PD-ABD-732
75649

FINAL REPORT:

Health Constraints to Rural Production

USAID Project #698-0408.1
Yaounde, Cameroon

Contract number:

631-0408-C-00-4013-00

FINAL REPORT:
HEALTH CONSTRAINTS TO RURAL PRODUCTION
USAID Project #698-0408.1,
YAOUNDE, CAMEROON

SUMMARY

1.OBJECTIVES

On August 22, 1983 the Republic of Cameroon and the United States of America signed an agreement of collaboration for the HEALTH CONSTRAINTS TO RURAL PRODUCTION PROJECT more commonly known as the SCHISTOSOMIASIS RESEARCH PROJECT.

The GOAL of the project was to develop an effective, economical and environmentally sound strategy for the control of the schistosomiasis in Africa.

The main OBJECTIVES of this project were to develop a schistosomiasis research center in Yaounde, Cameroon, capable of (1) mapping the prevalence, distribution and intensity of schistosomiasis infection and disease, (2) developing effective schistosomiasis control activities that are economical, environmentally sound and socially acceptable, (3) training Africans in laboratory and field research methodology and (4) serving as a center for schistosomiasis research capable of serving the sub-saharan African region with special reference to Francophone West and Central African nations.

For the Cameroonian government the responsibility for the implementation of this project was given to the MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH (MESRES) through the INSTITUTE OF MEDICAL RESEARCH AND STUDY OF MEDICINAL PLANTS (IMPM). The UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID) contracted with TULANE UNIVERSITY for the required technical assistance.

2.END OF PROJECT STATUS

EOPS # 1-A SCHISTOSOMIASIS RESEARCH CENTER staffed by Africans and capable of continuing a broad range of studies including laboratory studies on the clinical, malacological, parasitological and water chemistry aspects of schistosomiasis, experimental animal studies, epidemiological studies of the dynamics of disease infection and transmission, and socio-economic studies on its impact on the population. The center will contain required laboratory space and equipment, data processing and storage space, training facilities, and office space.

The schistosomiasis research center was built at Nkomo, on the grounds of IMPM. The main components of the research center are administrative offices, parasitology, malacology and water chemistry laboratories, a library, and a data-processing and biostatistics system.

From October 1984 to May 1989, a Technical Assistance Team (TAT) from Tulane University was based in Yaounde and collaborated with IMPM staff to implement the project. The TAT was composed of a physician-epidemiologist, a malacologist, a parasitologist and an administrator. They worked in collaboration with 5 senior Cameroonian researchers and 12 technicians during their stay in Cameroon. The Research Center was fully functional.

EOPS # 2-INCREASED KNOWLEDGE ABOUT SCHISTOSOMIASIS obtained from completed research on the bionomics, taxonomy, distribution and population dynamics of the

six known species of snails found in Cameroon, snail control using molluscicides as well as biological and other natural methods, clinical features in humans of various species of schistosomiasis parasites; the incidence and distribution of the disease, environmental and behavioral dynamics of schistosomiasis infection and transmission, schistosomiasis control techniques, pathological effects, the extent of incapacitation of infected humans and its economic implications on work force productivity.

The studies carried out were:

1.**Study of epidemiologic data collection.** All information available on schistosomiasis in Cameroon was systematically collected. This included a complete review of the scientific literature and the compilation of information from the national disease reporting system in collaboration with the Bureau of Schistosomiasis from the Ministry of Health.

2.**Map of Schistosomiasis prevalence and intensity.** The map located sites of infection from the three known species of the parasite which causes human schistosomiasis in Cameroon (Schistosoma haematobium, S. mansoni and S. intercalatum). To prepare this map a nationwide survey of 5th grade school children was undertaken. Five hundred and twelve schools were surveyed; 19,524 urine and 22,166 stool samples were examined. The 3 northern provinces with 29% of the population, had 87% of all the urinary and 82% of all intestinal cases. These provinces have a low, seasonal rainfall. The presence of temporary bodies of water and of molluscan intermediate hosts adapted to this environment fostered intense transmission of schistosomiasis haematobium and mansoni. In the rest of the country the distribution of S. haematobium and of S. mansoni was highly focal. Schistosoma intercalatum endemic areas were restricted to the equatorial forest and tended to be small, with relatively low prevalences and intensities of infection.

3.**Longitudinal Community studies.** The entire population of several small communities were studied longitudinally for a period of two to three years to collect data on the dynamics of disease transmission. Communities of 300 to 500 inhabitants were selected as representative of various ecological zones. The studies determined prevalence, incidence and intensity of human infection, patterns of diseases, migration and behavior with respect to contact with and contamination from various water sources (wells, dams, ponds, running water and piped water). The data was correlated with such variables as age, sex, occupation, water quality and use, distribution of intermediate snail hosts and relationship to development activities. These studies helped formulate ecologically specific control strategies.

4.**Socio-economic morbidity studies.** The longitudinal studies included a component to measure morbidity effects in relation to personal, household, community and environmental variables.

5.**Parasitological studies.** Quantitative field examinations were made of stool and urine specimens taken from population groups of the target areas. Evidence of eggs, cysts or parasites were recorded and specimens of particular interest were preserved for future use at the center. Studies were undertaken to describe newly discovered hybrid species of schistosomes.

6.**Malacological studies.** The bionomics, taxonomy and population dynamics of the eight species of Cameroonian snails which are potential intermediate hosts of schistosomiasis species were studied .

6.1.**Distribution map:** A nationwide survey for snail hosts of human schistosomes was carried out in Cameroon between 1985 and 1988. A total of 668 sites at 432 localities were sampled. In the arid, northern half of the country (Tropical Climatic Zone), where both intestinal and urinary schistosomiasis are hyperendemic, Biomphalaria pfeifferi was the only Schistosoma mansoni host, and

Bulinus globosus and B. senegalensis the most common S. haematobium hosts. In the that region these snails occurred almost exclusively in temporary bodies of water. Taking into account results from a companion study on the distribution of schistosomiasis in man, our results clearly show that temporary water bodies in the Tropical Zone are the principal foci of transmission. These findings disagree with commonly held views about schistosome transmission in Cameroon and will be useful for redirecting efforts toward meaningful, cost-effective control measures. Bulinus truncatus, a S. haematobium host, was also present in the Tropical Zone but was found principally in perennial habitats. Although some perennial habitats were important transmission sites, they represent only a small portion of the overall problem. B. truncatus is the principal S. haematobium host in the wetter southern half of the country, where schistosomiasis haematobium is highly focal. Although Biom. camerunensis was far more common than Biom. pfeifferi in the south, it did not occur at localities where S. mansoni prevalence rates were high and appears to be a poor host. Bulinus forskalii, the sole host of S. intercalatum in Cameroon, occurs widely throughout the country. There are no satisfactory explanations as to why that schistosome is restricted to a small region in the south of the country.

6.2.**Taxonomic studies:** Comparisons using electrophoretic migration patterns of isoenzymes and cytogenetics techniques were used to help determine the taxonomic relationships among some of the more closely related species of snail intermediate hosts. Among those that were compared are: Bulinus globosus, Bulinus rohlfsi, Bulinus truncatus, Bulinus forskalii, Bulinus senegalensis, Biomphalaria pfeifferi and Biomphalaria camerunensis.

6.3. **Susceptibility studies:** The degree of susceptibility of the following species of cameroonian snails in relation to the schistosomes were studied: Schistosoma haematobium with Bulinus senegalensis, B. camerunensis and B. truncatus; S. intercalatum with Bulinus senegalensis, B. forskalii, B. camerunensis and B. truncatus; S. mansoni with Biomphalaria camerunensis.

6.4.**Population dynamics:** Four sites were chosen for longitudinal studies on population dynamics and dynamics of infection of the snail hosts. These included sites in villages where longitudinal epidemiological studies were performed, and other sites were included to insure that the ecologically disparate regions of Cameroon are represented in this study.

6.5.**Experimental pond and snail control studies.** Experimental ponds were used to conduct biological control and molluscicide experiments. Niclosamide, pesticide and fertilizer effects on snails and the environment were assessed. The molluscicidal effect of Phytolacca dodecandra (Endod) local plants was investigated.

6.6.Research publications to date are shown below, by principal author.

PUBLICATIONS

Greer GJ, Mimpfoundi R, Malek EA, Joky A, Ngonseu E, Ratard RC 1990. Human schistosomiasis in Cameroon. II. Distribution of the snail hosts. *American Journal of Tropical Medicine & Hygiene 42(6):* 573-580.

Mimpfoundi R, Greer GJ 1989. Allozyme comparisons among species of the *Bulinus forskalii* group (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 55:* 405-410.

Mimpfoundi R, Greer GJ 1990. Allozyme comparisons and ploidy levels among species of the *Bulinus truncatus/tropicus* complex (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 56:* 63-68.

Mimpfoundi R, Greer GJ 1990. Allozyme variation among populations of *Biomphalaria camerunensis* (Boettger, 1941) (Gastropoda: Planorbidae) in Cameroon. *Journal*

of Molluscan Studies 56: 373-381.

Mimpfoundi R, Greer GJ 1990. Allozyme variation among populations of *Bulinus forskalii* (Ehrenberg, 1831) (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 56:* 353-371.

Mimpfoundi R, Greer GJ 1990. Allozyme comparisons among populations of *Biomphalaria pfeifferi* (Krauss, 1848) (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 56:* 461-467.

Monkiedje A, Englande AJ, Wall JH 1990. Environmental impact assessment of *Phytolacca dodecandra* (Endod 44) and niclosamide in the aquatic systems: Abiotic parameters and persistence under field conditions. *Proceedings of the 3rd International Workshop on Recent Developments and Future Directions in Endod Research, ICDR Monograph Series.*

Monkiedje A, Englande AJ, Malek E 1990. Studies on the effects of *Phytolacca dodecandra* (Endod 44) and niclosamide. I-Acute toxicity to snails *Biomphalaria glabrata* (albino), *B.pfeifferi*, and *Schistosoma mansoni* cercariae. *Proceedings of the 3rd International Workshop on Recent Developments and Future Directions in Endod Research, ICDR Monograph Series.*

Monkiedje A, Englande AJ, Wall JH 1990. Studies on the effects of *Phytolacca dodecandra* (Endod 44) and niclosamide. II-Acute toxicity to non target organisms under laboratory and field conditions. *Proceedings of the 3rd International Workshop on Recent Developments and Future Directions in Endod Research, ICDR Monograph Series.*

Monkiedje A, Wall JH, Englande AJ, Anderson AC 1990. A new method for determining concentrations of Endod-S (*Phytolacca dodecandra*) in water during mollusciciding. *Journal of Environmental Science and Health B, 25:* 777-786.

Monkiedje A, Englande AJ, Anderson AC 1990. Acute toxicity of *Phytolacca dodecandra* (Endod-44) and niclosamide to snails, *Schistosoma mansoni* cercariae, Tilapia fish and soil microorganisms. *Toxicity Assessment 6:* 405-414.

Ndamkou CN, Ratard RC 1990. Are sanitation, water supply and health center sufficient to control schistosomiasis? *Tropical Doctor 20:* 176-177.

Ratard RC, Ekani MM, Greer GJ, Kouemeni LK, Mimpfoundi R, Ngonseu E 1988. Schistosomiasis in Cameroon, (Letter to editor). *Parasitology Today 4:* 199.

Ratard RC, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN, Greer GJ, Spilsbury J, Cline BL 1990. Human schistosomiasis in Cameroon. I. Distribution of schistosomiasis. *American Journal of Tropical Medicine & Hygiene 42(6):* 561-572.

Ratard RC, Kouemeni L, Ekani-Bessala MM, Ndamkou CN 1990. Distribution and preservation of *Schistosoma mansoni* eggs in stools. *Journal of Tropical Medicine 93:* 413-416.

Ratard RC, Kouemeni LE, Ekani-Bessala MM, Ndamkou CN, Sama MT, Cline BL 1991. Ascariasis and trichuriasis in Cameroon. *Transaction of the Royal Society of Tropical Medicine & Hygiene 85:* 84-88.

Ratard RC, Greer GJ. A new focus of *Schistosoma haematobium / S. intercalatum* hybrid in Cameroon 1991. *American Journal of Tropical Medicine & Hygiene 45:* 332-338.

Ratard RC, Ndamkou CN, Kouemeni LE, Ekani-Bessala MM 1991. *Schistosoma mansoni* eggs in urine. *Journal of Tropical Medicine and Hygiene 94:* 348-351.

Tchounwou PB, Englande AJ, Malek EA, Anderson AC, Abdelghani AA 1991. The

effects of Bayluscide and malathion on the survival of miracidia of *Schistosome mansoni*. *Journal of Environmental Science Health B 26*: 69-82.

Tchounwou PB, Englande AJ, Malek EA, Anderson AC, Abdelghani AA 1991. The effects of ammonium sulphate and urea upon egg hatching and miracidial survival of *Schistosome mansoni*. *Journal of Environmental Science Health B 26*: 241-257.

IN PRESS

Ratard RC, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN. Estimation of the number of cases of schistosomiasis in a country: The example of Cameroon. *Transaction of the Royal Society of Tropical Medicine & Hygiene*.

Tchounwou PB, Englande AJ, Malek EA, Greer GJ, Anderson AC. The effects of Bayluscide and malathion on the behavior, mortality and infectivity of *Schistosome mansoni* cercariae. *Environmental Toxicology and Water Quality*:.

Tchounwou PB, Englande AJ, Malek EA. Toxicity evaluation of bayluscide and malathion to three developmental stages of freshwater snails.. *Archives of Environmental Contamination and Toxicology*:.

Tchounwou PB, Englande AJ, Malek EA. Toxicity evaluation of ammonium sulphate and urea to three developmental stages of freshwater snails.. *Archives of Environmental Contamination and Toxicology*:.

SUBMITTED FOR PUBLICATION

Befidi-Mengue R, Ratard RC, D'Alessandro A, Rice J, Befidi-Mengue R, Kouemeni LK, Cline BL. The impact of *Schistosoma haematobium* infection and of praziquantel treatment on the growth of primary school children in bertoua, Cameroon. *American Journal of Tropical Medicine & Hygiene*

Mvondo JL, James MA, Campbell CC. Malaria and pregnancy in Cameroonian women. I-Effects of *Plasmodium falciparum* parasitemia and the response to chloroquine.

Mvondo JL, James MA, Campbell CC. Malaria and pregnancy in Cameroonian women. II-Naturally acquired antibody response to asexual blood stage antigens and the circumsporozoite protein of *Plasmodium falciparum*.

Ndamkou CN, Ratard RC. Mesure et analyse des taux d'incidence de la bilharziose urinaire au village de Douloumi, Cameroun. *Bulletin de la Societe de Pathologie Exotique*.

Ndamkou CN, Ratard RC. Water contact patterns and schistosomiasis in the village of Douloumi, North Cameroon. *Journal of Tropical Medicine and Hygiene*.

Ngonseu E, Greer GJ, Mimpfoundi M. Dynamique des populations et infestation des mollusques hotes intermediaires des schistosomiases dans la Province de l'Extreme Nord Cameroun. I_Cas de *Bulinus globosus*. *Bulletin de la Societe Belge de Medecine Tropicale*.

Ratard RC, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN. Self selection in a village study. *International Journal of Epidemiology*.

Tchounwou PB, Englande AJ, Malek EA. Influence of selected environmental parameters on the potencies of bayluscide and ammonium sulphate against *Schistosoma mansoni* miracidia. *Environmental Research*.

PRESENTATIONS

Ekani MM, Ratard RC 1986. Cameroon schistosomiasis project: Nationwide parasitic survey in primary school children. *35th Annual Meeting of the American Society*

of Tropical Medicine, Denver, December 1986.

Mimpfoundi M, Joky A, Greer GJ, Same-Ekobo A, Malek EA 1986. Cameroon schistosomiasis project: The distribution of snail intermediate host of human schistosomiasis in Cameroon. *35th Annual Meeting of the American Society of Tropical Medicine, Denver, December 1986.*

Greer GJ, Mimpfoundi R, Malek EA, Ngonseu E 1990. The role of malacology in schistosomiasis control projects: The Cameroon experience. *39th Annual Meeting of the American Society of Tropical Medicine, New Orleans, November 1990.*

Ratard RC, Greer GJ, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN 1990. Description of a new focus of human infection with *Schistosoma haematobium /Schistosoma intercalatum* hybrids in Cameroon. *39th Annual Meeting of the American Society of Tropical Medicine, New Orleans, November 1990.*

EOPS # 3-CADRE OF TRAINED AFRICANS capable of staffing the research center and continuing multi-disciplinary research on schistosomiasis in the Sud-Saharan Africain region. Twenty-two Africans received post-graduate participant training : ten Cameroonians (four at the Doctoral level and six at the Master's level) and twelve from other sub-Saharan African countries at the Master's level. Fields of training include epidemiology, malacology, parasitology, water chemistry, biostatistics, environmental health, economics, and behavior science. Fifteen people from other sub-Saharan African countries will receive on-the-job training at the Yaounde center. Twenty laboratory and field technicians will receive third-country, in-country, or on-the-job training.

The training component was an important part of this project. It included both long-term and short-term training.

1.**Long-term training:** Graduate training was provided in specialties including epidemiology, parasitology, malacology, biostatistics, environmental health engineering, water chemistry, and behavioral sciences. Eleven participants from other countries from sub-saharan Africa were trained at the Master's level. Twelve Cameroonians entered doctoral programs; ten successfully completed their studies. Training was done at Tulane University School of Public Health and Tropical Medicine. Trainees were supported primarily by project funds.

Students, degrees, and doctoral dissertations are listed below:
a. Cameroonian

Stella Anyangwe, PhD	8/90	"The role of health education, community health workers and single-dose Metrifonate therapy in the control of morbidity related to urinary schistosomiasis, in an endemic focus in the far-north province of Cameroon"
Rosa Befidi-Mengue, PhD	8/90	"Schistosoma haematobium and nutritional status among primary school children in Bertoua, Cameroon: Effect of Praziquantel on hemoglobin levels, anthropometric measures, liver and spleen size"
Martyn Sama, DrPH	8/90	"Human behavior as an index to the prevalence and intensity of schistosomiasis transmission in the urban population of Kukmba SW Province, Cameroon"
Joseph Foumbi, PhD	12/90	"S. haematobium infection and uropathies in hyperendemic and hypoendemic communities in the Extreme Northern Province of Cameroon -

		ultrasonography, chemical reagent strip and bacteriologic correlates of morbidity"
Adolphe Monkiedje, ScD	12/90	"Laboratory and simulated field evaluation of the plant molluscicide Phytolacca dodecandra (Endod-44) as it relates to schistosomiasis control in Cameroon"
Joe Louis Mvondo, PhD	12/90	"Malaria & pregnancy; epidemiology & the immune responsiveness"
Felix Takougang, PhD	12/90	"Morphology, cytogenetics, susceptibility & taxonomy of Bulinidae: Hosts of schistosomiasis in Cameroon"
Paul Tchounwou, ScD	12/90	"The effects of chemical fertilizers and pesticides including the influence of selected environmental parameters on the transmission of schistosomiasis in Cameroon"
Pierre Ngou'Mou, PhD	1/91	"Relationship of the sickle cell trait with the development of acquired immunity to falciparum malaria in Cameroon children"
Emmanuel Wansi, PhD	8/91	"Morbidity of schistosomiasis intercalatum: A controlled population based study in Edea Cameroon"

b. Non-Cameroonians (Master degrees - no dissertation)

Victor Sima, MPH&TM	1987	Tropical Medicine
Lumbu Utshidi, MPH	1987	Epidemiology
Gakaitangou Fatchou, MPH	1988	Epidemiology
Victor Hounkonnou, MPH	1988	Epidemiology
Eugene Kpizingui, MPH	1988	Epidemiology
Hilaire Ndihokubwayo, MPH&TM	1988	Tropical Medicine
Luke Nkinsi, MPH	1988	Epidemiology
Jean L. Pare, MSPH	1988	Parasitology
Gagde Hinn-Dandje, MPH&TM	1990	Tropical Medicine
Justin Ndoyo, MPH&TM	1990	Tropical Medicine
Pascal Talani, MPH	1990	Epidemiology

2.**Short-term training:** The technical training was developed and started by the U.S. technicians who are Tulane Research Associate Professors and have been continued by the Cameroonians specialist trainees upon their return from studies. Much of the training was on-the-job.

EOPS # 4-INTERAGENCY AND REGIONAL RESEARCH NETWORK of governments and other institutions cooperating in schistosomiasis research, training, and dissemination and application of new knowledge to be achieved through participant and on-the-job training, regional conferences, a newsletter, collaborative research relationships, and a consultative group of experts meeting periodically to advise on strategies and priorities for research.

1.**Training:** Training Africans from countries susceptible to collaborate with the Cameroonians researchers was the main avenue to reach this objective. USAID provided fellowships for long-term training to 11 non-Cameroonians selected from those countries which expressed interest in conducting research on schistosomiasis. All participants were successful in receiving a Masters level degree from Tulane University School of Public Health and Tropical Medicine.

2. **Schistosomiasis research newsletter** : During the project a newsletter (*The African Schistosome*) was published semi-annually and provided information on progress in meeting research objectives. It was distributed to some 500 collaborating organizations, interested agencies and researchers. The newsletter attracted considerable interest and letters from readers.

3. **Consultation:** The members of the Technical Assistance Team were available for consultation on schistosomiasis epidemiology and control, training and cooperation with this project. Consultation was carried out to Chad and Equatorial Guinea.

EOPS # 5-STRENGTHENED INSTITUTIONAL CAPACITY OF IMPM and to some extent the Ministry of Health, CUSS, OCEAC, other Cameroonian institutions as well as other interested sub-Saharan African governments and institutions, to design and conduct research on schistosomiasis and to develop strategies for its control.

Numerous research projects were undertaken and completed during the 5 years of this project. At the end of the project it was obvious that many researchers were able to design and conduct research on schistosomiasis and other tropical diseases and had the facility, lab equipment and trained technicians to allow them to see their research projects through.

EOPS # 6-PREPARED A "NATIONAL SCHISTOSOMIASIS CONTROL MANUAL" which will become a reference document for all health personnel, especially those engaged in schistosomiasis control activities. This manual will contain all species of snail hosts found in Cameroon, where they are found and the type of schistosoma they transmit.

"Schistosomiasis Control in Cameroon: A Manual for Health Workers" was prepared by the project to serve as a guide to control. The manual was designed to be useful for a variety of workers ranging from program directors to field technicians. The English version has been distributed to many workers involved in schistosomiasis control in Cameroon and has been used in training courses for health workers in the pilot project in Kaele. A translation has been completed and will be published during 1992. (Copy is attached.)

EOPS # 7-PRODUCED A VIDEO ON SCHISTOSOMIASIS RESEARCH AND CONTROL IN CAMEROON to be used as a teaching tool and source of briefing material for top AID and GRC officials. The video also will be another way of disseminating findings/results of the schistosomiasis research project.

A video entitled "Schistosomiasis in Cameroon" was produced as a joint effort between the TAT, USAID/Yaounde, and video production experts, L. Klein and R. Anderson. Copies of this successful 15 minute video have been distributed to USAID officials and other interested parties to be used for administrative and educational purposes. The video fulfilled the requirement of the contractor "to produce a broadcast quality video on schistosomiasis research and control in Cameroon". (Copy is attached.)

1. ADMINISTRATIVE IMPLEMENTATION

1.1.PERSONNEL

1.1.1.TECHNICAL ASSISTANCE TEAM

On August 18, 1984 Thomas Talbot, Administrator, arrived in Yaounde to set up the administrative structure of the project. He was followed by Dr. Christian Raccurt, Chief of Party, Dr. Frank Cogswell, Parasitologist, Dr. George Greer, Malacologist, who arrived on October 6, 1985. For personal reasons Dr. Christian Raccurt had to leave the project on November 8, 1984. Dr. R. Ratard was recruited by Tulane University to replace Dr. Raccurt. On January 12, 1985 Dr. R. Ratard arrived in Yaounde and became the Chief of Party.

In October 1986 IMPM and AID agreed on modifying the length of stay of the members of the Technical Assistance Team: the Administrator stay would continue for another 2 years (until October 1988), the malacologist stay was extended by one year (until October 1988 instead of October 1987 as previously planned), no change was made for the Epidemiologist-Chief of Party or the parasitologist.

The parasitologist, Dr. F. C. Cogswell contract was for 2 years. By July 1987, he had successfully completed his assignment. The parasitology laboratory was functional, he had trained the technicians and his counterparts Dr. Kouemeni and Dr. Ekani were able to assume his duties.

Mr. Thomas Talbot, Technical Assistance Team Administrator, left in July 1988. The transition went smoothly because it had been well prepared. The Chief of Party took over the administrative and financial contractual responsibilities. Mr. Talbot had left a well organized computerized financial system. Personnel and property (inventory) management was assumed by Mr. Koungou. The library, newsletter, customs, freight, transportation and relations with other agencies became the responsibilities of Mr. Ningouloubel. They had been trained in the year prior to his departure by Mr. Talbot himself and were prepared for these tasks.

Dr. George Greer, Technical Assistance Team Malacologist, left in November 1988. His responsibilities were assumed by Dr. R. Mimpfoundi, from the Faculty of Science, working voluntarily with the project and by Mr. Ernest Ngonseu, Senior Malacology Technician. Dr. Greer came back during the following year for short consultations with the malacology staff.

The last member of the Technical Assistance Team, Dr. R. Ratard, Chief of Party, Epidemiologist, left Yaoundé on May 26, 1989. Tulane consultants continued to come for short visits to the project until its completion: the continuity of interaction between Tulane and IMPM staff was assured by visits from Pr. B.L. Cline, Senior Faculty Advisor, Dr. R. Ratard, Epidemiologist and Dr. G. Greer, Malacologist.

1.1.2.STAFF:

Tulane University (TU) had initially no funds to hire local personnel and IMPM was reluctant to hire new personnel or second their staff so early in the project. It became obvious that the project would be more efficient if local administrative personnel could be hired directly by the technical assistance team (TAT). In November 1984 a contract modification was suggested in order to provide the TAT the funds necessary for hiring a secretary, an accountant, a driver-mechanic, an assistant administrator, a driver and guards. The contract amendment was finalized on February 20, 1985.

The ability to control directly local employees for the daily administration of the project has been a major asset. It gave the TAT a better control

and more flexibility over administrative matters. When the move into the permanent building was planned it was agreed that Tulane would not keep any local employee. IMPM would take responsibility for administrative support, security guards, and drivers for the vehicles. The Tulane team began to phase out these employees in early 1988. The Assistant Administrator was was very well qualified and had received an intensive training on administrative matters. TAT and their national counterparts wanted to keep him in the project where he was a very productive staff member. However, the IMPM Direction insisted on sending him back to the Ministry of Health. He was employed by the Ministry of Health before being seconded to this project. Efforts were made to try to keep this important person in the project but other considerations prevailed and he had to go.

1.1.3.RESEARCHERS:

In October 1984, Dr. A. Joky, D.Sc. in malacology, researcher under contract with IMPM was seconded to the project. He remained the only full time IMPM person involved in project activities during the first year. At the end of the year he was taken away to meditate on the fate of political dissidents. He came back after 9 month of meditation and emigrated soon after.

At the beginning of the project, researchers were available mostly for consultation, their busy schedule preventing them from becoming involved in the project activities. These were Dr. L.Kouemeni, Dr. R.Lando and Dr. R.Leke, all three immunologists. Consultation was also available from Pr. A. Same Ekobo, Professor of Parasitology at the School of Medicine (CUSS). This approach was very unsatisfactory causing the Cameroonian counterparts to feel estranged from the project. It became obvious that it was necessary to insist that some researchers be appointed on a full time basis to the project.

Dr. R. Mimpfoundi, D.Sc. in malacology, from the School of Science of the University of Yaounde became involved in the project in late 1985. He participated very actively in all aspects of the malacological activities. He turned out to be the most dedicated and productive scientist of the project.

In June 1985 Dr. Awahmukallah, Ph.D. an entomologist, joined the project as a parasitologist. After he had participated in a single field trip, he was transferred without warning to the IMPM Kumba field station in August 1985.

Until early 1986 the daily supervision of lab technicians, distribution of work, quality control, and collection of data was done by the TAT parasitologist. When he was busy with other duties the laboratory performance seemed to suffer. Once the school survey started, it became obvious that a field epidemiologist would also be necessary. The field collections were done by the chief of party or the parasitologist. If these individuals were not available, the field work came to a halt.

Mr. Christian Ndamkou Ndamkou, after returning from a 2-year training program in Douake, Ivory Coast, sponsored by W.H.O., had applied for a position as a full-time researcher in IMPM. He has been waiting for a decision on his appointment for the last 6 months and has decided to volunteer his time starting in October 1985. Mr. Ndamkou was responsible for organizing and carrying out the school survey and had done an excellent job. He was nominated as senior technician in August 1986. By November 1986 his appointment had not yet gone through. After 11 months of working without being paid a salary, Mr. Ndamkou chose to leave the project to take a position with the National Veterinary Laboratory in Garoua where he was formally hired in less than one month. This was a great loss for the project. The main causes for this loss were the bureaucratic inertia and bad will of the IMPM administration.

Mr. Njiokou Flobert, with a bachelor's degree in Zoology was permanently assigned to the parasitology unit as a senior technician on May 21, 1986. He was granted a 2 week leave on October 13, 1986 and never returned to his post. His

whereabouts remained unknown for a long time. Two year later, he returned informing project staff that he was studying in France.

Mr. Ngonseu Ernest, with a master's degree in physiology was recruited as a senior technician for the malacology unit on June 30, 1986 and worked in that capacity for the length of the project.

The assignment of full-time researchers took a long time to come. Dr. L. Kouemeni and Dr. Marie Madeleine Ekani were assigned to the project as full time researchers in February 1986. After a short period of familiarization with the project, they took over the responsibility of running the parasitology laboratory. Their participation has provided a boost to the project activities. With the presence of permanent researchers from IMPM assigned to the project, it became possible to get them involved in the day to day decision-making. In late 1986 IMPM appointed Dr. L. Kouemeni as the IMPM Project Coordinator. This was a significant step in increasing participation from IMPM staff in decision making in the project. Weekly staff meeting were held in the project where all researchers are able to have input in the direction of the project.

After the departure of the last member of TAT, the project was left under the direction of Dr. L.K. Kouemeni. During the leave period she had accumulated, the project would have been left without direction at a critical period. Therefore the IMPM Director decided to recall Dr. J. Foumbi to Cameroon. Dr. Foumbi had completed his field studies in May 1988 in the Extreme North and had left for New Orleans in August 1988. It was felt that, after a year had past, Dr. Foumbi's analysis of the data should be almost finished and that he could complete the writing of his dissertation while in Yaounde. He would return for a few weeks in June 1990 to defend his dissertation. Therefore Dr. Foumbi came back to Yaounde in August 1989.

1.1.3.TECHNICIANS:

By August 1985 there was enough laboratory furniture and equipment available to start some field studies for which technicians were needed. Earlier attempts at getting IMPM to recruit technicians had fallen on deaf ears. The Melen Malacology Laboratory personnel who was part of the Ministry of Health staff were transferred to IMPM. The personnel consisted of 1 senior technician, 1 technician in training, 3 microscopists and 2 lab assistants. It took until late October to convince this personnel to come to work. Only then was the project able to start the first epidemiological activity: the school survey. In order to function better the laboratory needed the addition of a technician for malacology, several other microscopists and a laboratory supervisor.

Two additional technicians were recruited in 1986 for the laboratory bringing the total number to 6. However 4 of these technicians remained under the responsibility of the Ministry of Health. This created numerous problems. The 2 new technicians worked without pay for the year 1986 and were formally hired 1 year later.

The process of hiring additional personnel was extremely slow. This problem was extensively discussed with the IMPM Director; however, no easy solution was found for the following 2 reasons: 1-The bureaucratic process of hiring personnel was extremely slow and circumvoluted; 2-IMPM Direction was trying to save monies and have the project function only on the interests of funds deposited in an interest bearing account. This policy seriously hampered the development of the project.

In November 1986 five new technicians were hired, one full year after the school survey had started. They all had their BEPC degree with 6 years of secondary school education but had not graduated from secondary school (no baccalauréat). Their training started on December 1986. However several technicians left the project: a parasitology technician, left in November 1986, a

malacology technician, abandoned his post in October 1986. In March 1987 2 additional technicians were hired.

