

PD AAA-642

41064

EVALUATION OF SCHISTOSOMIASIS ACTIVITIES  
IN THE HASHEMITE KINGDOM OF JORDAN

A Report Prepared by PRITECH Consultant:  
EMILE A. MALEK, M.D.

During The Period:  
APRIL, 1985

TECHNOLOGIES FOR PRIMARY HEALTH CARE (PRITECH) PROJECT  
Supported By The:  
U.S. Agency For International Development  
AID/DPE-5927-C-00-3083-00

AUTHORIZATION:  
AID/S&T/HEA: 6/14/85  
ASSGN. NO.: SS 63

TABLE OF CONTENTS

	<u>Page</u>
I. SCOPE OF WORK	1
II. SUMMARY OF ASSESSMENTS AND RECOMMENDATIONS	2
III. SCHISTOSOMIASIS IN JORDAN	4
IV. THE USAID CONTRACT WITH THE UNIVERSITY OF JORDAN PROJECT NO. 278-6224 (1981-1984)	7
V. SUBCONTRACT WITH THE UNIVERSITY OF LOWELL AND THE UNIVERSITY OF MICHIGAN	8
VI. ASSESSMENTS OF ACHIEVEMENT OF SUBCONTRACT OBJECTIVES	12
VII. NEW APPLICATION FOR EXTENSION OF THE USAID CONTRACT WITH THE UNIVERSITY OF JORDAN	17
VIII. ASSESSMENT OF JORDANIAN AGENCIES AS TO SNAIL SURVEILLANCE AND CONTROL EFFORTS	18
IX. RECOMMENDATIONS	23
APPENDIX I - Persons With Whom Discussions Were Held	27
APPENDIX II - Bibliography	28

## I. SCOPE OF WORK

The objectives of the assignment were:

1. To evaluate the work already done by the University of Jordan under USAID supported project No. 278-0224 (1980-1984) entitled "Identification, Distribution and Ecology of the Snail Fauna in Jordan".

2. To review three interim reports and the draft of a manual entitled "A Handbook for Schistosomiasis and other Snail-Mediated Diseases in Jordan" as part of the process of assessing the achievements of a subcontract with the University of Lowell and the University of Michigan. The assessment of the subcontract covers the following:

- a. Assistance in conducting snail surveys in Jordan.
- b. Assistance with ecological studies.
- c. Preparation of an English-Arabic Handbook for local field use.
- d. Provision of technical backstopping.
- e. Assistance in organizing training programs for the Ministry of Health and the University of Jordan in schistosomiasis control.
- f. Assistance in strengthening the collaboration among GOJ agencies involved in the control program.
- g. Advice on ways to upgrade schistosomiasis laboratories.
- h. Assistance in defining the relationship of snails found in Jordan to those in adjacent countries.

3. To assess Jordanian Agencies' performance in snail surveying, surveillance, and control efforts.

4. To provide technical advice to USAID/Jordan concerning a proposed three-year extension of AID support to the University of Jordan. This advice being in the form of recommendations to USAID/Jordan.

## II. SUMMARY OF ASSESSMENTS AND RECOMMENDATIONS

In 1980-81 USAID/Jordan granted the University of Jordan a three year contract for \$187,741 to monitor and contain the prevalence of urinary schistosomiasis in Jordan. The project included a subcontract with the University of Lowell for technical assistance worth \$98,941. The University of Lowell in turn established a subcontract of \$43,087 with the University of Michigan.

Among the achievements of the University of Jordan are: the discovery of several new foci for the snail Bulinus truncatus (intermediate host of Schistosoma haematobium), the successful cultivation of snails in the laboratory, the study of the susceptibility of B. truncatus to infection with S. haematobium, the establishment of parasite and snail files, the preliminary identification of snail species, cytotaxonomic and electrophoretic investigations in an effort to compare B. truncatus of Jordan with the same species in neighboring countries, extensive chemical analyses of water in a large number of snail sites, studies on the susceptibility of snails to the molluscicide Bayluscide, and the preparation of some chapters of a Handbook on schistosomiasis and other snail-mediated diseases in Jordan. Results of investigations carried out by the University of Jordan have already been published or are in the process of being prepared for publication.

The University of Lowell and the University of Michigan assisted in purchasing chemicals, reagents, and small pieces of equipment for the University of Jordan, identified the snails collected by the University of Jordan and the Jordanian Ministry of Health, developed a computer program for the classification of the snail fauna of Jordan and their distribution, assisted in ecological studies and the most effective ways for presentation and interpretation of the findings, assisted in techniques and procedures used in studies of the susceptibility of B. truncatus to infection with S. haematobium, and assisted in the molluscicide program for snail control in Jordan. Unfortunately, a training course which was scheduled to be given in April 1983 was cancelled and no attempts were made to organize another course. The participants from the University of Lowell and the University of Michigan contributed considerably to the handbook. Although the handbook was intended for use in the field in Jordan, it is of a high standard and will only be used by University students and not by field workers. Sections of the Handbook on schistosomiasis mansoni and its biomphalarid snail hosts as well as the detailed discussions of the bulinid snails of Africa should be omitted or abbreviated. They are out of place in a book on schistosomiasis in Jordan.

As for the assessment of Jordanian agencies, performance in snail surveying, surveillance, and control effort have been satisfactory. There are two components to the program. The Ministry of Health is in charge of surveillance and control

activities, and the University of Jordan is in charge of field and laboratory support activities. During the period March 1979 to April 1982, the Ministry of Health spent \$406,053 on salaries, molluscicide, and the drug praziquantel, and the University of Jordan spent \$55,000 on salaries, gasoline, laboratory supplies, and secretarial support. The amount should be higher for the Ministry of Health in 1985 because there has been an increase in the numbers of laborers and technicians engaged in bilharziasis activities. The above amounts indicate the unstinting commitment of the Government of Jordan to schistosomiasis activities in the country. There is excellent collaboration between the Ministry of Health and the University of Jordan. Such close collaboration between academic and applied agencies has considerably benefited the program. The organization and activities of the schistosomiasis program by thorough surveillance and control of B. truncatus and by diagnosis and treatment of migrant agricultural laborers and Jordanians is in general adequate. However, it may benefit from modifications in the control procedures and this will lead to greater cost-effectiveness.

It is recommended that USAID consider assistance to the two agencies involved in the program. Support from USAID to the Malaria and Schistosomiasis Control Department of the Ministry of Health can be in the form of needed equipment (two or three compound microscopes, one movie projector, one overhead projector; two or three vehicles), and training for technicians and physicians in countries where the disease is endemic or where extensive research is being conducted such as in the United States. Assistance to the Ministry of Health can also be in the form of recruitment for short periods of one or two consultants from the U.S. who are experts in control, especially in the use of molluscicides. It is also recommended that USAID contract with the University of Jordan entitled "Identification, Distribution and Ecology of the Snail Fauna of Jordan" be extended for three years in the amount of \$96,700. As indicated in the request for extension by the University of Jordan, this new contract will not involve a subcontract with the University of Lowell or the University of Michigan.

