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SCHISTOSOMIASIS JAPONICUM TRANSMISSION AND CONTROL IN A PHILIPPINE VILLAGE

By

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ABSTRACT

SCHISTOSOMIASIS JAPONICUM TRANSMISSION AND CONTROL IN A PHILIPPINE VILLAGE

By

Renato L. Cerdeña

Schistosomiasis japonicum is a major public health challenge in small irrigation systems in the southern part of the Philippines. Public attention to its threat, however, is focused mainly on large water development and irrigation projects that benefit thousands of hectares of agricultural land. Small, dispersed units of water impoundments and irrigation systems that are managed by farmers and informal irrigators' associations have been neglected by health authorities and researchers. Yet, it is likely that these small impoundments and irrigation systems, in their totality, have an equally great or greater significance for human health. The rice and coconut farming village of Macanip on Leyte Island, Philippines illustrates the need to conduct a systematic investigation of the spatial distribution of and problems of schistosomiasis transmission in small irrigation systems. Despite annual chemotherapeutic control efforts, a review of the annual prevalence rates in the village over the last decade shows that after a significant drop in the first two years of screening and treatment, schistosomiasis prevalence rates have gradually risen: in 1992, the prevalence rate was 48 percent, three points higher than the pre-treatment level of 45 percent in 1982.

This study investigates the factors leading to the persistence of schistosomiasis japonicum in the village of Macanip, Jaro, Leyte, Philippines. It contends that the

transmission and control of schistosomiasis japonicum can best be understood by using an analytical framework modeled after the transmission cycle of the parasite.

A total of 251 household heads in the village were interviewed to gather data on demography, water contact behavior, living conditions, household expenses and income, livelihood, ownership of animals, health seeking behavior, knowledge of the schistosomiasis transmission cycle, community perceptions, attitudes and outlook, community participation, and attitudes and perceptions toward schistosomiasis. The Research Institute of Tropical Medicine provided parasitological and water contact data.

The persistence of schistosomiasis in the village is due largely to the failure of villagers to understand the roles of the human host and the animal reservoirs in the transmission cycle. Water contact patterns show that the highest frequency of water contact involve crossing canals and streams. The longest duration of exposure involves work in the rice fields. The children in this village are always at risk because they are assigned the role of collecting drinking water from springs along infected creeks and streams. Although the people are generally aware that schistosomiasis is acquired through water contact, poverty leaves them no choice but to engage in activities that expose them to potentially infected waters. The regular arrival of schistosomiasis control teams has also led to a dependence among villagers on chemotherapy. Very little is done to avoid water contact since they know that they can always take praziquantel to control the disease. The potential for reinfection remains very high despite almost complete treatment of human hosts because of the presence of substantial numbers of animal reservoirs such as dogs, pigs, and field rats.

DEDICATION

To my wife and children, Victoria, Angelica and Leon,

and to my parents, Rosalina and Tranquilino.

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CHAPTER 1

THE PROBLEM

The purpose of this study is to investigate the factors leading to the persistence of schistosomiasis japonicum in the village of Macanip, Jaro, Leyte, Philippines. This study is founded on the concept that the transmission and control of Schistosomiasis japonicum can best be understood by using an analytical framework modeled after the transmission cycle of the parasite. The main elements of the transmission cycle are parasitic flukes, human hosts, snails, animal reservoirs, and the environment in which they all interact. Since humans have an overwhelming influence on their environment, this study examines human behavior and practices in the study area to arrive at a better understanding of schistosomiasis transmission and control.

Background of the Problem

Schistosomiasis is one of the most important tropical diseases in the Philippines. It is outranked only by malaria and tuberculosis among the leading causes of morbidity in that country. Within the 24 provinces where schistosomiasis occurs, there are 1,152 endemic villages in 169 municipalities. The total exposed population, defined as the population of the endemic municipalities, is estimated at more than 6 million, or about 10 percent of the Philippine population (Blas, Bautista, and Lipayon, 1990; Schistosomiasis Control Service, 1987). In spite of continuing control efforts of the government with the help of international agencies such as the World Health Organization and World Bank, schistosomiasis continues to be a menace in many areas where water resources development, farming practices, and human settlement maintain or create additional transmission sites. A comprehensive knowledge of the environmental, demographic, social, human behavioral, and economic factors that influence the transmission of schistosomiasis japonicum is indispensable for the design of control programs that are sustainable over a long period.

Schistosomiasis is a chronic debilitating disease caused by the schistosome, a parasitic worm of the trematode class. The three major species of schistosomes that infect humans are *Schistosoma japonicum*, *S. mansoni*, and *S. haematobium*. Controversy still prevails as to whether *S. mekongi* is a separate disease-causing schistosome or a variant of *S. japonicum*. These human schistosomes differ in the morphology of the adults, the size and shape of their eggs and the larvae which hatched from the eggs. Another difference lies in their infectivity to the particular groups of snails that they utilize as intermediate hosts and in their infectivity to other mammalian hosts. *S. haematobium* worms live within the capillaries on the wall of the human bladder and the other two species dwell within the blood vessels of the intestines. The adult male worm is shorter and thicker than the longer, slender female worm. The male has a longitudinal body groove in which the female normally remains. Adult worms mate in the liver and make a paired migration against the flow of blood until they reach the smallest venules of their predestined location. The favored eventual location of the adult worm and, consequently, egg deposition, varies according to species: *S. haematobium* is concentrated near the bladder, *S. mansoni* favors the large intestine, and *S. japonicum* prefers the large and small intestine. The eggs accumulate and press on the tissues producing ulcerations and sores through which they are passed out in the feces (Webbe, 1982).

The parasite responsible for schistosomiasis in the Philippines is *S. japonicum.* The characteristics that differentiate it from other human schistosomes have been described by Mott (1982, p. 128):

> *S. japonicum* represents the extremes of biological characteristics of the human schistosomes. The developmental stages in the snail require the longest period of time, up to 10 weeks; a longer exposure to light is necessary before cercariae are shed, and yet the daily rate of cercarial shedding is the lowest. The adult worms are the largest, yet the eggs are the smallest. In man, the female worm excretes eggs in clumps, not singly, and in greater numbers than other schistosomes. The worm is found in a wider range of animals than the other schistosomes. . . .
>
> Although the life cycles of these parasites are, in general, similar to those of *S. haematobium* and *S. mansoni,* certain aspects of the life cycle of *S. japonicum* as well as some responses of the human body to it are very different, which results in differences in epidemiology, disease processes, and control of *S. japonicum.*

The basic life cycles of human schistosomes are similar (Figure 1.1). Human schistosome eggs hatch only in fresh water. Once in the water, which may be flowing or stagnant, the eggs hatch into miracidia, the first free-swimming larvae that infect the snails. The larvae require a freshwater snail as an intermediate host. In the Philippines, this function is performed by the *Oncomelania quadrasi* snail only. The miracidia must find the appropriate snail host within 48 hours or die. The worm must spend part of its life in this snail before it can develop into a form that can infect humans. On the basis of studies done in the Philippines, the average time between miracidial penetration and shedding of cercariae is 62 days for snails infected with a single miracidium or 64 days for multiple-infected snails (Garcia, 1976)

Inside the snail, the miracidia undergo asexual reproduction and metamorphose into the infective cercaria form. A snail inhabited by a single miracidium can expel several thousand cercariae, the second free-swimming larvae of the schistosomes. It is this second larval stage that infects human and animal hosts. Cercariae emerging from the same snail are the same sex as the original miracidium, although snails may be infected by many miracidia and thus shed cercariae of both sexes.

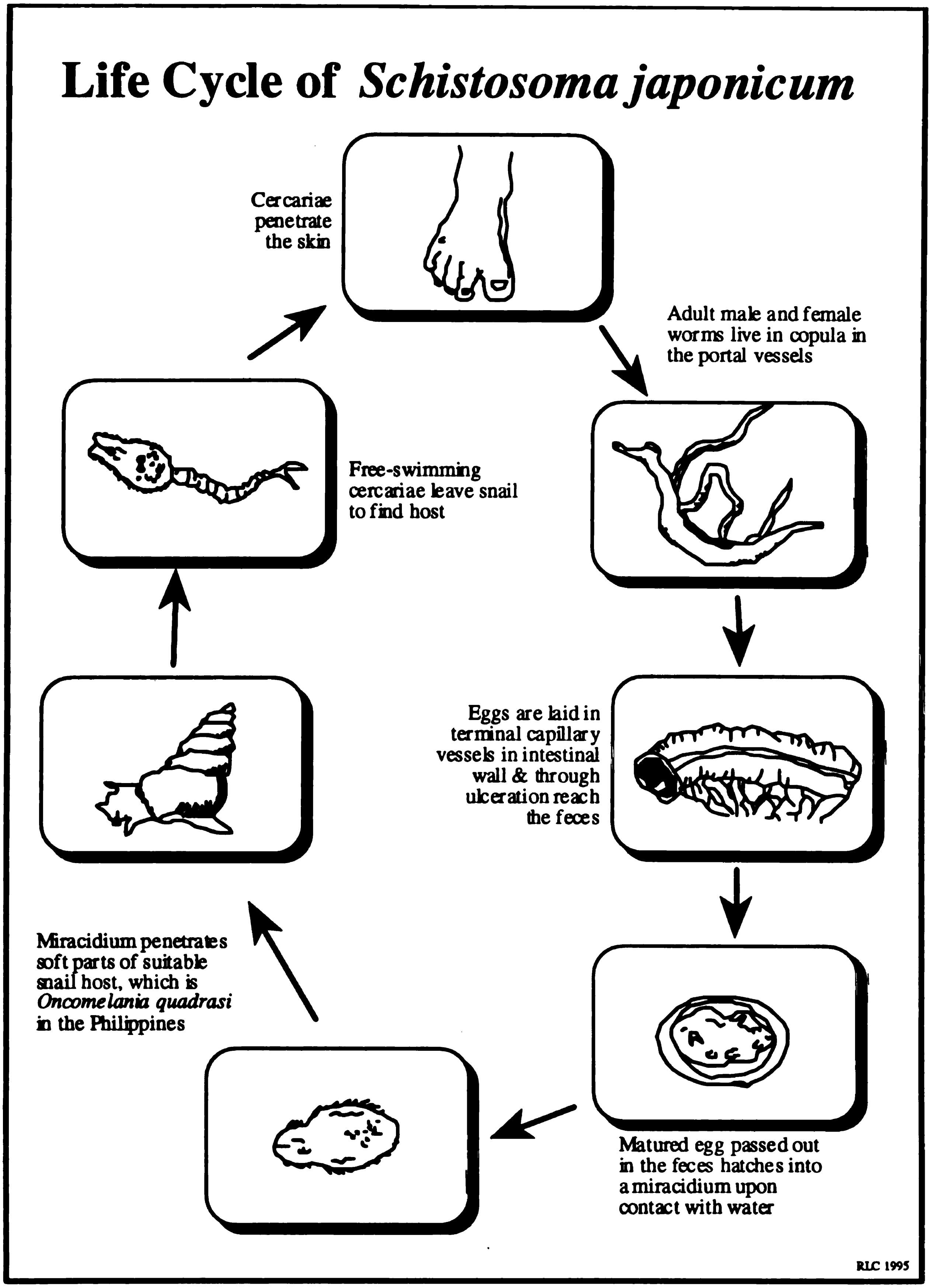

Figure 1.1 Life Cycle of *Schistosoma japonicum*. Source: Schistosomiasis Control Service. 1988. **Schistosomiasis Brochure**. Manila: Department of Health.

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Infection of humans occurs if the unprotected skin of a person is brought into contact with cercariae-infested water. The likelihood of infection increases with the length of time that the skin is exposed to water. Male and female cercaria penetrate the skin and, once inside the body, shed their tails to change into a form called schistosomules. The worms then move through the tissues to the circulatory system within which they migrate, by way of the heart, lungs, and liver (where they mate), to the bladder or intestine and so completing the cycle of the disease.

The duration of one complete cycle in animal and human hosts is approximately three months: intra-molluscan development is about two months while development within the human host takes a month. Experiments of Pesigan, Farooq, Hairston, Jauregui, Garcia, Santos, Santos, and Besa (1958a) on mice have shown that the time it takes between cercarial penetration and laying of eggs of the female worm ranges between 23 and 27 days. The mature eggs take about 10 days to develop into miracidia (Garcia, 1976). For passing of eggs to the feces to occur, it is thought that a threshold value of the number of eggs in the intestinal wall needs to be exceeded. This value is reached sooner when the worm burden is higher than when only a few worm pairs are present (Hinz, 1985). There are no fixed estimates of the time it takes for eggs to move from the intestinal wall to the feces.