Some progress was achieved during 1986 since the total number of technicians increased to 14. The major problems experienced then were:
1-the lack of supervisors for these technicians since both the epidemiology and parasitology senior technicians posts were still vacant.
2-the poor motivation of these field and laboratory technicians who all hoped to continue to further their education and resented having to come to work everyday to make a living.

A considerable amount of researcher time was spent supervising the performance and checking the quality of the technician's work.

To carry out some of the field work required by the longitudinal studies it was planned to hire local health service personnel and other village personnel on a part-time basis. For example, schoolteachers would have been a useful resource in some sites to monitor water contact, students from the School of Human Science would have collected the information needed for the socio-economic studies. The system agreed upon during the planning sessions, was that USAID would transfer to IMPM the funds intended for field investigations and data gathering ($135,000) and for experimental programs ($52,000). IMPM would then use these funds to compensate these local workers. This system has been put in place. However no progress was ever made in identifying reliable field supervisors and IMPM had always been reluctant to spend these monies on personnel not belonging to the Institute. This failure to act upon the plan limited the part-time personnel available and the scope of the longitudinal and socio-economic studies.

1.1.6.CONSULTANTS

Name	Position	Dates	Purpose
BL Cline	Senior Faculty Advisor	11/07-11/14 84	Planning & evaluation
A D'Alessandro	Faculty advisor	11/21-11/27 84	Plan for lab
BL Cline	Senior Faculty Advisor	02/12-02/19 85	Planning & evaluation
J Diem	Statistician	02/12-02/19 85	Statistical unit
E Malek	Malacologist	02/05-02/22 85	Malacology unit
BL Cline	Senior Faculty Advisor	07/03-07/16 85	Planning & evaluation
E Ruiz Tiben	Parasitologist	11/07-11/14 85	Parasitology unit
E Malek	Malacologist	07/23-08/09 85	Malacology unit
BL Cline	Senior Faculty Advisor	12/04-12/11 85	Planning & evaluation
E Malek	Malacologist	01/28-02/14 86	Malacology unit
F Richards	Immunologist	02/22-03/15 86	Immunologic methods
C Ripert	Epidemiologist	03/17-03/22 86	Epidemiology
A Buck	Epidemiologist	02/24-03/04 86	Project implem review
J Sheppard	Administrator	02/24-03/04 86	Project implem review
BL Cline	Senior Faculty Advisor	04/23-04/29 86	Planning & evaluation
P Kat	Biochemist	09/24-10/10 86	Electrophoresis
BL Cline	Senior Faculty Advisor	01/06-01/13 87	Planning & evaluation
J Geshner	Ultrasound specialist	10/30-11/13 87	Ultrasound activities
BL Cline	Senior Faculty Advisor	01/12-01/19 88	Planning & evaluation
S Gros	Tulane business office	01/12-01/19 88	Budget discussions (1)
E Malek	Malacologist	01/12-01/26 88	Malacology unit
T Hamrick	Dean	02/20-02/23 88	Evaluation (1)
L Walsh	Chancellor	07/25-07/27 88	Evaluation (1)
M Eberhart	Parasitologist	08/21-08/29 88	Student advisor
AJ Englande	Environmentalist	08/23-08/30 88	Student advisor
N Lanners	Parasitologist	09/05-09/10 88	Student advisor
BL Cline	Senior Faculty Advisor	09/06-09/14 88	Planning & evaluation
F Mac Cullough	Control specialist	10/13-10/23 88	Control plan

A D'Alessandro	Faculty coordinator	03/04-03/13	89	Student advisor
G Greer	Malacologist	03/02-04/21	89	Malacology unit
B Hewlett	Anthropologist	04/11-04/22	89	Socio-beh studies
BL Cline	Senior Faculty Advisor	05/10-05/19	88	Planning & evaluation
G Greer	Malacologist	07/10-08/16	89	Malacology unit
E Malek	Malacologist	08/15-09/03	89	Malacology unit
R Ratard	Epidemiologist	08/23-09/29	89	Epidemiology
L Klein	Video producer	09/20-09/29	89	Video production
G Greer	Malacologist	10/24-12/09	89	Malacology unit
R Ratard	Epidemiologist	11/20-12/18	89	Epidemiology
B Hewlett	Anthropologist	12/30-01/10	90	Socio-beh studies
R Ratard	Epidemiologist	02/11-03/11	90	Epidemiology
BL Cline	Senior Faculty Advisor	02/28-03/07	90	Planning & evaluation
G Greer	Malacologist	02/20-03/25	90	Malacology unit
R Ratard	Epidemiologist	04/23-05/05	90	Epidemiology

(1) Not funded by USAID

In spite of the inclusion of several consultancies in the project plans, serious difficulties were met when approval was sought from IMPM Direction. For example a consultancy for mollusk electrophoresis, recommended by the planning committee was initially disapproved by IMPM (August 1986), after much discussions it was approved with reluctance (September 1986). The consultancy finally took place in October 1986. Progress toward meeting the scientific objectives of the project was slowed on several occasions since it could not benefit from the experience of outside consultants. Another example can be found in the biostatistics consultancies. A first consultancy was approved after tremendous difficulties for February 1985. Since then the project researchers had to develop a data processing system on their own, with written advice of the consultants. The process was successful but slow. Difficulties in obtaining consultants had also the negative impact of isolating this project from other research institutions making it difficult to achieve EOPS # 4 (Inter-regional agency research network).

1.2.BUILDING

The original plan was that the Government of Cameroon would provide the facilities and ponds at Melen for the project pending the completion of the Nkomo Research Center. The Melen building needed extensive renovations in order to become suitable for the project. In October 1984 AID requested from the Government of Cameroon the authority to proceed directly to make renovations. This request was rejected in February 1985 by the Ministry of Plans which had to approve such a procedure. Furthermore personnel from the Ministry of Livestock, Fisheries and Animal Industries had put up fences around the Melen building and the ponds. Although the building itself remained accessible, its adequacy to house the project became questionable: the fences were restricting access to the ponds and eliminating the possibility of having a decent parking area. Extension of the surface area of the facility seemed to be also jeopardized.

When it became obvious that the building problem would take years to resolve, USAID allowed Tulane to rent a building to house the project.

The Direction of IMPM had planned to move its headquarters from a rental building in the Melen district to new buildings at the Nkomo site. These buildings would be temporary and would be replaced by permanent structures (undefined schedule) at Nkomo. With this new development, it would make sense to consider locating the project building at Nkomo instead of Melen, thus strengthening the Nkomo area as the main site for medical scientific research however the Nkomo site had some very serious drawbacks: it was located far away from the town, public transportation was poor in the area and water shortages were very serious. In March 1985 the IMPM Direction requested in writing to the Ministry of Scientific Research and Higher Education (MESRES) that the funds

originally intended for the renovation of the Melen building, be spent on the construction of a new structure at the Nkomo site.

In March 1985 the TAT moved from its single 9/15ft office into a rented building in the Bastos district of town. The facility was a two story apartment building. Each apartment consisted of a large living room, kitchen, store room and 3 bedrooms. The downstairs apartment housed the administrative and epidemiology offices, the upstairs one housed the laboratory and their personnel offices. Renting apartments was much more satisfactory than renting regular office space. The availability of large rooms which could be utilized for the laboratory and the library, of kitchens and bathrooms with easy access to water, of parking space, of a garage and shed for vehicle maintenance were an asset.

One year later, in March 1986 the Minister of Higher Education and Scientific Research (MESRES) wrote to the Director of AID to indicate his approval for construction on the Nkomo site.

Toward the end of 1986, the process of planning for building construction was underway. The building could have been located close to the IMPM Headquarters, however the Direction of IMPM insisted in locating the facility in a remote corner of the property, close to a native village so that the building could serve as a buffer. Numerous delays occurred because some squatters had settled on the grounds and needed to be compensated and evicted.

The administrative process of modifying the agreement between USAID and the Government of Cameroon was started in July 1986. In February 1987, AID staff, the Technical Assistance Team, IMPM Researchers and IMPM Deputy Director visited a laboratory building built by USAID in Yaoundé for the Department of Agriculture. The proposed project building would be built on the same model. The building visited was considered to be an adequate model for the project building. IMPM Researchers and TAT finalized the details of the interior floor plan and submitted their draft to the AID engineer. In April 1987, AID and IMPM representatives agreed that the Ministry of Higher Education and Scientific Research (MESRES), would take direct responsibility for selection of contractors and building the structure. AID would control the construction and make sure that all standards are met. These decisions were formalized by exchange of letters. A contractor was selected.

Construction started on the project building in Nkomo in the middle of 1987. The land disputes continued and slowed down the progresses of construction. After laying the foundation, the progress was slowed by an unexpected problem with the first contractor who was eventually dismissed. Construction was resumed under the responsibility of MESIRES which selected another contractor. A first target date was set for May 1988 for the move to take place.

The move finally took place in January 1989. The water problem is serious. Nkomo is an area of Yaoundé well known for its chronic and severe water shortages. However, it appeared that in spite of this knowledge, no provision were made to secure a decent water supply. The plan was to hook the project building on the IMPM facility that already lacks water. The project laboratory continued to run for the rest of the year without running water. Narrow minded scientists were upset about this situation. Fortunately decision makers who have a much broader vision, can see the futility of such trivial problems. Therefore it was decided that benign neglect was the best approach to solve the problem.

The inauguration ceremony for the building took place on March 28, 1990. The Ministers of Higher Education and Scientific Research, the Minister of Health, the US Ambassador were among the personalities present at this dedication ceremony.

1.3.EQUIPMENT

The large items of equipment were ordered directly by USAID. The input of IMPM and Tulane were limited to the selection of the items.

Several lists of equipment prepared by TAT in consultation with the Cameroonian researchers were submitted to USAID: laboratory equipment to be purchased locally in order to minimize delays, others to be purchased in the USA, office furniture, benches and laboratory furniture to be made locally according to the specifications of the TAT and computer equipment to be purchased in the US. On September 11 1986, the first air freight shipment of supplies (from the long list of equipment submitted to USAID in January 1985) arrived in Yaounde. By early 1988, the majority of the laboratory equipment had been delivered and was functional.

The computer equipment ordered in February 1985 was delivered in February 1986. Others orders were made as the need for more computers was felt. There were 7 computers in the project: 2 IBM portable with double floppy drives and CRT display, 2 IBM XT with 22MB hard disk and single floppy drive, 1 XT Clone with 2 hard cards (20MB) and double floppy drive and 2 IBM ATs with 21MB hard disk and dual floppy drives.

Three of the 4 project vehicles ordered by USAID were delivered to the project in October 1984. These were 2 Jeep Cherokee and 1 Jeep CJ8. Another Jeep Cherokee was ordered and delivered the following year. IMPM had provided a first vehicle in 1985 for use at the project office and a second vehicle in January 1987 to be stationed in the Extreme North the duration of the students' work in this province. IMPM never lived up to its commitment of 4 vehicles for the project. Transportation problems have continuously plagued the project. The purchase of US made vehicles was a poor choice. The Renault dealer in Cameroon was supposed to maintain a stock of spare parts for the Cherokees and Jeep, but this was never satisfactory. Spare parts had to be purchased by Tulane and shipped to Cameroon.

For a large part of the project, TAT had to purchase supplies and minor equipment to ensure the proper functioning of the project laboratory and administrative unit.

At the end of May 1989, the complete inventory of all furniture, laboratory equipment and supplies and the project vehicles were formally handed over to IMPM since Tulane was no longer having staff residing permanently in Yaounde.

1.4.BUDGET

The TAT administrator established a computerized system to keep tract of local expenses made by the TAT. The Tulane University business office was responsible for the budget of the whole project. TAT regularly provided the Tulane business office with monthly expenditures and justifications. The local accountants and assistant administrators were trained by the TAT administrator and have participated in this activity.

1.5.POLICIES

The project administrator contacted AID personnel and other AID project contractors in order to familiarize himself with the standard policies and implement similar policies in this particular project. Policies regarding TAT and local personnel were similar to those used in other USAID sponsored projects.

1.6.PLANNING, EVALUATION

From February 24 to March 4 1986, a project implementation review organized by AID took place. Dr. A. Buck and Dr. Sheppard were consultants that took part

in this exercise. In April 1986 the final recommendations of the Project Implementation Review Team were formally presented by USAID to IMPM and Tulane. The original implementation plan presented in the project proposal submitted by Tulane University in November 1983 was revised and updated. The planning committee consisted of Bibi Essama, Project Officer, representing USAID, Pr. J. Jato, Deputy Director of IMPM, Pr. Tsala Mbala, Chief of the Center for Medical Research, Dr. R. Leke, Researcher, all representing IMPM, since the Director could not attend, Dr. R. Ratard, Chief of Party, TAT. The plan was finalized in September 1986.

A team of independent scientists came to evaluate the project from April 11 to 30, 1988. The team was composed of C. Duboscq, Regional Health Officer from USAID Office in Abidjan, M. Herbert, Social Scientist, F. Mac Cullough, Epidemiologist - Vector Biologist, J. DeHasse, Management Consultant. The final report was submitted to USAID prior to their departure and a verbal summary was presented at a meeting held at IMPM on April 28, 1988.

1.7.COMMUNICATION,COLLABORATION, COORDINATION

The agencies that would participate directly or indirectly with the project were:

1-Institute of Medical Research and Medicinal Plants (IMPM) which is part of the Ministry of Higher Education and Scientific Research (MESRES).

2-Epidemiology and Malaria Service which is part of the Preventive Medicine and Public Hygiene Direction of the Ministry of Health.

3-Organization of coordination for programs against the endemies in Central Africa (OCEAC).

4-World Health Organization representative in Yaounde.

5-Centre Pasteur.

6-University of Yaounde School of Medicine Health Science Center (CUSS).

7-Office de la Recherche Scientifique dans les Territoires d' Outre-Mer (ORSTOM).

8-UNICEF office

On April 8, 1985 a formal meeting requested on November 15, 1984 took place. IMPM, USAID, TAT, Ministry of Health, CUSS, Centre Pasteur, WHO were represented. The project objectives and the need for collaboration were discussed. The collaboration between cameroonian researchers and the Technical Assistance Team (TAT) continued on a regular basis. Regular meetings of all researchers from other organizations that would be interested either in planning the research activities or getting the results from the research were held regularly throughout the duration of the project.

Collaboration with the MINISTRY OF HEALTH was excellent throughout the project. From the beginning close links were kept with the Bureau of Schistosomiasis from MOH. Mr. Ndeso Atanga Sylvester and Deborah Abgor-Tabi participated in all the coordination and planning meetings. In June 1985 TAT participated in a Schistosomiasis seminar sponsored by the Ministry of Health. Issues related to schistosomiasis control in Cameroon were discussed. Some difficulties were experienced because the decision to involve TAT was made informally with MOH staff and did not go through the official channels due to time constraints. This upset the IMPM Direction which considered that formality was more important that effectiveness. It became obvious that collaboration with agencies other than IMPM would have to be handled carefully. Formal collaboration was minimal because requests that had to go through formal channels got systematically lost in the maze of sinuous channels built by the bureaucracy. Most of the cooperation was done through informal contacts between researchers.

The Provincial Section of Preventive Medicine of the Ministry of Health in Maroua (Extreme North Province) had expressed an interest in following up the school survey with a more detailed survey of the Diamare Division, starting with the Maroua Subdivision. A detailed plan was prepared by the provincial staff in

collaboration with the project epidemiologist. This survey was successfully carried out. This active interest from a Province with the highest endemicity of urinary schistosomiasis led to the decision to recommend that the national control project start in this area.

Discussions with the Direction of Preventive Medicine of the Ministry of Health regarding the application of research result led to the decision to revise the Cameroon national plan for the control of schistosomiasis prepared with the collaboartion of W.H.O. in 1983. The project findings casted a new light on the schistosomiasis problem in Cameroon. It was obvious that the previous which was drafted without an in-depth knowledge of the situation had become obsolete. The new plan was was prepared by TAT, the project cameroonian researchers and the epidemiologists of the Bureau of Schistosomiasis during 1989. It was finalized in early 1990 and approved by the Minister of Health in March 1990.

CUSS researchers, Dr. Rose Leke, Dr. R. Lando, Dr. Asonganyi participated regularly in the planning meetings of the project. In March 1988, a survey of onchocerciasis was undertaken with Dr. Rose Leke, immunologist at CUSS, and Mr. Ngambon, student at Ecole Normale Supérieure, in the village of Kinding Njabi, which is a project longitudinal study site. One hundred and seventy persons were surveyed, there were 125 carriers of microfilariae, prevalence of 73.5%.

In November 1986, Pr. Abondo, Director of IMPM, and Dr. Ratard went to the U.S. to visit USAID in Washington, CDC in Atlanta and Tulane University Medical Center in New Orleans. This trip included technical visits and discussions about the project and its possible developments. In 1988, Dr. Barbara Fina, from the Office of Science and Technology discussed with the Cameroonian scientists of the project the possibilities of preparing grant applications for further research. An article titled "Cameroon and the US: Partners in medical research", by Mary O'Boyle Franco was published in # 174 of Topic magazine from USAID.

WHO officials were kept informed about the project progresses. In December 1986, Dr. Ratard attended the GTZ-WHO Schistosomiasis seminar in Nairobi, Kenya. Contacts were made with other groups involved with schistosomiasis research or control in Africa. In November 1989, researchers from the project and the two students presently in Cameroon attended a seminar on schistosomiasis and its control organized jointly by the Ministry of Health, GTZ and WHO. The main focus of the seminar was placed on maintenance of schistosomiasis control. An integrated approach, blending schistosomiasis control with other health delivery activities, was stressed. Most seminarists agreed that vertical schistosomiasis control programmes with specialized personnel and separate funding were not cost effective. Dr. S. Anyangwe attended a seminar held by the World Health Organization Tropical Disease Research and Socio Economic Research groups in Kadoma, Zimbabwe where she was a facilitator at a session on networking for schistosomiasis research project. Dr.S.Anyangwe was invited to be an instructor at the Tropical Epidemiology and Biostatistics Seminar for Health Professional of the Third World sponsored by the German Foundation for International Development.

Contacts were established with the PEACE CORPS regarding collaboration for longitudinal studies. The Peace Corps would have provided volunteers at the longitudinal study sites to work with a village counterpart. After discussion with the review team it was suggested to postpone the decision regarding the participation of Peace Corps. Given the time constraints in setting up these collaborative projects, the suggestion to delay action killed the initiative. This had a negative impact on the quality of the longitudinal studies since it was very difficult to identify responsible individuals at the village level.

It resulted from an informal meeting with the Secretary-general of OCEAC that there was a strong interest from this organization to collaborate with the project. The project Director was officially informed of this intent and asked to set in motion an official cooperation on March 20, 1986. It never happened

formally. However throughout the project, OCEAC epidemiologists attended planning and feed back meetings. The project provided some technical support for OCEAC data processing. The project participated in OCEAC's efforts to prepare a national epidemiologic atlas. The two project students working on malaria research worked part of the time in the OCEAC laboratory.

The project provided advice and was supporting the efforts of M. Coiron and J.B. Andreys, both working for the Rice Irrigation Scheme in Logone & Chari Division (SEMRY 3). This project is funded by the Government of Cameroon and European Development Fund. Its purpose is to set up rice culture patches irrigated by water pumped from the Logone and Chari rivers. The study's objective is to compare prevalence and intensity of infection before and after irrigation to evaluate the impact of irrigation on schistosomiasis endemicity. The initial survey was done in the Mara area in July 1987, prior to starting irrigation, and will be repeated one year after irrigation in 1988. A complete census showed a total population of 2352 persons. A random sample of 205 persons aged 5 and over was drawn. Urine samples were taken and examined, using the same techniques of the school surveys done by the project.

The project became a resource to numerous researchers in Cameroon. For example when Dr. J. J. Faure, Chief of the Forestry Department, Dschang University Center, and Dr. Chey had had to evaluate the environmental impact of a dam on the Mampe River they came to the project to obtain information on schistosomiasis endemicity and presence of intermediate hosts.

The elaborate COMPUTER facilities were very instrumental in fostering collaboration with other agencies. Project staff provided advice and support to epidemiologists from MOH, CUSS, OCEAC, ORSTOM, Centre Pasteur, the IMPM Kumba Research Station and the Nutrition Centre research station staff. For several years the project was the focal point of the Yaounde personal computer user club.

Collaboration with other institutions also took place: Dr. Brenner, from the Geneva School of Medicine's Department of Epidemiology and Tropical Medicine visited the project regularly. This school is collaborating with CUSS in the training of medical students at a field station in the NW Province and also in the modernization of data processing at CUSS.

Dr. C. Ripert, Professor of Parasitology at the University of Bordeaux II visited the project on April 7, 1988 to discuss progress made and problems encountered in the collaborative study of sensitivity and specificity of S. mansoni antigen in urine as a diagnostic tool. Dr. Vincendeau and Dr. Combe, Assistant Professors of Parasitologie at the University of Bordeaux II, visited the project in January 1987. They performed a schistosomiasis and malaria survey in the town of Edea with the collaboration of OCEAC. Their activities were coordinated with those of the project.

The project collaborated with SAVE THE CHILDREN regarding the inclusion of schistosomiasis in their primary health care policies. The project shared the knowledge acquired about schistosomiasis in Cameroon and how to best utilize it in view of controlling schistosomiasis. Support was provided to CARE regarding utilization of their computers and planning for evaluation of their health education-behavior modification program in the East Province.

In October 1989, Drs. Greer and Ratard went for consultation in Equatorial Guinea at the request of the Equato-guinean Center for Trypanosomiasis control (which also gets involved in schistosomiasis control). The main objective of the consultation was to determine the intermediate host of S. intercalatum in Bata. In March 1989 Dr. R. Ratard went to Moundou, Chad to participate in a consultancy from USAID VBC project whose objective was to evaluate the possibility of undertaking research on polyparasitism in this area.

The project was regularly represented at the Journées Médicales d' Afrique

Noire (held in Libreville one year, Abidjan the next) and at the meetings of the West African Society of Parasitologists by Pr. A. Same Ekobo, Professor of Parasitology at CUSS, consultant to the project.

1.8 INTERNATIONAL CONFERENCE

The original project agreement from 1983 called for two regional conferences to be hosted by the center. The first was to take place during the second year of the project, it was intended to "serve to familiarize African researchers from outside Cameroon with their facility, establish information exchange systems and review research protocols and methodologies". All parties concerned, IMPM, USAID and Tulane agreed that holding the first conference was inopportune considering the stage of project development at the second year. The project was housed in temporary quarters, the major equipments had not yet been received, the inter-regional research objectives had not received a high priority, most of the efforts from TAT were directed at fully developing the cameroonian components of the project. The second conference to be held during the final year of the project was two serve to review the results of studies and data analyses completed. IMPM indicated a strong interest in holding this second conference. The IMPM Directorate was formally given permission by the Government of Cameroon, to hold the seminar in Yaounde from February 26 to March 1, 1990. The Tulane and IMPM researchers were collaborating to prepare for this conference. The financial input from the contract has been limited by restrictions written into the USAID-Tulane contract, which reads "the regional conferences will be funded outside of this contract". A tentative schedule was prepared. IMPM printed the prospectus and send out the invitations. In late 1989 due to a lack of funds from the Government and the inability to raise sufficient monies from outside sources, the conference had to be canceled. However members of the Nigerian and Angolan delegations who had not received their cancellations notice did come. They were given an informal tour of the facilities and held discussions with all researchers present.

1.9.INSTITUTIONAL DEVELOPMENT

Given the difficult economic situation in Cameroon, the Government had to review the performance of all para-public institutions. A team of experts visited IMPM from June 18 to 23, 1989 and July 12 to 19, 1989. They looked at the following aspects: organization of the Institute, utilization of personnel, recruitment practices, applicability of research done, dissemination of information, management practices, performances. The recommendations made were under study by the government and IMPM. In this context it was very difficult for Tulane to implement recommendations regarding institutional development made by the USAID evaluation team in late 1988.

2. SCIENTIFIC OBJECTIVES

For the scientific community in Cameroon the project was identified as the Schistosomiasis Research Project. The scientific objectives were the following:

1.EPIDEMIOLOGIC STUDIES

1.1. SURVEILLANCE SYSTEM
1.1.1.Compilation of information from national system of disease reporting: all schistosomiasis and related clinical diagnosis.
1.1.2.Review of a sample of health units to evaluate the morbidity in relation to the population served by these units.
1.1.3.Review,plan and implement a laboratory surveillance and quality control system.
1.1.4.Establish a literature surveillance system to identify all publications about schistosomiasis in Cameroon and related topics.

1.2.PRIMARY SCHOOL SURVEY: Survey of a clustered stratified sample of school-children nationwide. Survey children not attending school wherever necessary.

1.3.LONGITUDINAL COMMUNITY STUDIES:In 10 communities of 500 to 1000 selected for their scientific interest, accessibility, stability and cooperation.
1.3.1.Census of the population
1.3.2.Prevalence,incidence and intensity of infection.
1.3.3.Case control studies of infections classified from 0 to +++
1.3.4.Quarterly snail studies: density, infection rate, cercaria output, population dynamics.
1.3.5.Quarterly water contact studies: direct observation, questions, assessment of beliefs and attitudes.
1.3.6.Domestic and feral animal studies.

1.4.MORBIDITY STUDIES
1.4.1.Hospital based morbidity studies.
1.4.2.Community based morbidity studies: cross sectional evaluation of population

1.5.URBAN SCHISTOSOMIASIS: Prevalence, incidence, intensity of infection, snail inventory, density, infection rate, cercarial output and population dynamics.

2. MALACOLOGIC STUDIES
2.1.INVENTORY AND GEOGRAPHICAL DISTRIBUTION OF INTERMEDIATE HOSTS
2.2.HABITAT INVENTORY:Ecological requirements of intermediate hosts.
2.3.POPULATION DYNAMICS:Seasonal fluctuation of snail densities, infection rate, cercarial output

3.EXPERIMENTAL PONDS
3.1.MOLLUSCICIDE STUDIES:Effectiveness of chemical molluscicides, most effective dispersion method for slow release of molluscicide (Cu, Niclosamide, TBTO) susceptibility of snails,environmental effects.
3.2.MOLLUSCICIDE PLANT STUDIES
3.3.BIOLOGICAL CONTROL EXPERIMENTS: Thiara & Helisoma spp., malacophagous fishes, herbivorous fishes, echinostoma.

4.CONTROL STUDIES IN WATER RESOURCE DEVELOPMENT AREAS
4.1.INVENTORY OF FEASIBLE ENVIRONMENTAL INTERVENTION STRATEGIES: Screening of methods that could be feasible
4.2.STUDY OF FEASIBLE CONTROL METHODS: Rotation fish rice, use of ducks, malacophagous fishes, periodic draining, weed control, snail predators, competing trematodes, molluscicides, water contact prevention, relocation of water bodies, modification of water flow.

5.PARASITOLOGY LABORATORY
5.1.IDENTIFICATION AND QUANTIFICATION of eggs for diagnosis.
5.2.SELECTION OF APPROPRIATE TECHNIQUE
5.3.QUALITY CONTROL SYSTEM
5.4.TAXONOMY REFERENCE
5.5.TRAINING OF FIELD PERSONNEL

6.MALACOLOGY LABORATORY
6.1.MAINTENANCE AND BREEDING of snails.
6.2.IDENTIFICATION AND QUANTIFICATION OF FIELD SAMPLES
6.3.QUALITY CONTROL of malacologic surveillance activities
6.4.TAXONOMIC STUDIES: morphologic, genetic and immunologic
6.5.SUSCEPTIBILITY TO INFECTION
6.6.TRAINING OF FIELD PERSONNEL

7.WATER CHEMISTRY LABORATORY: Identification of physical and chemical conditions suitable for intermediate hosts and schistosomes

2.1.EPIDEMIOLOGIC STUDIES

Basic information on the population of Cameroon was necessary to prepare surveys, calculate prevalence and incidence rates. The main source of information was the census of 1976.

2.1.1.COMPILATION OF INFORMATION FROM SYSTEM OF DISEASE REPORTING.

A close collaboration developed between the TAT and the Service d' Epidémiologie et du Paludisme (SEP) in charge of schistosomiasis related activities. Mr. Sylvester Atanga Ndeso and Mrs. Deborah Abgor-Tabi were taking an active part in these activities. Schistosomiasis is reported on a monthly basis on the "Fiche mensuelle épidémiologique" submitted by each divisional preventive medicine service. These reports come to the statistical unit attached to SEP and are manually compiled there. The reporting is at times irregular, some divisions do not submit reports and have to be prodded or they submit reports with significant delays. The Service des Statistiques Démographiques et Sanitaires (SSDS), a section of the Ministry of Health compiles the health related statistics in an annual "Rapport statistique d' activité des Services de Santé Publique". The last one available is from 1979. This report lists urinary and intestinal schistosomiasis by division for the entire year. An age-sex distribution table and a monthly table are presented. These tables were used to prepare a table and a map of schistosomiasis reported case rates. The SEP statistical unit has also collected data on reported cases from 1982 to 1989.

Based on the number of cases reported by each division from the years 1977 to 1979 and 1984-85 rates have been calculated for each division (see Tables PCD 1 and 2) and have been used to prepare some maps of "Schistosomiasis reported rates". These are not incidence rates since only a small proportion of the new cases go to health facilities where they are diagnosed. However such reported rates provide some useful information on the disease distribution and the use of health facilities by schistosomiasis cases.

2.1.2. COMPILATION OF INFORMATION ON SCHISTOSOMIASIS IN CAMEROON.

A computerized bibliographical index on schistosomiasis in general and more particularly about Cameroon was prepared. The program written in Dbase allows to find authors, topics and keywords. There were 1000 references on schistosomiasis and 96 references on tropical diseases in Cameroon. A copy of some 500 articles on schistosomiasis and 22 articles on schistosomiasis in Cameroon were stored in a reprint file.

A PAST SURVEY SUMMARY file was prepared. For each survey done in Cameroon there was the following information: focus name, division, province, author, reference, type of schistosome, time of the survey, physical information on the location of the survey, weather and rainfall in the area, methods used, prevalence, incidence, intensity of infection, immunologic studies, morbidity studies, man-water contact studies, malacologic studies. This file summarized 36 surveys.