The "Handbook of Schistosomiasis and other Snail-Mediated Diseases in Jordan" which was prepared during the contract that expired should be accepted with some modifications. For example deletion of detailed sections on intestinal schistosomiasis and on the bulinid snails of Africa. A better draft should be prepared of the Arabic translation and more accurate and classical Arabic used. Since the present draft (English and Arabic) is of a high technical standard, local Jordanian expertise can be utilized in the preparation of an abbreviated version of the text (in English and Arabic) for field use by technicians, beginners etc. The present handbook fails in that it was meant to be a field guide but it is not.

### III. SCHISTOSOMIASIS IN JORDAN

In their surveys for schistosomiasis and its snail intermediate hosts in the Middle East Abdel-Azim and Gisman (1956) found no positive cases of schistosomiasis or snail hosts in Jordan. Chu (1969) obtained similar results. Subsequent limited surveys did not reveal any positive cases among Jordanians, and thus it was thought that the possibility of schistosomiasis occurring in Jordan was very minimal. In the early 1970s with the influx of laborers from countries in the Middle East where the disease is endemic, urinary bilharziasis started to be diagnosed among these laborers in the laboratories of the Ministry of Health.

In 1975 two things happened which aroused concern about schistosomiasis in Jordan. A case of the urinary form was diagnosed by the Royal Jordanian Medical Services in January of 1975 at a hospital. The patient, 19-years old, indicated that he had never left Jordan and had worked for a few years as a farmer in the Jordan Valley where canals are used extensively for irrigation. A survey of snails in the Jordan valley was then carried out between March and November 1975, and specimens of Bulinus truncatus, an intermediate host of Schistosoma haematobium, were collected from a cemented reservoir in Muthalath Al-Masri area, about 13 Km south of Deir Alla village (Saliba et al, 1976). The reservoir often receives water from the nearby East Ghor canal. This canal receives water from the Yarmuk River on the northern borders of the country and occasionally from Wadi Zeglab and Zarqa River. In the meantime urine samples from about 3,000 Jordanians were collected while they were outpatients at the clinics in the Jordan valley, but they were found to be negative (Saliba et al, 1981). However, the foreign agricultural laborers who reside in Jordan pose a special threat as they represent a source of schistosome eggs which they discharge in the water directly and indirectly. During the period between March 1979 and April 1982, a total of 42,600 urine samples were collected from migrant workers and examined for S. haematobium eggs, and 10,011 (23.5%) were found to be positive. A total of 7,005 of the 10,011 migrant workers who were scheduled to work at various agricultural tasks in the Jordan Valley were treated with the antischistosomal drug praziquantel. The remaining 3,006 infected persons were scheduled to work in Amman and some of these were treated with Ambilhar (Dr. M.R. Tawfik, communication to Bruce and Burch, 1982).

Another focus of Bulinus truncatus was reported by Saliba and Salameh (1981) from a spring pool in the ancient Roman town of Jerash and its drainage canal carrying water to irrigate farms on the outskirts of the town. Subsequent to this finding B. truncatus has been found in large numbers in the reservoir of the King Talal Dam and in several sites in the Jordan River Valley.

The suspicion that natural transmission of the infection occurs in Jordan was confirmed later in 1985 when 24 positive cases of urinary schistosomiasis among 3,250 Jordanians were discovered in the southern region of the country, in the Hasa River Valley where the river drains into the Dead Sea. These Jordanians were examined between 1 November 1984 and 15 February 1985. Dr. M. Reda Tawfik Director of the Malaria and Schistosomiasis Section of the Ministry of Health kindly provided the following information. Four cases were discovered through complaints of haematuria, but no eggs were found in the urine. Twenty cases had eggs of S. haematobium in the urine; 10 cases complained of haematuria and had eggs of the parasite in the urine. When these 24 cases were considered by age groups the following was found:

1-5 years, 6 cases  
6-10 years, 8 cases  
11-15 years, 7 cases  
16 and over, 3 cases

Those who visited the Barbeita baths during 1983 are 13 males and 1 female; and those who visited the baths during 1984 are 21 males, and 3 females.

Twenty-one of the patients have never left Jordan, whereas three patients had visited Tabuk in Saudi Arabia.

Twenty cases said that they had come into contact with the water by swimming, 20 through playing, and 20 by washing. Twelve patients felt itching when they were in the water, 11 did not experience any itching, and one did not know.

Two more cases were later reported in the same area of Jordan. The Jordanian patients were treated with praziquantel (Biltricide) with a dosage of 40 mg/kg body weight. The number of patients cured (urine negative for eggs of the parasite) were six after one week from day of treatment, six after two weeks, eight after three, and four after four weeks.

Thus schistosomiasis is endemic in Jordan and that transmission is evidently very active. With increased development of water resources it is expected that the prevalence of the disease will increase.

The current development of an extensive system of irrigation canals (secondary and tertiary) will create ideal habitats for Bulinus truncatus, the snail intermediate host of urinary schistosomiasis.

The problem is still worse among foreign migratory agricultural laborers. Fortunately the Jordanian Ministry of Health is alert to the situation, and surveys to discover infected workers (mainly Egyptians) are continuing. Dr. M. Reda Tawfik provided the following information about urine examinations of the workers between 1977 and 1984.

---

Year	Number of Urine Samples Examined	Number of Samples Positive
1977	3,651	448
1978	7,542	852
1979	7,860	1,265
1980	8,515	1,972
1981	9,014	2,378
1982	9,142	2,690
1983	9,703	3,751
1984	5,130	875
Total	60,557	14,231

---

IV. THE USAID CONTRACT WITH THE UNIVERSITY OF JORDAN  
(Project No. 278-8224; 1981-1984)

In 1980-81, USAID Amman granted the University of Jordan a contract of \$187,741 for three years to monitor and control the prevalence of schistosomiasis (bilharziasis) in Jordan. The title of the project was "Identification, Distribution and Ecology of the Snail Fauna of Jordan". Besides the surveys for freshwater snails and ecological and susceptibility studies done in Jordan, the project included a subcontract for technical assistance between the University of Jordan and the University of Lowell, which in turn, established a subcontract with the University of Michigan (see Section V of this report).