The most prevalent form of the disease is chronic schistosomiasis, the severity of which is directly related to intensity of infection. It causes weakness, anemia, bloody urine or stools, diarrhea, and, due to the organ's reaction to the accumulation of eggs, inflammation of the liver and spleen. Another form, acute systemic schistosomiasis or Katayama fever is characterized by abrupt onset of high fever, chills, abdominal pain, diarrhea, nausea, and vomiting. It occurs two to three weeks after heavy initial infection, at the time of first egg release, and may last one or two months (Katz, Despommier, and Gwadz, 1989).

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In its 1993 report, the World Health Organization's Expert Committee on Schistosomiasis estimates that about 200 million people in 74 countries are infected with one or more of the *Schistosoma* species (WHO, 1993). The global magnitude and distribution of the schistosomiasis problem is visually apparent in the Atlas of the Global Distribution of Schistosomiasis (Doumenge, Mott, Cheung, Villenave, Chapuis, Perrin, and Reaud-Thomas, 1987). Despite the success of control programs, the WHO estimate has not changed since 1984, largely because of population increases in countries where the disease is endemic. According to WHO, the public health significance of schistosomiasis is often underestimated for two reasons. First, only few people in a community typically have severe infections and heavy worm loads while the rest of the community have light infections and show fewer symptoms or none at all. Second, it takes many years of mildly symptomatic infection before severe disease develops. Frequency and severity of schistosomiasis-related disease, incapacity, and premature death were suggested as measures to assess the public health impact of the disease.

Globally, the geographic distribution of schistosomiasis is confined to an area between 36 degrees north and 34 degrees south latitude, where freshwater temperatures average 25° to $30^\circ C$. Infections with *S. japonicum* are found only in East Asia, primarily in China, Malaysia, Indonesia, the Philippines, and Japan. Dogs, monkeys, rats, pigs, and cattle serve as its important reservoir hosts. *S. mekongi* is found in northeastern Thailand, Laos, and Kampuchea. The snail intermediate hosts of *S. japonicum* belong to the genus Oncomelania, which is amphibious and spends much of its time out of water, preferring moist soil at the edge of slow-flowing streams or irrigation canals. For *S. mekongi*, *Tricula aperta* is the natural snail host (Kitikoon, 1984). Infections with *S. mansoni* and *S. haematobium* prevail throughout much of Africa, parts of Southwest Asia, the Caribbean, and South America. *S. haematobium* is endemic in 54 countries of Africa and the eastern Mediterranean; *S. mansoni* is endemic in 52 countries and territories of South

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America, the Caribbean, Africa, and the eastern Mediterranean; and in 41 countries of Africa and the eastern Mediterranean, both parasites are present (WHO, 1993). The aquatic snails important in the transmission of these two parasites live in lightly shaded, slow-flowing (15 meters/minute), shallow (< 2 meters) water. *S. mansoni* is transmitted from person to person through snails belonging to the genus Biomphalaria. There are only a few known reservoir hosts, such as baboons and monkeys in Africa, and they usually do not transmit the infection to people. The intermediate hosts of *S. haematobium* are members of the genus Bulinus; the parasite has no important reservoir hosts other than humans (Laughlin, 1984).

Throughout the world, schistosomiasis is increasing in prevalence largely because of increased exposure to contaminated water associated with (1) wider use of irrigation for agricultural development; (2) population increase and movements; and (3) inadequate control measures. Human cultural habits of bathing, playing, and defecating and urinating in the same freshwater supply, as well as agricultural practices requiring intense human water contact are critical to the maintenance of the disease cycle. Endemic populations show human infection beginning as early as 6 months of age. The peak intensity and prevalence of infection, as measured by egg excretion, usually occur between 8 and 12 years of age in heavily infected communities and somewhat later in lightly infected areas. Most endemic populations will have a 40% to 60% prevalence rate of schistosome egg excretion at any one time; but almost everyone (i.e., 95%) will experience an infection during a lifetime (Laughlin, 1984).

Schistosomiasis control encompasses two parallel independent strategies: control of population morbidity and control of transmission. It includes five (5) general methods: chemotherapy, snail control, reduction of water contact and contamination, vaccination, and improved living standards. Chemotherapy has two broad objectives: in the individual patient, to eradicate infection--successful treatment will stop further deposition of eggs pre

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preventing further tissue damage and existing lesions will often regress; for the community, the cessation of egg excretion will block the egg/miracidium/snail stage of the biological cycle, thereby reducing transmission (Davis, 1982). A new generation of antischistosomal drugs are available that can be given safely in the field in single (or only a few) doses, that can cure at least 75% of those infected, and that reduce ova excretion by 90% to 95% in those not cured: oxamniquine for *S. mansoni* infections; metrifonate for *S. haematobium* infections, and praziquantel for *S. mansoni*, *S. haematobium*, and *S. japonicum* infections (Laughlin, 1984). The drug of choice in the Philippines is praziquantel, which is available under the trade names Biltricide of Bayer A.G., Germany or Distocide of Shin Poong Pharma, South Korea. The drug is dispensed in lacquered tablets containing 600 mg of praziquantel. Given in the proper dose of 3 x 20 mg/kg body weight at intervals of four (4) hours, it is highly effective while producing only minor side reactions (Schistosomiasis Control Service, 1987).

Snail control is a rapid and effective means of reducing transmission. The usual method of snail control is molluscicidng. Chemical compounds are generally used, but plant molluscicides have been the focus of recent research (Mott, 1987). Due to the limited funds for chemical control of snails in the Philippines, molluscicidng is used after clearing of vegetation and drainage of waterlogged areas when snails are confined to irrigation canals and resistant pockets. This is known as terminal molluscicidng. An alternative method of snail control is biologic control in which potential competitors or predators (including ducks, fish, turtles, fungi, and parasites) are introduced into the environment. Environmental modification, which involves the burying of snails by digging out irrigation ditches, was an effective but labor-intensive method of *Oncomelania* snail control in China. Other methods of environmental modification, e.g., cementing over or enclosing irrigation ditches, not only reduces the snail habitat but also diminishes human exposure to water (Laughlin, 1984; Blas, 1976; Schistosomiasis Control Service, 1987).

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In the Philippines, the geographical distribution of the parasite is coincident with that of the snail host *Oncomelania quadrasi*. Schistosomiasis is endemic in 24 provinces situated between 6°20′ N - 13°20′N and 121°15′ - 126°25′E (see map on p. 22). Within these boundaries, the environmental requirements of the snail intermediate host *Oncomelania quadrasi* dictate the local distribution of the disease. Since these snails cannot tolerate a long dry season and a high velocity of water flow, schistosomiasis is restricted to the lowland plains and plateaus with high rainfall evenly distributed throughout the year.

The disease is prevalent in the rural areas of the Philippines and it affects mainly the rural poor. It exerts significant and disruptive influences on nutritional reserves and growth from middle childhood through adolescence (McGarvey, Aligui, Daniel, Peters, Olveda, and Olds, 1992). It hampers agricultural productivity because it affects mostly farmers and their families especially young age groups including children and young adults aged 15-24 years. More males are affected than females, particularly those who earn their living as laborers and fresh-water fishermen. Its deleterious effect on the productivity of agricultural workers was revealed in a 1987 study that showed that among those afflicted an average loss of 41.6 days per year are lost due to disabilities engendered by the disease (Blas, 1988).

Schistosomiasis in the Philippines has an important zoonotic aspect. Many species of wild and domestic animals have been found to be infected, including field rats, dogs, cows, pigs, goats, and carabaos (water buffalo). These reservoir hosts play a very important role in transmitting schistosomiasis in endemic areas of the Philippines.

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Statement of the Problem

Schistosomiasis japonicum is a major public health challenge in small irrigation systems in the southern part of the Philippines. Public attention to its threat, however, is focused mainly on large water development and irrigation projects that benefit thousands of hectares of agricultural land. Small, dispersed units of water impoundments and irrigation systems that are managed by farmers and informal irrigators' associations have been neglected by health authorities and researchers. Yet, as has been observed in other parts of the world, it is likely that these small impoundments and irrigation systems, in their totality, have an equally great or greater significance for human health (Hunter, Rey, Chu, Adekolu-John, and Mott, 1993; Hunter, Rey, and Scott, 1982; Doumenge, et al, 1987). Usually there is a high degree of contact with water by people and animals, so that disease transmission rates, especially for schistosomiasis japonicum which has an important zoonotic aspect, are considerable. Once schistosomiasis is endemic in a rice irrigation scheme, its control is a long-term and expensive, but feasible, operation. As has been in the past, control of schistosomiasis in areas of irrigated rice production will be a major challenge in the future (Bergquist, Chen, and Mott, 1988).

The rice and coconut farming village of Macanip in Leyte Island, Philippines, illustrates the need to conduct a systematic investigation of the spatial distribution of and problems of schistosomiasis transmission in small irrigation systems. Despite annual chemotherapeutic control efforts, a review of the annual prevalence rates in the village of Macanip over the last decade shows that after a significant drop in the first two years of screening and treatment, schistosomiasis prevalence rates have gradually risen: in 1992, the prevalence rate was 48 percent, three points higher than the pre-treatment level of 45 percent in 1982. This illustrates the inadequacy of relying on chemotherapy alone to control schistosomiasis: annual chemotherapy reduces the prevalence and incidence of

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infection but cannot by itself eradicate infection. It also reflects the fact that previous investigations were aimed at an understanding of the disease with the end in view of targeting vulnerable points in the transmission cycle for drugs and vaccines to kill the parasite, and molluscicides to kill the snail intermediate host. The dynamic relationships involving the social, environmental, and water contact aspects of the disease have largely been ignored

Information on the different elements of the transmission cycle in the village came from a variety of sources. Socio-economic data were gathered through my survey that covered 251 households, or 77 percent of the total number of households in the village. The survey covered the following factors: demographic characteristics, living conditions, livelihood, income and expenditure, the animal population, water contact behavior, knowledge of schistosomiasis, attitudes toward schistosomiasis, control measures and the control program, degree of community participation, and health-seeking behavior. In addition, environmental data were gathered through direct field observations, map measurements, airphoto interpretation, and from published sources. Parasitological data and direct quantitative observations of actual water contact were furnished by the Research Institute of Tropical Medicine, Department of Health, Republic of the Philippines.

Medical geography offers an excellent springboard from which to launch integrative investigations of parasitic diseases, including schistosomiasis. There are many excellent examples, which do not need elaboration here (Hunter, 1966; 1972; 1981a; 1981b; 1992; Meade, 1976; Kloos, 1985; Fonaroff, 1968). By adopting a geographic perspective, it may be argued that the level of endemicity of schistosomiasis in an area is determined by the character of the place, which is seldom the result of any single physical factor. Rather, such endemicity is determined by the interaction of a number of social, economic, cultural and physical phenomena.

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CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter will review the current state of knowledge regarding schistosomiasis japonicum transmission and control in the Philippines. The characteristics of and linkages among the elements of the transmission system will be explored. Through examples, it will show the relationship between schistosomiasis transmission and the environment. The significance of water contact behavior and its consequences on morbidity and mortality will be examined. Finally, it will look at the different methods that have been applied in the Philippines for limiting schistosomiasis transmission.

The occurrence of schistosomiasis japonicum in the Philippines was first reported in 1906. Subsequent reports published in 1908 based on autopsy records of a patient in the Philippine General Hospital and fecal examinations of 4,106 prisoners in the National Penitentiary in Manila indicated that the disease may be endemic in the southern parts of the Philippines, particularly in the islands of Leyte, Samar, and Mindanao. The snail intermediate host, *Oncomelania quadrasi*, was first described using specimens from Surigao province in Mindanao. Its role as a snail intermediate host of schistosomiasis japonicum was first recognized in 1932 based on observations made at Palo, Leyte (Schistosomiasis Control Service, 1987).

The Parasite

Only one strain of *S. japonicum* exists in the Philippines (Garcia, 1976). Strains recovered from naturally infected dogs, pigs, carabaos, cows, goats, rats, and monkeys are morphologically indistinguishable from strains of human origin. This suggests that the control of schistosomiasis should involve more than the attack on the parasite through

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sanitation and treatment of the human host; it should also take into account the relative role in transmission played by animal hosts of *S. japonicum*.