Table PCD 1 : Intestinal schistosomiasis in Cameroon - Passive case detection rates

Province	Cases 1977	1978	1979	1980	1984	1985	Rates / 100 000 1977	1978	1979	1980	1984	1985	Average rate 1984-85
Logone-chari	0	34	42	57	61	49	0.0	21.0	25.6	32.4	33.5	26.1	29.8
Margui-Wandala	2448	945	1181	169	0	0	520.4	198.4	244.9	36.4			0.0
Mayo-Sawa	0	0	0	0	640	507					321.6	247.1	284.4
Mayo-Tsanaga	0	0	0	0	2139	1713					565.9	439.4	502.6
Diamare	409	90	571	639	571	1061	86.1	18.7	116.9	121.7	163.1	294.0	228.6
Kaele	0	0	0	0	117	8					50.6	3.4	27.0
Mayo-Danay	194	536	269	154	106	31	79.6	216.8	107.3	57.2	38.0	10.8	24.4
Extreme-North	3051	1605	2063	1019	3634	3369	226.2	117.4	148.9	71.0	224.5	201.8	213.2
Mayo-Louti	0	0	0	0	524	2030					251.9	956.7	604.3
Benoue	4078	2994	2773	3404	0	0	897.5	650.1	594.0	678.7	0.0	0.0	0.0
Faro	0	0	0	0	331	511					509.2	762.3	635.7
Mayo-Rey	0	0	0	0	0	203					0.0	234.2	117.1
North	4078	2994	2773	3404	855	2744	897.5	650.1	594.0	678.7	92.1	287.5	189.8
Faro-Deo	0	0	0	0	25	179					67.6	469.3	268.4
Vina	0	0	0	0	2	0					1.6	0.0	0.8
Mbere	0	0	0	0	21	566					18.9	495.0	256.9
Mayo-Banyo	0	0	0	0	235	158					276.5	180.2	228.3
Djerem	0	0	0	0	0	22					0.0	53.5	26.7
Adamaoua	1475	1714	1345	993	283	925	406.2	468.0	364.1	246.6	70.8	224.4	147.6
Menchum	2	0	0	5	0	0	1.0	0.0	0.0	2.3	0.0	0.0	0.0
Donga-Mantung	390	104	0	0	1	0	208.9	55.1	0.0	0.0	0.5	0.0	0.2
Momo	0	0	0	0	5	13	0.0	0.0	0.0	0.0	3.4	8.7	6.1
Mezam	118	401	4	0	2	4	36.5	122.6	1.2	0.0	0.5	1.1	0.8
Bui	0	7	0	0	0	0	0.0	4.5	0.0	0.0	0.0	0.0	0.0
North-West	510	512	4	5	8	17	51.4	51.0	0.4	0.5	0.7	1.5	1.1
Manyu	589	121	122	0	0	0	354.8	71.6	71.0	0.0	0.0	0.0	0.0
Ndian	180	0	0	0	0	0	222.9	0.0	0.0	0.0	0.0	0.0	0.0
Meme	484	39	0	0	3	73	226.4	17.9	0.0	0.0	1.2	27.9	14.6
Fako	6	7	91	110	0	0	3.5	4.0	51.4	57.4	0.0	0.0	0.0
South-West	1259	167	213	110	3	73	199.3	26.0	32.6	15.5	0.4	9.5	4.9
Noun	33	10	18	19	44	233	15.3	4.5	8.0	7.8	16.9	86.0	51.5

Table PCD 1 : Intestinal schistosomiasis in Cameroon - Passive case detection rates (cont'd)

Province	Cases 1977	1978	1979	1980	1984	1985	Rates / 100 000 1977	1978	1979	1980	1984	1985	Average rate 1984-85
Bamboutos	5	578	4	17	1	1	3.0	334.7	2.3	8.9	0.5	0.5	0.5
Menoua	0	0	0	132	5	4	0.0	0.0	0.0	53.1	1.9	1.5	1.7
Mifi	2	4	52	13	7	2	0.8	1.5	18.9	4.3	2.2	0.6	1.4
Haut-Nkam	11	12	1	0	6	9	9.7	10.3	0.8	0.0	4.4	6.3	5.3
Nde	0	6	5	16	10	11	0.0	7.9	6.5	18.9	11.1	11.7	11.4
West	51	610	80	197	73	260	4.8	56.0	7.1	16.4	5.7	19.6	12.7
Mungo	51	495	172	165	124	60	16.8	157.7	53.1	45.5	30.8	14.1	22.5
Nkam	5	4	22	8	34	0	13.2	10.2	54.6	17.7	68.0	0.0	34.0
Wouri	258	157	238	56	42	24	50.4	28.9	41.3	8.1	5.4	2.7	4.0
Sanaga Maritime	0	203	160	0	546	337	0.0	158.4	121.0	0.0	337.0	196.6	266.8
Littoral	314	859	592	229	746	421	32.1	83.9	55.2	18.4	53.4	27.5	40.4
Mbam	330	280	1310	0	552	656	183.6	152.3	696.3	0.0	250.9	285.6	268.3
Haute-Sanaga	15	15	10	10	19	20	24.2	23.5	15.2	14.3	25.3	25.6	25.4
Lekie	10	1	21	9	95	10	4.5	0.4	9.1	3.6	35.1	3.5	19.3
Mefou	2	0	0	0	1	1	1.5	0.0	0.0	0.0	0.5	0.6	0.6
Mfoundi	137	227	291	157	60	130	38.2	59.7	72.0	33.7	10.9	21.3	16.1
Nyong & Kelle	64	40	25	8	15	17	67.5	41.2	25.2	7.5	13.2	14.3	13.7
Nyong & Soo	269	213	650	74	0	80	316.3	245.0	731.4	76.1	0.0	73.7	36.8
Nyong & Mfoumou	1	5	53	23	0	1	1.3	6.1	63.6	25.3	0.0	1.0	0.5
Centre	828	781	2360	281	742	915	68.0	62.1	181.2	19.5	46.4	53.8	50.1
Ocean	4	0	0	0	0	2	5.5	0.0	0.0	0.0	0.0	2.1	1.1
Ntem	1	5	0	29	42	16	0.7	3.5	0.0	18.1	24.6	9.0	16.8
Dja & Lobo	12	0	6	1	0	0	11.7	0.0	5.5	0.9	0.0	0.0	0.0
South	17	5	6	30	42	18	5.4	1.5	1.8	8.3	10.7	4.4	7.5
Lom & Djerem	11	47	46	15	94	65	11.8	49.2	47.1	14.1	82.5	54.6	68.5
Kadey	13	0	0	0	23	73	13.5	0.0	0.0	0.0	19.3	58.7	39.0
Haut-Nyong	0	1	4	14	0	0	0.0	0.8	3.0	9.7	0.0	0.0	0.0
Boumba & Ngoko	9	3	6	0	0	0	15.6	5.1	10.0	0.0	0.0	0.0	0.0
East	33	51	56	29	117	138	8.8	13.3	14.3	6.8	25.4	28.7	27.1
Cameroon	11599	9293	9486	6267	6461	8862	156.3	122.3	122.0	74.1	67.7	88.7	78.2

TABLE PCD 2 : URINARY SCHISTOSOMIASIS IN CAMEROON - PASSIVE CASE DETECTION RATES

Province	CASES 1977	1978	1979	1980	1984	1985	RATES / 100 000 1977	1978	1979	1980	1984	1985	AVERAGE RATE 1984-85
Logone-Chari	0	252	243	259	147	615	0.0	155.7	148.1	147.2	80.8	328.0	204.4
Margui-Wandala	2275	1010	1549	103	0	0	483.6	212.1	321.2	22.2			0.0
Mayo-Sawa	0	0	0	0	977	1037					491.0	505.5	498.2
Mayo-Tsanaga	0	0	0	0	1634	2042					432.3	523.8	478.0
Diamare	2303	289	1790	2577	1152	2271	485.0	60.0	366.6	491.0	329.1	629.3	479.2
Kaele	0	0	0	0	424	62					183.5	26.0	104.8
Mayo-Danay	5911	5651	5068	2794	3108	1379	424.2	2286.0	2022.3	1037.6	1114.0	479.5	796.7
Extreme-North	10489	7202	8650	5733	7442	7406	777.7	526.9	624.4	399.6	459.7	443.7	451.7
Mayo-Louti	0	0	0	0	376	1068					180.8	503.3	342.1
Benoue	4017	23829	2911	3013	0	0	884.0	5173.8	623.6	600.7	0.0	0.0	0.0
Faro	0	0	0	0	120	91					184.6	135.7	160.2
Mayo-Rey	0	0	0	0	0	62					0.0	71.5	35.8
North	4017	23829	2911	3013	496	1221	884.0	5173.8	623.6	600.7	53.4	127.9	90.7
Faro-Deo	0	0	0	0	2	13					5.4	34.1	19.7
Vina	0	0	0	0	1	0					0.8	0.0	0.4
Mbere	0	0	0	0	1	2					0.9	1.7	1.3
Mayo-Banyo	0	0	0	0	15	98					17.5	111.8	64.7
Djerem	0	0	0	0	0	106					0.0	257.8	128.9
Adamaoua	143	208	180	159	19	219	39.4	56.8	48.7	39.5	4.8	53.1	28.9
Menchum	0	1	0	1	0	0	0.0	0.5	0.0	0.5	0.0	0.0	0.0
Donga-Mantung	0	62	0	0	3	0	0.0	32.8	0.0	0.0	1.4	0.0	0.7
Momo	0	0	0	0	11	6	0.0	0.0	0.0	0.0	7.6	4.0	5.8
Mezam	0	66	25	29	3	3	0.0	20.2	7.6	8.2	0.8	0.8	0.8
Bui	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
North-West	0	129	25	30	17	9	0.0	12.8	2.5	2.8	1.5	0.8	1.2
Manyu	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ndian	35	0	0	0	0	0	43.3	0.0	0.0	0.0	0.0	0.0	0.0
Meme	155	879	187	287	444	524	72.5	403.9	84.4	119.7	176.2	200.6	188.4
Fako	1	7	5	15	0	0	0.6	4.0	2.8	7.8	0.0	0.0	0.0
South-West	191	886	192	302	444	524	30.2	137.8	29.3	42.7	59.8	68.1	63.9

TABLE PCD 2 : URINARY SCHISTOSOMIASIS IN CAMEROON - PASSIVE CASE DETECTION RATES (cont'd)

Province	CASES 1977	1978	1979	1980	1984	1985	RATES / 100 000 1977	1978	1979	1980	1984	1985	AVERAGE RATE 1984-85
Noun	0	4	2	89	10	13	0.0	1.8	0.9	36.4	3.8	4.8	4.3
Bamboutos	1	0	3	4	6	2	0.6	0.0	1.7	2.1	2.9	0.9	1.9
Menoua	0	0	0	93	5	1	0.0	0.0	0.0	37.4	1.9	0.4	1.1
Mifi	44	41	247	63	30	0	16.6	15.2	89.7	21.0	9.4	0.0	4.7
Haut-Nkam	37	41	1	0	42	69	32.6	35.4	0.8	0.0	30.7	48.4	39.5
Nde	0	32	19	18	6	12	0.0	42.2	24.6	21.3	6.7	12.8	9.7
West	82	118	272	267	99	97	7.7	10.8	21.3	22.3	7.8	7.3	7.5
Mungo	754	774	717	478	616	492	247.9	246.6	221.3	131.9	153.2	115.4	134.3
Nkam	85	4	62	79	26	0	224.3	10.2	153.8	175.2	52.0	0.0	26.0
Wouri	57	76	88	8	23	18	11.1	14.0	15.3	1.2	2.9	2.0	2.5
Sanaga Maritime	1	155	81	0	238	42	0.8	121.0	61.3	0.0	146.9	24.5	85.7
Littoral	897	1009	948	565	903	552	91.7	98.5	88.3	45.3	64.6	36.1	50.3
Mbam	17	2	39	0	79	99	9.5	1.1	20.7	0.0	35.9	43.1	39.5
Haute-Sanaga	96	12	4	0	15	11	155.0	18.8	6.1	0.0	20.0	14.1	17.0
Lekie	27	0	2	199	20	4	12.2	0.0	0.9	78.6	7.4	1.4	4.4
Mefou	0	0	0	0	2	4	0.0	0.0	0.0	0.0	1.2	2.3	1.8
Mfoundi	100	42	71	139	11	3	27.9	11.0	17.6	29.8	2.0	1.3	1.7
Nyong & Kelle	7	4	11	18	13	5	7.4	4.1	11.1	16.8	11.4	4.2	7.8
Nyong & Soo	42	39	14	1	0	1	49.4	44.9	15.8	1.0	0.0	0.9	0.5
Nyong & Mfoumou	1	0	34	0	0	0	1.3	0.0	40.8	0.0	0.0	0.0	0.0
Centre	290	99	175	357	140	132	23.8	7.9	13.4	24.7	8.8	7.8	8.3
Ocean	2	0	0	0	4	0	2.7	0.0	0.0	0.0	4.4	0.0	2.2
Ntem	37	53	0	5	2	0	26.3	36.9	0.0	3.1	1.2	0.0	0.6
Dja & Lobo	121	46	58	70	0	0	117.5	43.3	52.8	60.2	0.0	0.0	0.0
South	160	99	58	75	6	0	50.6	30.5	17.4	20.8	1.5	0.0	0.8
Lom & Djerem	127	535	666	174	277	571	135.9	559.6	681.2	163.2	243.0	480.0	361.5
Kadey	1	1	0	0	30	128	1.0	1.0	0.0	0.0	25.2	102.9	64.0
Haut-Nyong	0	2	0	7	0	45	0.0	1.5	0.0	4.8	0.0	27.8	13.9
Boumba & Ngoko	0	1	3	0	0	0	0.0	1.7	5.0	0.0	0.0	0.0	0.0
East	128	539	669	181	307	744	34.2	140.7	170.7	42.2	66.7	154.8	110.8
Cameroon	16237	34019	14022	10607	9867	10904	218.8	447.8	180.3	125.5	103.4	109.1	106.3

2.1.3. PRIMARY SCHOOL SURVEY

Climatic Regions of Cameroon

The distribution of schistosomiasis is evaluated with regard to climatological as well as geographical and administrative divisions. Cameroon is bisected by two major climatic regions, which divide the country north/south at about 6° N latitude. The northern half falls in the Tropical Climatic Zone and the southern half in the Equatorial Climatic Zone.

The Tropical Zone includes the Extreme-North, North, and most of the Adamawa Province. It is characterized by a short rainy season of 4 to 6 months, followed by a long, rainless dry season. There are few permanent, natural water bodies in the region, but during and after the rainy season temporary ponds and mayos (streams) are numerous. The Tropical Zone is subdivided into two regions. The Sahara-type climate includes the Extreme-North and a small portion of the North Province. This region receives 500 to 900mm of rain annually. The Sudan-type climate includes most of the North and Adamawa provinces and receives between 900 to 1,500mm of rain annually.

The Equatorial Zone is characterized by abundant rainfall and, although there are dry periods, it rains every month of the year. Most water bodies are perennial, and even those that are considered to be temporary are dry for relatively brief periods. This zone is also subdivided into two regions. The Guinea-type climate, which includes the Centre, East, and South Provinces, has two rainy and two dry seasons. Rainfall ranges between 1,500 and 2,000mm of rain annually. The Cameroon-type climate includes the Littoral, West, Southwest, and Northwest provinces. This region, one of the wettest in the world, has one long rainy season of about 9 months followed by a brief dry period. The total annual rainfall varies from 2,000 to 10,000mm.

Sampling plan

We used a stratified, random-cluster sampling procedure with the 5th grade (primary school) as the basic sampling unit. In Cameroon, children in this grade level range from 10-19 years of age (mean 13). Previous surveys in Cameroon showed that this age group has a peak rate of infection and best reflects the degree of transmission in most communities.

Sampling units were selected from a complete list of the public and private elementary schools. Schools were selected at random with chances of being selected proportional to the school population. The sample size for each division was determined primarily by three factors: (1) the estimated prevalence determined on the basis of previous surveys or results from case reporting, (2) the precision of the rate deemed acceptable, and (3) the size of the general population obtained from the school census.

In the North and Extreme-North Provinces, school attendance rates, estimated from the last national census, are much lower than in the other provinces (35% versus 90 to 95% attended school). The survey methodology in these two provinces was modified and all children from the appropriate age group living in the community were invited to participate.

Specimen collection

After the necessary explanations to the school director, teachers, and pupils, the latter were registered and instructed to provide urine and stool specimens. Urine was collected in 50-ml plastic screw-cap tubes with conical bottoms, each pre-filled with 15 mg of sodium azide. In areas close to the main laboratory in Yaounde, no preservative was used. About 2 grams of feces were collected from each participant using 4ml plastic snap-cap tubes pre-filled with 5 mg of sodium azide. Fecal sample were mixed with an applicator stick. Pupils

received a two-page pamphlet describing schistosomiasis and methods of prevention. The pamphlet was designed as a cartoon with wording adapted to the grade level. Teachers received a more elaborate, 20 page pamphlet about the disease, the treatment, the transmission cycle, and prevention strategies. This material was a key factor in fostering goodwill and obtaining participant cooperation.

Parasitologic examination

Sedimentation was used for the examination of urine. Preliminary studies carried out in the project showed that sedimentation was more sensitive than filtration. Urine and stool samples were transported to the central laboratory for examination. Urine egg counts were calculated on the basis of 10 ml of urine. Mean intensities of infection are reported as the geometric mean egg counts of infected individuals. Stool samples were examined by a thick smear technique, using a 43-mg Kato-Katz template. In order to verify results obtained by the Kato method, a subsample of 10% of the stools were fixed in 10% formol-saline and examined by the more sensitive modified Ritchie Technique.

For quality control 10% of the urine and stool examinations were repeated by a supervisor. In areas of low prevalence, all schistosomiasis positive slides were reexamined.

Children with confirmed schistosomiasis were treated with praziquantel, 40 mg/kg in a single oral dose.

Results of the school survey

The school attendance rate, estimated by the proportion of children examined over children listed in the school-master roster, was excellent, with 90 to 95% attendance found in schools where such data were collected. Very few children (less than 1%) were unable to produce a urine sample. There was no statistically significant difference between children attending school and those not attending.

The distribution of S.haematobium by province and division is presented in Table School Survey 1 and in Map 1. The distribution of S. mansoni and S. intercalatum is presented in Table School Survey 2. Map 2 shows the distribution of S.mansoni. The abbreviations given for divisions in Table 1 and 2 are also used in Figure 1 and 2.

Since schistosomiasis in Cameroon is focal in distribution, it is useful to show the distribution of prevalences within provinces (Tables School Survey 3 and 4).

TABLE SCHOOL SURVEY 1

Results of the survey by divisions and provinces

	Division PROVINCE	Children selected	Urine examined	S. haematobium number positi	preval -ence	eggs /10ml
SW	Mayo Sawa	533	515	157	30.5	23
KA	Kaele	581	580	293	50.5	54
TS	Mayo Tsanaga	583	579	262	45.3	40
DI	Diamare	680	674	192	28.5	40
LC	Logone Chari	637	634	83	13.1	27
DN	Mayo Danay	725	724	317	43.8	36
	EXT. NORTH	**3739**	**3706**	**1304**	**35.2**	**39**
BE	Benoue	608	607	196	32.3	28
FA	Faro	205	205	39	19.0	8
LU	Mayo Louti	488	484	135	27.9	21
RY	Mayo Rey	536	534	124	23.2	19
	NORTH	**1837**	**1830**	**494**	**27.0**	**22**
VI	Vina	540	520	14	2.7	19
BO	Mayo Banyo	345	292	2	0.7	13
BR	Mbere	457	333	2	0.0	36
DJ	Djerem	308	233	4	1.7	25
FD	Faro Deo	323	231	6	2.6	17
	ADAMAOUA	**1973**	**1609**	**28**	**1.7**	**24**
MF	Mefou	691	325	1	0.3	3
LK	Lekie	1034	242	0	0.0	
NK	Nyong&Kelle	785	308	0	0.0	
NS	Nyong&Soo	563	224	0	0.0	
NF	Nyong&Mfoumou	335	306	0	0.0	
HS	Haute Sanaga	340	268	5	1.9	64
MB	Mbam	1399	455	4	0.9	6
FU	Mfoundi	293	223	0	0.0	
	CENTRE	**5440**	**2351**	**10**	**0.4**	**28**
BN	Boumba&Ngoko	308	308	1	0.3	54
LD	Lom&Djerem	693	690	62	9.0	14
HN	Haut Nyong	448	446	16	3.6	34
KD	Kadey	525	522	18	3.4	41
	EST	**1974**	**1966**	**97**	**4.9**	**23**
DL	Dja & Lobo	412	412	3	0.7	7
OC	Ocean	274	258	0	0.0	
NT	Ntem	284	284	3	1.1	20
	SUD	**970**	**954**	**6**	**0.6**	**13**
MG	Moungo	657	653	99	15.2	33
WO	Wouri	571	569	6	1.1	21
KM	Nkam	277	277	1	0.4	30
SM	Sanaga Mar	1061	376	2	0.5	38
	LITTORAL	**2566**	**1875**	**108**	**5.8**	**32**
NU	Noun	668	668	5	0.7	11
BA	Bamboutos	317	317	1	0.3	1
MN	Menoua	224	224	2	0.9	2
MI	Mifi	613	607	1	0.2	42
HK	Haut Nkam	713	708	19	2.7	48
ND	Nde	264	264	0	0.0	
	OUEST	**2799**	**2788**	**28**	**1.0**	**36**
MC	Menchum	270	267	0	0.0	
NM	NdongaMantung	269	262	0	0.0	
MO	Momo	173	154	0	0.0	
MZ	Mezam	334	329	0	0.0	
BU	Bui	235	233	0	0.0	
	NORTH-WEST	**1281**	**1245**	**0**	**0.0**	
MY	Manyu	245	243	2	0.8	25
DI	Ndian	254	250	4	1.6	80
ME	Meme	385	374	14	3.7	12
FK	Fako	333	333	0	0.0	
	SOUTH-WEST	**1217**	**1200**	**20**	**1.7**	**30**
	TOTAL	**23796**	**19524**	**2095**	**10.7**	

TABLE SCHOOL SURVEY 2:

Results of survey by divisions and provinces

Division PROVINCE	Children selected	Stool exam ined	-- Mansoni -- posi tive	prev alce	eggs /gm	Terminal spine posi tive	prev alce	eggs /gm
SW Mayo Sawa	533	474	43	9.1	71	5	1.1	28
KA Kaele	581	554	50	9.0	101	7	1.3	38
TS Mayo Tsanaga	583	557	150	26.9	91	15	2.7	24
DI Diamare	680	615	28	4.6	63	7	1.1	37
LC Logone Chari	637	579	9	1.6	55	4	0.7	109
DN Mayo Danay	725	698	30	4.3	63	8	1.1	38
EXTREME NORTH	**3739**	**3477**	**310**	**8.9**	**83**	**46**	**1.3**	**38**
BE Benoue	608	544	85	15.6	95	5	0.9	30
FA Faro	205	198	120	60.6	246	4	2.0	24
LU Mayo Louti	488	469	205	43.7	134	2	0.4	34
RY Mayo Rey	536	511	203	39.7	262	14	2.7	37
NORTH	**1837**	**1722**	**613**	**35.6**	**224**	**25**	**1.5**	**33**
VI Vina	540	513	83	16.2	104	1	0.2	24
BO Mayo Banyo	345	321	77	24.0	200	1	0.3	24
BR Mbere	457	440	77	0.0	107	1	0.0	72
DJ Djerem	308	280	9	3.2	63	0	0.0	
FD Faro Deo	323	303	123	40.6	308	2	0.7	24
ADAMAOUA	**1973**	**1857**	**369**	**19.9**	**191**	**5**	**0.3**	**34**
MF Mefou	691	683	30	4.4	125	4	0.6	27
LK Lekie	1034	1029	9	0.9	115	2	0.2	59
NK Nyong & Kelle	785	770	3	0.4	244	28	3.6	120
NS Nyong & Soo	563	561	6	1.1	105	11	2.0	165
NF Nyong & Mfoumou	335	328	5	1.5	130	1	0.3	672
HS Haute Sanaga	340	335	5	1.5	80	1	0.3	264
MB Mbam	1399	1374	226	16.4	144	4	0.3	293
FU Mfoundi	293	280	4	1.4	105	1	0.4	120
CENTRE	**5440**	**5360**	**288**	**5.4**	**152**	**52**	**1.0**	**32**
BN Boumba & Ngoko	308	282	2	0.7	152	0	0.0	
LD Lom & Djerem	693	622	5	0.8	127	3	0.5	94
HN Haut Nyong	448	408	1	0.2	72	1	0.2	24
KD Kadey	525	450	5	1.1	115	1	0.2	216
EST	**1974**	**1762**	**13**	**0.7**	**122**	**5**	**0.3**	**104**
DL Dja & Lobo	412	364	4	1.1	46	3	0.8	24
OC Ocean	274	239	1	0.4	312	2	0.8	186
NT Ntem	284	271	0	0.0		4	1.5	70
SUD	**970**	**874**	**5**	**0.6**	**99**	**9**	**1.0**	**80**
MG Moungo	657	620	1	0.2	456	14	2.3	50
WO Wouri	571	475	4	0.8	103	13	2.7	65
KM Nkam	277	246	1	0.4	96	2	0.8	34
SM Sanaga Maritime	1061	1048	6	0.6	82	75	7.2	157
LITTORAL	**2566**	**2389**	**12**	**0.5**	**121**	**104**	**4.4**	**129**
NU Noun	668	556	21	3.8	87	0	0.0	
BA Bamboutos	317	292	0	0.0		0	0.0	
MN Menoua	224	213	0	0.0		0	0.0	
MI Mifi	613	566	3	0.5	35	1	0.2	72
HK Haut Nkam	713	615	0	0.0		0	0.0	
ND Nde	264	238	8	3.4	39	0	0.0	
OUEST	**2799**	**2480**	**32**	**1.3**	**70**	**1**	**.0**	**72**
MC Menchum	270	256	17	7.0	71	1	0.4	24
NM Ndonga Mantung	269	241	1	0	96	0	0.0	
MO Momo	173	164	0	0		0	0.0	
MZ Mezam	334	317	0	0		0	0.0	
BU Bui	235	207	0	0		0	0.0	
NORTH-WEST	**1281**	**1185**	**18**	**1.5**	**72**	**1**	**0.1**	**24**
MY Manyu	245	232	0	0.0		0	0.0	
DI Ndian	254	218	0	0.0		3	1.4	44
ME Meme	385	341	3	0.9	35	3	0.9	55
FK Fako	333	269	0	0.0		0	0.0	
SOUTH-WEST	**1217**	**1060**	**3**	**0.3**	**35**	**6**	**0.6**	**50**
TOTAL	**23796**	**22166**	**1663**	**7.5**		**254**	**1.1**	

TABLE SCHOOL SURVEY 3:
Frequency distributions of prevalences of S.haematobium infections by provinces

Provinces	Number of schools with a prevalence of <1%	1-4%	5-19%	20-49%	>50%	Total number
Extreme North	5	4	13	28	20	70
North	3	3	12	12	7	37
Adamaoua	28	13	2	0	0	43
Centre	118	5	1	0	0	124
Est	34	10	9	2	0	55
Sud	26	3	1	0	0	30
Littoral	39	8	2	0	2	51
Sud ouest	21	6	2	0	0	29
Nord ouest	22	0	0	0	0	22
Ouest	39	9	2	1	0	51
Cameroon	332	61	44	43	32	512

TABLE SCHOOL SURVEY 4:
Frequency distributions of prevalences of S.mansoni infections by provinces

Provinces	Number of schools with a prevalence of <1%	1-4%	5-19%	20-49%	>50%	Total number
Extreme North	46	11	8	4	1	70
North	1	2	11	10	13	37
Adamaoua	7	9	14	9	4	43
Centre	83	21	15	3	2	124
Est	42	10	1	0	2	55
Sud	27	3	0	0	0	30
Littoral	43	8	0	0	0	51
Sud ouest	27	1	1	0	0	29
Nord ouest	20	1	0	1	0	22
Ouest	41	6	4	0	0	51
Cameroon	337	72	54	27	22	512

S. haematobium: prevalence and intensity

Urinary schistosomiasis is a serious public health problem throughout the Extreme-North and North provinces.

The Extreme-North Province, which has only 15% of the total population, has 60% of all urinary schistosomiasis cases. Most of that province has a Sahara-type climate and surface water is often in the form of temporary ponds that are present during, and for several months following, the rainy season. While transmission in these areas is limited in time, it is sufficiently intense to achieve egg output levels often higher than those found in areas with perennial surface waters.

Except for the Logone & Chari division, endemic levels of urinary schistosomiasis in the Extreme-North were the highest in the country. In the Logone & Chari the overall average prevalence was 13% with individual village rates ranging from 0-38%. The rest of the Extreme-North prevalence rates ranged from 28% to 50%, and the disease was more uniformly distributed. In Kaele Division the prevalence in all villages was greater than 25%, with children in two villages having rates of greater than 85%. In Gazawa Bizili, the most heavily infected village in our study, the prevalence among school children was 92.5%.

Mean intensity of infection in the Extreme-North, 39 eggs/10ml, was the highest in the country. Overall, 21% of the children had between 100 to 499 eggs/10 ml and 8.5% had greater than 500 eggs/10 ml. Gazawa Bizili had the highest intensity for a village with a mean of 349 eggs/10ml.

The low prevalence found in the Logone & Chari is probably due to the more severe climate of that region. Located on the flat Chad Basin, that division has a true Sahelian climate and receives only about 500mm of rain annually during a brief 3 month rainy season. In addition, the sandy soils found there retain water poorly, further contributing to the ephemeral nature of temporary water bodies. The only snail host there is Bulinus senegalensis.

In the other divisions in the Extreme-North surface waters are present for longer periods. Not only do they receive more rain but because the soils have greater clay content and are less porous. These more hospitable habitats have more diverse snail faunas including another important S.haematobium host, B. globosus.

Other than the Logone River, which forms the border with Chad in the east, the only permanent water bodies in the Extreme-North are man-made. These include lakes and reservoirs in the Mayo Tsanaga and Mayo Sawa divisions, close to the Nigerian border, and irrigation channels and ponds in the rice development scheme, mostly in the Mayo Danay division close to the Chadian border. In these habitats the most common intermediate host is Bulinus truncatus.

Prevalence rates and mean intensities of infection in the North Province were generally lower than in the Extreme-North. Average prevalence rates among divisions of this province ranged from 19-32%, and the range of prevalence among individual villages, 0-90%, was wider than in the Extreme-North. Even though very high endemic levels were attained in some villages, the proportion having prevalence rates from 20-49% and of those over 50% was lower than in the Extreme-North.

The mean intensity of infection in the North province was 32 eggs/10ml.

Besides the Benoue River, which is the main watershed system, large retention dams are the only permanent water bodies in the North Province. As in the Extreme-North, temporary water bodies are ubiquitous during and for several months following the rainy season. The intermediate hosts most commonly found were B. globosus and B. senegalensis, in temporary habitats and B. truncatus in

perennial habitats.

The Adamawa Plateau, which encompasses most of the Adamawa Province, has a mountain variant of the Sudan-type climate. There are numerous streams in the region and most surface waters are perennial. Transmission of S. haematobium in the Adamawa was low. Mean prevalence for all divisions was below 5% and for two of the five it was below 1%.

The Adamawa Plateau marks the southern limit of distribution of hyper-endemic schistosomiasis. Yet the large amount of migration between the Adamawa Province and the other two northern provinces, and the similarities in cultures and religion, suggest that levels of schistosomiasis transmission could become established if ecological conditions are, or become, favorable. The most commonly found intermediate host in that province was Bulinus truncatus.

Within the Guinea-type climate, which covers the Centre, East, and South provinces, the average prevalence rates by division were low. For all but one division the mean prevalence was below 5% and for the majority it was below 1%. These low rates suggest that most cases were imported. Schistosomiasis appeared to be restricted to very few foci in the East Province: Bertoua, Lom & Djerem Division with a prevalence rate of 43% and Gotto, Kadey Division with 24%.

Surface waters, comprised of small streams, rivers, and ponds, are numerous under the Guinea-type climate. Although both B. truncatus and B. globosus were found in this region, they were very scarce, which may account for the low prevalence of urinary schistosomiasis.

The Cameroon-type climate covers the Littoral, West, Southwest, and Northwest provinces. Isolated foci of high prevalence of schistosomiasis haematobium were found in all but the Northwest province. Endemic villages include Loum (53%) and Penja (56%) in Mungo Division, Littoral Province, Kumba (14%) and Barombi Kotto (16%) in Meme Division, Southwest Province, and Kekem (35%) in Haut Nkam Division, West Province.

B. truncatus is the principal host in the Cameroon-type climate. Bulinus camerunensis participates in transmission, along with B. truncatus, at the crater lake Barombi Kotto where, in spite of near elimination by chemotherapy and mollusciciding in the mid-1970's, transmission is presently very active. The absence of earlier reports of urinary schistosomiasis suggest that the focus at Kumba is of relatively recent origin. B. truncatus serves as the intermediate host there.

S. mansoni: prevalence and intensity

Schistosomiasis mansoni is widespread in the Tropical Zone of Cameroon. In the Extreme-North, the Mayo Tsanaga Division had an overall prevalence of 26%, and 9 of 11 villages had prevalences greater than 20%. The village of Moskota, with a prevalence of 64% and average intensity of infection of 144 eggs/g, was one of the most heavily infected villages in Cameroon. In the Mayo Sawa and Kaele divisions, prevalences were lower, about 9%, and in the remaining divisions, Diamare, Mayo Danay, and Logone & Chari, foci were few and isolated. Prevalence rates for these divisions ranged from 1.6% in the Logone & Chari to 4.6% in the Diamare. Mean intensities of infection were also relatively low, ranging from 55-63 eggs/g.

In the North Province, S. mansoni reaches its highest level of endemicity in terms of both prevalence and intensity. Mean prevalence rates were 16% in the Benoue Division, 43% in Mayo Louti, 40% in Mayo Rey, and 60% in Faro. One-third of the villages in the province had prevalence rates of over 50% and another third had prevalences between 20-49%. Of the schools and communities visited, few had rates below 4%. Intensities of infection were relatively high; one-fourth of the villages had mean intensities above 500 eggs/g. In Tchollire (Mayo

Rey Division) the mean egg count reached 2650 eggs/g for the 17 infected children.