The USAID supported project of the University of Jordan had the following objectives:

1. Determine the snail species inhabiting freshwater in Jordan--from the Jordan River to the desert.
2. Determine if any of the snails living in Jordan are of medical or veterinary importance, i.e. determine if they are actual or potential intermediate hosts of human and animal trematode parasites.
3. Determine the ecological conditions of currently existing bodies of water and those under construction which may provide suitable habitats for vector snails.
4. Prepare a monograph on the characteristics, identification, and ecology of these snails.
5. Work in close cooperation with the Ministry of Health surveillance program to investigate the presence of snail hosts of human diseases all over Jordan.
6. Train graduate students and other Jordanians in parasitology, malacology, and ecology, especially in regard to human and veterinary diseases.

V. SUBCONTRACT WITH THE UNIVERSITY OF LOWELL AND THE UNIVERSITY OF MICHIGAN

In March 1981 the University of Jordan granted under a subcontract to the University of Lowell, Lowell, Massachusetts, the amount of \$64,048 for technical assistance to the schistosomiasis project. An additional sum of \$34,893 was shortly after that added to the subcontract by a letter of amendment. This made the total amount of the subcontract from the University of Jordan to the University of Lowell \$98,941.

The University of Lowell then signed a subcontract of \$43,087 with the University of Michigan, Ann Arbor, for technical assistance to some aspects of the project. The main part (\$15,000) of the subcontract with the University of Michigan was devoted to the writing and preparation of an "English-Arabic Handbook on Schistosomiasis in Jordan." The rest of the subcontract was mainly for expenses incurred in identifying Jordanian snails, for conducting electrophoretic studies, and for international travel.

A. Objectives of the Subcontract with the University of Lowell

The specific objectives of the subcontract were to:

1. Assist in conducting surveys to determine the existence in Jordan of (a) Bulinus truncatus and other Bulinus sp. subgroups, the snail intermediate hosts of Schistosoma haematobium, (b) Biomphalaria sp., the snail intermediate host of S. mansoni, (c) species of snails transmitting other trematodes which infect humans and those of veterinary importance, and (d) snails which thrive in the same habitat as vector snails.

2. Assist the University of Jordan and the Ministry of Health in conducting ecological studies of currently existing Jordanian water resources or those under construction. These studies include the seasonal variations in water flow, snail densities, plant life, and water contact by farmers.

3. Prepare a manual, focusing on schistosomiasis, which contains morphology, taxonomy of the snail intermediate host, diagnosis of the disease in man, transmission patterns, water contact, ecology and control of the snail and its habitat, and field survey and collection methods. In addition, the manual would include information pertaining to snail intermediate hosts of other diseases of human and animal (veterinary) importance caused by trematodes.

4. Provide scientific backstopping for schistosomiasis control programs, i.e., sample gathering techniques, ecological testing, susceptibility of snails acting as vector, quantification of foci, and cultivation of snails needed for all aspects of the study.

5. Assist the Ministry of Health and the University of Jordan in organizing a training program to meet the needs of the Government of Jordan for its schistosomiasis control program for both current and long-range goals.

6. Assist in strengthening the collaboration between the various Government of Jordan agencies involved in the schistosomiasis control program.

7. Assist in organizing/upgrading the schistosomiasis laboratories including survey and surveillance teams of the University of Jordan and the Ministry of Health.

8. Assist in studies to define the relationships between snails found in various areas of Jordan and those from adjacent countries such as Iraq, Syria, Saudi Arabia, Yemen, and Egypt.

#### B. Interim Reports

During the duration of the subcontract (1981-1984), three interim reports were prepared by the University of Lowell and presented to the University of Jordan with copies sent to USAID, Amman. The first report covered the period June 1981-April 1982; the second report covered the period June 1982-June 1983, and the third was from June 1983-June 1984.

The first report (June 1981-April 1982) contained results of susceptibility studies of some populations of Jordanian Bulinus truncatus when they were exposed to miracidia of an Egyptian strain of Schistosoma haematobium. A part of this report was written by Dr. Mallett from the University of Lowell in which he emphasized the need for additional data on water quality, physical substratum, population dynamics, and growth potentials of the entire population of B. truncatus. During his visit to Jordan, Dr. Mallett, together with the University of Jordan attempted to develop experimental procedures for a rapid determination of residual concentrations of Bayluscide under field conditions. Colorimetric analytical techniques were employed in the field to estimate the effective doses of the molluscicide. A plastic curtain was designed in order to increase the contact time of Bayluscide with the snail host in the reservoir of the King Talal Dam.

The second interim report (June 1982-June 1983) contained results of studies of susceptibility of some populations of Jordanian B. truncatus to infection with an Egyptian strain of S. haematobium. Only those from Ain Sheikh Hussein and Zour Al-Hamam were not susceptible. There were also reports of visits to Jordan by Drs. Bruce, Mallett (University of Lowell), and Burch (University of Michigan). Dr. Bruce's report was mainly recommendations for improved research on bilharziasis and for prevention and control of the disease in Jordan. He emphasized that the need for training both at the technical and professional levels still exists. Dr. Burch reported on his visits to museums in Europe

for proper snail identification and for the study of Middle Eastern freshwater mollusk specimens, especially primary type specimens, housed in the pertinent principal European museums of natural history. Dr. Mallett indicated that the purpose of his visit was to provide cooperative interaction in the areas of field surveys, ecological assessments of habitat potential, and assessment of surveillance programs. Specifically, he was to (1) review the ecological survey data base for data collected up to that date, (2) review habitat surveillance procedures and progress, (3) review snail control strategies and procedures, and (4) discuss future activities relative to ecological relationships of habitat and vector snails. A presentation of the extensive data base on surface water chemistry as analyzed and compiled by the University of Jordan was followed by discussions of the most effective ways to present and interpret the findings. Ecological data were reviewed and discussed.

Three appendices were enclosed with the second interim report:

- Appendix I: Snail identification and collection sites for all specimens collected in Jordan by survey and surveillance teams.
- Appendix II: Ecological data for all snail species collected in Jordan.
- Appendix III: Susceptibility of snail populations from Ain Sheikh Hussein to experimental infection with Schistosoma haematobium from Egypt.

The third interim report (June 1983-June 1984) contained a summary of the susceptibility studies of Jordanian populations to B. truncatus. Nine of these populations (including two previously reported as being refractory) were capable of serving as vectors of S. haematobium from Egypt.

A description of the ecology of the freshwater snail habitats of Jordan is included in this, the third interim, report.

The analysis of genetic similarities by the use of electrophoresis for two of the snail populations (B. truncatus) from Jordan were done by comparing them with three populations from the Sudan, Egypt, and Portugal. No differences between these populations were found.

#### C. Data Bases

Two computer data bases were established. One computer program, developed at the University of Michigan, deals with the classification of the snail fauna of Jordan and its distribution. The second data base, developed at the University of Lowell deals with ecological data, physical and chemical.