Schistosoma japonicum is generally considered as the most virulent of the three human species of blood flukes because it produces a larger number of eggs than the other two species. In Leyte, Philippines, a study of egg-laying potential of *S. japonicum* in mice has shown that eggs are laid in clusters and that the female worm lays 116 eggs each time, 12 times daily (Pesigan et al., 1958a). The eggs require relatively clean freshwater with sufficient oxygen to hatch. The eggs that have been excreted out of the host are able to survive for up to one week, especially if they have been deposited in the shade. This implies that in schistosomiasis endemic areas in the Philippines where rainfall is distributed evenly throughout the year, the chances of eggs being washed into streams is high.

Observations of cercarial shedding of infected *Oncomelania quadrasi* snails revealed that the average period from miracidial penetration to shedding of cercariae from the snail is 64 days. The average shedding period is 66 days, with each snail producing a total of 279 cercariae on the average (Hunter, Ingalls, and Greene, 1947). Studies also show that due to the twin factors of duration and intensity of exposure to light, the swarming of cercariae from the snail is highest between 2:00 pm and 4:00 pm.. The greatest danger of infection to humans starts at dusk when 80 percent of cercaria have been shed, and continues until midnight (Pesigan et al., 1958a).

There are biological and environmental limitations on the life of cercariae. Their food reserves are exhausted within 48 hours after leaving the snail. They will die unless they find a suitable host within this period. A salt content of greater than 3 percent leads to cercarial death. The cercariae will survive for 2.5 days in water at 20°C to 35°C; for 4 hours at 40°C; and for only 3 minutes at 50°C (Jones and Brady, 1947). This implies that cercariae living in shallow waters which are exposed to sunlight and therefore high temperatures have only a very short period within which to infect the final host. This is the situat

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situation in inundated rice fields prior to planting. At later stages of rice growth, the rice shoots increasingly offer shade and thus moderate the increase of temperatures due to exposure to the sun.

The Snail Intermediate Host

Newly-hatched snails go through a 2-week aquatic stage before starting on an amphibian existence (Abbot, 1946). Within 180 days, males grow to a final size of 4.5 mm; females grow to a larger size of 5 mm. Sexual maturity is attained at a much earlier stage: copulation was first observed in snails of a length of 2.5 mm among males and 3 mm among females, respectively (Pesigan, Hairtston, Jauregui, Garcia, Santos, Santos, and Besa, 1958b). The mean life span of *O. quadrasi* was determined to be 25-35 weeks.

The vertical and horizontal distribution of *O. quadrasi* within the habitat is much affected by the depth of water, light intensity, the flow velocity, the steepness of the bank, and the plant cover. *O. quadrasi* is distributed neither evenly nor randomly over its habitats. Pesigan, et al. (1958b) made a study concerning the factors influencing the distribution within a colony. That study showed that snails were most numerous near the banks and their density seemed related inversely to light intensity and depth of water. These observations were made in mid-morning, from 9:00-11:00 in clear weather. A later study made by Tanaka, Santos, Matsuda, Hambre, Iwanaga, Shimomura, Blas, and Santos (1978) showed that in general most of the snails remain in the immediate vicinity of the banks. On the basis of investigations of a wide variety of water types, they arrived at the conclusion that "... *O. quadrasi* is determined not to be aquatic in habitual character than was presumed before ..." (p. 193).

Snail colonies investigated in the Philippines showed a very marked locational constancy; *O. quadrasi* is able to persist for decades in a suitable habitat. As described by Pesigan et al., (1958b), the most important types of places that harbor the snail may be grouped in several categories: (1) flood-plain forest and swamps that represent the most exten

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extensive original habitat of the snail; (2) ricefields where small holding agriculture is being practiced; (3) streams which are meandering and sluggish; (4) small water pockets located at the foot of high and steep banks that are fed by seepages and springs emerging below the banks; and (5) road ditches and borrow-pits that arise from the construction of roads in lowland areas.

The distribution of *O. quadrasi* as an amphibiously living snail is primarily determined by climatic conditions. Its sensitivity to aridity restricts its distribution range to those two climatic zones which receive precipitation throughout the year, and this in turn defines the potential area of schistosomiasis distribution in the Philippines (Santos, 1976).

The maximum flow velocity of waters that *O. quadrasi* can tolerate is about 20 m per minute (Hinz, 1985). The factors that influence the velocity of water flow are terrain, the distribution and quantity of precipitation, the land and water vegetation and the course followed by the waters themselves. Steep slopes cause the flow velocity to exceed the tolerance limit of *O. quadrasi*, especially during the aquatic phase of the young snails. For this reason, neither snails nor schistosomiasis are to be found in the hills or mountains of the Philippines. Thus, *O. quadrasi* habitats are characterized by their flatness (Pesigan et al., 1958b). Ample vegetation growth in waters can significantly reduce their flow velocities such that habitats suitable for snails are created. A precipitation regime that is constant throughout the year results in nearly constant water levels, which result in minor fluctuations in water velocity.

The nature of the water is significant for the occurrence of *O. quadrasi*. Heavily salinated areas in the coastal lowlands are unsuited as snail habitats because the snail can only tolerate fluctuations of 10-430 p.p.m. Water temperatures of between 23-30°C are favorable for snail habitats (Pesigan et al., 1958b). As far as the pH value of the water is concerned, the optimum for *O. quadrasi* lies in the slightly alkaline range at pH 7.4 -7.6 (Hunter, 1950).

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Animal Reservoirs

A variety of mammal species contribute to the persistence of schistosomiasis. The extent of their contribution to the process of transmission varies from one species to the next, however, and for every species from one area to the another. Pesigan et al. (1958a) found several animals acting as reservoir hosts of *Schistosoma japonicum* in Leyte, Philippines such as the dog, pig, carabao, cow, goat, and rat. Their studies showed that the cow had the highest prevalence (38.2%), followed by rat (22.7%), and dog (18.2%). The transmission index for each host was calculated by multiplying the factors of population, prevalence, mean daily egg output, and hatchability. Subsequently, they computed the relative transmission index for each host, which is expressed as the percentage of the total role played by all the hosts involved. They found the dog to be the most important reservoir host of *Schistosoma japonicum* in that area based on a high relative transmission index of 14.4% next to 75.7% index for humans. Cows, pigs, and rats had relative transmission indices of 5.7%, 1.5%, and 1.5%, respectively. A more recent study (Fernandez, Petilla, and Banez, 1983) highlighted the important role of the dog in maintaining the transmission cycle of *Schistosoma japonicum* in endemic areas due to its high transmission index. This role is enhanced by the fact that in areas where the study was conducted, these animals are regarded as pets and live for years in close contact with people.

Several recent studies have stressed the importance of the role of the field rat in maintaining schistosomiasis transmission. Hinz (1985) concluded that on the basis of results arrived at in Leyte, the greatest significance next to humans attaches to the field rats (*Rattus rattus mindanenis*) because of the numbers of its individuals, its way of life, and its high prevalence rates. Cabrera (1976) pointed out that the rapidity by which field rats multiply and the fact that they obtain their food from the ricefields plus their habit of defecating several times in 24 hours should all be taken into consideration when one tries to assess

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assess the role played by them in the dissemination of the infection in nature. His study of *Schistosoma japonicum* in field rats in Leyte, Philippines showed that approximately 73% of the wild caught field rats were found infected with *Schistosoma japonicum* as revealed by the findings of eggs in liver sections. The infection among field rats was highest in areas where no control measures were applied. Transmission of the disease in these areas is high possibly because there are more infected snails shedding cercaria in irrigation ditches and other water collection areas in the ricefields.

Seasonal fluctuations of prevalence rates in rats have been observed. They attained their highest values (95%) during the months of lower precipitation frequency (April to July), as opposed to an average of 76% during the remainder of the year. Meanwhile, the prevalence rate of schistosome cercariae in the snail increased during the relatively rainy season, October to February. Thus, it is suspected that miracidia hatched from eggs discharged from the feces of rats during April to July and, subsequently, the snails were infected with miracidia. It is also supposed that the cercaria which emerged from the snails might penetrate mammalian hosts during the rainy season, October to February (Kamiya, Tada, Matsuda, Blas, Noseñas, and Santos, 1980). This implies that the inhabitants in endemic areas of Leyte island were frequently exposed to cercariae during the rainy season. These observations also indicate that field rats not only maintain the infection as reservoir hosts, but are also an important source of infection as definitive hosts in the endemic areas of Leyte island. Control programs must take into account the role of the rat in schistosomiasis transmission.

Human Pathology

Schistosomiasis japonicum is a disease that has a variety of symptoms. The early and acute phases cover the period from the time of cercarial penetration to the oviposition of the mature female worm which is approximately 40 days. Cercariae, the infective larvae, gain entry by penetrating the skin. Cercariae successfully breaking through the skin underg

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undergo a period of migration and development which may give rise to a symptom-complex consisting of irregular fever, headache, stiff neck, malaise, anorexia, weight loss, abdominal cramps, muscle and joint pains, constipation or diarrhea, and cough or pulmonary involvement. During this phase, a majority of immune persons (70-80%) may be either mildly or moderately ill while the rest may be severely ill or asymptomatic. Among natives of endemic areas, this is generally less severe or may not be present at all especially in those having light infections (Olveda and Domingo, 1987).

The maturation of the worm with the onset of oviposition from a minimum of 30 days or longer after exposure paves the way for the acute or toxaemic case. This serum sickness-like stage commonly known as Katayama fever is marked by prominent eosinophilia which mainly accounts for the high level of leukocytosis arising from the absorption of worm metabolic products. Diarrhea or dysentery with bloody mucoid stools is seen in 25%, which at this stage is usually referable to colonic involvement. If the patient is left untreated, the disease may enter the third or chronic stage as early as three months after exposure. The early or chronic stage may be accompanied by temporary remission of acute signs and symptoms in some individuals. In endemic areas, some infected residents may start presenting a palpable liver or spleen in the third month after exposure. The more common forms of chronic schistosomiasis japonicum are hepatosplenic and intestinal; in some instances pulmonary and cerebral forms may be seen. One form may overlap another at any stage of infection presenting an unusual symptom complex. (Olveda and Domingo, 1987).

The complications that have been observed consist of extension of the lesions from the abdominal viscera to other tissues and organs of the body, and secondary infections or disease processes. Among these are: (a) neurological manifestations, which are frequently of the Jacksonian type of epilepsy demonstrated to be caused by the lodgement of *S. japonicum* eggs in the brain; (b) hematemesis (blood loss) resulting from the rupture of esop

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esophageal and gastric varices; (c) cor pulmonale characterized by enlargement of the right ventricle due to increased pressure in the pulmonary circulation caused by pathological changes in the pulmonary arteries or massive embolism where schistosomes are involved; (d) hepatic cirrhosis with or without splenomegaly may supervene; (e) supervening diseases, which may consist of chronic processes from which the patient may suffer like tuberculosis, malaria, deficiency diseases and acute infectious diseases such as pneumonia and infectious hepatitis (Schistosomiasis Control Service, 1987).

The following is a conventional classification of schistosomiasis cases based on the pathogenesis of the disease (Schistosomiasis Control Service, 1987).

Grade	Stage and Important Features
A	Pre-Egg Deposition Stage (not usually seen): With urticarial rashes, itchiness, localized dermatitis, cough, angioneurotic edema, fever and other allergic manifestations. May have diarrhea.
B	Early Egg-Deposition with Early Hepatic Irrigation: With bloody mucoid stools or diarrheic attacks of recent onset. Liver may be felt on deep inspiration, with slight tenderness toward the right of the epigastrium. Spleen not yet palpable. Duration of this stage -- 5th week from date of exposure to one year or even earlier depending on the heaviness and severity of the infection.
C	Late Egg-Deposition with Definite Liver Enlargement (Pre-cirrhotic stage): May have recurrences of diarrhea or dysentery-like symptoms. Abdominal and right hypochondriac pains increased. Liver enlargement marked especially below xiphoid process. Spleen only slightly enlarged. Duration of this stage -- 1 to 1.5 years from date of exposure.
D	Frank Cirrhosis: Size of liver receding but still palpable. Spleen markedly enlarged. Superficial abdominal veins visible. Ascites beginning. Emaciation is visible especially in undernourished individual. Patient may die of severe hemorrhage due to rupture of oesophagial varices. Duration of this stage -- 2nd year onwards.
E	Advanced Cirrhosis with marked emaciation. Very marked splenomegaly, liver small and contracted or non-palpable. Distinct ascites and very prominent superficial veins. Emaciation and anemia marked.

Diagnostic and laboratory methods to prove schistosomiasis infection can be parasitological or immunological. Parasitological techniques are necessary for providing a definitive diagnosis of an active infection: schistosome ova are demonstrated in urine or stools

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stools, less frequently in tissues; rarely, diagnosis may be made by finding adult worms in the histological sections. Immunological techniques include the WHO reference skin test, (Melcher's antigen), Complement fixation test, circumoval precipitin test (COP), fluorescent antibody test (FAT), ELISA (enzyme-linked immunosorbent assay), and RAI (radioimmunoassay) (Jordan, 1982).