In the Adamawa Province, Faro & Deo Division, which is adjacent to the Faro Division, had a mean prevalence of 40%. The Vina and Mayo Banyo divisions showed lower prevalence rates of 16% and 24%, respectively. The other divisions had very low prevalence rates, 3% in Mbere and 0% in Djerem.

In the Guinea-type climate of the Equatorial Zone, which includes the provinces of Centre, East, and South, the distribution is very focalized. In the Centre Province, 84% of the sites surveyed had less than 5% prevalence. These low prevalences very often are due to the presence of a few imported cases. Highly endemic foci are rare. Of the 124 sites surveyed in these provinces, only 2 (Gah Bape and Makenene) had prevalences higher than 50% and 3 (Bafia, Bokito, and Ndikinimeki) had prevalences in the range of 20-49%. These five sites were all in the Mbam Division. In other confirmed foci the endemic levels were relatively low, with prevalences ranging from 5-19% and the intensities of infection about 100 eggs/g. The village of Makenene, Mbam Division, had the highest prevalence recorded in the Equatorial Zone, with 82% prevalence rate and a mean egg count of 262 eggs/g.

In the East Province the only focus of S.mansoni identified was at Bertoua, where the prevalence rate was 2%. This town had an intense focus of urinary schistosomiasis. No foci of intestinal schistosomiasis were found in the South Province.

In the Cameroon-type climate, which includes the Littoral, West, Northwest, and Southwest provinces, S. mansoni was rarely found, except for a few isolated foci, notably the villages of Malantouen, Noun Division, West Province and Weh, Menchum Division, Northwest Province.

Thus, high endemicity for schistosomiasis mansoni was observed mostly in the North and Adamawa provinces with extensions northward into Mayo Tsanaga Division in Extreme-North Province and southward into Mbam Division in the Centre Province. In the North and Adamawa Provinces, S. mansoni was widely distributed, with endemicity showing no correlation with the occurrence of permanent surface water. The same high endemic levels were reached in villages where the only surface water were temporary ponds as in villages bordering permanent lakes. Biomphalaria pfeifferi occurs throughout the S. mansoni endemic regions and was the only host found in the Tropical Zone.

In the Equatorial Zone of Cameroon the distribution of S. mansoni is restricted to isolated foci, usually in savannah regions that border the Tropical Zone, such as Mbam Division. In the forest regions B. pfeifferi is replaced by B. camerunensis, a species that appears to be a relatively poor host for S. mansoni. This may account for the near absence of S. mansoni from large portions of the Equatorial Zone.

Schistosoma intercalatum: prevalence and intensity

Our results show the presence of terminal-spined eggs at several localities in the tropical region, however, prevalences were low, generally below 2%, and exceeded 5% in a only few isolated locations. There was a strong association between the occurrence of S. haematobium eggs in the urine and the terminal-spined eggs in the stools in this region, indicating that the terminal-spined eggs in stools were probably those of S. haematobium. Unfortunately, because of the heavy workload of the school survey, it was not possible at the time to examine those eggs more thoroughly.

In the Equatorial Zone of Cameroon prevalence rates of 2% or greater for S. intercalatum were found in only 2 divisions of the Centre Province and 3 divisions of the Littoral Province. In those divisions infection was present at

only 18 (22%) of 83 schools. Most foci were villages situated in densely forested areas, but also included three towns - Eseka, Edea, and Loum. Except for Edea, all foci had low prevalence rates, below 10%, and low mean intensities of infection, ranging from 20 to 50 eggs/g. At Edea the prevalence was 52% with a mean egg count of 250 eggs/g. The levels of endemicity normally seen for S. intercalatum are low in comparison with those of S. mansoni and S. haematobium.

Assumptions on the geographical distribution of schistosomiasis in Cameroon have been based on reports from numerous foci throughout the country. Our results indicate that some of those assumptions were not strictly correct. In the Sahelian region, human populations in close proximity to man-made, relatively permanent water have been selectively surveyed. The resulting impression was that was that "in Cameroon, the extent of the foci of schistosomiasis coincide fairly well with the development of hydro-agricultural projects" (Same Ekobo, 1984). For example, it was widely believed that the "largest foci of urinary schistosomiasis were in the Extreme-North . . . in the Mayo Danay and the Mandara Mountains . . . the other foci were in the Adamaoua" (Same Ekobo, 1984). The fact that the majority of the foci in the two northern provinces are dependent on small, temporary bodies of water had been completely overlooked. This is evident when a map from a recently prepared atlas for schistosomiasis, showing distribution of urinary schistosomiasis derived from pre-1985 studies [38], is compared with the present results.

S.haematobium and S.mansoni transmissions are most prevalent in the arid regions of Northern Cameroon with a short transmission season, dependent upon small temporary natural water sites. This offer opportunities to develop simple control approaches.

2.1.4.LONGITUDINAL STUDIES

KINDIG NJABI

Kinding Njabi is located in the Mbam Division, Ndikinimeki Subdivision, at 10 km from Makenene, which is a major stop along the paved road from Yaounde to Bafoussam. The area consists of lightly forested, gently rolling hills. The main dry season is from December to February. Rains start in March, peak in May, decrease to hit a low in July, and increase to a secondary peak in October. The town lies some 5 km from the main road, and consists of several houses distributed around its one street. A map and census of the village were done on September 23, 1986.

Table LCS/KIN 1 - Longitudinal study of Kinding Njabi

Population structure by age and sex

	Males #	Males %	CAM %
0- 4	23	6.7	8.7
5- 9	27	7.8	7.6
10-14	30	8.7	5.9
15-19	17	4.9	4.7
20-44	34	9.9	14.3
>45	35	10.1	7.8
TOTAL	166	48.1	49.0

	Females #	Females %	CAM %
0- 4	21	6.1	8.5
5- 9	30	8.7	7.5
10-14	25	7.2	5.3
15-19	12	3.5	5.0
20-44	48	13.9	16.9
>45	43	12.5	7.9
TOTAL	179	51.9	51.1

	Total #	Total %	CAM %
0- 4	44	12.8	17.2
5- 9	57	16.5	15.1
10-14	55	15.9	11.2
15-19	29	8.4	9.7
20-44	82	23.8	31.19
>45	78	22.6	15.7
TOTAL	345	100.0	100.0

Comparison between Kinding and Cameroon population structures
1 X represents 1%

Males	Age	Females
Percent each group in Kinding		
XXXXXXXXXX	>44	XXXXXXXXXXXX
XX	40-44	XX
XX	35-39	XX
XX	30-34	XXX
XX	25-29	XXX
XX	20-24	XXXX
XXXXX	15-19	XXX
XXXXXXXXX	10-14	XXXXXXX
XXXXXXX	5- 9	XXXXXXXXX
XXXXXXX	0- 4	XXXXXX
Percent each group in Cameroon		
XXXXXXXX	>44	XXXXXXXX
XXX	40-44	XX
XXX	35-39	XX
XXX	30-34	XXXX
XXX	25-29	XXXX
XXX	20-24	XXXXX
XXXXX	15-19	XXXXX
XXXXXX	10-14	XXXXX
XXXXXXXX	5- 9	XXXXXXXX
XXXXXXXXXX	0- 4	XXXXXXXXX

Households

Total number of households	93	
Average size	3.71	
No in house	Number	Percent
1	29	31.2
2	11	11.8
3 to 4	22	23.7
5 to 9	28	30.1
over 10	3	3.2

Headed by	Number	Percent
Male	67	72.0
Female	26	28.0
Age 20-44	42	45.2
Age over 44	51	54.8

Household with		
single spouse	37	39.8
2 spouses	5	5.4
over 2 spouses	1	1.1

Relation to head of house		
Head	93	27.0
Children	141	40.9
Gd children	35	10.1
Parents	1	0.3
Siblings	7	2.0
Friends	6	1.7
Other	62	18.0

Occupation

	Number	Percent
Farmers	108	31.3
Homemakers	56	16.2
Students	120	34.8
Teachers	4	1.2
Other	57	16.5

Residence history

Resident since	Number	Percent
Birth		
over 5 yrs	182	52.8
1 to 5 yrs	32	9.3
< 1 yr	2	0.6
No info	129	37.4

Building

	Number	Average /Hsehold
Structures	156	1.7
Living areas	96	1.0
Kitchens	51	0.5
Others	9	0.1

	Number	Percent
POOR:Dirt floor,mud wall,thatch roof	9	12.9
STD: Dirt floor, brick wall	55	78.6
GOOD:Cement floor, brick wall,tin roof	6	9.8

	Number	Percent
With latrines	48	57.1
Without latrines	36	42.9

POPULATION: Details on the village population are presented in Table LCS/KIN 1. A total of 345 persons live in the village. Their age distribution is different from that of Cameroon as a whole: for both sexes, there is a clear deficit of individuals from 20 to 44 years old, and an excess of persons over 44 years of age. Apparently, numerous young adults have left the village to find work elsewhere. Often, grandchildren are left in the village with their grandparents. The village has 93 households, with an average of 3.71 individuals per household. The households are relatively small: 31% are single-occupant, and 65% have less than 5 persons. A sizable minority of households, 28%, are headed by women. More than half of the household heads are older than 44. The majority of the population is native to Kinding Njabi and has resided there for more than 5 years. Among the married persons monogamy is the rule; 37 out of 42 marriages are monogamous.

OCCUPATION: The main occupations in the village are cash-crop (cocoa, coffee) farming, subsistence farming, and homemaking. Farmers, homemakers and students make up 82% of the population. Domestic activities are usually carried out by women and children, while cash-crop farming is performed by men. Farming is done in the fields surrounding the village, with most of extensive plantations a few kilometers away from the village on adjacent hills.

BUILDINGS, STRUCTURES: There are 156 structures, an average of 1.7 per household. Besides living areas, the most common type of structure is the kitchen, which is used for cooking, washing, and other domestic activities. The floors are of dirt or cement; the walls are made of amalgamated wood and dry mud, mud bricks, or cement; roofs are constructed of thatch or corrugated iron (tin). Fabrication of mud bricks is done during the dry season. The most common type of house has a dirt floor, brick wall, and tin or thatch roof (79%). Poor housing consists of a dirt floor, mud wall and thatch roof (13%). Better houses have a cement floor, cement wall, and a tin roof (10%). Latrines exist in 57% of the households.

INITIAL SURVEY OF MAY 1986: The schistosomiasis focus of Kindig Njabi was surveyed on May 29. Results are presented in Table LCS/KIN 2 Kindig Njabi is probably a new focus of urinary schistosomiasis because the disease has never been previously reported in the area.

Table LCS/KIN 2 : Prevalence survey in Kindig Njabi

Age	--Urine examination---				----------Stool examination--------						
	Terminal spine eggs				Terminal spine eggs				S. mansoni		
Sex	Exam	Pos	Prev	/10ml	Exam	Pos	Prev	/g	Pos	Prev	/g
0- 4	23	1	4.3	116	12	0	0.0	---	0	0.0	---
5- 9	31	11	35.5	27	26	10	38.5	159	1	3.8	48
10-14	45	16	35.6	9	43	25	58.1	163	4	9.3	45
15-44	56	3	5.4	82	41	8	19.5	185	2	4.9	107
> 45	49	10	20.4	49	45	14	31.1	82	0	0.0	---
Male	106	18	17.0	25	82	25	30.5	129	4	4.9	45
Fem	98	23	23.5	22	85	32	37.6	149	3	3.5	82
Total	204	41	20.0	24	167	57	34.1	140	7	4.2	58

The prevalence rates of infection with "terminal spine eggs" were 20% in urine (41/201) and 34% in stools (57/167). Analysis of the laboratory results of the 166 persons that gave both stool and urine samples revealed a strong association between presence of eggs in stool and presence of eggs in urine.

Table LCS/KIN 3 : Association between eggs in urine and stool

Stool	Urines pos	neg	total
pos	28	29	57
neg	8	101	109
total	36	130	166

X^2=38.5, df=1, p< .001
Significant association at 0.05.

This association may be due to two reasons: (1) hybrid eggs colonize both the intestinal and urinary tract; or (2) children exposed to infection by one species are also likely to be more exposed to the other species, for behavioral reasons. Morphologically, these terminal spine eggs resemble S. haematobium eggs in stools and urine, with a few large eggs resembling S. intercalatum. Measurement of a small number of eggs showed that their average size is close to that of S. haematobium, but with a greater variability due to the presence of a small proportion of very large eggs.

Table LCS/KIN 4 Preliminary results of egg measurement in Kindig

	haematobium	intercalatum	kindig eggs
Mean length in u	144	180	142
Standard deviation	14	18	24
Proportion of eggs > 170 u	2.5		15
Coefficient of variation	9.7	10.0	16.9

Based on the preceding observations, the presence of hybridization between S. haematobium and intercalatum was strongly suspected. More studies are presently underway to determine if this is a real hybridization. Since the focus of Kindig Njabi is apparently newly developed, it was decided , for ethical reasons, to eradicate this focus before urinary schistosomiasis spreads to other areas. Treatment of all infected persons, directly supervised by a team member, was carried out with praziquantel at the dose of 40mg/kg on September 30 and October 14). A village meeting was convened on September 30 to conduct a health education presentation. Attendance at the meeting was excellent; over 150 persons participated.

TREATMENT OF INFECTED INDIVIDUALS IN JUNE 1986 : In June 1986, there were 72 persons infected with terminal spine eggs out of 332 persons surveyed. Of these, 68 were in the village (96%) and were treated with a 40mg/kg single dose of praziquantel on September 30, 1986. 54 of these treated individuals were examined again on November 20, 1986. 46 no longer had schistosomiasis; i.e., a cure rate of 85%.

FOLLOW UP SURVEY AT 1 YEAR, JUNE 1987 : A comparison between the 1986 and 1987 surveys is presented in table LCS/KIN 5. Since the age composition of the successive samples is different, age-specific prevalence rates and intensities of infection were compared. The age group with the highest rates, 5-14 years of age, war chosen for these comparisons.

For terminal-spine eggs, the prevalence rates fell from 33% to 5% for eggs in urine, and from 40% to 1% for eggs in stool. The intensities of infection for infected individuals fell from 29 to 19 eggs/10 ml for eggs in urine, and from 127 to 24 eggs/g for eggs in stool. Over all, this represents a reduction of 98% of egg output. For S. mansoni the prevalence decreased from 5% to 1%, with a reduction in intensity of infection from 81 eggs/g to 24 eggs/g. Due to the low original prevalence and the absence of intermediate hosts for S. mansoni, it is supposed that these S. mansoni cases are imported from other villages.

Table LCS/KIN 6 was obtained by combining results from stool and urine samples in order to determine prevalence of infection in 1986 and 1987, incidence of infection and the rate of loss of infection after treatment. The first survey reached 332 persons, the second one 270. In all, a cohort of 255 individuals was followed. During the time period 1986-1987, the overall prevalence rate fell from 21.7% to 2.6%. Of the 255 persons followed, 2 became infected (giving an incidence of 0.8% per year), 56 lost their infection (a 91.8% rate of loss of infection after treatment), 5 remained infected,and 192 persons remained uninfected throughout the time period.

In summary the efforts at eradicating this unique focus of urinary schistosomiasis in the Centre Province are well under way. However, the continued presence of a few egg carriers and the detection of 2 new infections among the young age groups show that continuing efforts are necessary.

Table LCS/KIN 5 . Comparison between surveys done in Kinding Njabi in 1986 and 1987 for persons 5-14 years old.

Year of Survey	Terminal spine eggs: Urine examination				Terminal spine eggs: Stool examination				S. mansoni: Stool examination			
	Exam	Posv	Prev	Intn	Exam	Posv	Prev	Intn	Exam	Posv	Prev	Intn
June, 1986	109	36	33.0	29	109	44	40.4	127	109	5	4.6	81
June, 1987	83	4	4.7	19	78	1	1.3	24	78	1	1.3	24

Table LCS/KIN 6. Comparison between surveys done in Kinding Njabi in 1986 and 1987 by age and sex (Urine and stool infections combined).

Age & sex group		1986 survey			1987 survey			Longitudinal results		
		Exam	Posv	Prev	Exam	Posv	Prev	#Followed	Incid	Loss
0 to 4	M	23	1	4.3	19	0	0.0	19	0.0	100.0
0 to 4	F	21	0	0.0	12	0	0.0	12	0.0	0.0
5 to 9	M	26	8	30.8	22	2	9.1	21	4.7	83.3
5 to 9	F	30	12	40.0	27	1	3.7	27	0.0	90.0
10 to 14	M	31	16	51.6	24	1	4.2	24	0.0	91.7
10 to 14	F	24	19	79.2	23	0	0.0	22	0.0	100.0
15 to 19	M	15	7	46.7	11	2	18.2	9	11.1	83.3
15 to 19	F	11	4	36.7	8	0	0.0	7	0.0	100.0
20 to 44	M	30	1	3.3	29	1	3.5	26	0.0	0.0
20 to 44	F	43	3	6.9	38	0	0.0	35	0.0	100.0
Over 44	M	33	0	0.0	23	0	0.0	22	0.0	0.0
Over 44	F	41	1	2.5	32	0	0.0	30	0.0	100.0
Total		332	72	21.7	270	7	2.6	255	0.8	91.8

MALACOLOGY LABORATORY STUDIES: Important aspects of malacologic observations in Kindig included the recovery of terminal-spine eggs from the urine (20%) and stool (34%) of 166 persons from the general population of that small community. In general, the eggs from both urine and stool most closely resembled S. haematobium in shape and size, with an average length of 142 microns. However, a considerable proportion (15%) closely resembled S. intercalatum eggs in shape and in length (greater than 170 microns).

These findings suggested that either both S. haematobium and S. interca-

latum were being transmitted in the village or that the village was a foci for S. haematobium/S. intercalatum hybrids. This latter hypothesis was indirectly supported by information on the history of the disease in Kinding Njabi. Villagers reported that the disease was unknown there until several years ago, and that a number of immigrants from Loum, an area where natural hybrids have been reported from man,[1,2] had arrived during the past several years. This hypothesis also received support from the malacology team, which found B. forsaklii, a known host for S. intercalatum and the hybrid, but no hosts for S. haematobium in the vicinity of the village.

The malacology team began studies on the snail host specificity of Kinding Njabi miracidia in an attempt to establish the identity of this parasite. Previous research has shown that miracidia hatched from the urine of patients suspected of harboring hybrids are infective to both B. truncatus and B. forsaklii, whereas pure strains of S. haematobium do not normally infect B. forskalii, and S. intercalatum strains are not compatible with B. truncatus.[1]. Experimental observations have confirmed this broader host specificity for the hybrid and have also shown that the male S. haematobium/female S. intercalatum cross can be easily maintained in the laboratory, but the reverse is not successful.[1,2,3]

Initial attempts to infect snails with miracidia from Kinding Njabi eggs met with limited success: with miracidia obtained from urine samples, about 15% of B. truncatus exposed became infected, but all attempts to infect B. forsaklii with these miracidia failed. On the other hand, miracidia obtained from stool of these patients successfully infected B. forskalii but failed to infect B. truncatus. This success with miracidia obtained from eggs found in stool is in complete contrast to results from earlier work with hybrids in Cameroon.[2] This is one among several of our findings that are not in agreement with previous research and that taken together have made identification of this parasite difficult.

Cercariae from these laboratory infected snails were used to infect mice in order to further test the snail host specificity. Mice infected with cercariae from B. truncatus produced eggs containing active miracidia, but too few were obtained to use in further tests. Mice infected with cercariae from B. forsaklii, though, produced sufficient numbers of miracidia to expose 6 groups of 20 truncatus from various regions of the country and 8 groups of 10-20 forskalii. Interestingly, none of the B. truncatus became infected, whereas between 10-50% of the B. forskalii in 6 of 8 groups produced cercariae.

Taken together, our results give mixed indications concerning the nature of the schistosome at Kinding Njabi. The presence of only B. forsaklii at Kinding Njabi indicates that the schistosome is either S. intercalatum or a S. haematobium/S. intercalatum hybrid, because these are the only human schistosomes transmitted by this snail. However, the high prevalence of persons producing terminal-spine eggs in both urine and stool does not fit the pattern of S. intercalatum, which is usually found in the stool. And although both B. truncatus and B. forskalii were successfully infected with miracidia from Kinding Njabi patients, miracidia obtained after a passage through mice were infective only to B. forsaklii. This finding is not in agreement with earlier studies on the hybrid and leaves open the possibility that both S. intercalatum and S. haematobium are being transmitted in the village.

That final possibility, which necessitates the presence of a previously overlooked snail host at the site, is also problematical. If both S. haematobium and S. intercalatum were in the area, one would expect, based on previous studies, that hybridization would occur and evidence of this could be found in a broader snail host specificity.

Further work aimed at clarifying the taxonomic status of this parasite will include attempts to verify our earlier findings by infecting laboratory reared

B. truncatus and B. forskalii with miracidia from urine and stool of patients at Kinding Njabi. We will also try again to establish a laboratory isolate from naturally infected B. forsaklii collected in the village, which will be then tested for its snail host compatibility in a similar manner to other isolates.

References:
[1]Wright, C.A. et al. *Trans. Roy. Soc. Trop. Med. Hyg.* 68:413-414, (1974).
[2]Southgate, *et al. Z. Parasitenk.* 49:145-159, (1976).
[3]Mutani, A. *et al. Acta Trop.* 42: 319-331, (1985).

NOVEMBER 1987 SURVEY: The third stool survey was conducted in November 1987 and the urine survey in January 1988. The combined results of the surveys are presented in table LCS/KIN 7.

Table LCS/KIN 7. Results of Nov 1987/Jan 1988 surveys at Kindig Njabi by age and sex (Urine and stool infections combined).

Age & sex group		--- Survey results --- Exam	Posv	Prev	Intn	--------Longitudinal results------- #Followed	Incidence(%)	Loss(%)
0 to 4	M	21	0	0.0	0	18	0.0	0.0
0 to 4	F	17	0	0.0	0	12	0.0	0.0
5 to 9	M	27	3	11.1	5	21	14.3	100.0
5 to 9	F	29	1	3.4	1	24	4.2	100.0
10 to 14	M	25	2	8.0	9	20	10.0	100.0
10 to 14	F	16	3	18.8	6	15	20.0	0.0
15 to 19	M	11	1	9.1	336	6	0.0	0.0
15 to 19	F	9	1	11.1	24	6	16.7	0.0
20 to 44	M	31	1	3.2	5	26	3.9	100.0
20 to 44	F	45	1	2.2	24	36	2.8	0.0
Over 44	M	29	1	3.5	5	21	0.0	0.0
Over 44	F	40	0	0.0	0	31	0.0	0.0
Total		301	14	4.7	8	236	5.1	100.0

# new cases	12
# lost infection	5
# remained infected	0
# never infected	219

POPULATION CHANGE. Between June 1987 and November 1987, 11 persons moved into the village. In the same time period, 28 individuals left Kinding, giving a net population decrease of 17. Overall, the population went from 356 to 339.

PREVALENCE. The November 1987 survey examined 301 of Kinding's 339 inhabitants (89%). None of the newcomers to the village had schistosomiasis. Six of the 275 persons submitting stool samples were found infected with terminal spine eggs, suspected to be from the intercalatum/haematobium hybrid (prevalence 2.2%, mean intensity of infection 50 eggs/g). Eight of the 242 samples of urine collected also had terminal spine eggs (prevalence 3.3%, mean intensity 2 eggs/10ml). Combining the results of stools and urine, there were 14 persons infected out of 301 persons examined, prevalence of 4.7%. The original prevalence observed in June 1986 was 21%. In June 1987 it had dropped to 2.6% and has now slowly crept up to 4.7%. A comparison of sex-age group prevalences more accurately evaluates the situation (see Table 5): after the drastic reduction in prevalence following mass drug treatment in June 1986, prevalence increased in the age groups at highest risk. However, the mean intensities of infection in stools and in urine have remained low.

INCIDENCE. Twelve new cases of infection with the hybrid occurred during between June and November 1987: 7 with eggs in urine, 5 with eggs in stools, 8 among children 5-14, 2 in females over 15. The incidence was calculated at 10.2 cases/100persons/year. Besides these 12 cases, there were 2 additional cases that had not been examined in June 1987 but had been examined previously and were then

negative. Of these 14 cases, 3 were positive at the original survey and 11 never had any positive results until June 1987. In the June 1987 results, the presence of two new cases, in spite of the mass treatment of 1986, suggested that transmission has not been interrupted. Six months later it became clear that transmission is increasing. Obviously, treatment of all infected individuals has failed to completely interrupt transmission.

Table LCS/KIN 8. Evolution of prevalence and intensity of Schistosoma infection at Kinding Njabi over 18 months by age and sex.

Age & sex group		Prevalence Jun 86	Prevalence Jun 87	Prevalence Nov 87	Mean intensity Jun 86 ur*	Mean intensity Jun 86 st**	Mean intensity Jun 87 ur	Mean intensity Jun 87 st	Mean intensity Nov 87 ur	Mean intensity Nov 87 st
5-9	M	30.8	9.1	11.1	50	139	29	24	2	24
5-9	F	40.0	3.7	3.4	64	144	10	--	1	--
10-14	M	51.6	4.2	8.0	14	84	10	--	1	72
10-14	F	79.2	0.0	18.8	19	139	--	--	2	48
Total		21.7	2.6	4.7	25	131	17	34	2	50

*ur = urine. Concentration expressed as #eggs/10ml urine
**st = stool. Concentration expressed as #eggs/g stool

LOSS OF INFECTION. All cases infected in June 1987 were treated with Praziquantel, single dose of 40mg/kg, and eventually became negative (a few individuals needed a repeat treatment). Treatment seems to be extremely effective at the individual level: combining the results of June 1986 and June 1987, there were 74 persons infected and treated. Follow-up results are available on 71 of these; all (100%) of those followed up became negative after the first or repeat treatment. Three cases who were infected in 1986 were treated and found negative in the survey of June 1987, but became positive again in November 1987. These are obvious reinfections.

S. mansoni INFECTION. Kinding is in an area of S. mansoni endemicity, and although no transmission seems to occur in Kinding itself (Biomphalaria intermediate hosts have never been recovered in any water bodies around Kinding), cases of S. mansoni are observed in each survey. These are thought to result from visits to other villages, especially Makenene, a trading village and well-established mansoni focus located some 10km away.

In summary, the results of the mass treatment in Kinding show that Praziquantel used at the single dose of 40 mg/kg is an excellent drug to treat infected patients. It is also a very effective drug applied in mass treatment because drastic reduction of prevalence and intensity of infection are achieved in the population after a mass treatment. However, the disease hasn't been eliminated. In spite of intensive follow-up of a majority of the population, transmission is still occurring. Prevalence of infection seems to increase first, with intensities remaining depressed for a longer period.

OBILI

Yaounde has long been known to have several foci of S. mansoni schistosomiasis. Schistosomiasis prevails in the areas surrounding a string of man-made ponds along the river Olezoa. Obili, a quarter of Yaounde located between Melen Pond and the old Douala road going west, was selected as a site to carry out a longitudinal study of the urban transmission of S. mansoni schistosomiasis. The quarter consists of a few blocks of houses packed along small dirt paths.

PAST SURVEYS ON SCHISTOSOMIASIS IN YAOUNDE : These ponds were created from 1949-1958. Several surveys have confirmed the existence of these foci. The first reported case was a military officer who had swum in the Etang Militaire. A summary of past results is presented in Table LCS/OBI 1

Table LCS/OBI 1 : Summary of past surveys on schistosomiasis in Yaounde.

Reference	Persons examined	Number	Mansoni pos	Mansoni %	Intercalatum pos	Intercalatum %
Gariou *et al*.1960.*Bull.Soc.Path.Exot*.54:1053-59.	Water employees, Melen	61	39	64	--	--
Delas *et al*.1968.*Bull.Soc.Path.Exot*.61:625-40.	Residents of Melen	--	--	54	--	--
Mbarga & Ng.Edimo.1969.*Afr.Med*.75:855-60.	Water employees, Melen	120	105	88	--	--
Ngalle Edimo.1970.Rapport 5e Conference OCEAC,11:375-92.	Water division	24	16	67	7	29
Deschiens *et al*.1968.*Bull.Soc.Path.Exot*.61:772-78.9,1969	Melen	89	66	74	20	22
	Obili	71	46	65	8	11
	Olezoa	67	36	54	26	39
Wanji.1976.Thesis CUSS. Yaounde.	Residents of Melen	464	123	27	--	--
	Students	280	52	19	--	--
	Employees	21	7	33	--	--
SameEkobo.1984.Thesis FSR.Rennes.	Nkolbisson	265	81	31	--	--

Every year, a few cases of schistosomiasis are reported by the health services. These are a mixture of imported cases (chiefly for urinary schistosomiasis) and indigenous cases.

Some schools located in Obili were surveyed in February 1986, and high prevalences of mansoni schistosomiasis were found: 17,4% at Melen and 40,9% at Nkolbisson.

POPULATION: 371 persons live in the study area (Table LCS/OBI 2). Their age distribution is different from that of Cameroon as a whole: there is a clear deficit of both persons over 44 and the very young (0 to 4). Evidently, numerous young adults with their older children are living in town while the older persons and the young children have returned to their villages of origin. The site has 85 households, with an average of 4.38 individuals per household. The households are relatively small, 27% are single occupant, 56% have less than 5 persons. Although the majority of households are headed by a male (78%), the proportion headed by a female was high (22%). The large majority of household-heads are 20 to 44 (87%). Length of residence is equally divided among those who spent their life time there, those who spent over 5 years, from 1 to 4 years and recently arrived. Among the married couples, monogamy is the rule: 34 out of 39 marriages are monogamous.

OCCUPATION : Most persons in the area are clerical workers(office workers, secretaries), skilled workers (technicians, carpenters, electricians), or homemakers.

BUILDING : 90% of the houses usually have a cement floor, concrete brick walls, and corrugated iron roofs. The rest have dirt or concrete floors with mud and stick walls. The dirt streets between houses are narrow. Although,very little space exists between the buildings., some families manage to have a small garden or patio. 96% of the families have latrines. Few have piped water inside the house. The majority use "neighborhood" taps located outside. Water from Melen Pond is used for washing when the municipal water supply is cut off.

Table LCS/OBI 2. Longitudinal study of Obili

Population structure by age and sex

	Males #	Males %	CAM %
0- 4	24	6.5	8.7
5- 9	21	5.7	7.6
10-14	16	4.3	5.9
15-19	17	4.6	4.7
20-44	88	23.7	14.3
>45	10	2.7	7.8
Total	176	47.4	49.0

	Females #	Females %	CAM %
0- 4	34	9.2	8.5
5- 9	34	9.2	7.5
10-14	16	4.3	5.3
15-19	23	6.2	5.0
20-44	79	21.3	16.9
>45	9	2.4	7.9
TOTAL	195	52.6	51.1

	Total #	Total %	CAM %
0- 4	58	15.6	17.2
5- 9	55	14.8	15.1
10-14	32	8.6	11.2
15-19	40	10.8	9.7
20-44	167	45.0	31.19
>45	19	5.1	15.7
TOTAL	371	100.0	100.0

Comparison between Obili and Cameroon population structures
1 X represents 1%

Males	Age	Females
Percent each group in Obili		
XXX	>44	XX
XXXX	40-44	XXXX
XXXX	35-39	XXXX
XXXX	30-34	XXXX
XXXXX	25-29	XXXXX
XXXXX	20-24	XXXXX
XXXXX	15-19	XXXXXX
XXXX	10-14	XXXX
XXXXXX	5- 9	XXXXXXXX
XXXXXXX	0- 4	XXXXXXXXX
Percent each group in Cameroon		
XXXXXXXX	>44	XXXXXXXX
XXX	40-44	XX
XXX	35-39	XX
XXX	30-34	XXXX
XXX	25-29	XXXX
XXX	20-24	XXXXX
XXXXX	15-19	XXXXX
XXXXXX	10-14	XXXXX
XXXXXXXX	5- 9	XXXXXXXX
XXXXXXXXXX	0- 4	XXXXXXXXX

Households

Total Number of households	85	
Average size	4.38	
No in House	Number	Percent
1	23	27.1
2	12	14.1
3 TO 4	13	15.3
5 TO 9	31	36.5
Over 10	6	7.1

Headed by	Number	Percent
Male	66	77.6
Female	19	22.4
Age 20-44	74	87.1
Age over 44	11	12.9

Household with		
single spouse	34	40.0
2 spouses	5	5.9
over 3 spouses	0	0.0

Relation to head of house		
Head	85	22.9
Children	105	28.3
Gd children	34	9.2
Parents	3	0.8
Siblings	52	14.0
Friends	3	0.8
Other	30	8.1

Occupation

	Number	Percent
Homemakers	26	7.0
Unskilled worker	3	0.8
Semiskilled worker	0	0.0
Skilled worker	32	8.6
Commerce,service	11	3.0
Clerical	42	11.3
Semi professional	11	3.0
Professional	1	0.3
Other	245	66.0

Residence

Resident since	Number	Percent
birth	107	28.8
over 5 yrs	57	15.4
1 to 5 yrs	95	25.6
< 1 yr	94	25.3
no information	18	4.9

Building

	Number	Average /hsehold
Structures		
Living areas		
Kitchens		
Others		

	Number	Percent
Poor:Dirt floor,mud wall,thatch roof	9	10.1
Std: Dirt floor, brick wall	0	0.0
Good:Cement floor, brick wall,tin roof	80	89.9
With latrines	50	96.2
Without latrines	2	3.8

PARASITOLOGIC SURVEY, APRIL 1987 : The initial house-to-house survey was conducted from March 16 to 22, 1987. Cooperation of the population was poor, despite numerous meetings with the quarter's chief and extensive explanations given to residents. The survey team also had some difficulty finding some individuals at home.