Analyses of the data collected were begun. The presence or absence of different snail species was recorded for each of the Jordan sites sampled. Physical characteristics were recorded for 243 sites and chemical characteristics for 130 sites. Future analysis will involve searching for combinations of chemical and/or physical variables that characterize habitats in which each snail species was found and those characterizing habitats where they were not found. Also to be addressed is whether certain snail species exclude other snail species. Cross tabulations of presence and absence of snails for pairs of snail species will indicate sites in which one snail species was found and the other was not found.

A part of the "Handbook for Schistosomiasis and other Snail-borne Diseases in Jordan" was attached to this third interim report. The handbook includes information pertaining to the morphology and taxonomy of the freshwater snails of Jordan and also those in the Middle East and Africa. Information is also included about diagnosis, treatment, and the control of the diseases caused by Schistosoma haematobium and S. mansoni as well as the history of schistosomiasis in Jordan.

## VI. ASSESSMENT OF ACHIEVEMENT OF SUBCONTRACT OBJECTIVES

### A. Assistance in Conducting Snail Surveys in Jordan

The University of Jordan had experience in conducting snail surveys as evidenced work published prior to the award of the grant and the subcontract. However, the University of Lowell and the University of Michigan helped in conducting a systematic survey, identifying the snails collected, and in providing lists of species collected and collection sites. Moreover, a computer program, developed at the University of Michigan, deals with the classification of the snail fauna of Jordan and its distribution.

### B. Assistance on Ecological Studies of Jordanian Water Resources

The subcontractor helped in setting up protocols for ecological studies and emphasized ecological relationships of habitat and vector snails. Extensive data on surface water physico-chemical properties were collected by the University of Jordan. The subcontractor advised on the most effective ways for presentation and interpretation of the findings.

Computer programs were prepared at the University of Lowell for the data collected by the University of Jordan during ecological studies of the snail habitats. Certain statistical comparisons were also prepared during analyses of the data. The presence or absence of different snail types was recorded for each of the Jordanian sites sampled. Also recorded for 243 sites, are physical characteristics such as type of water body, types of aquatic animals and vegetation, slope of bank, and turbidity. Chemical properties such as pH, chloride, and hardness are available for 130 sites. For each snail type, summary statistics (mean, SE) were calculated for each chemical variable for sites where the snail was found, and separately for sites where the snail was not found.

### C. Preparation of an English-Arabic Handbook for Local Field Use

A handbook was prepared entitled "Handbook of Schistosomiasis and other Snail-Mediated Diseases in Jordan".

The handbook consists of three parts. Part I is on schistosomiasis. Part II is on malacology, and Part III contains appendices. Part I on schistosomiasis comprises a section on schistosomiasis in Jordan and a section on the schistosome parasite. Part II on malacology comprises sections on snails and disease transmission, freshwater snail fauna of Jordan, snail intermediate hosts of human schistosomes in the Near East and Africa, snail intermediate hosts of human and veterinary parasites other than schistosomiasis in Jordan, freshwater snail ecology in Jordan, and snail control. Part III, containing the appendices, contains sections on schistosomiasis (with various diagnostic

techniques), malacology with various diagnostic techniques, malacology with subsections on snail identification, snail surveys and the distribution of freshwater snails in Jordan, ecology (freshwater habitats in Jordan), and a glossary and bibliography.

Participants of the Schistosomiasis Control Program from the University of Lowell, the University of Michigan, the University of Jordan, and the Jordanian Ministry of Health contributed chapters to the book.

In general the book is good and the authors are to be congratulated on a job well done.

In the section of freshwater snail fauna of Jordan the snails are divided by subclass (Prosobranchia and Pulmonata) and then by family, genus, and species. For each species there is some description of the morphology, general geographical distribution outside Jordan, distribution in Jordan, and type of habitat (i.e. whether found in springs or spring pools, streams, rivers, swamps, ponds, a primary canal or a dam reservoir). For some species there is information under "parasitology", i.e., the capacity of the species to serve as intermediate host for certain trematodes.

Under the Prosobranchiata are mentioned the family Neritidae (Theodoxus jordani and Th. macrii), the family Valvatidae (Valvata saulcyi), the family Bithyniidae (Bithynia philalensis), the family Hydrobiidae (Semisalsa longiscata and S. contempta; Pseudamnicola gaillardotii, P. solitaria and Pseudamnicola sp.), and the family Thiariidae (Melanoides tuberculata and Melanopsis praemorsa). Under the Pulmonata are mentioned the family Lymnaeidae (Lymnaea (Radix) natalensis, and Lymnaea (Fossaria) truncatula), the family Physidae (Physella acuta), the family Planorbidae (Planorbis planorbis, Gyraulus piscinarum and Bulinus truncatus).

There is an excellent identification key for the freshwater snails of Jordan. In addition there is a guide for use in snail identification. It is important to know the terminology of the various parts of a snail's shell, and, therefore, this section is accompanied with illustrations to indicate shell terminology; the shell surface sculpture and types of opercula are also illustrated.

In the section on freshwater snail ecology in Jordan, certain subsections are treated and among these are the ecological aspects of snail-mediated diseases, Jordanian aquatic ecology, influence of physical factors on snail distribution, and the influence of chemicals on snail distribution.

In the section of the distribution of freshwater snails in Jordan in the appendix on malacology, it is stated that 17 species were found during the survey. These snail species are listed in the same taxonomic order that they occur in the section on Freshwater Snail Fauna of Jordan. The sites where each species was found are listed by numbers under the various species. The distribution of the species is shown on 13 maps. The maps were not included in the copy which the consultant examined.

Following are some criticisms of the handbook:

1. There is no need for a detailed section on intestinal schistosomiasis due to Schistosoma mansoni (page 23) since this form of the disease or its snail host is not found in Jordan.

2. There is no need for the section on the snail vectors of schistosomiasis mansoni in Africa and the Near East (page 67).

3. The need to discuss the bulinid snails, intermediate hosts of urinary schistosomiasis in the Near East, is understood, but why deal with those bulinids which occur throughout all of Africa (page 66)? This is a complex subject and is out of place in a handbook on Jordan, where so far, one bulinid species only has been found, that is, Bulinus truncatus.

4. One should consider for whom the handbook was written. It was the understanding at the beginning when the handbook was being composed that it is to be used in Jordan by those engaged in the schistosomiasis control program. The way it is now the handbook is of a high standard and is only suitable for students at the Faculty of Medicine and the Faculty of Science. It is not suitable as a field guide as it had originally been intended.