Schistosomiasis lacks the impact that some tropical diseases deliver to affected populations. This is because it provides a case of successful parasitism: the parasite relies on co-existence rather than elimination of the human host. Previous studies in Palo, Leyte have shown that only 37.8 percent of schistosome-infected individuals were symptomatic and that the prevalence of infection reaches its peak in the age group 20-24 years. High prevalence and intensity of infection have been noted in women between 45 and 55 years old. The most vulnerable group are children aged 10-14 wherein 73% of those infected manifest symptoms related to schistosomiasis. It has been observed that although prevalence remains high, egg output gradually decreases after the age of 20 (Schistosomiasis Control Service, 1987).

A growing tolerance of the infection appears to suppress clinical manifestations, and acute attacks become infrequent once the individuals get past the most vulnerable age. Infection among adults therefore is not synonymous with the disease. This can only be explained on the basis of immunity, which causes the destruction of schistosomules during migration, developing as a result of constant exposure to schistosome infection from early life. Schistosomiasis is claimed to be an immunological disease due to granulomatous hypersensitivity to parasite eggs. Different degrees of immunity have been considered: innate immunity (i.e. that only a relatively small proportion of an infecting inoculum of cercariae will develop into adult worms), the possible occurrence of non-specific immunity (e.g. in patients with tuberculosis), the development of only partial degrees of specific immunity (as demonstrated in many experimental animals), and the occurrence of immun

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immunoregulatory phenomena that supress immunopathology and hence disease (Warren, 1982). It has been observed that the egg counts of people in age groups past the age of peak prevalence are notably less than those of younger people. Studies show that the majority of infected persons excrete low numbers of eggs and the patterns of prevalence and/or intensity is bimodal (Jordan and Webbe, 1982; Hairston, 1973).

Human behavior is exceptionally important in the transmission of schistosomiasis. Agriculture may have the effect of reducing snail populations through control of streams, drainage and proper cultivation, but it may also bring about great increases, especially through the requirement of irrigation, and also through certain improper practices, such as permitting the land to become waterlogged and inadequate cultivation. Human contact with water increases in rural farming populations and also increases directly with temperature (Hairston, 1973). Some activities involve contact with water for long periods; other activities may only be brief and unintended. These activities include plowing, weeding of rice fields, washing clothes, bathing, swimming, obtaining water, and wading across rivers, irrigation canals, and snail habitats.

The endemic areas of schistosomiasis in the Philippines (Figure 2.1) were identified through a series of studies and mass surveys. These endemic areas lie between 6° and 14° North latitude in the provinces of Mindoro Oriental and Sorsogon in Southern Luzon; the provinces of Northern, Eastern, and Western Samar, Leyte, and Bohol in Eastern Visayas, and all the provinces of Mindanao except Misamis Occidental, Davao Oriental and Maguindanao. In these areas, there is no pronounced dry season. Of the four climatic types present in the Philippines, all endemic areas fall under Type II and IV, both of which are characterized by the absence of a dry season. Type II has a pronounced maximum rain period from November to January while Type IV has no pronounced maximum rain period. Types I and III have distinct dry seasons (Blas, Bautista, and Lipayon, 1990).

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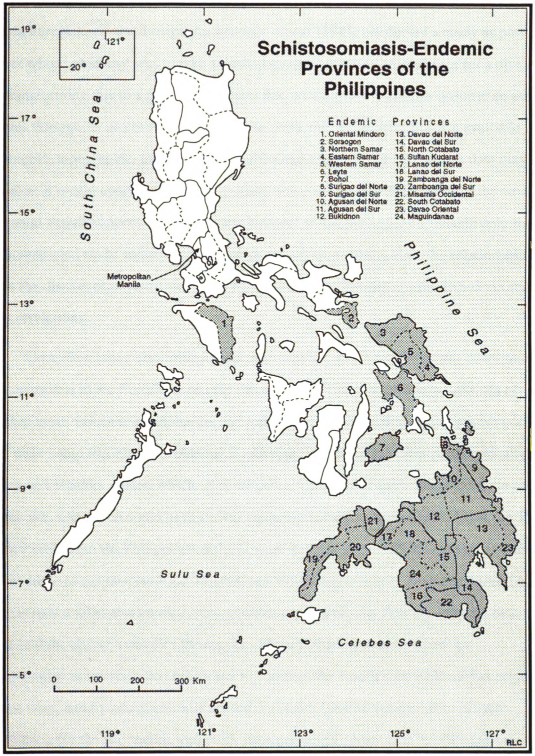

Figure 2.1 Schistosomiasis-Endemic Provinces of the Philippines. Source: Author's figure; data from Blas, Bautista, and Lipayon, 1990.

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The climatic and terrain limitations of the snail intermediate host open possibilities for a prediction system that would locate potential schistosomiasis-endemic areas that may contain unregistered small irrigation systems. Cross (1984) conducted a study as part of a project whose objective was to take a limited quantity of point or local data for a disease, and transforming this to a prediction system that would provide disease occurrence probabilities throughout an entire region. As conceived, the model would utilize available geographic, topographic, and climatic variables and whatever limited disease data may be available; it would operate without an explicit biological model, since many of the environmental variables necessary for the development of disease foci are available only for small, restricted study areas; and it would be statistical in nature, since the relationship between the disease occurrence and the geographical variable must be established via statistical correlations.

Cross developed discriminant analysis models to describe the known distribution of schistosomiasis in the Caribbean and the Philippines in terms of summary variables of monthly mean values of precipitation and temperature. Although the results were good, there were some recognized problems: (1) disease site information was geographically co-located to a weather station which, in some cases, was located a few miles from the actual disease site, and which could have caused some inaccuracy in the analysis; (2) of the 157 weather stations in the Philippines, only 27 were in areas where schistosomiasis occurred, and (3) some of the misclassified observations were in areas where terrain features, i.e., location near a lake, areas with a steep gradient causing rapidly flowing streams, etc., which had the ability to modify the results. These problems were rectified by incorporating an interpolation procedure to compute the weather variables at the actual disease sites, and by using remotely sensed data from Landsat spacecraft to provide information for the geographic variables. Incorporating Landsat data into the system provided some geographic information, as well as permitting the extension of point data to an entir

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an entire area. Thus, a disease distribution map can easily be produced, based on the statistical correlation between disease occurrence and geographical variables and the accuracy of prediction assessed visually.

People living in endemic areas are generally aware of the schistosomiasis problem. However, Tiglao (1979) showed that there are gaps regarding their knowledge of how the disease is transmitted and controlled. Although people knew that schistosomiasis is acquired through water contact, for lack of convenient options, they continued to frequent potentially infected bodies of water. The role of the snail intermediate host in the transmission of the disease was not generally known. Toilets, even if in existence, are not utilized. None of the respondents in the study knew that animals such as dogs and pigs can act as reservoir hosts of schistosomiasis. The study indicates that knowledge of schistosomiasis transmission and control is affected by sex, age, educational attainment, occupation, and experience with the disease. Those who are less knowledgeable about the disease are usually females, the younger and older age group, those with low educational attainment and economic status, laborers, and those who have not had any experience with the disease. Among the factors that influence disease awareness, age, educational attainment, and economic class exert significant influence on the attitude towards elimination of the snails. The factors that influence attitudes towards willingness to participate in a snail campaign are age, prevalence of the disease, and experience with the disease.

As revealed in a follow-up study (Tiglao and Camacho, 1983), the prevalence rate of schistosomiasis was 55% in two villages, with males having a higher prevalence rate than females. The study showed that three variables have significant relationships with intensity of infection, namely: economic activities, gender, and bathing. This means that males tend to have a higher infection than females; economic activities, particularly washing farm animals and bathing, are likely to produce heavy infection. This may be explained by the fact that the data show that males have longer duration of exposure than females; that their economic water contact activities tended to be twice as long as their other non-economic activities and that the economically active age groups had the higher mean duration of water contact. When the water contact activities of the positive and negative cases were compared, it was noted that the activities that really discriminate between the two groups were washing farm animals, washing farm tools and equipment and ditch tending. People continued to frequent the infected waterways despite being aware of the risk of infection because they were forced to for economic reasons. The study concluded by stressing that provision of an adequate source of drinking water and public baths and laundry areas are of paramount importance in the control of schistosomiasis. However, providing such water sources should take cognizance of the psycho-social factors attendant to the use of the waterways. It also recommends the implementation of an educational program to: (1) encourage better waste disposal through the construction and proper utilization of sanitary toilets and, (2) create the correct perceptions about the cause, transmission and control of the disease. Finally, the study recommends that greater effort should be directed towards reaching the males and economically active age groups.

To fill a gap on the epidemiology and morbidity of *S. japonicum* in the Philippines, Lewert, Yogore Jr., and Blas (1979) chose Barrio San Antonio, a coastal settlement on the San Juanico straits in the municipality of Basey on the island of Samar, the Philippines. Although some individuals of Barrio San Antonio have sought therapy, this population and area have been largely unstudied and have not up to the time of the study been involved in control or mass chemotherapy programs. The village has a population of approximately 1,900 in 320 households. Rice farming is the primary occupation. There is an annual rainfall of about 250 cm with 220 rainy days. The endemicity of *S. japonicum* in the municipality of Basey was established in surveys in 1951. Infected *Oncomelania quadrasi* were also demonstrated. Initially, 851 residents (45%) of 240 households partici

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participated in the survey to determine the prevalence and intensity of *Schistosoma japonicum* infection, and morbidity as indicated by associated hepatomegaly and splenomegaly. As a result of an initial single stool examination of 1 ml by a modified formalin concentration technique, 40% of this population was found to be infected. On subsequent examinations, with the addition of serologic techniques and recording the history of therapy, approximately 70% of this population was found to be infected with *S. japonicum* after the age of 10 years. If judged by the number of eggs produced per milliliter of feces, infection intensity in this population might be considered to be low. However, 25% (73 of 391 positives on single examination) exhibited schistosomal hepatomegaly or hepato-splenomegaly and had a mean egg count of 10.9. Those infected but without hepatomegaly had a slightly lower mean egg count of 8.4. Of the infected males with hepatomegaly, 75% were 19 years of age or less, and 45% of these were producing less than 10 eggs/ml of stool. Of infected females with hepatomegaly, only 28% were 19 years of age or less, and 68% of these were producing less than 10 eggs/ml. of stool. Abdominal pain, distress, diarrhea, and dysentery were significantly more frequent in the infected than uninfected persons, and this frequency was related to egg output. The heights and weights of these infected individuals were less than those of the uninfected members of this population and significantly less than the Filipino norm. The small percentage of the infected population (6.6%) that were producing 51% of the eggs had a mean egg count of approximately 260 with a mean age of 33.7. In this group, 7 of the 22 individuals were in the age group 10-14 years and 15 were above 20 years of age. The findings of this survey give an opportunity to determine the impact of control programs when they are instituted in this area.

An investigation covering two villages in Irosin, Sorsogon province showed that the overall prevalence of *Schistosoma japonicum* infection was 49.5% in a total study population of 755 persons. The peak prevalence rate of 70.2% and the highest egg counts were found in the 15-19 age group. The prevalence and intensity of infection were higher in me

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in men than in women except in the 45-54-year age group. A small proportion (4.1%) of the study population (age range 6-53 years) excreted 50% of the eggs counted in the study. However, individuals with high egg counts were found in other age groups. Thus, the study stresses that although contamination of the environment is due to a small number of highly infected persons, chemotherapy directed at a specific age group could not be expected to reduce significantly the total number of eggs excreted, or to have an impact upon morbidity related to high intensity infections. Liver and spleen enlargement were significantly associated with *S. japonicum* infection in all age groups. The frequency of a past history of dysentery and marked liver enlargement increased in parallel with increasing egg counts. Clustering of individuals with high egg counts in households was observed, but there was no correlation between geographical proximity of residence to potential transmission sites and household infection rates. An effective control strategy would be based on treatment of all infected persons in this endemic area rather than only a selected age group (WHO Workshop, 1980).