Results of the survey are presented in Table LCS/OBI 3. Although the survey team attempted to collect samples from everyone, only 157 of the quarter's 371 residents (42%) provided samples. No persons were infected with either S. haematobium or S. intercalatum. The overall prevalence of S. mansoni was 4.5%, with a mean intensity of infection of 164 eggs per gram (geometric mean of infected individuals). No one under 10 years old was infected. Prevalences observed in the age groups 10-14 and 15-19 were rather high (10 to 25%). Few adults were infected. Further investigations will attempt to pinpoint the precise site of transmission.

Table LCS/OBI 3. Survey of March, 1987 for S. mansoni in Obili

Age & sex group		Total popul	Survey results Exam	Posv	Prev %	Intn eggs/g
0 to 4	M	24	9	0	0.0	
0 to 4	F	34	14	0	0.0	
5 to 9	M	21	9	0	0.0	
5 to 9	F	34	20	0	0.0	
10 to 14	M	16	5	1	20.0	312
10 to 14	F	16	6	1	16.7	999
15 to 19	M	17	8	2	25.0	59
15 to 19	F	23	10	1	10.0	168
20 to 44	M	88	34	1	2.9	72
20 to 44	F	79	32	1	3.1	192
Over 44	M	10	6	0	0.0	
Over 44	F	9	4	0	0.0	
TOTAL		371	157	7	4.5	164

SURVEY OF OCTOBER 1987 A follow up survey was undertaken in Obili in October 1987. Results are presented in Table LCS/OBI 4.

POPULATION CHANGE: Between April and November 1987 an additional 101 persons were recorded in the census (some were absent during the previous census, a few are newcomers). During this time period, 15 individuals left, giving a net increase of 86 persons. The population now stands at 458.

PREVALENCE: The November 1987 survey examined 255 of Obili's 458 residents (55.7%). Nine persons were found infected with S. mansoni, giving a prevalence of 3.5%. Three of these nine individuals were newcomers to Obili. Only one individual, an adult male, was infected with S. intercalatum. The prevalence of intercalatum schistosomiasis was, therefore, 0.39%.

INCIDENCE: Of the 110 persons surveyed both in April and November 1987, there were 3 new cases of mansoni. These new cases were all adults (2 women and 1 man). Only one of the women could be interviewed, and she told the survey team that she frequently went to the pond at the site and did not leave Yaounde. The incidence, calculated from the 110 persons followed for 7 months is 4.6 cases of mansoni/100 persons/year. Similarly, 1 new case (adult male) of intercalatum schistosomiasis occurred, giving an incidence of 1.6 cases/100 persons/year.

LOSS OF INFECTION: Five persons infected with mansoni schistosomiasis in April 1987 were no longer infected in November 1987. Three of these individuals were interviewed during the November survey, and none of them reported taking any anti-schistosomal medicine.

Table LCS/OBI 4. Results of October 1987 survey at Obili for S. mansoni by age and sex.

Age & sex group		--- Survey results --- Exam	Posv	Prev	Intn	--------Longitudinal results------- #Followed	Incidence(%)	Loss(%)
0-4	M	17	0	0.0	0	6	0.0	0.0
0-4	F	29	0	0.0	0	11	0.0	0.0
5-9	M	22	0	0.0	0	9	0.0	0.0
5-9	F	25	0	0.0	0	15	0.0	0.0
10-14	M	9	0	0.0	0	6	0.0	100.0
10-14	F	14	0	0.0	0	6	0.0	100.0
15-19	M	10	0	0.0	0	6	0.0	100.0
15-19	F	20	1	5.0	2376	5	0.0	0.0
20-44	M	41	2	4.8	204	18	5.6	0.0
20-44	F	56	5	8.9	79	20	5.0	100.0
>44	M	5	0	0.0	0	4	0.0	0.0
>44	F	7	1	14.3	48	4	25.0	0.0
Total		255	9	3.5	134	110	2.7	83.3

# new cases	3
# lost infection	5
# remained infected	1
# never infected	101

MFOU

Mfou, the capital of Mefou Division in the Center Province, is a small town representative of S. mansoni foci found in Cameroon's equatorial forest. The town is mostly an administrative center. The commercial center is relatively unimportant. Mfou is located on the central plateau at 770m of altitude about 22 km from Yaounde. It has an equatorial climate with 2 rainy seasons and 2 dry spells. The main rainy season lasts from September to November and is followed by a dry season from the end of November to mid February. A short rainy season lasts from March to May and is followed by a dry season from June to August. For the last 2 years, the mean annual rainfall was 2064,7mm in 1984 and 2060 mm in 1985. The mean annual temperature was 23°8C in 1984 and 23°9C in 1985 (Principal Meteorological Station of Yaounde).

The only water bodies in town are a small municipal pond, created artificially at the bottom of a depression between small hills, and a swamp located on the south side of town. Mfou's public water supply consists of 4 water fountains.

Table LCS/MFO 1. Longitudinal study of Mfou

Population structure by age and sex

	Males #	Males %	CAM %
0- 4	27	7.3	8.7
5- 9	30	8.2	7.6
10-14	34	9.2	5.9
15-19	35	9.5	4.7
20-44	64	17.4	14.3
>45	13	3.5	7.8
Total	203	55.2	49.0

	Females #	Females %	CAM %
0- 4	22	6.0	8.5
5- 9	26	7.1	7.5
10-14	21	5.7	5.3
15-19	30	8.2	5.0
20-44	59	16.0	16.9
>45	7	1.9	7.9
TOTAL	165	44.8	51.1

	Total #	Total %	CAM %
0- 4	49	13.3	17.2
5- 9	56	15.2	15.1
10-14	55	14.9	11.2
15-19	65	17.7	9.7
20-44	123	33.4	31.19
>45	20	5.4	15.7
TOTAL	368	100.0	100.0

Comparison between Mfou and Cameroon population structures
1 X represents 1%

Males	Age	Females
Percent each group in Mfou		
XXX	>44	XX
XXX	40-44	XXX
XXX	35-39	XXX
XXX	30-34	XXX
XXX	25-29	XXX
XXXX	20-24	XXX
XXXXX	15-19	XXXXX
XXXXXX	10-14	XXXXX
XXXXXXXX	5- 9	XXXXXXX
XXXXXXX	0- 4	XXXXXX
Percent each group in Cameroon		
XXXXXXXX	>44	XXXXXXXX
XXX	40-44	XX
XXX	35-39	XX
XXX	30-34	XXXX
XXX	25-29	XXXX
XXX	20-24	XXXXX
XXXXX	15-19	XXXXX
XXXXXX	10-14	XXXXX
XXXXXXXX	5- 9	XXXXXXXX
XXXXXXXXXX	0- 4	XXXXXXXXX

Households

Total Number of households	65	
Average size	5.66	
No in House	Number	Percent
1	14	21.5
2	5	7.7
3 TO 4	9	13.8
5 TO 9	25	38.5
Over 10	12	18.5
Headed by	Number	Percent
Male	45	69.2
Female	20	30.8
Age 20-44	50	76.9
Age over 44	15	23.1
Household with		
single spouse	25	38.5
2 spouses	2	3.1
over 3 spouses	0	0.0
Relation to head of house		
Head	65	17.7
Children	182	49.5
Gd children	8	2.2
Parents	1	0.3
Siblings	24	6.5
Friends	6	1.6
Other	82	22.3

Occupation

	Number	Percent
Homemakers	26	7.1
Students	210	57.1
Unemployed	0	0.0
Handicapped	0	0.0
Agriculture	0	0.0
Unskilled worker	0	0.0
Semiskilled worker	2	0.5
Skilled worker	3	0.8
Commerce,service	9	2.4
Clerical	13	3.5
Semi professional	40	10.9
Professional	5	1.4
Other	83	22.6

Residence

Resident since	Number	Percent
birth	40	10.9
over 5 yrs	169	45.9
1 to 5 yrs	103	28.0
< 1 yr	52	14.1
no information	4	1.1

Building

	Number	Average /hsehold
Structures		
Living areas	not recorded	
Kitchens		
Others		

	Number	Percent
Poor:Dirt floor,mud wall,thatch roof	5	7.7
Std: Dirt floor, brick wall,tin roof	5	7.7
Good:Cement floor, brick wall,tin roof	55	84.6
With latrines	29	100.0
Without latrines	0	0.0

POPULATION: The neighborhood which borders the municipal pond was chosen for study. A total of 368 persons live in the area (See Table LCS/MFO 1). Their age distribution is different from the one of Cameroon as a whole: there is a clear deficit of persons over 44 and of those less than 5. Apparently, numerous young adults live in town with their older children, while the older persons and the young children have stayed in their villages of origin. There are 65 households, thus an average of 5.66 individuals per household. The households are vary in size: 21% are single occupant, 22% have from 3 to 5 persons, 38% from 5 to 9 persons, and 18% have more than 9 persons. Although the majority of households are headed by a male (69%), the proportion headed by a female is high (31%). The large majority of household-heads, 77%, are 20-44 years old. Length of residence shows a minority being originally from Mfou (11% born there). 46% of the population has lived in Mfou for over 5 years. 28% have lived there from 1 to 5 years, and 14% have spent less than 1 year in Mfou. This last group probably consists of high school students residing temporarily in the town. Among the married couples, monogamy is the rule with 25 out of 27 marriages being monogamous.

OCCUPATION: Most individuals are semi-professional workers or homemakers. A few clerical workers and professionals exist.

BUILDINGS: 85% of the houses have cement floors, concrete or brick walls, and corrugated iron roofs. Only 8% have dirt floors, mud and stick walls, and thatch roofs. Most houses have pit latrines. The neighborhood has 2 public fountains. The pond water is used for washing when the town water supply is cut off. The swamp is seldom used.

PREVIOUS STUDIES DONE IN MFOU : In June 1985, an initial survey was done in the town of Mfou by our team and was extended in December 1985. It included 593 persons. Results of this survey are presented in Table LCS/MFO 2. 94 persons were found to be infected with S. mansoni (prevalence of 15.8%) with mean intensity of infection of 165 eggs/g. The highest prevalences were observed among the children of ages 10 to 14 years. The malacological survey showed the presence of Biomphalaria pfeifferi in the pond.

In October 1985, the national school survey was done in Mfou subdivision. Out of 203 schoolchildren examined, 20 were infected with S. mansoni, giving a prevalence of 9.8%.

PARASITOLOGIC SURVEY, MAY 1987: A house-to-house survey was conducted from May 18 to 22, 1987. Results are presented in Table LCS/MFO 3. Participation of the population in the survey was not good: only 161 samples, representing 44% of the population of stools were collected. Experience has shown that non-cooperation is a problem in city or town settings.

No infections of S. haematobium or S. intercalatum were found. The overall prevalence of S. mansoni was 8.1%, with a mean intensity of infection of 105 eggs per gram (geometric mean of infected individuals). Infection was not observed in individuals less than 5 years old. The prevalence rate was highest in the 10-14 years old group.

INCIDENCE, LOSS OF INFECTION : It was possible to find 85 persons that were surveyed in 1985. However, 1987 parasitological examination results are available for only 46 of these individuals. Results of the the 1985 survey restricted to those individuals also surveyed in 1987 are presented in Table LCS/MFO 4 along with incidence and loss of infection data.

Table LCS/MFO 2. Results of June/December 1985 survey at Mfou for S. mansoni.

Age group	Exam	Pos	Prevalence	Eggs /gram
0 - 4	111	0	0.0	---
5 - 9	126	8	6.3	127
10 - 14	97	32	32.9	196
15 - 44	221	47	21.2	146
> 45	30	2	6.6	96
Unknown	8	5	---	---
TOTAL	593	94	15.8	165

Table LCS/MFO 3. Results of May, 1987 survey for S. mansoni at Mfou.

Age & sex group		Survey results Exam	Posv	Prev	Intn
0 to 4	M	9	0	0.0	0
0 to 4	F	7	0	0.0	0
5 to 9	M	16	1	6.2	72
5 to 9	F	11	1	9.1	72
10 to 14	M	15	1	6.7	864
10 to 14	F	10	1	10.0	192
15 to 19	M	8	1	12.5	72
15 to 19	F	17	0	0.0	0
20 to 44	M	29	2	6.9	34
20 to 44	F	26	5	19.2	92
Over 44	M	8	1	12.5	384
Over 44	F	5	0	0.0	0
TOTAL		161	13	8.1	105

Certainly, transmission is still occurring in Mfou: of the 46 persons surveyed twice at the 18 month interval, there were 3 new cases (2 among children and 1 adult woman). The incidence calculated from the 46 persons followed for 18 months is 6.5% or 4.3/100 person/year. Of the 14 persons found to be infected in 1985, all had lost their infection. It should be noted, though, that after the 1985 survey, results were given to the Health Department so that all infected individuals would be treated with niridazole. However firm documentation of treatment is not available.

Table LCS/MFO 4: Surveys of December 1985 and May 1987 (restricted to persons present in both surveys)

Age & sex group		----Survey results---- Exam	Posv	Prev	Intn	--Survey of May 1987- Exam	Posv	Prev	Intn	-----Longitudinal results---- #Foll	New cases	Incid	Loss	Distribution
0 to 4	M	4	0	0.0	0	9	0	0.0	0	1	0	0.0	0.0	# new cases
0 to 4	F	3	0	0.0	0	7	0	0.0	0	1	0	0.0	0.0	3
5 to 9	M	6	0	0.0	0	16	1	6.2	72	4	0	0.0	0.0	# lost infection
5 to 9	F	9	1	11.1	72	11	1	9.1	72	4	1	25.0	100.0	14
10 to 14	M	13	4	30.8	239	15	1	6.7	864	6	1	16.7	100.0	# remained infect
10 to 14	F	7	2	28.6	271	10	1	10.0	192	4	0	0.0	100.0	0
15 to 19	M	5	2	40.0	152	8	1	12.5	72	2	0	0.0	0.0	# never infected
15 to 19	F	8	5	62.5	210	17	0	0.0	0	6	0	0.0	100.0	29
20 to 44	M	7	3	42.9	199	29	2	6.9	34	4	0	0.0	100.0	
20 to 44	F	13	2	15.3	269	26	5	19.2	92	8	1	12.5	100.0	
Over 44	M	7	0	0.0	0	8	1	12.5	384	4	0	0.0	0.0	
Over 44	F	3	2	66.7	96	5	0	0.0	0	2	0	0.0	100.0	
Total		85	21	24.8	192	161	13	8.1	105	46	3	6.5	100.0	

SURVEY OF NOVEMBER 1987: The second survey of residents of the neighborhood bordering the municipal pond was conducted in November 1987. Results are presented in Table LCS/MFO 5.

POPULATION CHANGE: Between May 1987 and November 1987, 142 persons moved into the neighborhood. The majority of these individuals represent (1) older schoolchildren who happened to be home during the survey; and (2) families with established households but missed in the first survey. During the specified time period, 52 persons left the neighborhood, giving a net population increase of 90. Presently, the population is 458.

PREVALENCE: Two-hundred thirteen of the neighborhood's 458 residents submitted stool samples for analysis (47%). Seventeen of these individuals (10 males and 7 females) were found infected with S. mansoni, giving a prevalence of 7.98%. Fifteen of them were between the ages of 5 and 19. The other 2, one male and one female, were in the 20-44 year old age group. Five of the 17 persons infected were newcomers to the neighborhood. Seven of the 17 infected persons are new cases (see paragraph below). Two of the 17 have been infected since May 1987, and two of the 17 presently infected were not surveyed in May.

INCIDENCE: Of the 55 residents providing stool samples for both the June and November 1987 surveys, 7 new cases of mansoni schistosomiasis were detected. The incidence, calculated from the 55 persons followed for 6 months is 25.4 cases/100 persons/year.

Four of these new cases were in males; 3 in females. All infected persons but one, a nineteen year-old woman, were primary or secondary schoolchildren. Two infected persons were from the same household. Six of the seven cases reside in houses without running water: these persons reported using water from wells or public fountains for drinking and washing. Only one of the households containing a new case are in close proximity to the municipal pond.

Three of the new cases were infected with schistosomiasis in December 1985 (some of the individuals followed in the longitudinal study were part of a house-to-house survey carried out in December 1985), were negative in May 1987, and then positive in November 1987.

LOSS OF INFECTION: Four individuals infected with schistosomiasis in May 1987 had lost their infections by November 1987. Two of these persons were wives of the same husband. The other two individuals were a 40 year old male and a 13 year old boy. None of these persons reported taking anti-schistosomal medicine between the 2 surveys. However, it is possible they visited the local clinic and were treated. It should be noted that 2 households in the neighborhood had both individuals losing infections (*i.e.* acquiring the disease before May 1987) and persons becoming infected from May to November 1987. Evidently, these families may engage in water-contact behavior that makes them particularly susceptible to infection by S. mansoni.

Table LCS/MFO 5. Results of Nov 1987 survey at Mfou for S. mansoni by age and sex.

Age & sex group		--- Survey results --- Exam	Posv	Prev	Intn	--------Longitudinal results------- #Followed	Incidence(%)	Loss(%)	
0-4	M	21	0	0.0	0	5	0.0	0.0	# new cases
0-4	F	14	0	0.0	0	4	0.0	0.0	7
5-9	M	24	1	4.2	24	6	0.0	0.0	# lost infection
5-9	F	19	2	10.5	24	7	14.3	0.0	4
10-14	M	26	7	26.9	114	7	57.1	100.0	# remained infected
10-14	F	8	2	25.0	687	1	0.0	0.0	2
15-19	M	19	1	5.3	72	4	0.0	0.0	# never infected
15-19	F	14	2	14.3	72	5	40.0	0.0	42
20-44	M	26	1	3.9	24	5	0.0	100.0	
20-44	F	32	1	3.1	48	8	0.0	100.0	
>44	M	5	0	0.0	0	2	0.0	0.0	
>44	F	5	0	0.0	0	1	0.0	0.0	
Total		213	17	8.0	86	55	12.7	66.7	

MAKENENE

Makenene is a hyperendemic focus of S. mansoni schistosomiasis that seems to be decreasing naturally, probably because of environmental changes brought about by road construction. To monitor transmission dynamics, three cohorts of schoolchildren have been followed at Makenene: cohort A, children who were in the highest grade of primary school (CM2) at the time of the first survey in March 1986; cohort B, two classes of younger schoolchildren (CE1 and CE2) who were first surveyed in May 1986; cohort C, a new group of children examined in May 1987 who had never been previously examined. Results of all surveys performed at Makenene are presented in Table LCS/MAK 1. The March/May 1986 results for cohorts A and B indicate that there was an extremely intense schistosomiasis endemicity, with prevalence rates close to 100% and very high intensities of infection (200-400 eggs/gm). However, the initial survey of a new group of schoolchildren, cohort C, one year later revealed a prevalence of only 42.5% and mean intensity of 198 eggs/gm. This decrease in prevalence has been attributed to the draining of several ponds to construct the paved road through town improvement in environmental conditions. The most recent follow-up survey was done in November 1987. Twenty children from cohort A were still in school and examined. Six of these children were positive, giving a prevalence of 30% with a mean intensity of infection of 141 eggs/g. There were two cases of reinfection: children originally infected in March 1986 who were treated and later found negative in May 1987, but have become infected again by November 1987.

Table LCS/MAK 1. Results of surveys at Makenene for S. mansoni by cohort.

	March/May 1986				May 1987				November 1987			
Cohort	Exam	Posv	Prev	Intn	Exam	Posv	Prev	Intn	Exam	Posv	Prev	Intn
A	98	90	91.9	238	10	3	30.0	79	20	6	30.0	141
B	145	144	99.3	430	32	15	46.9	168	33	12	36.4	64
C	----------				80	34	42.5	198	46	15	32.6	78

Concerning cohorts B and C, most of these children received single-dose praziquantel treatment before the end of school in May 1987 from the headmaster, who unfortunately did not record the identities of the children he treated. The effect of this treatment was to lower slightly the overall prevalence to about 35%, with a more visible decrease in the intensity of infection. Between May and November 1987, there were 13 new cases of S. mansoni schistosomiasis among the 52 children of cohorts B and C examined on both occasions, giving an incidence rate of 43 cases/100 persons/year. Thus, transmission is still continuing at Makenene.

Results of a preliminary case control study found that no major morbidity was associated with schistosomiasis, but it's possible that the differences in morbidity between cases and controls were too subtle to be detected by the methods used. The study also examined children's reported water-contact behavior. Most of the contact time was, as expected, spent swimming and playing, but cases reported spending less time in the water than controls. The geographical distribution of places of residence and places of water contact did not point toward any specific high-risk contact site.

2.1.5.MORBIDITY STUDIES

2.1.5.1.MORBIDITY DUE TO S. mansoni IN OBILI.

With a small number of cases, it was expected that morbidity data collected would be difficult to interpret, and levels of significance would probably not be reached. However, an attempt was made to find out if there was some major morbidity among infected cases compared with uninfected controls. The plan was to use the 14 known cases and 28 age and sex matched controls (2 per case). Due to difficulties in reaching the people at home and the poor motivation of the technicians, only 7 cases and 17 controls were interviewed. The results of these 7 cases and 14 matched controls are reported in Table MOR 1:

Table MOR 1. Results of Obili morbidity study

	Cases		Controls	
Number interviewed	7		14	
Medical history in the last 6 months:	#	%	#	%
no sickness	1	5.8	3	21.4
sickness	6	94.2	11	78.6
malaria,fevers	5		5	
flu,cough	1		1	
stomach pain...	1		2	
other	3		3	
went to med. facility	5		5	
to trad. healer	2		1	
Medical history of past 1 week				
no sickness	4	57.0	8	57.0
fever	3		2	
diarrhea	0		1	
stomach pain...	0		4	
taken some drug	3		3	

Water contact. Water contact information was collected on the 7 cases and 14 controls interviewed. Four of the cases (57%) admitted going regularly to the lake versus 3 of the contacts (21%), p=0.10 Fisher's exact test.

2.1.5.2.S.MANSONI MORBIDITY AND PERCEPTIONS OF DISEASE IN MAKENENE

A preliminary case control study was done in Makenene to evaluate the potential morbidity associated with S. mansoni and to determine the appropriateness of some of the methods to be used in later studies. Results of the study are presented in Table MOR 2.

The questionnaire explored the symptoms as perceived and reported by the subjects. It examined two periods, the last 6 months and last week. For "the last 6 months" period, the subject was asked to list illnesses and symptoms he had experienced during this time period. The most common groups of symptoms mentioned were {malaria, fevers}, {stomach pain, diarrhea, abdominal problems},

{schistosomiasis}, {jaundice} and {others miscellaneous symptoms, filariasis, skin disorders}. Jaundice seems to be a difficult entity to define: children insisted that they had definite jaundice; however, a child who said that he was having "jaundice" at the time of examination did not exhibit any yellow color of the sclera. "Jaundice," as seen in this society, is evidently a different entity than the standard jaundice of western medical texts.

Unlike the results of a similar study in an urban setting (Obili), flu, cough, and other minor ailments were never reported by the children of Makenene. One question explored the type of help sought by those who had experienced symptoms of illness: the health center or hospital were the most commonly mentioned sources of care. Traditional healers seemed to play a lesser role. Most subjects reporting disease also reported seeking help for these symptoms, thus giving some credibility to their complaints. There were no differences between cases and controls.

Table MOR 2. Results of the preliminary morbidity study in Makenene

	Cases		Controls	
	Numb	Percent	Numb	Percent
Number interviewed	28		28	
Medical History in last 6 months				
malaria, fever	1		5	
schistosomiasis	2		1	
stomach pain, diarrhea	7		3	
"jaundice"	3		4	
other	5		5	
Total reporting 1 or more symptom	17	60.7	17	60.7
Total reporting none	11	39.3	11	39.3
Went to a medical facility for care	13		13	
to a traditional healer	2		0	
Total seeking help	15			
% of those reporting symptoms that seek help		88%		76%
Medical history in last week				
malaria, fever	5		3	
diarrhea	1		5	
stomach pain	5		5	
other	1		1	
Total reporting 1 or more symptoms	8	28.6	12	42.8
Total reporting none	20	71.4	16	57.1
Total that took drug or seeked help	4	14.3	4	14.3
% " " " " "		50%		33%
Enlarged speen	1	3.6	0	0.0
Enlarged liver	2	7.2	1	3.6

For "the last week" period, children were asked if they had experienced fever, diarrhea, and/or stomach pain during the last week. It is felt that more

accurate answers were obtained from this section because subjects were being asked to recall a more recent and shorter period of time. Other symptoms could also be reported in an open-ended manner. A smaller percentage of those experiencing symptoms during the past week had taken some drugs or gone to a medical facility for help (50% and 33%).

There was an apparent association between reporting disease in the past week and reporting disease in the last 6 months: of 17 persons reporting disease during the last week, 15 reported symptoms in last 6 months (88%); while only 20 of the 39 reporting symptoms during the last week reported no symptoms during the last 6 months (51%), p=0.007, Fisher's exact test. This result seems to validate that responses obtained are generally consistent from one section of the questionnaire to the next. In this section, as in the "last 6 months" section, there were no differences between cases and controls.

Palpation of the spleen and liver were made in recumbent position. Very few enlarged spleens or livers were detected. There were again no differences between cases and controls. The low prevalence of enlarged spleen or liver was surprising in an area of known malaria endemicity.

In summary, no major morbidity seemed to be associated with schistosomiasis mansoni in Makenene. However, it is possible that the methods used were too crude to detect more subtle differences in morbidity between cases and controls.

Water contact. The questionnaire also explored children's water-contact behavior: location of contact, nature of contact (fording, swimming, playing, fishing, washing clothes, washing body, collecting water) and length of contact. Most of the contact time was, as expected, spent swimming and playing in the water. The cases spent on the average 2.5 hours/week in water (SD=1.99) and the controls 3.5 hours per week (SD=3.7). Obviously, the times reported by these children were too inaccurate to be interpretable. Approaching the question of water contact based only on a questionnaire may provide some very misleading results. The geographical distribution of places of residence and places of water contact did not point toward any specific high risk contact site.

2.1.5.3.MORBIDITY STUDY OF S. haematobium IN THE YAGOUA AREA

Dr. J. Foumbi has started his research in the Yagoua area. The villages selected, Toukou and Zoulla, will serve as a longitudinal study site. The first activities were to carry out a complete census of the study population and prepare a map of the area detailing the location of each household. Urine sample were then collected. From November 4 to 13, Dr. Foumbi was assisted by M. J. Geshner in setting up the ultrasound equipment for the examination of his study subjects.

A special study entitled "Bacteriuria and Urinary Schistosomiasis" was undertaken in the Yagoua area by Dr. Foumbi in collaboration with the Pasteur Centre in Garoua. The purpose was to determine whether S. haematobium is associated with bacteriuria and with morbidity in the Yagoua area. The study population is the same one that Dr. Foumbi used for his research on morbidity by S. haematobium.

2.1.5.4.MORBIDITY STUDY OF S. intercalatum IN EDEA

Dr. E. Wansi studied **the morbidity of S. intercalatum**. There had been only a limited interest on S. intercalatum morbidity. This lack of interest was be partly due to the fact that for a long time, S. intercalatum was known to be

limited to the central African region; Zaire, Gabon, Congo, Central African Republic and Cameroun. However, recently, case reports coming from countries such as Nigeria, Upper Volta, Senegal, Mali, Angola, Equatorial Guinea, Sao Tome suggested that the disease had a wider distribution than initially thought or was in extension. This may not come as a total surprise. In fact, the intermediate hosts (Bulinus forskalii and Bulinus africanus) are widely spread throughout Africa and the parasite is restricted to a much more smaller area for reasons not clearly understood. There was a controversy over the pathology associated with S. intercalatum, whereas some authors considered the disease as severe, others concluded that it was a mild condition.

The purpose of the study was to determine the degree of the morbidity associated with S. intercalatum infection. Besides looking at some sociodemographic factors associated with the infection status, he assessed whether the severity of the disease warranted any major concern. Using a population based approach, he selected about 100 cases and controls in the town of Edea. Morbidity was be measured through interview, physical examination, rectoscopy, sonography and laboratory investigations. Risk factors were evaluated through interview and direct observation. The objectives of this study were: (1) To determine the relationship between S. intercalatum infection status and morbidity measured by interview, physical examination, rectoscopy, sonography and laboratory investigations, (2) to determine the relationship between the intensity of the infection and the severity of the disease, (3) to determine risk factors associated with morbidity. These factors included variables such as, sex, age, length of stay in Edea, education and age of parents, family income, in-house water supply, type of house, (4) to determine the relationship between these factors and the intensity of the infection, (5) to compare the different diagnostic methods and their impact on the statistical conclusion pertaining to the relationship between infection and disease, (6) to assess the impact of past exposure on present morbidity, (7) to determine the relationship between anorectal varices and portal hypertension in schistosomiasis.

This study was a blind controlled study, cross sectional in design and combining a non directional and backward approaches.

2.1.5.4.MORBIDITY STUDY OF S. haematobium IN BERTOUA

Dr. R. Befidi studied the effect of praziquantel on hemoglobin levels, anthropometric measures, physical fitness and spleen size. The study was designed to clarify the contribution of S. haematobium infection to morbidity by comparing parameters such as blood hemoglobin levels, anthropometric measures, physical fitness, spleen and liver size, proteinuria, hematuria before and six months after treatment with praziquantel. Other parasitic diseases present in the study subjects were identified in order to control for their potential effect. The study was carried out in Bertoua and was limited to male school children between the ages of 6 and 15. Infected children and uninfected controls participated in the study. Children with heavy infections were treated and excluded from the study. After making the baseline measurements, children with light to moderate infections were divided in two groups, one was treated with praziquantel and the other group with a placebo. After 6 months, both groups and the uninfected controls were reexamined. This study contributed to the understanding of the effect of S. haematobium infection and influence the strategy of chemotherapeutic control and decision about the extent to which treatment can be delayed.

2.1.6. IDENTIFICATION OF NEW SCHISTOSOMIASIS FOCI

Prior to the school survey pilot community surveys were conducted in order to test sampling and laboratory techniques. Surveys were done in Nkolmeyos and Mfou, both are foci of S. mansoni in the vicinity of Yaounde and in Bertoua, administrative capital of the East Province where both S. mansoni and S. haematobium are endemic.

Table : Summary of the community surveys

Community	Persons examined	S.mansoni Prevalence	S.mansoni Mean egg/g	S. haematobium Prevalence	S. haematobium Mean egg/g
Nkolmeyos	170	15	166	-	-
Mefou	179	13	111	-	-
Bertoua	514	4	-	42	29

Results of the June school survey indicated that new foci of mansoni schistosomiasis may have appeared in certain regions of the Northwest and West Provinces: Weh (Menchum Division, Northwest Province), Foumban (Noun Division, West Province), Foumbot (Noun Division, West Province), and Tonga (Nde Division, West Province). In September, these sites were visited to determine whether the cases detected by the survey were indigenous or only migrants from other endemic areas of Cameroun.