Moreover, the Arabic translation of the handbook is not satisfactory. Dr. M. Rida Tawfik gave the impression that the Arabic language used is not classical and not accurate in many places and this is probably so. What is needed now is to assign the job of translation to Arabic to an Arabic-speaking scientist who is a specialist in the field. Dr. M. Rida Tawfik suggests that a good possibility is a scientist at the Theodor Bilharz Institute in Cairo, Egypt. In addition, a simplified version of the handbook in Arabic is needed for use by technicians involved in the schistosomiasis control program in Jordan and probably also in neighboring countries where the disease is endemic. The preparation of a simplified Arabic version can be assigned to both the Ministry of Health and the University of Jordan.

Dr. M. Adnan Bakhit, Dean of Scientific Research, University of Jordan, suggested that the Department of Arabic, University of Jordan may help in the translation of the Handbook to Arabic.

5. And finally, the section on schistosomiasis in Jordan should be updated to include recent information on autochthonous cases among Jordanians in Wadi Hasa. At present, schistosomiasis in Jordan exists and is endemic, and is no longer considered a "potential" hazard.

D. Provision of Technical Backstopping

The University of Lowell assisted the University of Jordan regarding techniques and procedures used in studies of susceptibility of snails to infection with *Schistosoma haematobium* and in procedures utilized in the cultivation of snails. It also assisted in the mollusciciding program. For example, the molluscicide curtain, once used in the King Talal dam, was designed by the University of Lowell.

E. Assistance in Organizing Training Programs for the Ministry of Health and the University of Jordan in Schistosomiasis Control

Unfortunately a training course which was scheduled to be given in April 1983 was aborted. Arrangements for this course between the University of Michigan, the University of Lowell, and the Jordanian agencies did not materialize. No further attempts were made to organize another course.

F. Assistance in Strengthening Collaboration Among GOJ Agencies Involved in the Control Program

In assessing the Government of Jordan's agencies involved in the control program it has always been observed that the Government of Jordan, mainly through the initiative of the Ministry of Health, has always shown unsustaining commitment in support of the control program. Moreover, excellent collaboration always existed between the Ministry of Health, the Malaria and Schistosomiasis Section, and the University of Jordan, Department of Biological Sciences. This collaboration has been recorded by observers from the World Health Organization and from U.S. Naval Medical Research Unit 3 (NAMRU 3) in Cairo.

It is hard to assess the part which the University of Lowell and the University of Michigan have played in furthering collaboration among GOJ agencies, a collaboration which had already existed.

G. Advice on Ways to Upgrade Schistosomiasis Laboratories

The University of Lowell advised the University of Jordan on some necessary equipment, and chemicals were purchased for the University of Jordan and shipped from the United States by Lowell. Other equipment, reagents, and laboratory accessories were purchased by the University of Jordan by project funds.

H. Assistance in Defining the Relationship of Snails Found in Jordan to those in Adjacent Countries

The main part of this task was carried out by investigators at the University of Jordan. They obtained, in addition to several populations of Jordanian *Bulinus truncatus*, the same species of snails from Iraq and from Syria. With the help of one of the

graduate students in the Department of Biological Sciences, they carried out susceptibility studies and also compared them as to their electrophoretic patterns. The University of Michigan helped by carrying out a study on a population of B. truncatus from Egypt.

VII. A NEW APPLICATION FOR EXTENSION OF THE USAID CONTRACT WITH  
THE UNIVERSITY OF JORDAN

In 1984 the University of Jordan presented a request to USAID, Amman, through the Government of Jordan National Planning Council to extend for a further three years the project entitled "Identification, Distribution and Ecology of the Snail Fauna of Jordan. The long range objectives of the project are (1) to prevent schistosomiasis haematobia from gaining a foothold in Jordan and (2) the creation of an efficient and routinely-run machinery for the control of the snail intermediate hosts of bilharziasis and other economically important parasitic diseases.

The immediate objectives of the project are:

1. To continue the current studies of population dynamics, ecology, and biology of the snail Bulinus truncatus in Jordan.
2. In collaboration with the Ministry of Health, to continue monitoring all freshwater bodies, irrigation canals, and reservoirs for the possible appearance of new foci or populations of the snail.
3. To study the effects of molluscicides currently in use as well as any that may be introduced in the control of Bulinus truncatus and other snails in Jordan.
4. To participate in the control campaigns launched by the Ministry of Health through positive identification of the snails, defining the effective doses of molluscicides and their possible effects on non-target species.
5. To study the possibilities of introducing biological control agents as a step towards an ideal integrated control program.
6. To carry out parallel studies on snail intermediate hosts of other diseases of importance in Jordan.

The University of Jordan is planning to achieve these objectives by conducting investigations in two phases, each of 18 months duration. The itemized budget for Phase I is JD 20,525 and for Phase II, JD 13,325. The total amount requested from USAID is JD 33,850 or \$96,700 over a three-year period.

It should be noted that this application for extended support from USAID does not contain any mention or request for continued technical assistance and a subcontract with the University of Lowell or the University of Michigan.

VIII. ASSESSMENT OF JORDANIAN AGENCIES AS TO SNAIL SURVEILLANCE AND CONTROL EFFORTS

A. Administration

The efforts of the University of Jordan are coordinated by the President of the University, the Vice President for Scientific Research and Graduate Studies, the Dean of the Faculty of Science, the Dean of Scientific Research, the Chairman of the Department of Biological Sciences and Professor of Parasitology. The latter is the principal investigator for the Schistosomiasis Research Project. At the University of Jordan there is a snail survey team and a laboratory team. The survey team consists of a senior research assistant, two to four research technicians, and a vehicle driver. The laboratory team consists of a graduate research assistant and one or two research technicians.

At the Ministry of Health the efforts for schistosomiasis surveillance and control are coordinated by the Minister of Health, the Undersecretary of Health, the Director of the Department of Preventive Medicine, and the Director of the Malaria and Schistosomiasis Control Department. The latter is assisted by an Assistant Director in charge of Schistosomiasis. The field operations are administered by the Director of the Malaria and Schistosomiasis Control Station, Dair Alla, Jordan Valley (surveillance team, specimen collection team, drug dispensary team, administrative staff); the Director of the Rural Diagnostic Laboratory, Dair Alla, Jordan Valley; the Coordinator of the field surveillance team; and the Coordinator of the field operations team (molluscicide team). In the Malaria and Schistosomiasis control Department there is an administrative staff (statistical and data computation; records, secretarial) and a logistical support staff in charge of equipment including a motor pool, motor launch, vehicle and launch drivers, expendable supplies, and equipment.