In the rice farming village of Santa Rosa, Leyte, Domingo, Tiu, Peters, Warren, Mahmoud, and Houser (1980) observed that there was no relationship between splenomegaly and the presence or intensity of infection. Like the Irosin study, a peak prevalence was noted in the 15-19 age group of this village. Of the 1,098 individuals who were examined, 32.4% were found infected with *S. japonicum*. Of these, 21% had light infections (1-100 eggs/g feces), 8% had moderate infections (101-400), and 3% had heavy infections (>400). The mean egg count for the entire population (uninfected and infected) was 50 eggs/g, males averaging 73 and females 27. The mean egg count for the infected population was 154 eggs/g; that for infected males was 186 and infected females 105. The intensity of infection in males peaked at age 15-19 (256 eggs/g) and in females 25-29 (253 eggs/g). The study revealed that in comparison with an uninfected control group in the same community there was no impairment in activity, no increased incidence of colicky abdominal pain and no increase in the number of stools per day, in their consistency nor in the presence of blood in the feces. The investigators concluded that *S. japonicum* infection of a moderate prevalence and intensity was associated with low morbidity. They further observed that schistosomiasis japonicum did not appear to be a significantly more pathogenic infection than schistosomiasis mansoni.

An expanded study on the relationship between intensity of infection and morbidity was conducted by Olveda, Tiu, Fevidal, De Veyra, and Domingo (1983) in three Philippine villages with differing prevalences of infection. Due to a flat to nearly flat topography and an even distribution of rainfall throughout the year, rice is grown in the three villages. The sources of water for domestic use are mostly open dug wells, although some households are equipped with hand pumps. Water sealed toilets are available for half the population but are rarely used because of the difficulty of obtaining water for domestic use. Almost all inhabitants are farmers, and agricultural activities are carried out all year round. Prevalences of 26%, 39%, and 44% were found in the three villages. A majority of their populations (56-74%) were not infected. Within the total population, 17-30% had light infections, 7-14% had moderate infection, and only 2-7% had heavy infections. Symptoms of inability to work, weakness, abdominal pain, and diarrhea correlated with the presence of infection in the area with the highest prevalence, but not in the area with the lowest prevalence. Except for diarrhea, there was no relationship between symptoms and intensity of infection. This study showed that there was no significant association between area prevalence and intensity of infection. Age prevalence and egg excretion peaked earlier in areas with higher prevalence than in the area with lowest prevalence.

Because schistosomiasis is an example of successful parasitism, deaths due to the disease alone are relatively low and often difficult to ascertain. Blas, Cabrera, Santos, and Noseñas (1986) conducted a study to gather data that can serve as a basis for computing the economic burden imposed by deaths due to schistosomiasis. The study is a response to the dearth and unreliability of data on the number of deaths from schistosomiasis. This state of affairs was caused by the refusal of the relatives of dead patients to give permission to have the abdomen punctured with a viscerectomy instrument. To remedy this situation, the authors thought of following up on a cross-sectional study on the clinical gradient of schistosomiasis that was conducted 12 years earlier in connection with the Schistosomiasis Control Pilot Project in Palo, Leyte, Philippines. At the start of the project, 48% of the population was found positive for *Schistosoma japonicum* eggs in their stools. From the positive cases, a 20% stratified sample consisting of 278 individuals in the different zones of Palo were examined and followed up periodically. All the 278 cases previously found positive for *S. japonicum* eggs in their stools were included in the follow-up study. However, only 154 cases including those who died could be located because the rest had migrated to other places. Of the 154 cases followed up, 19 were treated with schistosomicidal drugs and were therefore excluded in the analysis. Of the remaining 135, a total of 23 (17.04%) died from various causes of which 12 (8.89%) had signs and symptoms attributable to schistosomiasis as the immediate cause or one of the main causes of death. Among the surviving cases, only 25% remained symptomatic compared to 54.5% 12 years earlier. The case fatality rate of 8.89% in a span of 1 to 11 years, which corresponds roughly to 1.78% of the infected cases per year, is considered as a conservative estimate because in other deaths due to other diseases, schistosomiasis is a contributory cause.

Snail Control

The studies of Pesigan, et al. (1958b) regarding potential repopulation of snail colonies paved the way for the evaluation of subsequent snail control measures. Their findings showed that young snails, especially those in the aquatic stage, are most suscep

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susceptible to any sort of control measure and that most or all of the survivors after control will be adult snails. They concluded that:

> . . . any method, such as the use of molluscicides, that leaves the habitat suitable for repopulation will have to be repeated at frequent intervals. . . . the chemical would need to be applied before the peak of the first generation of the young, or at intervals of 120 days -- three times a year.
>
> . . . prevention of breeding is more important than success in killing the snails that are present. The potential for repopulation can only be attacked through radical re-population of the habitat, making further breeding impossible or reducing it to the point where it does not keep pace with normal mortality rates. . . . (p. 344).

The discovery of new snail habitats and area-wide mollusciciding were the concerns of the study conducted by Yasuraoka, Santos, Blas, Tanaka, Matsuda, Irie, Shimomura, and Pangilinan (1989) in the municipalities of Trinidad and Talibon, Bohol Island, Philippines. The endemic focus of schistosomiasis on the island is confined only to the left bank of Ipil River or to two of the 46 municipalities of the island, namely, Talibon and Trinidad. The study team succeeded in locating seven new snail populations between 1985 and 1987. The team was led by the proximity of the snail habitat to the residence of the infected individuals. In addition they often used palawan plants (*Cryptosperma merkusii*), a relative of taro, as an indicator of snail habitats. This plant can grow only in very wet ground and provides an excellent shade and enough moisture for snails to thrive. *O. quadrasi* was found less resistant to dryness than *O. nosophora*, the intermediate host of *S. japonicum* in Japan. *O. quadrasi* seldom, if ever, survived longer than three weeks under relative humidities ranging from 60 to 85 percent at temperatures of 24 to 27°C, while they could survive at least three months in a moist environment (99 to 100% relative humidity). The continuous wet condition in Northern Bohol appeared to make the major difference between places that do and those that do not support the snails. Mollusciciding activities involved twice yearly clearing of vegetation by mowers and rakes and applying chemical molluscicides (niclosamide and phebrol) manually by uniform spraying at a rate of 5-10 grams per square meter. The study revealed that although combined vegetation removal and chemical mollusciciding appeared successful in eliminating and reducing the

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snail population in most of the swamps, it did not yield satisfactory results in meandering streams. Ecological or engineering measures such as cement-lining could be expected to limit or reduce the snail populations.

Makiya, Tanaka, Banez, Blas, and Santos (1986) chose to control snail populations through environmental modification such as clearing of vegetation, reclamation of swampy land, draining water by channeling and excavation. About 50 snail populations were surveyed at 18 sites in 3 project areas, i.e., Dagami (4.3 hectares), Matagob (0.5 ha.) and Tacloban (2.2 ha.) in Leyte, Philippines, from 1974 through 1977. They made a quantitative evaluation to measure the change of snail density as the effect of control measures in the project areas that were based on theoretical principles derived from previous snail population studies. Environmental modification included clearing of heavy vegetation, leveling of swampy depression and drainage of stagnant water in the waterlogged areas by heavy equipment. Channeling and excavation of water pathways were performed by manual works to improve the water flow in ditches, streams, and abandoned areas around the rice fields. Reclaimed areas were maintained by human labor every 3 months or from time to time depending upon the conditions of water flowing. Density reduction was observed at 13 of 18 sites with reduction rates from 10.5 to 100% at the survey in the final year, and significant reduction was confirmed at 9 sites. The structure of the snail population changed from a distribution of colonies (clusters of snails) into a distribution of individual snails with the decrease of soil moisture and snail density. It was concluded that drainage work is an effective and long-lasting control measure against snail populations if the drainage canals are well-maintained and functioning properly. The snail distribution, following the double Poisson or Neyman Type A distribution at first, became fitted better to the negative binomial distribution in the later years in most sites. From the theoretical analysis of distribution types, it seemed that the types of distribution changed from a colonial distribution into that of individual snails

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without forming clusters as the population density decreased. The study concluded that there is no doubt that the snail population can be reduced by physical environmental modifications. For effective control of schistosomiasis japonicum by means of snail control, a large scale plan of land reclamation together with persisting maintenance of reclaimed areas is necessary.

Proper water management and sound agricultural practices to attack and eradicate the snail as the intermediate host of the parasite was the approach used by Santos, Blas, Redona, and Santos (1970). An agricultural demonstration area was put up in Sitio Mayaot, Barrio Malirong, Palo, Leyte, Philippines to demonstrate ways of increasing rice yield while at the same time controlling the snails transmitting schistosomiasis. The area selected consists of 2.95 hectares which used to be part of a water-logged area overgrown with thick vegetation. This snail-infested area was initially drained by an intercepting and a main drainage canal. Subsequently, the reclaimed area was diked and subdivided into paddies. Finally, irrigation pipelines from the irrigation canal to the diked paddies and a system irrigation, drainage, and intercepting canals were installed. With the land preparation completed, two rice crops were planted on successive planting seasons. Snail densities before, during and after planting were obtained. An adjacent area which remained fallow throughout the experiment and wherein snail densities were similarly gathered served as the control plot. In the initial snail sampling, a baseline data of 231 snails per square meter was observed in the experimental area and 196 per sq.m. in the comparison area. The snail density in the latter was lower, because it was relatively drier. After the completion of the system of drainage and irrigation canals, an appreciable decrease in the snail density to 91 per sq.m. was noted while the density in the comparison area remained practically the same. Results of another sampling before farming and planting revealed a further decrease to an average of 1.6 snails per sq.m. in the demonstration area. In the comparison area the snail density was 166 per square meter. After the first harvest, another snail sampling conducted in the area gave an average of 0.7 snail per sq. meter. A subsequent sampling done after the second harvest showed that the snails had been totally eradicated in the demonstration area. On the other hand, an increase in snail density was observed in the comparison area during the sampling made after the first and second harvest. The results of this study showed that a good drainage system together with control of water supply is not only a sound agricultural practice, but also detrimental to the snail hosting *S. japonicum*. Together with thorough preparation and constant weeding, these factors led to the disruption of the ecological set-up which prevented snail breeding.

Agro-engineering and sanitation improvement methods to control *S. japonicum* were also carried out in Leyte with the assistance of the United Nations Food and Agricultural Organization (Blas, 1976). The agro-engineering methods include stream channelization, seepage control, diversion and intercepting channels, canal lining, drainage and irrigation schemes, combined vegetation removal and drainage, earth filling, ponding, and improved rice culture. Sanitation improvement methods include latrine construction, provision of safe water supply, building of foot bridges, and control of stray animals.

Chemotherapy

Praziquantel was first introduced in the Philippines for clinical trials against human schistosomiasis in 1975. Initially, praziquantel was tested for tolerance and efficacy against placebo in two consecutive double-blind clinical studies in Leyte using a single dose of 50 mg/kg body weight and a total dose of 60 mg/kg body weight given in 3 divided doses at 4-6 hours intervals. A subsequent trial was conducted among outpatients to determine the toxicity and efficacy of three other dosage schemes and whether these are influenced by such variables as age, intensity of infection as measured by egg count per gram of stool (EPG) and intestinal parasitism. The most frequent side reaction was abdominal discomfort, followed by fever, vomiting, dizziness and headache. While a single dose is more convenient and advantageous, the divided dosage is necessary to minimize the occurrence of severe side effects. The dose of 3 x 20 mg/kg body weight or a total of 60 mg/kg body weight seemed to be the optimum dosage scheme in terms of efficacy and minimum severe side effects. The results of the trials showed that a dosage of 2 x 20 mg/kg was suitable and practical for large scale field treatment after treating over 1000 patients without encountering any severe side effect (Noseñas, Santos, Blas, Tormis, Portillo, Poliquit, Papasin, and Flores, 1984).

The use of chemotherapy on cerebral and hepatosplenomegalic forms of schistosomiasis were the subject of two separate studies in Leyte. Hayashi, Matsuda, Tormis, Noseñas and Blas (1984) conducted a follow-up study of the 127 cases of cerebral schistosomiasis that had been treated with antischistosomal drugs at Palo, Leyte, Philippines since 1975. Clinical changes of the brain before and after the treatment with antischistosomal drugs were studied by close neurological examination, electroencephalography and computer tomography. Cerebral schistosomiasis was selected by parasitological finding and by excluding clinically, vascular disorder of the brain, brain tumor, genuine epilepsy, and trauma of the brain. Before treatment, 64 or 91% experienced a high frequency of seizures no less than once a month. After treatment, the seizure disappeared in 53, became 50% less frequent in 13, the frequency did not change in 2, but was increased in 2 cases. Overall, the effective cure was observed in 66 out of 70 (94%). The study compared the curative effects of stibophen, niridazole, and praziquantel based on results of parasitological examination. Before 1977, stibophen and niridazole had been utilized. Among 47 cases treated with these drugs, completely cured cases were 8 with a cure rate of 17%, transient effectiveness in their clinical course was in 2, and non-effective in the rest of the cases. After 1977, 49 patients were treated with praziquantel at a total dose 50 to 60 mg per kg of body weight in a day. Thirty-four out of them were treated with praziquantel because of non-effectiveness after treatment with stibophen or niridazole in

1975 or 1976. Complete cure was observed in 37 (75%) cases, transient cure in 5 cases, and non-effective in 7 cases(14%). It appeared that praziquantel was more effective than the other antischistosomal drugs.