Since the majority of children from Weh and Foumban with schistosomiasis reported after extensive interviewing that they have never moved from their towns, it was concluded that these two sites are most likely new foci. Tonga is probably also a new focus: although only 2 of the original 5 positive cases were year-round residents, the Sept. survey of children always staying at Tonga showed a 6% prevalence of mansoni schistosomiasis. It was concluded that Foumbot is not a focus because more intense questioning of most of the children found infected in the June survey revealed that they had either recently moved to Foumbot or spent their vacations in other regions of the country. Moreover, no new cases of schistosomiasis were found among the Sept. sample of year-round residents.

The identification of Weh as a focus of mansoni schistosomiasis is particularly striking because schistosomiasis has never been previously described in the Northwest Province. Results from the national malacological survey and additional surveying in September revealed that B. pfeifferi is the probable snail host. Stool samples from children in three neighboring villages (Esu, Kuk, and Kumfutu) were taken to determine if the Weh focus is isolated or spreading. Only 1 of the 151 children sampled was positive, and this child reported that he frequently visits Weh. Thus, it appears that the focus at Weh is, for the moment, isolated.

2.2. PARASITOLOGIC STUDIES

Before embarking on the nationwide school survey it was decided to review the quantitative techniques for the diagnosis of schistosome eggs in urines and stools. An important consideration in the selection of techniques was the type of technicians working in the project. These were persons that could not be expected to travel extensively. Therefore preference was given to techniques requiring a minimum of handling in the field. Preservation techniques were necessary.

2.2.1.COMPARISON OF CENTRIFUGATION, SEDIMENTATION AND FILTRATION FOR THE DIAGNOSIS OF URINARY SCHISTOSOMIASIS

These methods were compared during an epidemiologic survey performed in Bertoua. A 10ml sample of urine was examined after centrifugation, sedimentation and filtration on a nuclepore* filter. A triple comparison was done on 242 samples. Of these 147 were negative in all 3 methods, 95 positive in 1 or more methods and only 71 positive in all 3 methods. Defining sensitivity as the percentage of these cases detected by a single method, centrifugation was the most sensitive with 89%, followed by sedimentation (85%) and filtration (75%). The difference between filtration and the other two methods was significant at p=0.05. In urine samples with high egg count sedimentation proved to underestimate the egg counts. Because of its good sensitivity and ease of performance, sedimentation was selected as the method to use in this project.

2.2.2.SENSITIVITY AND SPECIFICITY OF REAGENT STRIPS IN URINARY SCHISTOSOMIASIS

The comparative studies done in Bertoua included examination with reagent strip for detection of hematuria and microscopic examination for detection of red blood cells in the urine. Sensitivity was clearly related to the intensity of infection: 64% for infections of 1-10 eggs/10ml, 87% for infections of 10-99 eggs/10ml and 100% for infections greater than 100eggs/10ml. The "trace" results from the reagent strip were clearly associated with the presence of eggs. The specificity was 81%. The false positive were rare in small children and more common in older age groups. A distinction between males and females of menstruation age showed that females are for the most part responsible for the false positives. In conclusion it would be reasonable to use reagent strips for screening of urinary schistosomiasis whenever microscopic examination would not be feasible.

2.2.3.STOOL EXAMINATION TECHNIQUES

Examination of stools is performed by the Kato method with a 40mg stool sample. Stools to be examined by Kato are preserved by mixing a 5 mg of sodium azide with approximately 1 gram of stools.

A 10% subsample is examined by a modified formol-ether concentration technique, as modified by Knight from the technique originally described by Ritchie. The Knight technique, which examines a gram of fecal material has the advantages of high sensitivity, ease of reading and and quantitation because of clean sediment, low variability if egg counts and ease of collecting and preservation in the field. The Knight technique constitutes the reference diagnostic procedure for fecal examinations.

2.2.4.DISTRIBUTION OF S. mansoni EGGS IN THE STOOLS

The scientific literature contains several contradictory statements regarding the distribution of S. mansoni eggs in feces. Some authors state that the eggs are concentrated at the surface of the fecal matter, especially in the mucus, while others state that the eggs are uniformly distributed throughout the stool. Since the person providing the stool sample selects only a portion of the stool to give to the survey team, non-uniform distribution of eggs in stool could bias results. Thus, it was important to determine the nature of egg distribution in fecal matter.

Ten school children from Makenene, Mbam division, Cameroon, infected with S. mansoni were asked to deposit their entire stools on paper plates lined with aluminum foil. An amount of approximately 200mg of stool was carefully taken with a scalpel from the surface and the center of the stool at the opposite ends of the stools. Samples collected were preserved with sodium azide, brought back to the laboratory, and examined by the Kato thick smear technique.

Results, expressed as eggs/42mg, are presented in Table PAR 1. No obvious pattern in the distribution of eggs was observed. A Friedman Two-way ANOVA test revealed no significant statistical differences in the number of eggs per 42 mg among the 4 stool sites (X^2=2.88, df=3, p=0.41)

Table PAR 1 : Results of stool examination expressed as eggs/42mg

#	C1	C2	S1	S2
1	11	19	38	20
2	24	50	30	71
3	17	5	6	9
4	5	2	18	8
5	59	21	42	43
6	19	52	40	62
7	43	22	21	49
9	136	--	194	24
10	5	--	6	--

Thus, the data support the hypothesis than S. mansoni eggs are randomly distributed throughout the stool specimen. Perhaps, the uneven distribution reported by some authors applies only to patients with acute diarrhea associated with S. mansoni. Such individuals were not sampled in this study.

In conclusion, in an epidemiologic survey of S. mansoni, the selection of different portions of stools has no apparent influence on the number of eggs obtained.

2.2.5.PRESERVATION OF S. mansoni EGGS WITH SODIUM AZIDE

The Kato thick smear has become a standard method used in numerous schistosomiasis projects because of its simplicity, reproducibility and economy[1,2,3]. Unfortunately, a major disadvantage associated with its use is the difficulty in preserving specimens for examination at a later date. Recent research, however, has shown that sodium azide mixed with the stool at a concentration of 2 to 5 mg per gram of stool effectively preserves eggs of Trichuris, Ascaris and Necator.[4] Since large molecules readily cross schistosome egg shells[5], sodium azide should penetrate schistosome eggs. Thus, the compound was tested as a preservative for feces containing Schistosoma mansoni

eggs.

Stool samples were collected at a primary school in the village of Makenene, Mbam Division, Center Province, known for its high prevalence of S. mansoni. After immediate return to the Yaounde laboratory, Kato thick smears were prepared using a portion of each fresh sample. The rest of each sample was placed in a hemolysis tube, and then 3 to 5 mg of sodium azide per gram of stool was added to each tube and mixed well into the stool. The tubes were kept on a shelf, and samples were taken at 1, 2, 4, 8, and 12 weeks for Kato thick smear examination.

The results of the 38 samples examined for 12 weeks are presented in Table PAR 2.

Throughout the 12 weeks, there were no signs of deterioration of the samples; egg morphology remained good throughout the time of conservation. No gas was produced, and a decrease in odor of the preserved specimens was noted.

The geometric mean of the samples showed a small decrease from the initial examination, 23 eggs/40mg, to the end of the first week, 18 eggs/40mg. From then on the results were relatively stable. Analysis of the data was performed in the following manner: for each sample, the log of the counts was regressed on time, obtaining a rate of decay for each sample. Then, a T-Test was performed to determine if the mean rate of decay for all samples was significantly different from 0. Results of the analysis showed a significant decrease in the number of eggs over time ($T = -2.81, p\ .01$). However, on average less than half the eggs were lost. More important, no sample became negative.

Table PAR 2. Preservation of S. mansoni eggs in stools, egg counts per 40mg stool.

Sample Id no.	Examination at week number 0	1	2	4	8	12
1	8	8	4	8	18	6
2	61	22	22	31	20	28
3	44	57	16	47	46	46
4	10	16	16	20	14	14
5	18	10	44	19	21	16
6	65	45	36	16	8	9
7	116	84	116	96	100	178
8	137	99	155	114	70	98
9	44	57	50	70	68	48
10	18	13	20	14	4	19
11	66	46	48	14	14	8
12	151	52	80	88	96	139
13	135	62	89	53	44	73
14	14	10	17	16	17	16
15	26	33	18	5	8	14
16	13	7	8	3	4	12
17	30	18	19	38	12	8
18	25	27	21	9	20	39
19	12	2	1	5	1	2
20	12	10	1	4	7	4
21	26	14	34	8	16	17
22	15	6	12	3	6	11
23	9	18	2	1	12	18
24	4	4	16	1	5	2
25	37	34	16	29	12	34
26	35	51	85	38	60	58
27	6	8	5	2	4	8
28	52	17	11	16	16	20
29	2	14	32	6	4	9
30	62	16	14	11	38	46
31	40	37	52	25	38	28
32	19	26	15	7	8	6
33	25	10	8	62	14	16
34	4	4	11	14	10	1
35	58	17	12	2	10	5
36	13	10	19	2	9	19
37	10	13	12	10	7	1
38	10	12	13	2	8	16
Geometric mean	23	18	18	12	14	15

Despite the loss of eggs over time, sodium azide is an apparently effective agent to preserve S. mansoni eggs in stools since eggs are found after 12 weeks of preservation. However, there is an initial decrease in egg counts from the fresh stool to the first examination after 1 week. This decrease may result from a change in stool consistency from the fresh to the preserved stools. Further studies are needed to clarify why samples lost eggs. For practical purposes, though, this decrease in egg count has very limited impact on the results of a

mass epidemiologic survey in areas of high schistosomiasis mansoni endemicity. However, in special studies requiring an optimum sensitivity, use of sodium azide to preserve stools for Kato examination would not be recommended. If preservation is a must, use of formalin and examination by a modified formol-ether concentration method would be preferred.[6]

References:

[1]Kato, K. & Miura, M. *Jap. J. Parasit.* 3: 35, (1954).
[2]Katz, N. *et al.* *J. Parasit.* 56: 1032, (1970).
[3]Martin, L.K. & Beaver, P.C. *Amer. J. Trop. Med. Hyg.* 17: 382, (1968).
[4]Bundy, D.A. *et al.* *Parasit.* 90: 463, (1985).
[5]Boros, D.L. & Warren, K.S. *J. Exp. Med.* 132: 488, (1970).
[6]Knight, W.B. *et al.* *Amer. J. Trop. Med. Hyg.* 25: 818, (1976).

2.2.6. LABORATORY PERFORMANCE

A system to monitor the absenteeism and performance of the laboratory technicians was put in place in October 1985. First we evaluate the technician output (number of effective days of work). Each important activity was timed: for example on an average day a technician should be able to prepare 90 Katos, read 40 Katos, prepare and read 15 formol-ethers (Ritchie), sediment 120 urines and read 60 urines. For each week the total number of activities performed are added and then divided by the average/day in order to figure out the day-equivalent. For example if 180 Kato are prepared and 450 Kato are read during a week, the output for the week is 180/90 = 2days for Kato preparation, + 450/30 = 15 days for Kato reading, a total of 17 days for the week. Additional activities are calculated on their day-equivalent and added. The effective output of the lab for the week is in the column "work days effective". Second we monitor the input from the technicians: number of workdays during the week (usually 5), total number of technicians on duty, actual number of days technicians were present. If there were 5 days in the week and 4 technicians were on duty, there should have been 20 technician-days for the week. If there were only 18 days of technicians, the percentage of presence (measure of technician absenteeism) is 18/20 = 90%. Knowing the input and output in technician time, it is possible to calculate the "percent of performance" that evaluate how effective the technician were. For example if the actual number of technician days of presence were 18 days and if the output was 17 days, the percentage of performance 17/18 = 94.4%.

2.2.7. QUALITY CONTROL

At the same time a system of quality control was instituted. All slides read are set aside and a 10% random sample is drawn each day. The selected slide are re-examined in a blind manner by a second technician. The laboratory supervisor will then compare first and second examination results. If there is a disagreement, the supervisor examine the slide in order to determine the right reading. Records are kept as false positive or false negative readings. For numerical value first and second reading are recorded. A reasonable range of error was prepared, error beyond the range are recorded as such. If the examinations takes place in an area of very low prevalence, all positive slides and 10% of the negative slides are controlled.

2.2.8. COMPARISON KATO AND RITCHIE

The Kato technique is very simple to use and therefore was the method of choice for large scale stool surveys. However in a typical Kato smear, one looks at about 40mg of stools. In areas of very low endemicity with low intensities of infection, one may miss a significant number of infections. In order to evaluate the underestimation of prevalence done by Kato, a system of cross checking with Formol-ether concentrations was established. The formol-ether technique uses 1 gram of stools (24 times more than the Kato). Performing the formol-ethers is time consuming and requires special care. Therefore it could not be done on a large scale. A sample of 10% of the stools are thus examined by the formol-ether technique. At the beginning (October 1985), the technicians were not performing the formol-ether very well and were missing positive stools. In latter months the formol-ether improved to the point that they became more sensitive than the Katos (expected result).

2.3. MALACOLOGIC STUDIES

2.3.1.NATION-WIDE MALACOLOGICAL SURVEY

Cameroon has a diversity of ecosystems ranging from lowland rain forest in the Equatorial Climatic Zone of the south, to sahelian conditions in the Tropical Climatic Zone of the extreme north. There is also an unusually large number of different schistosomes endemic in man - S. haematobium, S. intercalatum, S. mansoni and a S. haematobium/S. intercalatum hybrid. Eight potential snail hosts for these schistosomes have been reported from Cameroon[3].

Snails were collected by hand or, more often, with a scoop. Attempts were made to visit all sites included in the national survey of school children. Collecting expeditions to various regions of the country were undertaken during the late rainy season and/or early dry season.

Sampling sites usually included contact points indicated by local inhabitants to be frequently used for washing and bathing. The location, type of habitat, and pertinent ecological data were recorded for each sampling site. Habitats were roughly classified as follows: ponds, standing water less than 200m in diameter; lakes, standing water greater than 200m in diameter; swamps, standing water with emergent vegetation found throughout; streams, flowing water less than 3m wide; and rivers, flowing water greater than 3m wide. Snails were preserved in 70% ethanol and identified at the main laboratory in Yaounde. Infections in bulinid snails from the sahelian regions were occasionally identified on the basis of eggs recovered from experimentally infected hamsters.

Our survey, carried out between 1985 and 1988, included sampling at 668 sites in 432 towns, villages, and rural settlements throughout Cameroon. Collections were made in all 49 political divisions and in 141 of 182 subdivisions. Seven species of snails known to hosts human schistosomes were recovered: Bulinus senegalensis Muller, Bulinus globosus (Morelet), B. truncatus (Audouin), Bulinus camerunensis Mandahl-Barth, Bulinus forskalii (Ehrenberg), Biomphalaria camerunensis (Boettger), and Biomphalaria pfeifferi (Krauss). We also found a diploid B. truncatus/tropicus-complex snail that has tentatively been identified as B. natalensis (Kuster).[6] Although the role of this snail as a host of schistosomes infecting man is doubtful, it has been included in the discussion below. We did not find Bulinus umbilicatus Mandahl-Barth, previously reported by Same-Ekobo [3] from one locality in northern Cameroon.

The distributions of snail hosts of Schistosoma haematobium (Bilharz) are shown in Figure 1. Bulinus senegalensis was present at 49 sites in the Tropical Zone, making it the most commonly recovered snail in that zone. It occurred only in the more arid regions and does not occur south of 8° N latitude, between Ngaoundere and Garoua. It was found on laterite, clay, and sandy-clay substrates. It was more common in standing water (1 lake, 24 ponds, 1 swamp) than flowing water (7 rivers, 8 streams). It was more frequently found in the smaller water bodies (ponds and streams) than in the larger ones (lakes and rivers).

Bulinus globosus was found at a total of 32 sites, of which 28 were temporary and 4 permanent. Twenty-nine sites are in the Tropical Zone where it shows a more southerly distribution than B. senegalensis. Its extended from slightly north of Maroua to near Ngaoundere. Bulinus globosus was found at only three sites in the Guinea-type Equatorial Zone. Two of these sites are at the fringe of the savannah and the third is in the middle of the capitol, Yaounde. It was present in an equal number of standing water (3 lakes, 13 ponds) and

flowing water (6 rivers, 10 streams) habitats. It was more common in the smaller than larger water bodies.

Bulinus truncatus was recovered from 22 sites, 11 in the Equatorial Zone and 11 in the Tropical Zone. Although this species was widely distributed in the Tropical Zone, it is highly focal, being restricted in all but one case to man-made water bodies. In the Equatorial Zone it was concentrated in the Cameroon-type region, with only one site in the Guinea-type region. This species is predominately associated with permanent water (22 sites). Even the four temporary sites, located in water development projects in the extreme north of the country, do not undergo to the severe drought normally experienced by natural water bodies in that region. This species was more common in standing water (12 lakes, 3 ponds, 1 swamp) than flowing water (6 rivers, 4 streams). Its preponderance in larger water bodies, particularly lakes supports evidence that it is almost strictly found in permanent habitats, in contrast to B. globosus or B. senegalensis.

Bulinus camerunensis was only found at the two localities where it has previously been reported. Barombi Kotto and Lake Debunscha, both crater lakes in the Cameroon-type region, comprise the known worldwide distribution of this species.

Bulinus natalensis was found at 9 sites in the Cameroon-type region, where they occur predominately in crater lakes.

The distribution of snail hosts of Schistosoma mansoni Sambon are shown in Figure 2. Biomphalaria pfeifferi was found at 34 sites scattered widely throughout most of the country. It was notably absent from the Sahara-type climatic region and, except for one locality, from the eastern half of the Guinea-type region. It was most common in the Sudan-type region (16 sites). Overall it occurred more often in permanent (22 sites) than in temporary (12 sites) habitats. It was present in almost equal numbers of standing water (10 lakes, 6 ponds) and flowing water (5 rivers, 13 streams) habitats and in roughly equal numbers of large and small water bodies.

Biomphalaria camerunensis was found at 42 sites throughout the Equatorial Zone, being notably absent from the coastal areas. This species showed a marked preference for permanent habitats. It was found in 39 permanent and only 3 temporary habitats. Even these temporary sites, being located in the wetter region of the country, are dry for relatively short periods of time. It was less common in standing water (3 lakes, 6 ponds, 7 swamps) than in flowing water (4 rivers, 22 streams) and more often found in the smaller water bodies.

The distribution of B. forsaklii, the only host for S. intercalatum in Cameroon, is shown in Figure 3. This species is the most common and widely distributed of all the schistosome host species. It was found at 68 sites, which were about equally divided between the Tropical(32) and Equatorial (36) Zones. It was also recovered from roughly equal numbers of temporary (35) and permanent (33) habitats. Bulinus forskalii was less common in standing water (8 lakes, 19 ponds, 1 swamp) than flowing water (15 rivers, 25 streams) and was more common in the smaller water bodies.

Among species with ranges that overlapped considerably, an analysis for the occurrence of shared habitats revealed some interesting associations among some species. Positive associations were strongest in temporary habitats of the Tropical Zone where B. globosus occurred with B. senegalensis at 14 sites, with B. forsaklii at 15 sites, and with B. pfeifferi at 10 sites. Bulinus forskalii

and B. senegalensis were together at 18 sites, and Bulinus senegalensis was present at 4 of the 17 B. pfeifferi habitats.

Negative correlations were also evident in the Tropical Zone. Bulinus truncatus was found in the same site with B. globosus only once and never with B. senegalensis, reflecting the strong preference of B. truncatus for more permanent water bodies and the latter two species for temporary habitats. Among species with overlapping ranges in both Tropical and Equatorial Zones, B. forsaklii and B. truncatus occurred together at 9 sites, B. forsaklii and B. pfeifferi at 11 sites, B. truncatus and B. pfeifferi at 4 sites. Of species associations limited to the Equatorial Zone, B. forsaklii and B. camerunensis were together at 6 sites. We noted a strong negative correlation between Biomphalaria camerunensis and B. pfeifferi in this region. These snails were never found together despite broad overlaps in their distributions and habitat preferences. And to a lesser extent there was a negative correlation between Biomphalaria camerunensis and B. truncatus, which occurred together at one site.

Schistosoma haematobium cercariae were recovered from B. globosus, B. truncatus, and B. senegalensis collected in the Tropical Zone.

Snail host distributions are particularly interesting in light of the distribution of schistosomiasis. In the northern half of the Sahara-type region, the most arid region of Cameroon, B. senegalensis is the only snail host present and prevalence levels of Schistosoma haematobium among school children range from 5 to 19%. Further south, where both B. globosus and B. senegalensis are most common, the prevalence levels for S. haematobium are by far the highest in the country. Bulinus truncatus is also present in that region but is restricted to rice agriculture schemes in the east and man-made reservoirs in the west. Still further south in the Tropical Zone B. globosus and B. senegalensis become less common and disappear, B. truncatus is the most common snail host, and prevalences of S. haematobium drop below 5%.

Throughout most of the Tropical Zone, and particularly in the north half where the prevalence of S. haematobium are highest, the only surface water present is temporary ponds and streams. These are generally heavily used by local inhabitants and are frequently habitats for B. globosus and/or B. senegalensis. The highest prevalences of urinary schistosomiasis [1] correspond well with regions where the distributions of B. globosus and B. senegalensis overlap, suggesting that the combined transmission by these species is partly responsible for the elevated prevalences.

Several recent studies have concentrated on schistosomiasis in water development projects in the extreme north, such as the rice scheme along the Chadian border [3,9,10] and small reservoirs in the Mandara Mountains near the Nigerian border. [3,11,12] Those relatively permanent water bodies have been implicated as the major foci of transmission and, not surprisingly, the importance of temporary water bodies in transmission and the wide-spread occurrence of B. senegalensis were overlooked.

The prescient observations of Wright, [13] made some thirty years ago with regard to transmission foci of urinary schistosomiasis in arid regions of sub-Saharan Africa, are still pertinent today. "While there is no doubt that many of these foci are centered on oases or near rivers and streams where the intermediate hosts probably belong to the B. truncatus group or even to the Bulinus (Physopsis) globosus complex, it is more than likely that hitherto undetected populations of B. senegalensis are of even greater epidemiological

significance. Such populations will only be found during the wet season or in the early part of the dry season when the rain pools still contain water." Our evidence indicates that B. globosus is also be an important host in such temporary water habitats.

In the Equatorial Zone, where there are several important but highly focal schistosomiasis haematobium endemic areas, B. truncatus is the principal snail host. Other known hosts in that region are B. camerunensis, known to transmit S. haematobium or a S. haematobium/S. intercalatum hybrid at Barombi Kotto crater lake, [14] and B. forsaklii a host, along with B. truncatus , for S. haematobium/S. intercalatum hybrids at Loum. [15]

The distribution of S. mansoni and those of its potential hosts clearly indicate that B. pfeifferi is the principal host in Cameroon. In the Eastern and Southern regions of the Equatorial Zone, where B. camerunensis is most common, prevalence rates of S. mansoni seldom exceeded 5%. [2] We suspect that this may be due to poor compatibility between B. camerunensis and S. mansoni, an idea that has received some support. Ripert et al. [16], working in a Cameroonian village where B. camerunensis was the only host present, found the prevalence in man to be below 5%, whereas in a nearby village with only B. pfeifferi present the prevalence in man was greater than 20%. Mandahl-Barth et al. [17] found that B. camerunensis played a relatively minor role in transmission when compared to that of B. pfeifferi in Zaire. Frandsen, [18] using an elaborate laboratory test for compatibility, examined several populations of B. camerunensis and B. pfeifferi for susceptibility to isolates of S. mansoni. He demonstrated both B. pfeifferi and B. camerunensis from Central and South Africa could host S. mansoni from that same region, but snails from only two of five B. camerunensis populations were good hosts whereas snails from four of five B. pfeifferi populations were good hosts. Poor compatibility with B. camerunensis may be a major factor in the near absence of S. mansoni from large regions of Cameroon where that snail is most common.

The distribution of B. forsaklii is far greater than the distribution of S. intercalatum in Cameroon [2] and in Africa in general. Bulinus forskalii from regions of the country where the disease is not found are susceptible to S. intercalatum (unpublished observations), thus the absence of suitable snail hosts is apparently not a factor in this limited distribution. Two hypotheses have been offered to explain the discrepancies between the distributions of S. intercalatum and its snail hosts (Southgate,1978). Wright et al. demonstrated that S. intercalatum cercariae release the contents of their penetration glands and are no longer infective to mammals soon after they have been subjected, in the presence of strong light, to small increases in temperature. This response would obviously inhibit transmission to mammals in large areas of Africa that experience relatively large temperature changes, such as the savannah and sahelian regions. A second hypothesis suggest that the ease with which S. intercalatum hybridizes with S. haematobium and the dominance of the latter species in backcrosses, means that S. intercalatum would eventually be replaced by S. haematobium.(Southgate, 1978)

3. Same-Ekobo, A. 1984. Faune Malacologique du Cameroun. Doctoral Thesis. University of Rennes.
4. Wright, C.A., 1965. The freshwater gastropod molluscs of West Cameroon. *Bull. Brit. Mus. (Nat. Hist.), 13*: 75-98.
5. Gwanfogbe, M., and Melingui, A., 1983. *Geography of Cameroon*. MacMillan, London.
6. Mimpfoundi, R., and Greer, G.J. Allozyme comparisons and ploidy levels among

species of the Bulinus truncatus/tropicus complex (Mollusca: Planorbidae) in Cameroon. *In preparation*
7. Betterton C., Fryer S.E., and Wright C.A., 1983. Bulinus senegalensis (Mollusca: Planorbidae) in northern Nigeria. *Ann. Trop. Med. Parasitol., 77*: 143-149.
8. Goll, P.H., 1981. Mixed populations of Bulinus senegalensis (Muller) and Bulinus forskalii (Ehrenburg) (Mollusca: Planorbidae) in the Gambia. *Trans. R. Soc. Trop. Med. Hyg., 75*: 576-578.
9. Wibaux-Charlois, M., Yelnik, A., Ibrahima, H., Same-Ekobo, A., and Ripert, C., 1982. Etude épidémiologique de la bilharziose à S. haematobium dans le périmètre rizicole de Yagoua (Nord-Cameroun) II. Distribution et écologie des hôtes intermédiaires. *Bull. Soc. Path. Exot., 75*: 72-93.
10. Yelnik, P.A., Issoufa, H., Appriou, M., Tribouley, J., Gentilini, M., Ripert, C., 1982. Etude épidémiologique de la bilharziose à S. haematobium dans le périmètre rizicole de Yagoua (Nord-Cameroun). I. Prévalence. *Bull. Soc. Pathol. Exot., 75*: 62-71.
11. Ripert, C., Steveny, J., Tieche, A., Tribouley, J., Appriou, M., Lucas, J.J., and Cavallo, J.D., 1983 Etude épidémiologique des helminthiases intestinales et de la bilharziose urinaire dans la région de Koza (Monts Mandara - Nord Cameroun). *Travaux et Documents de Geographie Tropicale, 48*: 177-186.
12. Granier, H., Granier-Filloux, F., Granier-Guionie, M., Couprie, B., Same-Ekobo, A., Appriou, M., Tribouley, J., and Ripert, C., 1985. Etude épidémiologique des bilharzioses intestinale et urinaire dans la région de Tala Mokolo (Mont Mandara - Nord Cameroun). *Med. Tropicale, 45*: 27-33.
13. Wright, C.A., 1959. A note on the distribution of Bulinus senegalensis. *West African Med. J. 8*: 142-148.
14. Duke, B.O.L., and Moore, P.J., 1971. The control of Schistosoma haematobiumin West Cameroon. *Trans. R. Soc. Trop. Med. Hyg., 65*: 841-843.
15. Southgate, V. R., Van Wijk, H.B., and Wright, C.A., 1976. Schistosomiasis at Loum, Cameroun; Schistosoma haematobium, S. intercalatum and their natural hybrid. *Z. Parasitenk., 49*: 146-159.
16. Ripert, C., Ambroise-Thomas, P., and Rousselle-Sauer, C., 1978. Etude épidémiologique des foyers de schistosomose à S. mansoni de Minkama et Nalassi. (Département de la Lékié, Cameroun). *Rev. Epidemiol. Sante Publ., 26*: 403-412.
17. Mandahl-Barth, G., Ripert, C., and Raccurt, C., 1974. Nature du sous-sol, répartition des mollusques dulcaquicoles et foyers de bilharzioses intestinale et urinaire au Bas-Zaire. *Revue Zool. Africaine, 88*: 553-584.
18. Frandsen, F., 1979. Discussion of the relationships between *Schistosoma* and their intermediate hosts, assessment of the degree of host-parasite compatibility and evaluation of schistosome taxonomy. *Z. Parasitenk., 58*: 275-296.
Southgate, V.R., 1978. On factors possibly restricting the distribution of Schistosoma intercalatum Fisher, 1934. *Z. Parasitenk., 56*: 183-193.

2.3.2.MALACOLOGICAL MUSEUM

The museum has now roughly 200 specimens on file in the computerized catalog system.

2.3.3.LABORATORY STUDIES

Colonies for all snail hosts in Cameroun had been established in the main laboratory in Yaounde.

Most malacologists agree that the systematics of the biomphalarids, and the bulinid snails of Central and West Africa, needs stabilization. The problem is compounded by the existence of species and strains or ecotypes of the same bulinid species, each susceptible to only a certain strain of the schistosome. Even at the generic level, more than one type of Bulinus has been proposed. According to Mandahl-Barth (1958) the genus Bulinus is divided into the subgenus Bulinus, comprising the B. forskalii, B. truncatus and B. tropicus groups, and the sub-genus Physopsis, comprising the B. africanus group. On the other hand, Brown (1980) divides the genus Bulinus into the B. forskalii, the B. reticulatus, the B. truncatus/tropicus and the B. africanus groups. Because of the complexity of the Bulinus taxonomy, several taxonomical tools, notably morphology, chromosome cytology, genetics, enzyme electrophoresis were used for the correct identification of the various snail stocks collected from the field.

2.3.3.1.ELECTROPHORETIC STUDIES

In recent years, malacologists have attempted to refine enzyme electrophoresis of certain bulinid and biomphalarid snails. In these studies foot muscle, digestive gland, whole snail and egg proteins from the perivitelline fluid have been used to separate species and different populations of the same species. In taxonomic studies using electrophoresis the advantage of recording several enzymes phenotypes from each specimen is to increase the possibility of detecting closely related species.

Populations of most snail host species, collected from locations representative of various ecological regions of Cameroon, have been studied. Extracts obtained from ground wild adult snails and laboratory first-generation adults were used for starch gel electrophoretic analysis in 15 isoenzyme systems.

It was first believed that diploid species of Bulinus occur only south of the Sahara and the only species that had been studied north of the Sahara were tetraploids. However, tetraploid populations were also found in south saharan countries. In Cameroon, tetraploid populations of B. truncatus/tropicus complex were found in several sites (Wright, Rollison, 1981). Dr. P. Kat, who is presently working at the National Museum of Kenya Laboratories, was the consultant chosen to help the project set up rapidly the electrophoretic analyses. An electrophoretic protocol for Bulinus has been designed based on 11 enzyme loci. This protocol can be expanded to survey a total of 16 enzyme loci. In the future it has the potential to be expanded to a 30 enzyme loci.

2.3.4.SNAIL POPULATION DYNAMICS STUDIES

PROCEDURES: Timed collections were carried out on a monthly (Obili, Mfou) or three-weekly (sahelian sites) interval at the same sites by the same worker(s). Samples were returned to the work station where the snails were separated and measured. Snail measurements were grouped into the following size categories: <2.0mm, 2.0-2.9mm, 3.0-3.9mm, etc. Snails greater than 3mm in length

were then placed individually in containers that were checked the following morning beginning at 10h30 for cercariae. Snails not producing schistosome cercariae were returned to their respective sites and released.

From these data, growth curves and other population parameters, such as intrinsic rate of natural increase, were determined for the various species of snail hosts collected. Prevalence rates helped identify the location and time of greatest transmission to man. These data were used to develop intervention strategies.

Cercariae are identified to the family level for non-schistosome species. Schistosomatidae cercariae are further differentiated in the field into those belonging to genus Schistosoma and those belonging to other genera. Identification to the species level was attempted, when possible, based on adult worms recovered from mice and hamsters exposed to these cercariae.

SITES: In conjunction with the epidemiology team, work was carried out in two longitudinal study sites in the Center Province: a lake in Yaounde's Obili Quartier behind CUSS, and a lake in the town of Mfou, located about 40 km south of Yaounde. Obili, an urban site, was chosen despite the apparent recent cessation of transmission because of its convenience for training of staff and because of the occurrence of at least two snail hosts: B. globosus and B. forsaklii. Previous studies at Mfou indicate that transmission is limited to a lake in the center of town where B. pfeifferi and B. forsaklii occur.