B. Activities

The schistosomiasis control program in Jordan consists of control activities and field and laboratory activities:

1. Bilharziasis Control Activities:

The Malaria and Schistosomiasis Department of the Ministry of Health is responsible for a survey of water bodies for snails (in cooperation with the University of Jordan), classification of water bodies and mapping of sites where snails are found (in collaboration with the University of Jordan); molluscicide application to areas where Bulinus truncatus is found and follow-up of threatened areas, data computation and statistics, collection of urine specimens from migrant workers and from Jordanians for laboratory diagnosis (in collaboration with the University of Jordan), and chemotherapeutic treatment and follow-up of infected patients.

2. Field and Laboratory Support Activities:

The Parasitology Unit, Department of Biological Sciences, University of Jordan is responsible for ecological field studies; water sample collection and physiochemical analyses, vector snail habitat description, snail population dynamic studies, and preliminary snail identification. There are also laboratory activities which comprise snail cultivation and schistosome life cycle maintenance, examination of snails for their natural infection, snail susceptibility studies, identification of other parasites of human and veterinary importance, establishment of parasite and mollusc reference files, cytotaxonomic and electrophoretic studies, and determination of the susceptibility of snails to molluscicides recommended for control.

C. Cost Analysis

The funds to finance the schistosomiasis control program in Jordan came principally from the Government of Jordan, but some contributions also came from the United States Agency for International Development (USAID) and the World Health Organization (WHO) (Bruce and Burch, 1982).

1. The Government of Jordan

The cost to the Government of Jordan (15 April 1979 to 30 April 1982) is as follows:

a. Ministry of Health

Staff salaries of the Schistosomiasis Control Section

Laborers (24), US 55,296, (= JD 18,433)  
Surveillance team members (20) \$45,080 (= JD 15,027)  
Physicians (3), \$46,080 (= JD 15,360)  
Technicians for area laboratories (2), \$5,376  
(= JD 1,792)  
Vehicle drivers (3), \$10,368 (= JD 3,455)  
Administrators (2), \$6,912 (= JD 2,304)  
Gasoline and vehicle repairs, \$4,800 (= JD 1,600)

Total for salaries is \$173,912 (= JD 57,971)

Molluscicide Cost

The molluscicide Bayluscide costs JD 10,000 per ton (= \$30,000). Nine tons were purchased at a cost of JD 90,000 (= \$270,000).

A total of 5,375 Kg (5.92 tons) of Bayluscide has been used (15 April 1979 to 30 April 1982), with the participation of 24 workers carrying out the actual spraying operation. The cost for the amount of Bayluscide used is JD 53,750 (= \$161,350). There were about three tons in stock.

Cost of Praziquantel for Treatment of Infected Migrant Workers

The Ministry of Health purchased JD 50,000 (=\$150,000) worth of praziquantel for its treatment program. The cost for a single tablet (600 mg) is 0.50 JD (=\$1.50). The average number of tablets which are dispensed to a migrant worker for a single treatment regimen is five or six. Thus the cost of a single treatment regimen is JD 2.5 to 3.0 (=\$7.50 to \$10.00).

The total cost for the drug used by the Ministry of Health is 19,264 JD (=\$52,791).

Equipment

A motor launch was purchased for exclusive use in molluscicide application in the King Talal Dam. Cost of the motor launch was JD 6,000 (=\$18,000).

b. University of Jordan

For the same period the University of Jordan contributed about JD 16,500 (=\$55,000) covering three years. This amount covers salaries, gasoline, laboratory facilities and secretarial support.

The total cost expended by the GOJ for the control program salaries is JD 222,304 (=\$666,912).

2. Donors

- a. USAID has contributed funds to support the following activities:
- ° Grant to the University of Jordan in collaboration with the Universities of Lowell and Michigan, JD 62,330 (=\$187,000).
  - ° Support of staff travel for the Ministry of Health (two people) and the University of Jordan (one person) to visit a U.S. institution for short term training, \$11,000 (= JD 3,666).
  - ° Support of travel of USAID advisory personnel from Washington and NAMRU - three (Egypt) to Jordan, \$5,000 (= JD 1,666).

Total USAID contribution is \$203,000 (= JD 67,000).

- b. World Health Organization (WHO) estimated contribution \$37,000 (= JD 12,500).

### 3. Summary of the Cost of the Control Program

The total cost of the Schistosomiasis Control Program in Jordan (April 1979 to April 1982) is JD 302,304 (= \$906,912).

Additional recent information was obtained on the amount of molluscicide (Bayluscide) used by the Ministry of Health in snail control operations between 1980 and 1984:

1980	2600 Kg
1981	1875 Kg
1982	1125 Kg
1983	1350 Kg
1984	2800 Kg

In 1985, 1450 Kg have already been used. The total for the six years is 11,200 Kg., i.e., 12.3 tons which cost \$307,000.

#### D . Comments on the Schistosomiasis Program in Jordan

One of the outstanding features of the schistosomiasis survey, surveillance, and control program in Jordan is that the government has shown an unsustaining commitment in the support of the program. Added to this is excellent collaboration between the Ministry of Health and the University of Jordan. Such close and continuous collaboration between academic and applied agencies has benefited the program considerably. The Ministry of Health has formed a workforce which can deal with the diverse techniques for surveillance and control. This is supplemented by laboratory research and field activities of the University of Jordan.

A special comment should be made on the excellent interaction of the Government of Jordan (the Ministry of Health and the University of Jordan) with USAID and certain American universities and with an international organization such as the World Health Organization (WHO). The Government of Jordan had asked for the collaboration of American universities and NAMRU 3, Cairo, all supported by USAID. It has also asked for technical assistance from WHO which sent a member of its Geneva staff (Dr. F. McCullough) to advise on the schistosomiasis program and to determine the potential role of a slow-release formulation of Bayluscide in the control of the snail Bulinus truncatus in different habitats in Jordan. The GOJ is to be commended for its desire to have the program evaluated regularly and to benefit from experiences of several experts in the field. It should also be noted that WHO has a vital interest in the Jordanian control program because it represents in effect a model of the final phase of control programs in many countries, particularly those close to the Mediterranean basin where bilharziasis is endemic.

The organization and activities of the program through survey, surveillance, and control of B. truncatus and by diagnosis and treatment of infected foreign agricultural laborers and infected Jordanians is in general adequate. This is a strategy combining snail control with chemotherapeutic treatment. However, the program may benefit from modifications in the control procedures, and this no doubt will lead to greater cost-effectiveness. For example, it is not feasible to attempt to control B. truncatus in a large water body such as the King Talal reservoir by mollusciciding, especially during high water periods. The molluscicide applied to the reservoir is considerably diluted in the large quantities of water. Moreover, applying the molluscicide during low-water periods has to be evaluated before it is judged to be not feasible. To reduce snail populations in the reservoir, and to reduce the possibility of snails being carried down to the Jordan Valley, the large quantities of accumulating floating debris, especially near the retaining wall, should be removed, preferably by mechanical means. In this respect, collaboration with the King Talal dam authority should be sought.