Tanaka, Blas, Noseñas, Matsuda, Hayashi, and Santos (1985) studied the effect of selective mass-chemotherapy with praziquantel at a dose of 60 mg/kg a day on the annual incidence of *Schistosoma japonicum* on 1,800 school children enrolled at 9 primary schools at Dagami, Leyte, Philippines. Praziquantel was given to all egg positives detected not only from school children but also from the other dwellers in villages. The patients were given praziquantel at a dose of 20 mg/kg perorally 3 times in a day, at 8 am, 11 am and 2 pm, and they were cared for until 4 pm. All school children were examined for the schistosome egg by the MIFC method of fecal examination and/or for circumoval precipitin (COP) reactions every year since 1979, except for school year (SY) 1981/1982. The incidence of infection was utilized to evaluate the effect of control measures on schistosomiasis because it is more sensitive to the change brought about by the effective control measures than the prevalence. The incidence rates before mass-chemotherapy were 22.2, 24.2, 26.9, 9.6, and 28.4% in a period from school year 1975/76 to 1979/80, respectively. The low incidence in school year 1978/79 was analyzed to be caused by an unusual drought in the previous school year, 1977/78. Egg positives including village people were treated and the numbers treated yearly were 22, 943, 273, 300, and 341 from school year (SY) 1978/79 to SY 1982/83, respectively. Following the start of mass-chemotherapy, the incidence fell drastically, i.e., 8.4% in 1980-81, 6.8% in 1982-83, and 15.4% in 1983-84. This demonstrated the efficacy of mass-chemotherapy on reduction of transmission. Thus, mass chemotherapy was proven to be effective for the control of disease transmission and this method is considered realistic in the area where funds are limited. Before mass-chemotherapy, a trial was made to control schistosomiasis through environmental modification by (1) draining water, (2) improvement of irrigation canals,

(3) filling and, (4) leveling of wet areas in 50 ha. at the most depressed site in the project area. Although the land reclamation planned at a large scale resulted in successful control of schistosomiasis in Japan and China, a small scale environmental modification in this area for some years had little effect on reduction of transmission. Moreover, available funds were not adequate to conduct large scale public works for schistosomiasis control in most infested areas. On the other hand, selective mass-chemotherapy needed comparatively lesser funds than public works and resulted in drastic reduction of the incidence.

The preceding studies have shown that the physical environment imposes limitations on the distribution of schistosomiasis in the Philippines and that within the suitable environments it is the cultural habits of humans that determine whether schistosomiasis transmission will be successful. Most of these investigations were aimed at an understanding of the disease with the end in view of targeting vulnerable points in the transmission cycle for drugs and vaccines to kill the parasite, and molluscicides to kill the snail intermediate host. The dynamic relationships involving the cultural, environmental, and water contact aspects of the disease in which humans play a major role have largely been ignored.

The schistosomiasis transmission cycle, viewed from the geographic perspective, offers an ideal framework for the analysis of the interplay between the cultural, environmental, and water contact aspects of the disease. Following this framework, the remaining chapters will describe how the interaction of physical and cultural factors makes the village of Macanip a place where schistosomiasis transmission persists despite annual control efforts of the government.

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CHAPTER 3

METHODOLOGY

Analytical Framework

The key concepts of geography that give the discipline its distinct identity and cohesion relate to space, holism, and people-environment relationships (Hunter, 1971). The applicability of the spatial geographical approach to the problem of schistosomiasis was given emphasis in the recent Atlas of the Global Distribution of Schistosomiasis (Doumenge, et al., 1987). The atlas stressed the fact that the epidemiology of schistosomiasis is as varied as the human ecology and environment in which it occurs. It demonstrated the utility of the geographer's main tool, the map, in understanding the epidemiological diversity of schistosomiasis.

This study uses an analytical framework modeled after the transmission cycle of the parasite that combines concepts related to space, holism, and people-environment relationships (Figure 3.1). The framework reveals five subsystems of relationships that arise from the movement of the parasitic schistosome through the different stages of its life cycle in the human host, the animal host, and the amphibious snail *Oncomelania quadrasi*. The five inter-related subsystems resulting from the interaction of the four factors are: (1) the human host-snail relationship, (2) the animal host-snail relationship, (3) the snail intermediate host-parasite relationship, (4) the parasite-human host relationship, and (5) the animal-parasite relationship. The locus of these subsystems of relationships is water, the human and animal use of which results in the convergence of the four factors of the

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Schistosomiasis japonicum disease system. The framework suggests that schistosomiasis infection persists when the life cycle of the parasite is allowed to be completed. It also indicates the numerous opportunities to interrupt the life cycle of the parasite.

The framework shows two independent loops that represent two pathways for the completion of the parasite's life cycle. The first loop shows a transmission cycle that is completed via a human host while the second shows completion via an animal reservoir. These two cycles function independently, which implies that transmission can be maintained even if one of them is interrupted. This feature of the *Schistosomiasis japonicum* life cycle makes the disease an anthropozoonosis. It sets it apart from other forms of human schistosomiasis that do not involve animal reservoirs. It complicates efforts to control disease transmission.

Postulated Relationships

Based on the framework that I have adopted for this study, the following postulated relationship is offered: that human schistosomiasis infection in Macanip is associated with the interaction of the following elements of the transmission cycle: hazardous human behavior, favorable environmental characteristics, presence of intermediate host snails, and presence of animal hosts. This broad postulated relationship may be broken down into the following interrelated considerations:

1. The transmission of schistosomiasis is associated with favorable environmental characteristics such as slow-flowing water, even distribution of rainfall throughout the year, and shade-providing vegetation.

2. The transmission of schistosomiasis is associated with contamination of water bodies by human feces.

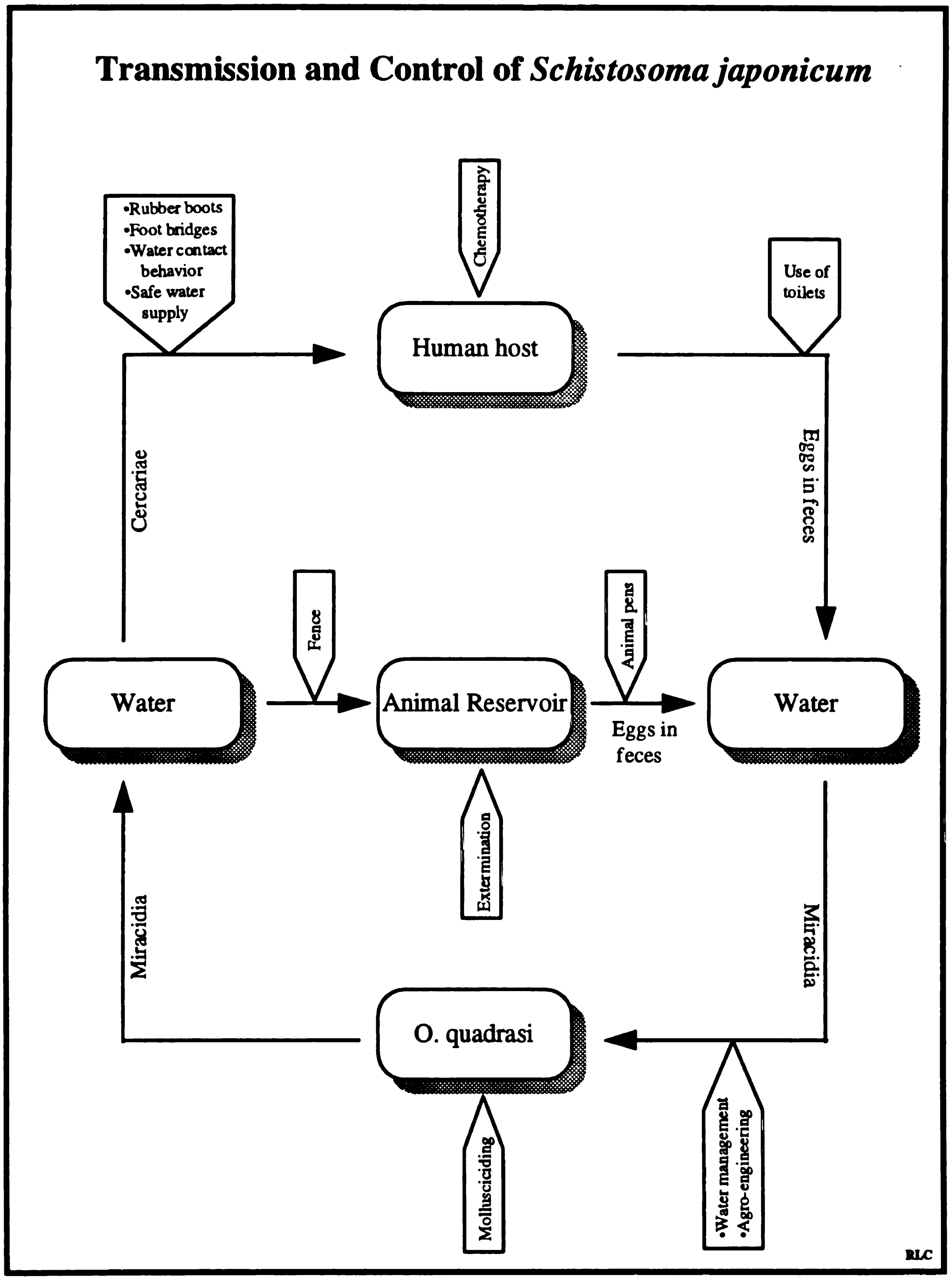

Figure 3.1 Model of Schistosomiasis Transmission and Control. Source: Author RLC.

3. The transmission of schistosomiasis is associated with agricultural practices that favor the *O. quadrasi* population.

4. The transmission of schistosomiasis is associated with hazardous water contact behavior.

5. The persistence of schistosomiasis is associated with inadequate knowledge about the schistosomiasis transmission cycle.

6. The persistence of schistosomiasis is associated with the inability of the control program to interrupt the zoonotic cycle of the parasite.

7. The persistence of schistosomiasis is associated with poverty.

8. The transmission of schistosomiasis is associated with the absence of a safe domestic water supply.

Selection of Study Area

The availability of accurate parasitological data was my main reason for the choice of Macanip, Jaro, Leyte, Philippines as the target village for this study. One of the requirements of the study is an assessment of the level of schistosomiasis infection in the study area based on accurate diagnosis. This diagnosis can be made by the Kato-Katz method or the Circumoval Precipitin Test (COPT). The former involves the counting of *Schistosoma japonicum* ova in human stools using a microscope while the latter involves a blood test. Both of these methods were beyond my financial resources and academic training. Given these limitations, I am grateful that the RITM (Research Institute of Tropical Medicine) through its director, Dr. Remigio Olveda, gave me access to infection data that have been gathered since the RITM started screening and treatment in Macanip in 1982. In addition, the RITM gave me access to data representing two cycles of observations in their on-going study of human water contact in a portion of the village.

The RITM is one of the leading research institutions in the Philippines with a strong record of international research cooperation. It has eight multidisciplinary research programs addressing the following disease areas: acute respiratory infections, diarrheal diseases, schistosomiasis japonicum, human immunodeficiency virus infections/acquired immunodeficiency syndrome, viral hepatitis, leprosy, malaria, and rabies. Its Schistosomiasis Research Program was implemented with the support of major funding institutions like the US National Institutes of Health, the WHO Tropical Disease Research (TDR) program, the Rockefeller Foundation, and the Edna McConnell Clark Foundation. The research projects have for their main goals the development of a cost-effective strategy for schistosomiasis control and the development of a vaccine against *Schistosoma japonicum.*

The village of Macanip is located in the municipality of Jaro, 38 kilometers west south west of Palo, another municipality in the island of Leyte, Philippines. It is 10 kilometers from the national highway. To reach it from the national highway, one has to cross two rivers. Both bridges to these two rivers were washed out in a 1991 typhoon. During weekdays, most village people use public transport motorcycles that seat four people -- one in front of the driver and three behind. The fare is P10.00 (about US $0.40) each passenger for the 30-minute ride through a rocky and gravelly road. Trips to and from the village frequently require a long wait because the motorcycle driver would not go unless there are three passengers. Passengers frequently get their feet wet during the river crossings. During Sunday, which is usually market day, two "Asian Utility Vehicles", that ordinarily accommodate 17 passengers, ferry people from the village to the town center. The fare is half of the motorcycle fare -- P5.00. Because there are only two trips in the morning and two in the afternoon, these vehicles are always packed with passengers. I counted 46 passengers during one trip.