In addition to the Obili and Mfou sites in the Central Province, four sites in the sahelian region of the Extreme North Province were chosen for our longitudinal study. Sites were chosen in the Extreme North Province because the national school survey found widespread occurrence of both S. haematobium and S. mansoni throughout the province, with very high prevalences in certain subdivisions. This sahelian region has one wet season (June-September) and one dry season (October-May). Few bodies of permanent surface water exist, and the numerous earlier studies noting the problem of schistosomiasis in the Extreme North have focused exclusively upon the relatively small transmission sites in the two areas where permanent water bodies are found: the Logone-Chari River drainage system and associated rice schemes extending along the Chadian border from Yagoua to Lake Chad.[1,2,3,4,5], and the Mandara Mountain region of the Mokolo and Koza Subdivisions, where permanent man-made reservoirs are thought to be responsible for increased transmission.[6,7] These reports uniformly suggest that permanent standing water is the major, if not the sole, source of transmission.[2,3,4,5,6,7] However, no study has demonstrated its importance vis-a-vis temporary bodies of water in the same area.

Our malacological studies revealed that B. globosus and B. senegalensis, both potential hosts for haematobium, are common in temporary bodies of water throughout most of this region, while Biomphalaria pfeifferi is less common, but also widely distributed. Additionally, Two studies have pointed out the potential importance of Mayo Guerleo, a temporary river bordering part of the rice scheme, as a source of transmission.[5,8]

Thus, with evidence indicating that temporary bodies of water are probably the major source of transmission throughout the North and Extreme North, we chose sites that would be typical for the region rather than focusing solely upon permanent surface-water bodies. Another criterion for selection was that the sites chosen offer an opportunity to compare the prevalence of haematobium infection in its various potential host species and to compare the prevalence of

infection in snails in temporary and permanent bodies of water. The four sites chosen are described below.

Kolofata, seat of Kolofata Subdivision near the Nigerian border, is the western most site. The school survey indicated prevalences of 71% for haematobium schistosomiasis and 3% for mansoni schistosomiasis. Bulinus globosus, B. senegalensis and B. forsaklii were recovered from temporary bodies of water in the village during the national malacological survey. There is no permanent surface water in this village. Seven collecting sites were chosen: 2 at a small temporary pond .7km from town center, one at a small seasonal pond .3km from town center, and four along Mayo Kolofata, a temporary river running through the town (mayo is a Fulfulde word meaning a temporary river). Collecting sites on Mayo Kolofata, and at mayos at other sites, were standing pools that remain after the rains have subsided.

Guereme is located on the border between Kaele and Guidiguis Subdivisions about 60 kilometers south of Maroua. The school survey found prevalences of 67% for haematobium infection, 61% for mansoni and 14% for terminal spined eggs in the stool. Snail species found there include B. globosus, B. senegalensis, B. forsaklii and Biomphalaria pfeifferi. There is no permanent permanent surface water in this village. Ten collecting sites were chosen: 2 at a seasonal pond in town, 4 at Mayo Going about 200m from town, and 4 on Mayo Toroc which runs through town.

Yagoua, a city of approximately 25,000 located near the Chadian border, is the administrative seat for SEMRY, the quasi-public company managing the rice schemes in the Extreme North. Prevalences from the school survey were 40% for haematobium, 12% for mansoni and 4% for terminal-spined eggs in the stool. Snails found in town include B. globosus, B. senegalensis and B. forsaklii. The closest permanent standing water to Yagoua is the Logone River, about 5 km from town's center. Ten collecting sites were chosen: 3 on Mayo Danay, which runs through the center of town, 5 at a series of ponds in Djibetsou Quarter west of town, and 2 at Mayo Guerleo north of the town's center .

Toukou is a village about 6 km north of Yagoua and is located in the SEMRY rice scheme. The school survey did not include this village but Yelnik *et al.*[2] reported a prevalence of 60 % for S. haematobium. There are both permanent and temporary bodies of water in Toukou. Fifteen collecting sites were chosen: 2 at a small temporary pond behind the school, 2 at another temporary pond in the village, 2 at a borrow pit between the levy for the irrigation canal and nearby homes, 5 along the main irrigation canal, 2 at secondary irrigation canals, and 2 in the rice paddy fields. B. globosus, B. senegalensis, B. forsaklii and B. truncatus have been recovered from the irrigation ditches. B. senegalensis is the only species that has been recovered from the temporary bodies of water.

Preliminary results:

Obili. Large numbers of B. globosus and B. forsaklii have been taken at this pond since February, but none has been infected. This lack of infection is not surprising, though, because the epidemiologic survey found only S. mansoni in the local population. Previous research has indicated that Biomphalaria pfeifferi, present in the lake until roughly three years ago, has disappeared for unknown reasons.[9]

Mfou. Small numbers of B. pfeifferi and B. forskalii have been recovered from the small lake. One S. mansoni-infected B. pfeifferi was collected in April

and two in July 1987.

The year 1987-88 rainy season has not been "typical." Although, the first rains in the region came on time in early June, it did not rain again in Kolofata or Guereme until about mid-July. During most of this period there was no standing water, and, naturally, no snails. By September, the snail populations had begun to increase substantially in those villages. Below is a rough site-by-site account of our findings through the end of September:

Kolofata. Snails were found the first week of June within 4 days of the season's first rains, but none was collected again until late August. No schistosome-infected snails have been recovered.

Guereme. Snails were found the first week in June but not again until the 19th of July. No infected snails have been recovered.

Yagoua. At a small temporary pond in Djibetsou Quarter, B. globosus specimens were collected continuously from the end of June to September. Infections were first found in mid-August when 5 infected snails were isolated. Sampling in late September produced 35 infected snails from the five sites at this pond. One infected B. senegalensis snail has been recovered from Mayo Guerleo.

Toukou. Two infected B. truncatus have been recovered from the main irrigation canal; one in late June and one in mid-July.

References:

[1]Deschiens, A. *et al.* *Bull. Soc. Path. Exoc.* 5: 772-777, (1968).
[2]Yelnik, A. *et al.* *Bull. Soc. Path. Exoc.* 75: 62-71, (1982).
[3]Wibaux-Charlois,M. *et al.* *Bull. Soc. Path. Exoc.* 75: 72-33, (1982).
[4]Ripert, C. *et al.* *Bull. Soc. Path. Exoc.* 76: 689-697, (1983).
[5]Audibert, M. *et al.* *Acta Trop.* 40: 177-186, (1903).
[6]Ripert, C. *et al.* *Trop. et Sante C.E.G.E.T.*,(4-6 Oct 1982).
[7]Granier, H. *et al.* *Med. Trop.* 45: 27-33, (1985).
[8]Dololme, H. *et al.* *Bull OCEAC* 56: 75-92, (1983).
[9]Mimpfoundi, R. Personal Communication.

2.3.5.HYBRIDIZATION STUDIES:

Important aspects of malacologic observations in Kindig included the recovery of terminal-spine eggs from the urine (20%) and stool (34%) of 166 persons from the general population of that small community. In general, the eggs from both urine and stool most closely resembled S. haematobium in shape and size, with an average length of 142 microns. However, a considerable proportion (15%) closely resembled S. intercalatum eggs in shape and in length (greater than 170 microns). These findings suggested that either both S. haematobium and S. intercalatum were being transmitted in the village or that the village was a foci for S. haematobium/S. intercalatum hybrids. This latter hypothesis was indirectly supported by information on the history of the disease in Kindig Njabi. Villagers reported that the disease was unknown there until several years ago, and that a number of immigrants from Loum, an area where natural hybrids have been reported from man,[1,2] had arrived during the past several years. This hypothesis also received support from the malacology team, which found B. forsaklii, a known host for S. intercalatum and the hybrid, but no hosts for S. haematobium in the vicinity of the village. The malacology team began studies on the snail host specificity of Kindig Njabi miracidia in an attempt to establish the identity of this parasite. Previous research has shown that miracidia hatched from the urine of patients suspected of harboring hybrids are infective to both B. truncatus and B. forsaklii, whereas pure strains of S. haematobium do not normally infect B. forskalii, and S. intercalatum strains are not compatible with B. truncatus.[1] . Experimental observations have confirmed this broader host specificity for the hybrid and have also shown that the male S. haematobium/female S. intercalatum cross can be easily maintained in the laboratory, but the reverse is not successful.[1,2,3] Initial attempts to infect snails with miracidia from Kindig Njabi eggs met with limited success: with miracidia obtained from urine samples, about 15% of B. truncatus exposed became infected, but all attempts to infect B. forsaklii with these miracidia failed. On the other hand, miracidia obtained from stool of these patients successfully infected B. forskalii but failed to infect B. truncatus. This success with miracidia obtained from eggs found in stool is in complete contrast to results from earlier work with hybrids in Cameroon.[2] This is one among several of our findings that are not in agreement with previous research and that taken together have made identification of this parasite difficult. Cercariae from these laboratory infected snails were used to infect mice in order to further test the snail host specificity. Mice infected with cercariae from B. truncatus produced eggs containing active miracidia, but too few were obtained to use in further tests. Mice infected with cercariae from B. forsaklii, though, produced sufficient numbers of miracidia to expose 6 groups of 20 truncatus from various regions of the country and 8 groups of 10-20 forskalii. Interestingly, none of the B. truncatus became infected, whereas between 10-50% of the B. forskalii in 6 of 8 groups produced cercariae. Taken together, our results give mixed indications concerning the nature of the schistosome at Kindig Njabi. The presence of only B. forsaklii at Kindig Njabi indicates that the schistosome is either S. intercalatum or a S. haematobium/S. intercalatum hybrid, because these are the only human schistosomes transmitted by this snail. However, the high prevalence of persons producing terminal-spine eggs in both urine and stool does not fit the pattern of S. intercalatum, which is usually found in the stool. And although both B. truncatus and B. forskalii were successfully infected with miracidia from Kindig Njabi patients, miracidia obtained after a passage through mice were infective only to B. forsaklii. This finding is not in agreement with earlier studies on the hybrid and leaves open the possibility that both S. intercalatum and S. haematobium are being transmitted in the village. That final

possibility, which necessitates the presence of a previously overlooked snail host at the site, is also problematical. If both S. haematobium and S. intercalatum were in the area, one would expect, based on previous studies, that hybridization would occur and evidence of this could be found in a broader snail host specificity. Further work aimed at clarifying the taxonomic status of this parasite will include attempts to verify our earlier findings by infecting laboratory reared B. truncatus and B. forskalii with miracidia from urine and stool of patients at Kindig Njabi. We will also try again to establish a laboratory isolate from naturally infected B. forsaklii collected in the village, which will be then tested for its snail host compatibility in a similar manner to other isolates.

References:
[1]Wright, C.A. et *al*. *Trans. Roy. Soc. Trop. Med. Hyg*. 68:413-414, (1974).
[2]Southgate, *et al*. *Z. Parasitenk*. 49:145-159, (1976).
[3]Mutani, A. *et al*. *Acta Trop*. 42: 319-331, (1985).

2.3.6.MOLLUSK CONTROL STUDIES

2.3.6.1.USE OF ENDOD

Mr. Monkiedje did a laboratory and simulated field evaluation of endod-s (Phytolacca dodecandra) as it related to schistosomiasis control in Cameroon. One of the most effective methods to control schistosomiasis continued to be large scale chemical mollusciciding of the snail intermediate host. In addition to the adverse effects of prolonged, continuous molluscicide application on aquatic biota, the cost of molluscal control remained prohibitively expensive. In view of these obstacle to snail control, the World Health Organization's Special Program on Tropical Diseases had considered the feasibility of using plant molluscicide in the control of schistosomiasis. Out of more than 1100 plant species tested for molluscicidal properties since the early 1930's, the soapberry Phytolacca dodecandra (or Endod, its native Ethiopian name), was selected as the most promising. Extensive studies since 1965 have proven Endod to be a viable plant molluscicide in the control of Schistosomiasis. The existing information on its toxicity and environmental properties however, was insufficient to allow an adequate assessment of its impact on the environment and potential hazard it could cause despite its growing use.

This study was designed: 1)To compare the acute toxicity of Endod to both target snail (Biomphalaria pfeifferi), cercaria, and non-target aquatic organisms such as fish (Tilapia nilotica), algae, Daphnia, and mosquito larvae, with that of Bayluscide (reference molluscicide) to similar organisms, 2)to compare in laboratory conditions the effects of some water quality parameters such as pH, temperature and carbonate hardness on the potency of these molluscicides, 3)to compare in field conditions the impact of Endod-S and Bayluscide on some water quality parameters such as dissolved oxygen, temperature, pH, total hardness, turbidity, total acidity, total alkalinity, conductivity and water algae content.

In order to compare the behavior of these two xenobiotics in the aquatic environment, several important physico-chemical and biological properties of these molluscicides required investigation. These included their solubility in water,their octanol/water partition coefficients, their evaporation rates, their sorption isotherms in soil and activated carbon, their degradation rate under ultra-violet light and their biodegradation rates.

2.3.6.2.EFFECTS OF FERTILIZERS AND PESTICIDES

Mr. P.B. Tchoumwou studied the effects of chemical fertilizers and pesticides including the influence of selected environmental parameters on the transmission of schistosomiasis in Cameroon. Schistosomiasis transmission in most endemic areas was associated with many types of water bodies, both small and large, shallow and deep, standing and flowing, temporary and permanent. Natural habitats include rivers, streams, ponds, marshes and swamps, while artificial systems include irrigation canals, impoundments above dams, as well as man-made ponds. Man-made reservoirs and irrigation schemes are often constructed with the aim of improving the economy, the living standard and the health of the populations involved. However, the creation of these water networks may provide extensive habitats, favorably suited to schistosome eggs and larval stages; as well as to their specific snail hosts. Irrigation systems are likely to be built, adverse health effects due to increase habitat of schistosome proliferation can be expected. In such areas, however, agricultural chemicals such as fertilizers and pesticides are often applied in order to increase the productivity (fertilizers) of crops and to control insects as well as other pests (pesticides). These applications may control potential proliferation.

His study was designed to investigate the effects of chemical fertilizers (ammonium sulfate and urea) and the pesticide malathion recently applied in ricelands of Cameroon, and bayluscide as a reference molluscicidal chemical on various life cycle forms or stages (eggs, miracidia and cercariae) of Schistosoma mansoni and on different developmental stages (eggs, juveniles and adults) of a specific intermediate host (Biomphalaria pfeifferi and of non susceptible freshwater snails (Biomphalaria havanensis and Helisoma trivolvis). It was also intended to study in the laboratory the influence of selected environmental parameters such as temperature, hydrogen ion concentration (pH), dissolved oxygen, hardness, UV light, salinity and conductivity on the effectiveness of such chemicals against S. mansoni eggs, miracidia or cercariae. In addition, this research will attempt to field-verify laboratory findings at longitudinal study sites, and to recommend effective and economically feasible measures for environmental control of schistosomiasis in ricefield agroecosystems of Cameroon.

2.3.6.3.USE OF MOLLUSCICIDES

A pilot study on the use of molluscicide to control snail host was conducted in the area of Dourkoula, Extreme North Province by April MacDowell, a US Peace Corps Volunteer. This study was done in collaboration with Save the Children and the Ministry of Health staff in Dourkoula. The following is a summary of the report submitted by A. MacDowell.

The study's purposes were (1)to explore the effectiveness of mollusciciding as a means of control of the snail host, (2)to identify problems considerations for using molluscicide as part of a large scale schistosomiasis control program. This study was carried out during the rainy season in July and August, 1988.

Molluscicide was applied at different intervals in different locations and the affect on snail populations monitored. Simultaneously, three of the locations (two villages and one neighborhood of Dourkoula) where snail populations were being studied, were also chosen for study of infection rates of the human population. Urine samples were gathered and examined. Medication was provided for those infected.

Ponds from several villages surrounding Dourkoula and two neighborhoods

within Dourkoula were sampled. Based on this information and other factors, five villages and one quarter of Dourkourla were chosen for further study. Snails were collected each two weeks from the locations. In some locations where ponds were numerous, a few ponds were chosen as representative. Ponds that did not yield snails initially were not included.

Collections were performed at the same spot for five minutes using a scoop. The following day, the snails were examined periodically for Schistosoma cercaria. Whenever possible the snails were kept for longer than one day and examined each day for cercariae.

Niclosamide was applied to the ponds at a concentration of 1.5% as recommended by Goll et al. (1984) with the ultimate concentration in the pond not exceeding 0.6mg/liter. Niclosamide is also used as a tapeworm medicine. Since some of these ponds are used for drinking water, using a chemical which would not have adverse affects for humans on the water supply was an important consideration. One village was to be sprayed once every three weeks (three applications), two villages once every month (two applications), two villages only once at the beginning of the project and one village not at all. As new ponds were discovered they were sprayed also. In areas where there were many ponds, only selected ponds were sampled but all ponds were molluscicided. The solution was mixed and poured into a plastic bag with small holes in the bottom. In this way the solution could dribble out. Where possible, in order to facilitate mixing, the person who was applying the solution walked through the water where solution had just been applied. An attempt was made to cover all vegetated areas with solution. The advantage of this method was that the solution could be slung into areas which could not be walked through and therefore the bag, in effect, had a greater range of application area.

In conjunction with work in the ponds, the study was concerned with prevalence of urinary schistosomiasis in the area.

The results were as follows:

Snail Collection: During this study no Bulinus globosus were found; B. senegalensis was the only agent of transmission of schistosomiasis recovered. The following table shows the numbers of snails collected from each location, the date of collection, and the dates of molluscicide application (*).

In Boubaye molluscicides were applied once, snail numbers were increasing markedly after 6 weeks, specially at site 2. It was a very large pond which was difficult to spray. The central vegetated area could not be reached with the sprayer, the pond size increased dramatically after the beginning of the operations and remained very large for the rest of time. Douaye received only one molluscicide application. After a month and a half, snail populations begun to rise again in all ponds, but had not yet reached very high levels. In Dourkoula-Casablanca with approximately 20 ponds, only 4 ponds were sampled for snails though all were molluscicided. Pond 1 was the one the population used most. Molluscicides were applied twice. The number of snails in the ponds were high initially, it decreased after mollusciciding but the populations in site 1 were already rebounding after a few weeks. All of these ponds had a lot of vegetation, and are in a low area. Pond 1 especially receives rain water from a large area from many ponds during rainstorms. Dilution, reintroduction of snails and difficulties in reaching the center may explain the poor results. In Sirlawe 10 ponds were identified. The majority of these ponds were located on the second visit and sprayed at this time. Only one application was made and snail numbers fell drastically after initial spraying. Snails in Ponds 2 and 3 which are the

two most heavily used ponds, began to increase at the time of the last collection, which was approximately one month after initial spraying. In Zouaye 8 ponds were identified. While initial populations were fairly high in some ponds, with two molluscicide applications, once per month, populations never built up to large numbers again. Lokoro was chosen as the control village in which ponds would only be sampled but not molluscicided. For the most part the population of snails continued to grow throughout the study period.

Month	July		August			
week#	3	4	1	2	3	4
Boubaye						
site 1	4*	-	27	-	33	54
2	75*	-	0	-	8	206
3	14*	-	3	-	10	26
4	-	-	-	-	34*	3
Douaye						
site 1	-	26*	16	-	21	70
2	-	17*	0	-	0	51
3	-	1*	2	-	21	31
Dour-koula						
site 1	-	49*	113	*	2	29
2	43	332*	0	*	0	0
3	-	228*	21	*	1	0
4	-	234*	9	*	0	5
Lokoro						
site 1	114	-	118	37	-	59
2	58	-	81	163	-	190
Sirlawé						
site 1	11*	-	0	2	-	10
2	9*	-	0	28	-	39
3	-	-	86*	2	-	36
4	-	-	12*	0	-	0
5	-	-	912*	0	-	1
6	-	-	20*	0	-	-
Zouaye						
site 1	159*	-	24	23*	-	3
2	60*	-	1	0*	-	0
3	235*	-	18	8*	-	6
4	17*	-	0	0*	-	0
5	305*	-	8	8*	-	0
6	-	-	39	20*	-	0
7	-	-	-	63*	-	6

Overall a large number of ponds were found in most of the villages. Many of these ponds had large snail populations. The mollusciciding program was effective though there was a lot of variation between ponds. In some areas a single application was effective throughout the study period while at other sites, an application every three weeks was insufficient. Overall, a schedule of mollusciciding every four to five weeks would seem to be effective for most ponds. The ponds where this schedule would not be effective would have to be identified and targeted in any large mollusciciding program.

Urine Sampling: Urine examinations were carried out on 1022 persons from the three locations: Dourkoula-Casablanca, Sirlawe and Lokoro. A total of 471 positive cases (46%) were identified overall. There was a great deal of variation in infection levels between the locations.

Initiating a mollusciciding program will require a great commitment on the part of any community, division or province. One of the most striking problems

is the large number of ponds in villages, and in between villages. All ponds have the potential to be used by the population. The only ponds which seem to be totally devoid of snails, are the large man-made reservoirs that are only used by animals. There, the water is deep, they are considered unusable for swimming or bathing and unfit for drinking. Otherwise most other ponds have vegetation and support snail populations.

It seems that an interval of a month to five weeks between molluscicide applications would be adequate in most cases. Application should begin, however, earlier than it was begun in this project, as populations were already very high. Some large ponds may have to be monitored to see if more frequent applications will be needed. In summary, this could mean that within one rainy season, four applications of molluscicide would be necessary at each pond. Considering the huge number of ponds even within one subdivision, this would entail a large amount of work and money.

The only way large scale mollusciciding would be possible would be to have the work done on a low level, such as the subdivision, and to have cooperation from the villages. A person or committee from the village would need to be responsible for identifying ponds used by villagers or others in the region. Villagers could act as assistants to the person responsible for that subdivision. When he came to the village with the molluscicide he could enlist their help in actually applying the chemical. In this case a simpler means of application, such as the plastic bag method or watering can would be more advisable.

In view of the many difficulties with mollusciciding, other methods should also be examined. Many of the very heavily used ponds are small but have large amounts of vegetation growing around the edges and into the pond. Perhaps during the dry season the areas occupied by these ponds could be weeded with hoes and then maintenance continued through the rainy season to keep the vegetation from returning. Most of these villages have primary schools. Often the students have scheduled work periods or work during free periods cutting grass, gathering wood, etc. The clearing off of vegetation from some of the ponds could be incorporated into this schedule. After school was out, the villagers would have to form work groups to continue maintenance.

Obviously village participation and interest would be a major aspect of any large scale overall program to combat schistosomiasis which concentrates on the snail populations. Therefore a program of education for the villagers and in the schools would be a very necessary aspect of the overall program.

2.4. SOCIO ECONOMIC STUDIES

Preliminary discussions were held in order to plan the socio economic studies. Participation from the Centre de Recherche Sociale (CRESS) of the Institute of Social Health (ISH) and from CUSS has been sought. The main problem so far has been to identify the principal investigator for these studies. Very little progress being accomplished in regards to socio economic studies, it became obvious that it would be necessary to have a coordinator for the socio-economic studies. Discussions with the Peace Corps Office were successful in providing one Peace Corps Volunteer, Jim Spilsbury, MPH, to act as socio-economic study coordinator.

2.4.1.HEALTH BELIEFS ASSOCIATED WITH SCHISTOSOMIASIS

Village longitudinal studies contain a research component examining villagers' beliefs associated with schistosomiasis. In collaboration with social scientists from the Centre de Recherche des Sciences Sociales (CRESS), a twenty-four item study instrument has been developed to examine these beliefs. The first six items are multiple-choice questions that assess the respondent's degree of knowledge about schistosomiasis. The remaining eighteen items measure the strength of villagers beliefs that certain personal factors (e.g., playing in water, losing an important family member, insulting one's ancestors, taking care of the sick at the local hospital) increase the likelihood of contracting the disease. These factors, hypothesized to be associated with villagers' beliefs concerning the causes of schistosomiasis, were identified from both discussions with CRESS scientists and from informal interviews with inhabitants of several villages in the Center Province.

2.4.2. HEALTH EDUCATION STUDY

During the national school survey, health education pamphlets are distributed to the pupils, questions are answered. The teacher often takes this opportunity to reinforce any knowledge about schistosomiasis. It was decide to attempt to measure the impact of this education. Two schools were selected in the East Province, one in Bertoua, in a intense but isolated urinary schistosomiasis focus, the other in Abong Mbang, about 100km away in an area with no urinary schistosomiasis. A questionnaire was administered to the schoolchildren in CM2 (5th grade) soon after unannounced arrival of the team in the classroom. No one was warned about any follow up questionnaire. A month later, during the follow up visit made to distribute drugs to the infected children, a follow up questionnaire was administered.

2.4.3.HOUSEHOLD HEALTH AND MORBIDITY

Dr. Barry Hewlett who designed a socio-behavioral study to be carried out in the Extreme North Province has selected Helen Regis as the social scientist that will be responsible for the implementation of this activity.

Ms. Helen Regis resided in the village of Guereme, Kaele Division, to carry out a socio-behavioral study of schistosomiasis. She studied the health problems as viewed by the villagers and the mechanisms to cope with illness. Special attention was given to the role of family members (chiefly women) in the decision making process in the face of illness in the household. She elicited categorization of illness, remedies and health practitioners. Ranking of the elicited categories were performed. Data on knowledge pertaining to health was

collected from several age groups. Methods used included: census of the population, basic ethnographic survey of the population, mapping, proxemics, kinship analysis,investigation of the hierarchy and cosmology of the village, subsistence strategies, work load and productivity, life histories with periodic updates, monthly household interviews about illnesses experienced during the past month in the household, clinic surveys to complement the information derived from the households, time allocation study for water contacts, anthropometric measurements, screening tests for hematuria. The study provided a better understanding of how illness (in particular schistosomiasis) was experienced and dealt with by the villagers. This knowledge allowed better planning of control and better involvement of the population in control efforts.

2.4.3.HUMAN WATER CONTACT BEHAVIOR

Sama Martin studied the human water contact behavior as an index to the prevalence and intensity of schistosomiasis transmission in the urban population of Kumba. A preliminary survey of 1980 persons was completed. The areas selected were (1)between the Kumba river and Nkoto street, (2)across the river at the same time site, and (3)upstream around the Betel school between the river and the main road. Infected individuals that participated in the preliminary survey but were not selected in the detailed study were treated with praziquantel, single dose, 40mg/kg.

Detailed maps of the areas selected for the detailed study were completed. The following activities took place during the detailed study: interview with each individual whether infected or not, completion of a questionnaire about socio, economic and cultural background, water contact behavior, knowledge and beliefs about schistosomiasis. He collected a second specimen of urines and stools. 200 interviews were completed.

The other part of the study is the observation of water contact. Four observation sites were selected:
1 across Bethel mission on Main street
2 across church on Main street
3 across the church on Nkoto street
4 waterfall at the end of Nkoto street

A schedule of observations was prepared so that each site would be observed 4 times a month at different days of the week, Saturdays, Sundays and week days were included. The initial rate of observations made was about 20 people/site/day.

2.4.4.OTHER ACTIVITIES

Additionally, the project staff has been assisting CRESS researchers with the coding and analyses of an environmental survey of six-hundred Yaounde households carried out by CRESS in 1986. A small portion of the survey questionnaire examined health beliefs concerning schistosomiasis.

2.5.INTERVENTION STUDIES

2.5.1.PREPARATION OF A PILOT SCHISTOSOMIASIS CONTROL PLAN:

On January 15, 1988, IMPM convened a large meeting with representatives from the IMPM Directorate, IMPM research staff, TAT, Faculty of Science, Health Science Center (CUSS), OCEAC, Ministry of Health's Department of Preventive Medicine, and the Ministry of Education. The results of the national schistosomiasis survey were presented, and a 35-page summary of the survey was distributed to each participant. The discussion focused on survey results and the action to be taken to implement schistosomiasis control. The Director of Preventive Medicine reaffirmed the Ministry of Health's strong interest in schistosomiasis, and it was decided that a committee should be established by the Ministry of Health to plan the coming schistosomiasis control activities.

Following up on this meeting it was resolved that the MOH, with collaboration of project staff, should prepare a plan for a pilot project in an area of high endemicity with about 30,000 to 50,000 people.

2.5.2.DRUG EFFICACY STUDY

The efficacy of **metrifonate in the treatment of** S. haematobium **infections** was evaluated in Seradunda in the Extreme North Province. Schoolchildren from the school were treated for urinary schistosomiasis on March 2 with metrifonate at a single dose of 10mg/kg. Evaluation of treatment efficacy was done on May 4. During this time, there was no rain and no surface water, therefore there was no new infections. Out of 35 schoolchildren examined in March and May, there were 22 children that had no eggs in their urine (rate of complete negativation of 63%). Considering a 90% reduction in egg count as a success, there was a 80% rate of success (28 out of 35). Considering that metrifonate is a very inexpensive drugs, it would appear to be a drug of choice in any mass drug administration (in 1987 the Bayer dealer was selling metrifonate for 10FCFA per tablet of 100mg and praziquantel for 450FCFA per tablet of 600mg, thus the cost of treating one adult with metrifonate was 60 FCFA and with praziquantel 1800FCFA (30 times more).

The efficacy of **Praziquantel for the control of schistosomiasis in a village** was studied in Kindig (see longitudinal study of Kindig.

2.5.3.HEALTH EDUCATION, COMMUNITY HEALTH WORKERS AND SINGLE DOSE CHEMOTHERAPY IN THE CONTROL OF MORBIDITY RELATED TO URINARY SCHISTOSOMIASIS

Dr. S. Anyangwe studied the role of health education, community health workers and single dose chemotherapy in the control of morbidity related to urinary schistosomiasis in the Maroua area. The villages of Katoual, Zongoya and Minawa were selected. The design is an experimental study comparing several interventions: health education combined with the presence in the village of a health volunteer with drugs available (village of Katoual), health education only (village of Zongoya), control village with no intervention (village of Minawa). All villages were located at approximately the same distance to a health center (Gazawa-Bizili and Gawel). Information on consultations for schistosomiasis was gathered at the health centers and at the village health worker hut. A register was left in each post, to list all persons coming in with any complaint related to schistosomiasis. Name, age, sex, locating information, symptoms and treatment are recorded. The health worker in Katoual and nurses in the health centers were given paper strips for the detection of blood in urine, and tube prefilled with sodium azide to collect and preserve urines. Treatment schedules for a single treatment with metrifonate at the dose of 10mg/kg were explained. Drugs and

scales were provided. Treatment was to be given under direct supervision. The centers of Gazawa and Gawel are part of the primary health care system supported by the Belgian Technical Cooperation.

The initial step was to map the areas to be surveyed, to conduct a complete census and carry out the baseline survey. The next major activity was health education and monitoring the passive case detection system. At the end of the study, another survey was done in order to evaluate the accomplishments.

The principal parameter of evaluation was the conditional probability that an infected case seek treatment: Probability of being treated given that the person was infected. The total number of infected individuals was compiled from the list of infected individuals at both surveys and during the passive case detection. This parameter is not influenced by variability of transmission. It truly evaluates the change in treatment seeking behavior. Other parameters that were evaluated are of secondary importance in this specific study: prevalence, intensity of infection, prevalence of heavy infections. Although these parameters reflect the ultimate goal of the study, they were not be sensitive enough to be influenced in the short time that this study lasted.

2.6.OTHER TROPICAL DISEASES CAUSING CONSTRAINTS TO RURAL DEVELOPMENT

The main diseases that were studied within the limits of this project are (besides schistosomiasis) malaria and dracunculiasis.

Dr. Njock research was carried out on the **transmission of Dracunculus medinensis in the Mandara mountains.**

Dr. Mvondo undertook a study to measure, using parasitologic and epidemiologic parameters, **the interaction between P.falciparum infection and pregnancy.** He seek to determine whether pregnant women with malaria have a reduced immunoresponsiveness in general, and to P. falciparum antigens in particular, as compared to non-pregnant women with malaria).