Also with respect to snail control in the King Talal reservoir, consideration should be given to biological control through the use of certain non-medically important snails such as Marisa cornuarietis and Thiara granifera. Preliminary experiments should be first conducted in the laboratories of the University of Jordan.

The rest of the mollusciciding operations in the Zarga River and in the Jordan Valley, i.e., by regular and consistent surveillance and focal application of the molluscicide, seems to be adequate and should be continued. However, it should also be supplemented by environmental modification measures, such as drainage, or removal of mud and aquatic vegetation. Studies projected to be carried out on snail population dynamics, i.e., the seasonal rhythms of snail population densities will greatly increase the success of the surveillance and mollusciciding program.

As to survey and laboratory investigations carried out by the University of Jordan, under the USAID-supported project entitled "Identification, Distribution and Ecology of the Snail Fauna of Jordan", they have been in general satisfactory. Accomplishments have been made with regard to: snail cultivation, snail susceptibility to S. haematobium, establishment of parasite and snail files, cytotoxic studies; electrophoretic studies of Jordanian B. truncatus and the same species from neighboring countries, and determination of the susceptibility of snails to Bayluscide. Results of some of the laboratory studies have already been published, as indicated in the list of references included at the end of this report. Both the University of Jordan and the Ministry of Health have contributed chapters to the "Handbook on Schistosomiasis and other Snail-Mediated Diseases in Jordan".

## IX. RECOMMENDATIONS

Potential urinary schistosomiasis has been considered a threat to public health in Jordan since the snail vectors were discovered in 1975 and since many disease cases have been diagnosed among foreign migrant agricultural laborers.

However, since about three months ago, urinary schistosomiasis has been a real threat in Jordan because of the discovery of several cases among Jordanians in the Wadi Hasa region in the south, indicating that transmission of the infection has been established in the country.

It is recommended, therefore, that USAID consider seriously assistance to the agencies of the Government of Jordan involved in research, survey, surveillance, and control of the disease to prevent further expansion over wide areas.

### 1. Recommended Assistance to the Ministry of Health

It is suggested that some support by USAID be given through the Ministry of Health, Department of Malaria and Schistosomiasis Control.

It has been stated under Section VIII of this report "Assessment of Jordanian Agencies as to Sanil Surveillance and Control Efforts" that the Ministry of Health has spent during the period 15 April 1979 to 30 April 1982 the amount of \$173,912 (=57,971 JD) for the control program salaries; added to this is \$161,350 (=53,750 JD) cost of the molluscicide bought; \$52,791 (=19,264 JD) cost of the chemotherapeutic drug, praziquantel used, and \$18,000 (=6,000 JD) cost of a motor launch for application of molluscicide at the King Talal dam.

The cost of the control program to the Department of Malaria and Schistosomiasis Control has increased since 1982 because of employment of more laborers and technicians and use of more molluscicide. So far the achievement of the department has been satisfactory in surveillance and in control, with the exception of control at King Talal dam. Of course there is always room for improvements in control operations and in the adoption of other control measures and control strategies.

The support from USAID to the Malaria and Schistosomiasis Control Department can be in the form of equipment and training.

#### Equipment:

- 2 or 3 compound binocular microscopes
- 1 movie projector
- 1 overhead projector
- 2 or 3 vehicles

### Training:

Two or three technicians should be sent to observe diagnosis and control operations in one of the Arabic speaking countries. Two physicians should be sent to the U.S. to learn up-to-date techniques in diagnosis, surveillance, and control of schistosomiasis.

Moreover, the Ministry of Health and the University of Jordan expertise can be utilized in presenting local training courses to technical personnel involved in surveillance and control. The need for training exists, and refresher courses, as well as an evaluation of the efficacy of the techniques used in the control program, are necessary.

USAID assistance to the Ministry of Health can also be in the form of recruitment, for short periods, of one or two consultants from the United States who are experts in surveillance and especially in disease control, as for example Dr. Ernesto Ruiz-Tiben of CDC, Atlanta, Georgia.

### 2. Recommended Assistance to the University of Jordan

Extension of the grant to the University of Jordan, Section of Parasitology, Department of Biological Sciences is recommended.

The department has made considerable progress and achievements of the objectives of the grant. Namely, it has determined the snail species inhabiting freshwaters in Jordan, determined that some of these species are of medical and veterinary importance, determined the ecological conditions (physical and chemical) of Jordanian water bodies, worked in collaboration with the Ministry of Health in its surveillance program to determine the distribution of Bulinus truncatus (the intermediate host of urinary schistosomiasis in Jordan), trained graduate students in the field of parasitology, malacology, and ecology, especially with regard to human and veterinary diseases, and participated in the preparation of a "Handbook on Schistosomiasis and other Snail-Mediated Diseases in Jordan".

Results of some of the above accomplishments have been published as scientific papers in some refereed journals, while others are in preparation or in press.

The extension of the grant is suggested for three years in the amount of \$96,700. The title of the proposal can be changed to cope with the present conditions with regard to schistosomiasis in Jordan.

The objectives of the new proposal and the specific aims are actually similar to those of the grant that ended but are amended in the light of the investigators' previous findings.

Some of the suggested studies in the new proposal are a follow-up and ramifications on studies of susceptibility.

USAID should request from the University of Jordan an amendment to the application for extension to include information about recent developments, i.e., discovery of infection among Jordanians, better presentation of the specific aims, and further elaboration on the methods and procedures.

When the extension of the contract is granted, it should be specified that the University of Jordan is required to prepare an annual progress report to be presented to USAID.

It is to be noted that in the application for the extension of the contract there is no mention of subcontracts with the University of Lowell or the University of Michigan and no funds for these subcontracts were requested. It would appear from both the University of Jordan and the Ministry of Health that the subcontracts are not needed. It is felt, therefore, that there is no need for extension of the subcontracts with the University of Lowell and the University of Michigan. The participants of both Universities have benefited their Jordanian counterparts and have accomplished some of the objectives of the subcontracts. Present participants from both Lowell and Michigan, because of their familiarity with the project and their previous assistance should be considered when the chance arises for recruitment of short-period consultants.

For both the Ministry of Health and the University of Jordan, USAID support can be in the form of contributions of books on schistosomiasis and others on parasitology and malacology. Also subscriptions to some scientific journals which are not being received by the library of the University of Jordan. Some of these journals are devoted to parasitology or malacology, while others, from time to time, publish articles on schistosomiasis and its control.