Since the village was my "laboratory", I decided to live in the village during the field research. The head of the house where I stayed is a rice farmer while his wife works as a st

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as a stool collector of the World Bank-funded schistosomiasis component of the Philippine Health Development Project (See Acknowledgements: Arturo and Juanita Adlawan). Both of my hosts were born in the village and have lived in it for much of their lives. Both of them gave me valuable insights into village life, customs and traditions. The wife serves as the Secretary of the village governing body. Their house stands opposite the Macanip Elementary School, where the RITM holds its annual screenings and treatment.

Recruitment of Field Guide and Interpreter

Throughout the length of my stay in the village I was aided constantly by my guide and interpreter (See Acknowledgements). He is a village councilman and the treasurer of the "Samahang Nayon," the association of farmers in the village. I needed an interpreter because I could not speak and I barely understand the local dialect. Although the villagers understand Tagalog, the Philippine national language, most prefer to talk in the local language called *waray*. A high school graduate with two years of college education, my guide acts as field supervisor of RITM's water contact study in the village. Because of this position, he is familiar with most of the aspects of schistosomiasis in the village. I found these qualities to be very useful when we had to translate the questions in my interview schedule from English to *waray*. His understanding of the transmission process provided me with valuable insights into the schistosomiasis disease system in the village during our discussions and interviews. An added advantage for my purposes is the fact that he together with two assistants had just conducted a population census of the village six months before my visit. His knowledge of the village population and their house locations was therefore current at the time of my survey. His familiarity with the layout of the village including the location of houses was particularly valuable when I mapped the village using the compass traverse method.

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Method of Data Gathering

Socioeconomic survey

An interview schedule, which is shown in the Appendix, was the main socioeconomic survey instrument that was used in this study. I formulated the questions in the interview schedule with the objective of eliciting information on the human component of the schistosomiasis disease system. Its preparation involved three phases. In the first phase, I drafted a set of open-ended questions based on my study objectives and my review of the literature. With these questions in mind, I devoted my first few days going around the village observing patterns of life in the village. I took note of the patterns that I deemed to be key elements of the schistosomiasis transmission cycle. At the same time, I discussed my initial set of questions with my hosts, my interpreter, a coconut farmer, a rice farmer, a schoolboy, the President of the Irrigators Service Association of the village, and the municipal agricultural technician assigned to the village (See Acknowledgements).

During the second phase, I re-cast the questions into a form that is compatible with the village setting. I drafted the questions in English and subsequently translated them into *waray* with the help of my interpreter. I knew a little of *waray* because my father, being from the adjacent province of Samar, spoke it fluently. I picked up the dialect from him and from my relatives. I grouped the questions under the headings of demography, water contact behavior, living conditions, household expenses and income, livelihood, ownership of animals, health seeking behavior, knowledge of the schistosomiasis transmission cycle, community rating, attitudes and outlook, community participation, and attitudes and perceptions toward schistosomiasis. Opposite the questions, I added the possible range of responses, which I gathered during the initial open-ended interviews, and assigned numerical codes to each. This facilitated the recording of responses during actual interviews. It also simplified the inputting of the responses into the computer.

During the third phase, I tested the interview schedule on 20 respondents. I made a purposive proportional sampling of respondents based on age, occupation, and location of residence. Here I had the opportunity to make sure that the questions were clear enough to be understood by the respondents and that very little was lost in the translation process. I also wanted to know how long each interview would last. Because of the nature of the questions, I deemed it necessary that the household head be the respondent. To enable the respondents to thoroughly understand the questions and thus respond accordingly, the interview was conducted in *waray*. I decided that the questions will be asked by my interpreter and I will record the responses. On the average, the interview lasted one hour.

With few exceptions, we conducted the interviews in the respondent's residence. We usually made arrangements for the interview a day or two before. The spouse was usually present during the interview. In cases where the husband was the respondent, I found the presence of the wife to work to my advantage. My interpreter thought that the husband usually was more truthful when the wife was present especially with regard to income.

I conducted the household survey between March 8 and May 31, 1993 to determine the village's socioeconomic characteristics and the knowledge, attitudes, and practices of the people that may have a bearing on schistosomiasis prevalence. I was able to include 251 households. This figure constitutes 77 percent of the total number of households in the village. The survey area is divided into 13 zones (see map on p. 55). All the respondents are heads of households, 88 percent are married, and 90 percent are male. Most of the respondents have very little formal education. More than 90 percent said that they did not go to school or they had reached only the fourth grade of elementary education. Thus, the majority of the respondents possess only the barest essentials of reading and writing. Sixty-seven percent of the respondents were born in Macanip; 85 percent have

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have not moved from their residence within the past 5 years. The largest number of respondents, representing 51 respondents or 20 percent of the total, come from Sitio Gapas (Zone 10). Almost 40 percent come from the main settlement cluster, the village *poblacion*, which is composed of Zones 1 to 5. Some household heads could not be interviewed because they were deaf, mentally impaired, or too ill. Other potential respondents deliberately avoided being interviewed.

Field mapping and aerial photo interpretation

The analysis of transmission patterns requires a clear locational component to be of value for control programs. It is important to know where the people are being exposed and where elements of the natural environment are most susceptible to intervention or avoidance. In the case of Macanip, detailed field mapping was necessary because available maps covering the village were either too small in scale or out of date that they cannot be used for village level analysis of transmission patterns. For purposes of this village-level study, I made a land use and settlement pattern map of the village. The base map that I used was a 1:4,000 scale tax map in the Municipal Assessor's office. The map, which was plotted from information originally gathered in 1928, showed roads, waterways, individual lot boundaries, and lot numbers within the village. Some of the latter had been updated. Tax declarations from the same office listed the land use for each lot. I used this listing as a starting point to plot land use on the base map. Taking due account of seasonal differences in agricultural land use, I field-checked the land use map and found it generally accurate for analysis on the village scale. I supplemented this ground verification by examining black and white aerial photographs of the village that were taken in 1976. Using an ordinary US Army prismatic compass that enabled azimuth compass readings, I plotted the location of all houses in the village by compass traverse method. Since there are no natural or man-made delineations on the ground, the boundaries of the political subdivisions of the village that I plotted on the map are only approximate.

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From the National Cartographic Authority of the Philippines with offices in Fort Bonifacio in Makati, Metro Manila, I was able to obtain a 1:50,000 topographic map that contained Macanip. The map was made based on aerial photography done by the US Army between 1947 and 1953. It showed that Macanip was a rice-production area in that period. I used it to examine the topography and land use in and around the village. From this map, I calculated the average slope and elevation in the village. This map was too small in scale for analysis at the sub-village level.

The RITM commissioned a licensed surveyor to make a map of a portion of the village that was used for its water contact studies. I was given one copy that showed the locations of the 31 water contact sites, houses, and waterways. Together with an RITM field observer, I inspected each of the water contact sites and took color slide photographs. To indicate the location of the water contact sites, the RITM placed numbered metal plate markers nailed to coconut trees, or attached to wooden posts. I ground-checked the accuracy of the map and found it to be reliable.

Village Census

RITM undertook a census of inhabitants in June 1992. The census revealed that there were 1,701 inhabitants in the village. This population was distributed in 327 households resulting in an average household size of 5 inhabitants per household. There are more males (52 percent) than females (48 percent). Fifty-three percent of the population are between the working ages of 15 and 65. The dependent age group 0-15 constitute 42 percent. Thirty-seven percent of the households are located in the main settlement cluster in the center of the village.

Snail Infection Data

RITM provided snail infection data from two cycles of observations: the first cycle was from August to October 1992 while the second was from March to June 1993. The comb

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combined collection for these two periods amounted to 17,803 snails. The total number of snails collected during the first period was low: only 2,762 or 15 percent of the total. Some sites contained no *O. quadrasi* although they did contain other snails. Other sites contained *O. quadrasi*, but none were infected while still other sites contained *O. quadrasi* of which only a few were infected. In the second cycle, the RITM increased the chances of finding snails by increasing the number of field workers collecting at each site and by "baiting" the sites with dead banana leaves three days before the collection. Each site was searched by four field workers for one hour during the day that the site is scheduled for snail collection. The snails that were collected were placed in petri dishes containing wet filter paper, and brought to the Schistosomiasis Research and Training Center laboratory in Palo for identification and crushing.

Parasitological Data

The RITM provided me with parasitological data showing the intensity of infection for individuals who participated in their annual schistosomiasis treatments during the years 1982-1992 (no data for 1988). The data were in Dbase III format and contained the following fields: name, subject ID, date of examination, egg count per gram of stool, age, and sex. The number of individuals examined varied yearly from a low of 851 in 1984 to a high of 1552 in 1989. The data showed the number of schistosome eggs per gram of stool as determined by the modified Kato-Katz method. Almost half of the individuals examined by RITM during the 10-year period did not live in the village. Relatives and friends of the villagers apparently took advantage of the free annual schistosomiasis examination and treatment. For purposes of this study, I discarded the records of the non-residents of Macanip. Likewise, I did not use the records of those individuals who were not listed in the June 1992 census (Table 3.1).

Table 3.1. Macanip Schistosomiasis Infection Records 1982-1992

Year	No. of Records Received from RITM	Number of Records Used in this Study
1982	1158	493
1983	1010	472
1984	851	419
1985	1021	474
1986	1087	565
1987	1075	602
1988	none	none
1989	1552	623
1990	1232	663
1991	1075	679
1992	964	547
Total	11025	5537

Parasitological data were obtained from Macanip residents through informational meetings and close cooperation with village leaders. On arrival of RITM doctors in the village, word was passed around through unit leaders that the RITM team had arrived and that there would be a meeting in which examination and treatment procedures would be explained. During the meeting, an RITM doctor explained to the villagers the importance of their cooperation in the treatment and study of schistosomiasis in the village. Five stool cups per individual were distributed to households that were in the water contact study area. The need for diagnostic accuracy in the water contact study was the reason why five stool samples were given per individual. For the rest of the village, only one stool cup per individual was given. The stool cups were picked up by four village-based field workers of the RITM the following morning. Only one stool cup was collected each morning per individual. Thus, five stool samples for five days were obtained in the water contact study area; only one stool sample was obtained for the rest of the village population. Samples from the collected stools were immediately mounted on glass slides (using the Kato-Katz technique) by two trained workers. These slides were later transported to the Schistosomiasis Research and Training Center in Palo, Leyte for counting of schistosoma ova.

Water Contact Data

The RITM also provided field data in Dbase III format on water contact observations and snail infection data in 31 observation sites in a portion of the village. RITM classified the 31 observation sites into eight water types. As shown in Table 3.2, 12 or 40 percent of the water types are paddy fields.

The targets of the water contact observations were 480 persons belonging to 86 households located in the *sitios* (hamlets) of Gapas, Guinwalohan, and Cutay-Sapa. Each of these individuals was given an identification number. Painted metal plates nailed on the front of the houses indicated household numbers. The water contact sites were likewise marked through easily visible painted metal plates nailed on trees or placed on chest-high wooden stakes. There were two cycles of observations: the first was conducted during the last quarter of 1992 and the second was made during the second quarter of 1993. Each cycle comprised ten periods of 8 days, as follows:

Day 1	water contact observations at site a
Day 2	snail collections at site a
Day 3	water contact observations at site b
Day 4	snail collections at site b
Day 5	water contact observations at site c
Day 6	snail collections at site c
Day 7	rest
Day 8	rest

Table 3.2. Water Contact Observation Sites

Macanip, Jaro, Leyte, Philippines

Description	Number of Sites	Site Numbers	Number of Valid Observations, 92 & 93	% of total obs., 92 & 93	% of total obs., 1992 only*	% of total obs., 1993 only**
Main river (Mainit river only)	4	2, 12, 22, 31	862	37.1	25.5	51.3
Small river (Taytay and Mamlag rivers)	3	7, 17, 20	325	14.0	10.4	18.3
Large irrigation canals	3	3, 13, 23	323	13.9	17.4	9.5
Small irrigation canals	3	8, 18, 28	16	0.7	--	1.5
Paddy fields (rice plantation beds)	12	1, 4, 6, 9, 11, 14, 16, 19, 21, 24, 26, 29	479	20.6	25.7	14.3
Seepages (ground with soft soil with still or sluggish water and vegetation; muddy ground with creek/river runoffs)	2	5, 27	218	9.4	13.4	4.4
Flood pool (ground depressions that stay underwater most of the time including small swamps)	2	10, 25	31	1.3	1.9	0.6
Carabao wallow (deep ground depressions filled with water that is most often used by carabaos; water is almost always cloudy or muddy)	2	15, 30	72	3.1	5.6	--
Total			2326	100	100	100

* covers the months of August, September, and October
** March, April, May, and June
Source: Author's analysis of RITM data.