Malaria is an important public health problem in the tropics where pregnant women are at a higher risk of infection than non pregnant women. In order to plan and implement a successful antimalarial program aimed at pregnant women, more knowledge of the epidemiology and immunology of malaria during pregnancy is required. Malaria in pregnancy is associated with prematurity, still-births and decreased birthweight in newborns, a condition often correlated with increased neonatal morbidity. Because of the important public health implications, malaria in pregnancy has been studied in several African countries, i.e., Nigeria, Tanzania, The Gambia and Zaire. These studies have been conducted in geographical regions which differ in climate, intensity of malaria transmission, application of malaria control measures, and sociocultural attitudes towards malaria. Since no such study has been conducted in Cameroon, an analysis of the relationship between falciparum malaria and pregnancy in this country would provide useful information to provide a rationale base for the development of control strategies.

The study was conducted in a 6-month period in Mfou, a hyperendemic malarious location in Cameroon. It consisted of both cross-sectional and longitudinal analyses, involving both epidemiologic and laboratory-based studies. The principal parameters included: parasite rates, gestational age, parity, geometric mean parasite density, antimalarial antibody titers, and lymphocyte stimulation index. Two hundred and twenty-five (225) pregnant women and seventy five (75) non-pregnant controls were recruited. Information was

obtained by interview using a questionnaire and from clinic records. Blood samples were collected from each women for parasitology, serology (IFA, MIFA, ELISA) and lymphocyte blastogenesis studies. In addition, the pattern of antimalarial drug use and the effect of chloroquine on parasitemia was determined.

The following objectives were carried out in Mfou, a rural community in Cameroon, hyperendemic for malaria: 1)to determine the pattern of P.falciparum infection/disease during pregnancy, 2) to determine the use of antimalarial drugs during pregnancy and the effect of chloroquine on parasitemia, 3) to compare humoral and cell-mediated immune responses, general and P.falciparum-specific,in pregnant vs. non-pregnant women.

Dr. P. Ngoumou studied **the influence of hemoglobin S on the resistance to malaria.** Most of the mortality caused by anemia, cerebral complications and other manifestations is associated with P. falciparum. Recurrent infections with this parasitic agent lead to the gradual development of a semi-immune state. Therefore in holoendemic regions, malaria is usually a childhood disease. In addition to acquired immunity, which is mainly B cell-mediated, genetic factors play an important role in the natural resistance to malaria. Allison reported in 1954 evidence for the sickle-cell trait as a genetic determinant of relative resistance against malaria. Luzzato (1974) explained later that an intrinsic change in the red cell could improve host resistance in three ways: 1) the red cell may be more resistant to parasite invasion, 2) the red cell may be less suitable for subsequent parasite development, and 3) the red cell may be more susceptible to destruction in the host at some stage of parasite development, with consequent destruction of the parasite itself.

It is hypothesized that the protection afforded by the sickle hemoglobin against P. falciparum is not entirely at the erythrocyte level. Instead protection with this genetic trait may also be in the form of immune modulation by carriers. Children with HbAS hemoglobin types are apparently protected because they are capable of acquiring immunity to malaria earlier than most of the semi-immune HbAA children. Premunition, a state of immunity in a previously malaria-infected host in malaria endemic area, is gradually acquired with age, so that infants and young children (2 to 5 years old) suffer severely from primary malaria attacks. It is thought that the "premunition status" as well as the level of certain immune serum factors is reached at a much earlier age (usually between 2 and 5 years old) among HbAS children than among HbAA. Moreover, three phases in the protection of HbAS children have been noted in malaria endemic areas: 1) before 2 years of age, the sickle trait affords no protection, as parasite prevalence and densities of HbAS children are similar to those in HbAA children; 2) between 2-5 years old, the sickle gene is highly protective. It reduces morbidity and prevents mortality from complications such as cerebral malaria; a marked drop in prevalence and in parasite densities among HbAS carriers is observed. The distribution in the titers of various P. falciparum-specific antibodies is lower in AS and SS persons as compared to those of AA individuals, suggesting a reduced antigenic stimulus due possibly to parasite removal from the circulation; but evidence suggests that the sickle-cell trait protects against malaria by enhancing the antibody response against the malaria parasite; 3) at age 5 and above, the sickle gene affords little apparent protection; parasite rates are similar in both HbAS and HbAA children. The frequent exposure to malarial antigens between 2 to 5 years of age steadily induces an early premunition in children with the sickle trait. Consequently, the protective effect of sickle hemoglobin depends on the degree of exposure of gene carriers to falciparum malaria and is probably expressed by an acquired immune mechanism. If the immune response to malaria in sickle trait carriers is enhanced and is

protective in 2 to 5 year-old children, what is the antimalarial immune status of HbAS children living in malaria-endemic areas ?

The objectives of his study were: 1) to determine the difference in parasite counts between the HbAA and HbAS children in Obala, a malaria-endemic area in rural Cameroon, 2) to determine differences in the antimalarial immune profiles of HbAA and HbAS children, aged 2 to 5 years, using humoral and cellular parameters. More specifically: 1) to initiate an *in vitro* culture of a well established West- African Plasmodium falciparum strain (FCR-3), in hypoxanthine-enriched medium and use the parasites as a source of antigen for the indirect fluorescent antibody assay (IFA) and enzyme-linked immunosorbent assay (ELISA), 2) to collect blood samples from children (2-5 years old), and determine the hemoglobin types by the sickling test and by cellulose acetate membrane electrophoresis, 3) to quantify antibody titers to P. falciparum in the two groups of children using the IFA and ELISA, 4) to identify antibodies to malaria antigens, specifically to malaria-derived synthetic peptides (C2, 29mer, C5, C10), in the sera of the above children by Western blot and Dot Peptide-Elisa, 5) to study the lymphocytic proliferative response to malaria antigens and mitogens (concanavalin A, pokeweed, PHA), using lymphocytes separated from blood of HbAS and HbAA children.

The locality selected for the study was Obala. This community was chosen because of: 1) the respective population homogeneity, 2) easy accessibility from Yaounde, 3) endemicity of malaria, and 4) the existence of a local hospital. Obala is situated north-west of Yaounde, approximately 30 miles from the capital city. The locality is inhabited by forest- dwelling people, living primarily of agriculture. Children aged 2 to 5 years , attending the outpatients clinic in Obala were recruited for the study.

The study was cross-sectional and experimental. It tested the hypothesis of whether or not the sickle-cell protects against malaria by enhancing the immune response of the carriers. It also allowed the collection of baseline information for future studies, and the description of differences between two defined subgroups (HbAS and HbAA children) from laboratory analyses.

3.TRAINING

The training component was an important part of this project. It included both long-term and short-term training.

1. Long-term training : Graduate training in epidemiology, parasitology, malacology, biostatistics, environmental health engineering, water chemistry, health economic was planned for 10 Cameroonian (4 at the Doctoral level and 6 at the Master's level) and 12 participants from other countries from sub-saharan Africa at the Master's level. Training was done at Tulane University School of Public Health and Tropical Medicine. Trainees were supported by USAID fellowships.

2.Short-term training : The technical training was developed by the U.S. technicians who are Research Associate Professors in their University and completed by the Cameroonian specialists. Much of the training was on-the-jot. Training was also planned for Africans from other countries at the Yaounde Research Center. However the IMPM Director was always reluctant in approving such training and none took place.

3.1.Long term training

The 12 Cameroonian students enrolled at Tulane received their MPH and 10 continued their studies to obtain doctoral degrees. Their field of study are in epidemiology, parasitology, biostatistics, malacology, environmental health and sociology.

Table TRG 1 : Long term training at Tulane University School of Public Health

Name	TIT	Previous job	Employer	Country	Departmt	MPH start	MPH end	DOC end	Dissertation topic
Foumbi Joseph	MD	Researcher	IMPM	Cameroon	Epidemio	Jun84	Sep85	Dec88	Haematobium morbidity Yagoua
Anyangwe Stella	MD	Physician Central Hosp.	CUSS	Cameroon	Epidemio	Jun85	Dec86	Dec89	Alt. methods of drug deliv.
Befidi Rosa	MD	Physician Central Hosp.	PH	Cameroon	Trop med	Jun85	Dec86	Dec89	Schisto & trop dis interacti
Kamguia Pierre	MD	Researcher	IMPM	Cameroon	Biostat	Jun85	Dec86	Dec89	Schisto information system
Monkiedje Adolphe	MSC	Student	None	Cameroon	Env hlth	Jun85	Dec86	Dec89	Environmental intervention
Mvondo Joe Louis	MD	Physician Subdiv. Hosp.	CHU	Cameroon	Trop med	Jun85	Dec86	Dec89	Malaria and pregnancy
Ngoumou Pierre	MD	Physician Subdiv. Hosp.	PH	Cameroon	Trop med	Jun85	Dec86	Dec89	Animal schisto
Njock Emmanuel	MD	Physician Subdiv. Hosp.	PH	Cameroon	Trop med	Jun85	Dec86	Dec89	Transmission of GWD
Takougang Innocent	MSC	Student	None	Cameroon	Trop med	Jun85	Dec86	Dec89	Taxonomic studies
Tchounwou Paul	MSC	Student	None	Cameroon	Env hlth	Jun85	Dec86	Dec89	Physical & chemical paramete
Téyha Sama Martin	MSC	Student	None	Cameroon	Epidemio	Jun85	Dec86	Dec89	Water contact
Wansi Emmanuel	MD	P.H.Physician Region	PH	Cameroon	Epidemio	Jun85	Dec86	Dec89	Reporting system
Sima Ovana Victor	MD	P.H.Physician Region	PH	Eq. Guinea	Trop med	Sep86	Jan88		
Laopan Pare Jean	PHA	Pharmacist Prov. Hosp.	PH	Burk. Faso		Sep86	Jan88		
Hounkounnou Victor	MD	Assistant Epidemiologist	PH	Benin	Epidemio	Sep86	Jan88		
Ndihokubwayo H.	MD	Researcher LMTC Pjt.	PH	Burundi		Sep86	Jan88		
Fatchou Gakitangou	MD	P.H.Physician Region	PH	Chad		Sep86	Jan88		
Utshudi Lumbu	PHA	USAID Project Officer	USAID	Zaire	Epidemio	Sep86	Jan88		
Nkinsi Luke	MD	Physician Central Hosp.	PH	Zaire	Int hlth	Jan87	Sep88		
Kpizingui Eugene	MD	P.H.Physician Region	PH	CAR	Epidemio	Jan87	Sep88		

3.2. Short term training

The local training was focused on the technicians and researchers from IMPM.

TABLE TRG 2 : LOCAL TRAINING

IMPM SCHISTOSOMIASIS RESEARCH PROJECT - LOCAL TRAINING -

YEAR	DATES	COURSE TOPIC SCHEDULE TYPE OF COURSE	TOTAL HOURS FACULTY	NAME OF PARTICIPANT	EDUC-ATION	JOB TITLE	EMPLOYER
1985	OCT15-DEC15	SCHISTO MICROSCOPIC DIAGNOSIS DAILY,2H LAB DEMO, JOB	40 COGSWELL	BESSONGO LOUISE	CEP	MICROSCOPIST	IMPM SCHISTO
				WADJORE THENE	CEP	MICROSCOPIST	IMPM SCHISTO
				MBAREDOA JULIETTE	CEP	MICROSCOPIST	IMPM SCHISTO
				NGA MADELEINE	CEP	MICROSCOPIST	IMPM SCHISTO
				ATANGANA JULES	RN	MICROSCOPIST	IMPM SCHISTO
1985	OCT09-OCT24	EPIDEMIO SURVEY TECHNIQUES WEEKLY2,6H FIELD DEMO,JOB	24 RATARD	WOGUIA BERNARD	RN	PUB. HLTH. TECH.	PREV. MED.
	OCT09-OCT24-85			FONGANG JEAN	BEPC	PUB. HLTH. TECH.	PREV. MED.
1985 1987	EACH DIVISION	EPIDEMIO SURVEY TECHNIQUES DAY,6H FIELD DEMO,JOB	6 RATARD	12 PARTICIPANTS	RN	PUB. HLTH. TECH.	PREV. MED.
1985 1986	OCT01- -NOV05	EPIDEMIOLOGY OF SCHISTO MED. STUDENT THESIS DISCUSS,DEMO,JOB	40 RATARD	SOP LUC	MD	PHYSICIAN	PREV. MED.
1986	JAN10-JUL04	DATA PROCESSING, COMPUTER WEEKLY,2H LECTURE,DEMO,HOMEWK	50 TALBOT	NGOA BEKONO	BEPC	ACCOUNTANT	IMPM SCHISTO
				NINGOULOUBEL JEAN	BLAW	ADMINISTRATOR	IMPM SCHISTO
				NDAMKOU CHRISTIAN	MSC	EPIDEMIOLOGIST	IMPM SCHISTO
				ABGORTABI DEBORAH	MPH	EPIDEMIOLOGIST	IMPM SCHISTO
1986	JAN10-JUL04	BASIC EPIDEMIOLOGY WEEKLY,2H LECTURE, EXERCISE	40 RATARD	EKANI MARIE	MD	RESEARCHER	IMPM SCHISTO
				KOUEMENI LISETTE	PHD	RESEARCHER	IMPM SCHISTO
				NDAMKOU CHRISTIAN	MSC	EPIDEMIOLOGIST	IMPM SCHISTO
1986	JUN02-JUL28	SCHISTO MICROSCOPIC DIAGNOSIS DAILY,2H LAB DEMO, JOB	40 STAFF,GREER	FOUDA MESSI	CEP	MICROSCOPIST	IMPM SCHISTO
				IVINA RENE	CEP	MICROSCOPIST	IMPM SCHISTO
1986	JUL01-SEP30	MALACOLOGIC TECHNIQUES DAILY,1H LAB DEMO, JOB	60 GREER	NGONSEU ERNEST	MSC	SENIOR TECHNICIAN	IMPM SCHISTO
1987	JAN02-MAR31	SCHISTO MICROSCOPIC DIAGNOSIS DAILY,2H LAB DEMO, JOB	100 KOUEMENI,EKANI	SOPI BERNADETTE	BEPC	MICROSCOPIST	IMPM SCHISTO
				BENGONO NSIA	BEPC	MICROSCOPIST	IMPM SCHISTO
				YAKAN BESSONG	BEPC	FIELD TECHNICIAN	IMPM SCHISTO
				MBARGA BRUNO	BEPC	MICROSCOPIST	IMPM SCHISTO
				NTAH HENRI	BEPC	MICROSCOPIST	IMPM SCHISTO

IMPM SCHISTOSOMIASIS RESEARCH PROJECT - LOCAL TRAINING -

YEAR	DATES	COURSE TOPIC SCHEDULE TYPE OF COURSE	TOTAL HOURS FACULTY	NAME OF PARTICIPANT	EDUC-ATION	JOB TITLE	EMPLOYER
1987	FEB09	BASIC EPIDEMIOLOGY DAY LECTURE, EXERCISE	3 RATARD	CARE PERSONNEL 3 ADMINISTRATORS 4 PH.TECHNICIANS	BS RN	3 ADMINISTRATORS 4 PH.TECHNICIANS	CARE CARE
1987	MAR05-JUN30-87	SCHISTO MICROSCOPIC DIAGNOSIS DAILY,2H LAB DEMO, JOB	100 KOUEMENI,EKANI	MA'A NGUELE CHARLE KWATI BEATRICE AKAME NDONGO	BEPC BEPC BEPC	MICROSCOPIST MICROSCOPIST MICROSCOPIST	IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO
1987	MAR02-MAR05-87	VILLAGE CENSUS AND MAP DAILY,4H FIELD DEMO	12 RATARD	YAKAN BESSONG	BEPC	FIELD TECHNICIAN	IMPM SCHISTO
1987	MAR02-MAY31-87	BASIC MALACOLOGY, TAXONOMY, FIELD DAILY,3H DEMO,LECTURE,FIELD	180 GREER	TCHUENTE LOUIS	B.SC.	SCIENCE STUDENT	NONE
1987	SEP01-NOV30-87	SCHISTO MICROSCOPIC DIAGNOSIS DAILY,2H LAB DEMO, JOB	100 KOUEMENI,EKANI	NGUE MONIQUE	BEPC	MICROSCOPIST	IMPM SCHISTO
1987	SEP01-DEC31-87	EPIDEMIO SURVEY TECHNIQUES WEEKLY,6H FIELD DEMO,JOB	6 RATARD	BOMBA LAURENT	TEC	PUB. HLTH. TECH.	IMPM SCHISTO
1987	SEP01-OCT31-87	MALACOLOGIC TECHNIQUES DAILY,1H LAB DEMO, JOB	60 GREER	EDZOA POLYCARPE	BAC	TECHNICIAN	IMPM SCHISTO
1987	NOV01-DEC31-87	MALARIA MICROSCOPIC DIAGNOSIS DAILY,3H LAB DEMO, JOB	120 KOU,IMPM TEC,RR	AKAME NDONGO BENGONO NSIA BESSALA KWATI BEATRICE MAA NGUELE CHARLES MBAREDOA JULIETTE NGUE MONIQUE NGEUCHEU NTAH HENRY SOPI BERNADETTE YAKAN BESSONG	CEP BEPC BEPC BEPC BAC CEP CEP BEPC BEPC BEPC BEPC	MICROSCOPIST MICROSCOPIST MICROSCOPIST MICROSCOPIST MICROSCOPIST MICROSCOPIST MICROSCOPIST MICROSCOPIST MICROSCOPIST MICROSCOPIST MICROSCOPIST	IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO
1988	MAR01-APR30-88	INTERVIEW TECHNIQUES & SCHISTO WEEKLY, 3H LECTURE, DISCUSSIONS	120 SPILSBURY RR	12 SOCIOLOGY STUDENTS	LICENSE ES LETTRES		IMPM SCHISTO IMPM SCHISTO IMPM SCHISTO

In May 1989, Pr. Cline and Ratard were member of a doctoral jury at the Faculté des Sciences. The candidate, Ndamkou Ndamkou Christian had worked in the project in 1985-86. He had participated in the school surveys and was one of the most active members of the epidemiology team. After leaving the project in 1986, he had continued with his interests in schistosomiasis. With the guidance of the project epidemiologist, he had carried out a longitudinal study of the village of Douloumi, close to Garoua in the North Province. He had completed two extensive surveys of the village at one year interval, monthly water contact observations throughout one year and a snail population dynamics study. His worked was accepted with high honors.

4. OTHER OUTPUTS

4.1.NEWSLETTER

The first issue of the project newsletter "*THE AFRICAN SCHISTOSOME*" was sent out in October 1985 to 430 individuals and organizations from 70 different countries. It contained a description of the project along with a brief review of past epidemiologic studies which have been conducted in Cameroon. The following issue # 2 to 6 were sent every six months. Numerous requests for reprints of studies done in the project and correspondence from interested readers were received. The newsletter was a big success.

4.2.PRESENTATIONS

The project was well represented at the annual meeting of the American Society of Tropical Medicine and Hygiene held in conjunction with the annual meeting of the American Society of Parasitology in Denver, Colorado from December 7 to 11, 1986. A section of the Scientific session B on schistosomiasis was devoted to the project with the following:

1.Objectives of a bilateral research program and technical improvements in laboratory support for large-scale field studies. R. Moyou, A. Abondo, F. Cogswell, B. Cline, E. Ruiz-Tiben. Institute for Medical Research and Study of Medicinal Plants, MESRES, Yaounde, Cameroon; Tulane University, New Orleans, Louisiana.

2.Nationwide parasitic survey in primary school children. M. M. Ekani, R. Ratard. Institute for Medical Research and Study of Medicinal Plants, MESRES, Yaounde, Cameroon; Tulane University, New Orleans, Louisiana.

3.Field testing of the FAST-ELISA for schistosomiasis mansoni diagnosis. L.E. Kouemeni, F.O. Richards, K. Hancock, V. C. W. Tsang. Institute for Medical Research and Study of Medicinal Plants, MESRES, Yaounde, Cameroon; Tulane University, New Orleans, Louisiana; Centers for Disease Control, Atlanta, Georgia.

The Malacology section presented a poster session:

4.The Distribution of Snail Intermediate Hosts of Human Schistosomes in Cameroon. R. Mimpfoundi, A. Joky, G. Greer. Institute for Medical Research and Study of Medicinal Plants, MESRES, Yaounde, Cameroon; Tulane University, New Orleans, Louisiana.

Participation in this meeting proved to be an excellent experience both for the cameroonian researchers and the TAT. Contacts were made with other researchers in the same area that could benefit the project.

4.3.PUBLICATIONS

PUBLICATIONS

Greer GJ, Mimpfoundi R, Malek EA, Joky A, Ngonseu E, Ratard RC 1990. Human schistosomiasis in Cameroon. II. Distribution of the snail hosts. *American Journal of Tropical Medicine & Hygiene 42(6):* 573-580.

Mimpfoundi R, Greer GJ 1989. Allozyme comparisons among species of the *Bulinus forskalii* group (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 55:* 405-410.

Mimpfoundi R, Greer GJ 1990. Allozyme comparisons and ploidy levels among species of the *Bulinus truncatus/tropicus* complex (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 56:* 63-68.

Mimpfoundi R, Greer GJ 1990. Allozyme variation among populations of *Biomphalaria camerunensis* (Boettger, 1941) (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 56:* 373-381.

Mimpfoundi R, Greer GJ 1990. Allozyme variation among populations of *Bulinus forskalii* (Ehrenberg, 1831) (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 56:* 353-371.

Mimpfoundi R, Greer GJ 1990. Allozyme comparisons among populations of *Biomphalaria pfeifferi* (Krauss, 1848) (Gastropoda: Planorbidae) in Cameroon. *Journal of Molluscan Studies 56:* 461-467.

Monkiedje A, Englande AJ, Wall JH 1990. Environmental impact assessment of *Phytolacca dodecandra* (Endod 44) and niclosamide in the aquatic systems: Abiotic parameters and persistence under field conditions. *Proceedings of the 3rd International Workshop on Recent Developments and Future Directions in Endod Research, ICDR Monograph Series.*

Monkiedje A, Englande AJ, Malek E 1990. Studies on the effects of *Phytolacca dodecandra* (Endod 44) and niclosamide. I-Acute toxicity to snails *Biomphalaria glabrata* (albino), *B.pfeifferi*, and *Schistosoma mansoni* cercariae. *Proceedings of the 3rd International Workshop on Recent Developments and Future Directions in Endod Research, ICDR Monograph Series.*

Monkiedje A, Englande AJ, Wall JH 1990. Studies on the effects of *Phytolacca dodecandra* (Endod 44) and niclosamide. II-Acute toxicity to non target organisms under laboratory and field conditions. *Proceedings of the 3rd International Workshop on Recent Developments and Future Directions in Endod Research, ICDR Monograph Series.*

Monkiedje A, Wall JH, Englande AJ, Anderson AC 1990. A new method for determining concentrations of Endod-S (*Phytolacca dodecandra*) in water during molluscicidiing. *Journal of Environmental Science and Health B, 25:* 777-786.

Monkiedje A, Englande AJ, Anderson AC 1990. Acute toxicity of *Phytolacca dodecandra* (Endod-44) and niclosamide to snails, *Schistosoma mansoni* cercariae, Tilapia fish and soil microorganisms. *Toxicity Assessment 6:* 405-414.

Ndamkou CN, Ratard RC 1990. Are sanitation, water supply and health center sufficient to control schistosomiasis? *Tropical Doctor 20:* 176-177.

Ratard RC, Ekani MM, Greer GJ, Kouemeni LK, Mimpfoundi R, Ngonseu E 1988. Schistosomiasis in Cameroon, (Letter to editor). *Parasitology Today 4:* 199.

Ratard RC, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN, Greer GJ, Spilsbury J, Cline BL 1990. Human schistosomiasis in Cameroon. I. Distribution of schistosomiasis. *American Journal of Tropical Medicine & Hygiene 42(6):* 561-572.

Ratard RC, Kouemeni L, Ekani-Bessala MM, Ndamkou CN 1990. Distribution and preservation of *Schistosoma mansoni* eggs in stools. *Journal of Tropical Medicine 93:* 413-416.

Ratard RC, Kouemeni LE, Ekani-Bessala MM, Ndamkou CN, Sama MT, Cline BL 1991. Ascariasis and trichuriasis in Cameroon. *Transaction of the Royal Society of Tropical Medicine & Hygiene 85:* 84-88.

Ratard RC, Greer GJ. A new focus of *Schistosoma haematobium / S. intercalatum* hybrid in Cameroon 1991. *American Journal of Tropical Medicine & Hygiene 45:* 332-338.

Ratard RC, Ndamkou CN, Kouemeni LE, Ekani-Bessala MM 1991. *Schistosoma mansoni* eggs in urine. *Journal of Tropical Medicine and Hygiene 94:* 348-351.

Tchounwou PB, Englande AJ, Malek EA, Anderson AC, Abdelghani AA 1991. The effects of Bayluscide and malathion on the survival of miracidia of *Schistosome mansoni*. *Journal of Environmental Science Health B 26:* 69-82.

Tchounwou PB, Englande AJ, Malek EA, Anderson AC, Abdelghani AA 1991. The effects of ammonium sulphate and urea upon egg hatching and miracidial survival of *Schistosome mansoni*. *Journal of Environmental Science Health B 26:* 241-257.

IN PRESS

Ratard RC, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN. Estimation of the number of cases of schistosomiasis in a country: The example of Cameroon. *Transaction of the Royal Society of Tropical Medicine & Hygiene*.

Tchounwou PB, Englande AJ, Malek EA, Greer GJ, Anderson AC. The effects of Bayluscide and malathion on the behavior, mortality and infectivity of *Schistosome mansoni* cercariae. *Environmental Toxicology and Water Quality*:.

Tchounwou PB, Englande AJ, Malek EA. Toxicity evaluation of bayluscide and malathion to three developmental stages of freshwater snails.. *Archives of Environmental Contamination and Toxicology*:.

Tchounwou PB, Englande AJ, Malek EA. Toxicity evaluation of ammonium sulphate and urea to three developmental stages of freshwater snails.. *Archives of Environmental Contamination and Toxicology*:.

SUBMITTED FOR PUBLICATION

Befidi-Mengue R, Ratard RC, D'Alessandro A, Rice J, Befidi-Mengue R, Kouemeni LK, Cline BL. The impact of *Schistosoma haematobium* infection and of praziquantel treatment on the growth of primary school children in bertoua, Cameroon. *American Journal of Tropical Medicine & Hygiene*

Mvondo JL, James MA, Campbell CC. Malaria and pregnancy in Cameroonian women. I-Effects of *Plasmodium falciparum* parasitemia and the response to chloroquine.

Mvondo JL, James MA, Campbell CC. Malaria and pregnancy in Cameroonian women. II-Naturally acquired antibody response to asexual blood stage antigens and the circumsporozoite protein of *Plasmodium falciparum*.

Ndamkou CN, Ratard RC. Mesure et analyse des taux d'incidence de la bilharziose urinaire au village de Douloumi, Cameroun. *Bulletin de la Societe de Pathologie Exotique*.

Ratard RC, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN, Greer GJ, Spilsbury J, Cline BL 1990. Human schistosomiasis in Cameroon. I. Distribution of schistosomiasis. *American Journal of Tropical Medicine & Hygiene 42(6):* 561-572.

Ratard RC, Kouemeni L, Ekani-Bessala MM, Ndamkou CN 1990. Distribution and preservation of *Schistosoma mansoni* eggs in stools. *Journal of Tropical Medicine 93:* 413-416.

Ratard RC, Kouemeni LE, Ekani-Bessala MM, Ndamkou CN, Sama MT, Cline BL 1991. Ascariasis and trichuriasis in Cameroon. *Transaction of the Royal Society of Tropical Medicine & Hygiene 85:* 84-88.

Ratard RC, Greer GJ. A new focus of *Schistosoma haematobium / S. intercalatum* hybrid in Cameroon 1991. *American Journal of Tropical Medicine & Hygiene 45:* 332-338.

Ratard RC, Ndamkou CN, Kouemeni LE, Ekani-Bessala MM 1991. *Schistosoma mansoni* eggs in urine. *Journal of Tropical Medicine and Hygiene 94:* 348-351.

Tchounwou PB, Englande AJ, Malek EA, Anderson AC, Abdelghani AA 1991. The effects of Bayluscide and malathion on the survival of miracidia of *Schistosome mansoni*. *Journal of Environmental Science Health B 26:* 69-82.

Tchounwou PB, Englande AJ, Malek EA, Anderson AC, Abdelghani AA 1991. The effects of ammonium sulphate and urea upon egg hatching and miracidial survival of *Schistosome mansoni*. *Journal of Environmental Science Health B 26:* 241-257.

IN PRESS

Ratard RC, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN. Estimation of the number of cases of schistosomiasis in a country: The example of Cameroon. *Transaction of the Royal Society of Tropical Medicine & Hygiene*.

Tchounwou PB, Englande AJ, Malek EA, Greer GJ, Anderson AC. The effects of Bayluscide and malathion on the behavior, mortality and infectivity of *Schistosome mansoni* cercariae. *Environmental Toxicology and Water Quality*:.

Tchounwou PB, Englande AJ, Malek EA. Toxicity evaluation of bayluscide and malathion to three developmental stages of freshwater snails.. *Archives of Environmental Contamination and Toxicology*:.

Tchounwou PB, Englande AJ, Malek EA. Toxicity evaluation of ammonium sulphate and urea to three developmental stages of freshwater snails.. *Archives of Environmental Contamination and Toxicology*:.

SUBMITTED FOR PUBLICATION

Befidi-Mengue R, Ratard RC, D'Alessandro A, Rice J, Befidi-Mengue R, Kouemeni LK, Cline BL. The impact of *Schistosoma haematobium* infection and of praziquantel treatment on the growth of primary school children in bertoua, Cameroon. *American Journal of Tropical Medicine & Hygiene*

Mvondo JL, James MA, Campbell CC. Malaria and pregnancy in Cameroonian women. I-Effects of *Plasmodium falciparum* parasitemia and the response to chloroquine.

Mvondo JL, James MA, Campbell CC. Malaria and pregnancy in Cameroonian women. II-Naturally acquired antibody response to asexual blood stage antigens and the circumsporozoite protein of *Plasmodium falciparum*.

Ndamkou CN, Ratard RC. Mesure et analyse des taux d'incidence de la bilharziose urinaire au village de Douloumi, Cameroun. *Bulletin de la Societe de Pathologie Exotique*.

Ndamkou CN, Ratard RC. Water contact patterns and schistosomiasis in the village of Douloumi, North Cameroon. *Journal of Tropical Medicine and Hygiene*.

Ngonseu E, Greer GJ, Mimpfoundi M. Dynamique des populations et infestation des mollusques hotes intermediaires des schistosomiases dans la Province de l'Extreme Nord Cameroun. I_Cas de *Bulinus globosus*. *Bulletin de la Societe Belge de Medecine Tropicale*.

Ratard RC, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN. Self selection in a village study. *International Journal of Epidemiology*.

Tchounwou PB, Englande AJ, Malek EA. Influence of selected environmental parameters on the potencies of bayluscide and ammonium sulphate against *Schistosoma mansoni* miracidia. *Environmental Research*.

PRESENTATIONS

Ekani MM, Ratard RC 1986. Cameroon schistosomiasis project: Nationwide parasitic survey in primary school children. *35th Annual Meeting of the American Society of Tropical Medicine, Denver, December 1986*.

Mimpfoundi M, Joky A, Greer GJ, Same-Ekobo A, Malek EA 1986. Cameroon schistosomiasis project: The distribution of snail intermediate host of human schistosomiasis in Cameroon. *35th Annual Meeting of the American Society of Tropical Medicine, Denver, December 1986*.

Greer GJ, Mimpfoundi R, Malek EA, Ngonseu E 1990. The role of malacology in schistosomiasis control projects: The Cameroon experience. *39th Annual Meeting of the American Society of Tropical Medicine, New Orleans, November 1990*.

Ratard RC, Greer GJ, Kouemeni LK, Ekani-Bessala MM, Ndamkou CN 1990. Description of a new focus of human infection with *Schistosoma haematobium /Schistosoma intercalatum* hybrids in Cameroon. *39th Annual Meeting of the American Society of Tropical Medicine, New Orleans, November 1990*.

4.4.VIDEO

A video describing the project was prepared. Plans were initially made by Dr. Cline, Senior Faculty Coordinator and Larry Klein, Video producer. The filming for the video was done by Ms. Rose Epie, producer for the video, Mr. Moto, cameraman, and a soundman. Dr. Ratard served as the technical adviser. Mr. R. Anderson took over the production of the video in New Orleans using the footage brought back to him from Cameroon.