With regard to the "Handbook on Schistosomiasis and other Snail-Mediated Diseases in Jordan", it is recommended that the handbook be accepted, but with the stipulation suggested in Section V, above in connection with the assessment of the objectives of the subcontract with the University of Lowell and the University of Michigan. It is felt that, with the exception of the key to the freshwater snails and the characteristics important in identification, the handbook is not for "field use" as it was intended to be. Moreover, a detailed discussion of intestinal schistosomiasis and its snail hosts and a detailed discussion of the bulinid snails of the entire continent of Africa are not relevant in a handbook prepared specifically for Jordan. Such sections should be deleted. In the meantime, consideration should be given to USAID assistance to both the Ministry of Health and the University of Jordan in publishing a small handbook in Arabic for use by technicians of the Ministry of Health. The

expertise at both agencies can be utilized in the preparation of such a handbook. The latter could be a simplified and an abbreviated form of the handbook that was prepared under the contract that ended.

With regard to an Interagency Committee to supervise all activities concerning schistosomiasis in Jordan, it is recommended that an attempt should be made to activate this committee. Agencies which should be represented on the committee are the Ministry of Health, the University of Jordan, the Ministry of Labor, the Department of Irrigation, and the National Planning Council. During my discussions with officials in the Government of Jordan, those at the University of Jordan were in favor of the committee, but those at the Ministry of Health felt that such a committee delays decisions concerning the efforts of its various constituents.

APPENDIX I

PERSONS WITH WHOM DISCUSSIONS WERE HELD

USAID, Amman

Robert H. Haladay, Health and Family Planning Officer  
Gerald F. Gower, Director USAID Mission  
Nancy Hardy, Assistant Program Officer

University of Jordan

Dr. Elias K. Saliba, Professor, Department of Biological Sciences  
Dr. Rashad Natour, Chairman, Department of Biological Sciences  
Dr. Mohamed Hamdan, Dean, Faculty of Science  
Dr. Adnan Bakhit, Dean of Scientific Research  
Randa E. Ayed and Ratib M. Al-Ouran, graduate students,  
Department of biological Sciences

Ministry of Health

Dr. M. Reda Tawfik, Director, Malaria and Schistosomiasis  
Control Department  
Dr. M. Motasem, Malaria and Schistosomiasis Control Department

## APPENDIX II

### BIBLIOGRAPHY

- Abdel-Azin, M. and A. Gismann. 1956. Bilharziasis survey in south-western Asia, covering Iraq, Israel, Jordan, Lebanon, Saudi Arabia and Syria, 1950-1951. *Bull. Wld. Hlth. Org.*, 14: 403-456.
- Ayed, R.E. 1983. Susceptibility of Jordanian Bulinus truncatus snails to infection with Schistosoma haematobium from Egypt, with an electrophoretic comparison of this snail with three other populations. M.S. Thesis, Univesity of Jordan, Amman, May, 1983.
- Ayed, R.E., and E.K. Saliba. 1985. Further studies on the relationship between Bulinus truncatus from Jordan and Schistosoma haematobium from Egypt. *Jap. J. Parastiol.* 34 (4): 87-94.
- Bruce, J.I. and J.B. Burch. 1982. Evaluation of the progress of the bilharzia control program in the Hashemite Kingdom of Jordan. A report prepared for His Excellency the Minister of Health and His Excellency the President of the University of Jordan.
- Chu, K.Y. 1969. A survey of schistosomiasis in East Jordan (22-30 July 1969), Summary Report, WHO/EMRO, Alexandria, 4 pp.
- Daud, A.M. 1982. A preliminary study on the susceptibility of Bulinus truncatus snails from Jordan to infection with an Egyptian strain of Schistosoma haematobium and the effect of some environmental factors on the survival of the snails. M.S. Thesis, University of Jordan, Amman. May, 1982.
- Ismail, N.S., Saliba, E.K. and R.G. Lutfy. 1978. Fascioliasis in Azraq Oasis, Jordan. I. Incidence and degree of infection in cows and buffaloes. *Acta Parasitol. Pol.*, 25: 43-49.
- Ismail, N.S., E.K. Saliba and M. Tomo. 1983. Studies on larval stages of digenetic trematodes of Melanopsis praemorsa L. Snail from Azraq Oasis, Jordan. *Jap. J. Parasitol.*, 32: 517-523.
- Lutfy, R.G., N.S. Ismail and E.K. Saliba. 1978. Larval trematodes from Lymnaea auricularia in the Azraq Oasis of Jordan. *Bull. Zool. Soc. Egypt*, 28: 47-61.
- McCullough, F. 1983. Report on a mission to the Ministry of Health, Jordan to assist in evaluating the schistosomiasis (S. haematobium) surveillence and control programme, 25-31 March 1983.
- Saliba, E.K. 1977. A brevifurcate schistosoma cercaria from Lymnaea auricularia snails in the Azraq Oasis, Jordan.

- Saliba, E.K. 1984. Laboratory studies on the susceptibility of "Bulinus truncatus" snails from Jordan to Bayluscide. *Jordan Med. J.*, 18: 37-34.
- Saliba, E.K., R.G. Lutfy and N.S. Ismail. 1978. Fascioliasis in Azraq Oasis, Jordan. II. Infection of Lymnaea auricularia with Fasciola gigantica Cobb., 1955 cercariae. *Acta Parasitol. Pol.*, 25: 51-55.
- Saliba, E.K., A. Masa'deh and M. Reda. 1976. First record of Bulinus truncatus (Audouin) in Jordan. *Ann. Trop. Med. Parasitol.*, 77: 369-370.
- Saliba, E.K. and M.I. Othman. 1980. Further studies on natural infection of Lymnaea auricularia with larval trematodes and its susceptibility to infection with Fasciola gigantica Cobb., from Azraq, Jordan. *Acta Parasitol. Pol.*, 27: 285-292.
- Saliba, E.K., J.B. Burch, J.I. Bruce, M.R. Tawfik and J.C. Mallett. 1980. The threat of schistosomiasis to Jordan. *Jordan Med. J.*, 14: 11-16.
- Saliba, E.K., J.I. Bruce, J.B. Baily and J.B. Burch. 1981. Susceptibility of Bulinus truncatus (Audouin) from Jordan to experimental infection with Schistosoma haematobium from Egypt. *Jordan Med. J.*, 15: 183-190.
- Saliba, E.K. and E. Salameh. 1981. A second finding of Bulinus truncatus in Jordan. *Malacol. Rev.*, 14: 65-66.
- Wurzinger, K.H. and E.K. Saliba. 1979. A cytological and / electrophoretic comparison of Jordanian Bulinus with three other tetraploid Bulinus populations. *Malacol. Rev.*, 12: 59-65.