should be a full discussion of the SAT findings and recommendations with the Secretary:

To alert him to the degree to which the existing SESPAS/CEB data misrepresent the present extent and distribution of *S. mansoni* infection within the population.
To point out the shortcomings in the present CEB effort.
To advance for his consideration a plan for modification and reorientation of the CEB effort.

A. Program Elements

The elements in this plan would include the following actions:

1. Since existing benchmark data on *S. mansoni* prevalence are not only inaccurate but do not reveal the actual transmission points, survey and map the problem areas with respect to human *S. mansoni* infection, (including prevalence and intensity data); transmission points; and identified habitats. The Dominican academic community has the capacity for this effort.

2. Identify intermediate, measurable targets, to be achieved within defined periods of time. The SAT-proposed reorientation of the CEB program suggests the possibility of but does not spell out such targets.

3. Orient the program to disease prevention by systematic reduction of the human reservoir of infection, concentrating first on points where infection is identified. This implies:
   a. A policy of active case detection, back-tracking detected cases to determine the probable transmission point.
   b. Stool tests of all known users of any infective transmission point.
   c. Curative drug treatment of all detected infections.
   d. Focal mollusciciding of snail habitats in the waters of transmission point, or leading to the transmission point—repeated at appropriate intervals to eliminate recently hatched snails before they reach maturity.
   e. Systematic follow up of detected cases.
   f. For *S. mansoni* infections detected in the process of routine stool examinations in Centros de Salud, a back-tracking like that described in subsections a-e above.
   g. Within locations where transmission appears to have been interrupted, an annual sample survey to detect possible reinfection or new incidence of infection.
4. **The program does not necessarily have to be conducted everywhere at the same time.** Within funding limitations, however, design the program to protect the maximum number of people, moving on to additional areas as funds permit and as transmission is interrupted at initial points of attack.

5. Retain program planning, management, supervision of execution, supply functions and evaluation in a central location within SESPAS.

6. Make maximum use of the much larger, more geographically diversified and outward-looking rural health delivery system to add an outreach factor to the program. In particular, train the "promotoras" in the *S. mansoni*-prevalent areas (as defined in recommendation 1, above) to undertake the following functions:

   a. Observation of locations, frequency and kinds of population contact with water.

   b. Identification of *B. glabrata* habitats; snail collection and determination whether the habitat contains infected snails.

   c. Collection, identification and preservation of stool samples (for testing at Centros and Subcentros de Salud); notification to confirmed infected individuals of need for treatment; case follow-up.

   d. Possible treatment of Centro de Salud-confirmed cases following prescribed dosages per kilo of body weight (particularly if orally administered oxamniquine is substituted for the currently used bithionol, as recommended by SAT).

   e. Augmented health education (see 8, below), including emphasis on environmental sanitation.

7. **Within the funding limits of existing programs of potable water supply and sanitary excreta disposal, reorient these programs to provide priority attention to areas which face *S. mansoni* problems.** Latrine construction at common-use water sites should be considered.

8. Revitalize the efforts of the Health Education Service to elicit maximum cooperation from the population at risk of *S. mansoni* infection in preventing fecal pollution of water, particularly common-use water.

9. Encourage and solicit the efforts of the academic community to support and indeed participate in the program. Such efforts would include: among others:
a. Full responsibility to conduct a geographically broad and longitudinally extended survey to determine all communities in the eastern provinces which show *S. mansoni* infection, to determine prevalence and intensity of infection, and to provide this information as base-line data for the reorientated CEB program.

b. Research studies of the correlation between intradermal and/or serological tests, on the one hand, and stool tests on the other, to determine whether and to what extent the quicker and more easily observable skin test may be used as a screen to reduce the number of stool tests required.

c. Assignment of third and fourth year medical students to administer drug treatment in the field to identified individuals or, as demonstrated useful under 9(b), above, administer skin tests.

d. Malacological and epidemiological investigations, including the preparation of a map of all identified *B. glabrata* habitats.

10. Exchange information with and utilize the training facilities of the CDC laboratories in San Juan, Puerto Rico, and the Center for Energy and Environment Research of the University of Puerto Rico.

11. Assure constant attention to prevent the introduction and establishment of *S. mansoni* infection in non-infected areas where endemicity could cause a major public health problem. These would include areas of present or potential irrigated agriculture, where work patterns would facilitate constant reinfection and high levels of intensity of infection. The possibility of spread to areas of tourist development and to the major cities cannot be excluded.

12. Establish and maintain a cadre of technically and administratively competent leadership, familiar with, concerned with and able to deal with the problem of *S. mansoni* infection and transmission. This requires recognition of the problem in terms of a line-item budget, with permanent status for both administrators and skilled, professionally qualified technicians.

B. USAID Support

To the extent that the Secretary of State for Public Health and Social Assistance accepts and is prepared to adopt such a plan
of attack, USAID may wish to consider support in three key areas:

1. **Support of goal-oriented research** efforts by members of the Dominican academic community, to delineate current areas of *S. mansoni* infection and to establish prevalence and intensity benchmarks.

2. **Support of overseas training** in Puerto Rico or elsewhere for administrative and technical leadership of a redirected program of schistosomiasis control.

3. **Modification of existing USAID-supported programs** in such health-related areas as potable water supply, sanitary excreta disposal and, in particular, rural health delivery, to enable their maximum contribution to the control of *S. mansoni* infection. Such modifications would represent a geographic shift within the water supply and excreta disposal projects, to give a higher priority to the eastern provinces. The rural health delivery service, given modest training, can provide the outreach factor which the present CEB lacks.
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