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Table 3.3. Number of Water Contact Observations Per Site, 1992 and 1993

Site	Type	Date Observed		Day of Week.		No. of Observations			% of Observations		
		1992	1993	1992	1993	1992	1993	Totl	1992	1993	Totl
1	Paddy	8/12	3/18 4/27	3	4, 2	73	81	154	5.7	7.8	6.6
2	M. River	8/14	3/20 4/29 6/11	5	6, 4, 5	86	100	186	6.7	9.6	8.0
3	L. Canal	8/16	3/22	7	1	49	4	53	3.8	0.4	2.3
4	Paddy	8/20	3/26	4	5	60	8	68	4.7	0.8	2.9
5	Seepage	8/22	3/28	6	7	112	40	152	8.7	3.8	6.5
6	Paddy	8/24	5/9, 3/30	1	7, 2	43	18	61	3.3	1.7	2.6
7	S. River	8/28	4/3, 5/13	5	6, 4	30	79	109	2.3	7.6	4.7
8	S. Canal	--	4/5	--	1	--	3	3	--	0.3	0.1
9	Paddy	9/1	--	2	--	6	--	6	0.5	--	0.3
10	Fld. Pool	9/5	--	6	--	13	--	13	1.0	--	0.6
11	Paddy	--	--	--	--	--	--	--	--	--	--
12	M. River	9/9	4/15 5/25	3	4, 2	53	34	87	4.1	3.3	3.7
13	L. Canal	9/13	4/19	7	1	49	26	75	3.8	2.5	3.2
14	Paddy	--	4/21	--	3	--	3	3	--	0.3	0.1
15	Wallow	--	--	--	--	--	--	--	--	--	--
16	Paddy	--	3/18 4/27	--	4, 2	--	18	18	--	1.7	0.8
17	S. River	9/23	3/20 4/29 6/11	3	6,4,5	22	54	76	1.7	5.2	3.3
18	S. Canal	--	3/22	--	1	--	13	13	--	1.2	0.6
19	Paddy	--	3/26	--	5	--	6	6	--	0.6	0.3
20	S. River	10/1	5/7 3/28	4	5, 7	82	58	140	6.4	5.6	6.0
21	Paddy	--	3/30	--	2	--	11	11	--	1.1	0.5
22	M. River	10/7	4/3 5/13	3	6, 4	188	298	486	14.6	28.6	20.9
23	L. Canal	10/9	4/5	1	1	126	69	195	19.8	6.6	8.4
24	Paddy	--	4/7	--	3	--	4	4	--	0.4	0.2
25	Fld. Pool	10/15	4/11	4	7	12	6	18	0.9	0.6	0.8
26	Paddy	--	--	--	--	--	--	--	--	--	--
27	Seepage	10/19	4/27	1	2	60	6	66	4.7	0.6	2.8
28	S. Canal	--	--	--	--	--	--	--	--	--	--
29	Paddy	10/25	--	7	--	148	--	148	11.5	--	6.4
30	Wallow	10/27	--	2	--	72	--	72	5.6	--	3.1
31	M. River	--	6/2 4/23	--	3, 5	--	103	103	--	9.9	4.4

Source: Author's analysis of RITM data

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The chosen format allowed observations on both weekdays and weekends. As originally intended by RITM, the format would allow each of 30 sites to be observed once and collected once in each 80-day cycle. As shown in Table 3.3, however, some sites did not have any observation records while other sites were observed more than once during the 80-day cycle. In the 1993 observation cycle, for instance, Sites 2, 12, and 31, which are parts of the Mainit River, were observed more than once. The same is true for Sites 1. 6, and 16, which are paddy fields. Thus, one would expect a greater chance of obtaining more water contact observations at these sites. Another confounding factor is the fact that some sites like river crossings and seepages yielded point observations while other sites such as paddies and the Mainit River yielded area observations that represented recordings gathered over a wider area. Again, the chances of getting more water contact observations in "area" sites are greater than those of "point" sites. These should be borne in mind when interpreting the water contact data.

The 1992 water contact data that was provided by RITM consisted of 1,600 observation records; that of 1993 consisted of 1360 records. The fields in the data set were site number, date, day of week, observer, ID number, sex, age, time start of water contact, time end of water contact, activity type, type of water, and degree of contact. Since the data set was "raw," records that could not be used had to be removed. The records that were discarded include those of non-residents of the study area and cases wherein sex, age, activity and type of water are undetermined. After data cleaning, the 1992 data consisted of 1,284 water contact observations: 453 in August, 143 in September, and 688 in October. The 1993 data, which contained the same data fields as the previous year's data, consisted of 1,042 observations: 222 in March, 544 in April, 208 in May, and 68 in June. Many of the water contact sites had dried up by May 1993, which accounts for the lower number of observations in May and June.

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CHAPTER 4

VILLAGE PROFILE

This chapter describes the physical and cultural circumstances in the village that collectively exert an influence upon schistosomiasis transmission and control.

Physical Environment

Macanip is located in the municipality of Jaro in Leyte island, Philippines, which is about 1,000 km from the southeast coast of the mainland of Asia. The village lies at coordinates 11°09′north latitude and 124°47′east longitude. As shown in Figure 4.1, it is situated on the western edge of a plain in the northeastern part of Leyte. The plain is 70 km long with a width varying between 10 and 20 km. The foothills of the Leyte Cordillera mountain range are only 5 kilometers from the village's southeastern boundary. The nearest body of water is Carigara Bay, which lies 30 km north of the village.

The general configuration of Macanip is very similar to that of the lower peninsula of Michigan, which looks like the back of a person's left hand (Figure 4.2). The north-western and southeastern boundaries are defined by creeks: Hambabalud (east) in the southeast and Hambabalud (west) in the northwest. The village measures 5 km along its north-south axis and about 3 km along its east-west axis. The municipal road, which is the

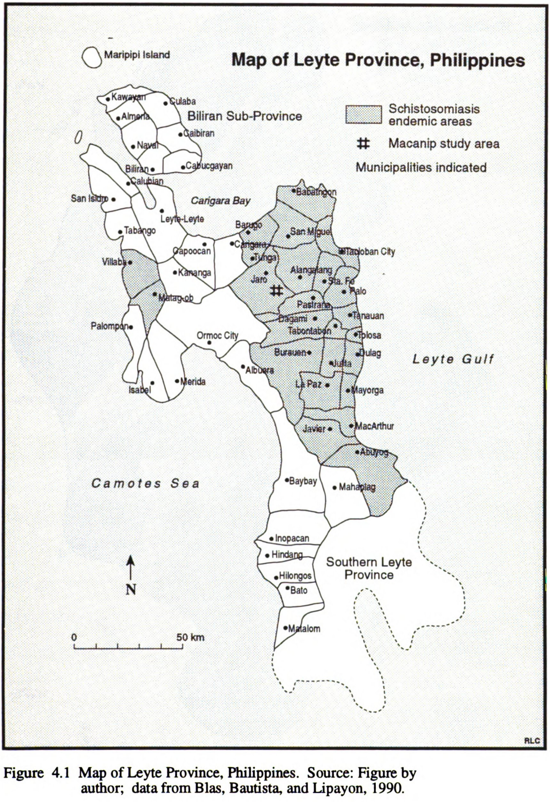

Figure 4.1 Map of Leyte Province, Philippines. Source: Figure by author; data from Blas, Bautista, and Lipayon, 1990.

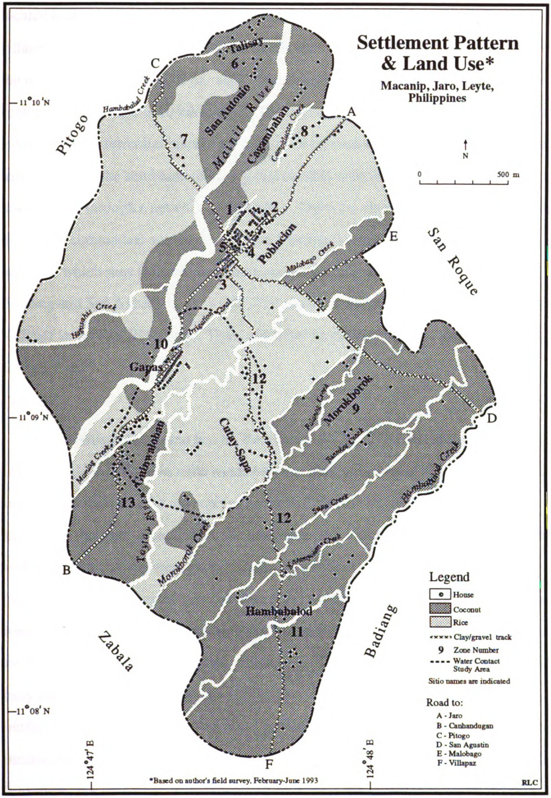

Figure 4.2 Settlement Pattern and Land Use. Macanip, Jaro, Leyte, Philippines.

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main transportation artery of the village, runs in a southwest to northeast direction and is located in the upper half of the village. It connects Macanip with Canhandugan, the village to its south, and northward to several other villages leading to the marketplace at the town center of Jaro (A-B on map). The distance between Macanip and the town center along this road is 10 kilometers. The road is composed of clay and gravel so that it is vulnerable to torrential rains of the area. The location of this road renders the lower half, especially the southeast, relatively inaccessible to motorized transport. Access to this lower half is through a network of foot trails. There are also two smaller village roads that can accommodate animal drawn carts. The first is the Pitogo-San Agustin Road (C-D on map), which runs from north to south and connects Macanip with the villages of Badiang and San Agustin in the south. The second connects Macanip with the village of Villapaz in the east (F on map). These roads have a mostly clayey surface. Their width is about 1.5 m.

Climate

The village is situated just off the eastern slopes of the central mountain range in Leyte, which is exposed to trade winds blowing in from the Pacific Ocean. This windward location is responsible for the copious amount of rainfall that the village receives throughout the year. Runoff from the mountains also ensures sufficient amounts of water for the streams that run through the village. The nearest climatological station of the Philippine Weather Bureau is in Tacloban City, which is 38 kilometers east of Macanip. Since this distance is small, and the region is almost flat, it is fair to say that readings from the Tacloban station can be applied to Macanip. The station recorded an average of 210 rainy days a year. The rainiest months are October to February. The average annual rainfall is 2,216 millimeters. Prolonged dryness, which is not well tolerated by the snail intermediate host of schistosomiasis japonicum, is unusual because rain is distributed throughout the year. There are at least 15 rainy days per month. The range between the lowest

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lowest and highest temperature is only 2 degrees Celsius. The mean annual temperature is 27°C. The months of April and October are the warmest months with a mean of 28°C while January and February are the coolest with a mean of 26°C (Table 4.1 and Figures 4.3 and 4.4).

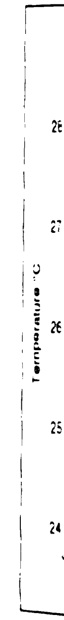
Table 4.1 **Rainfall and Temperature by Month, 1951-1985**
Station: Tacloban City

Month	Rainfall (mm)	Rainy Days	Mean Temp (°C)
Jan.	262	20	26
Feb.	205	18	26
Mar	138	16	27
Apr.	121	15	28
May	146	15	28
Jun.	155	16	28
Jul.	167	17	28
Aug.	129	15	28
Sept.	147	16	28
Oct.	184	19	28
Nov.	245	20	27
Dec.	317	23	27
Total /Mean	2216	210	27

Source: National Statistics Office. 1990. **Leyte Provincial Profile**. Manila: National Statistics Office.

Surface waters

The main sources of surface water in Macanip are year-round rainfall and runoff from the eastern slopes of the Leyte Cordillera. The natural and man-made surface water features in the village assure plenty of opportunities for water contact and snail growth.



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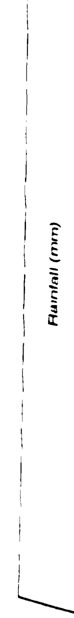

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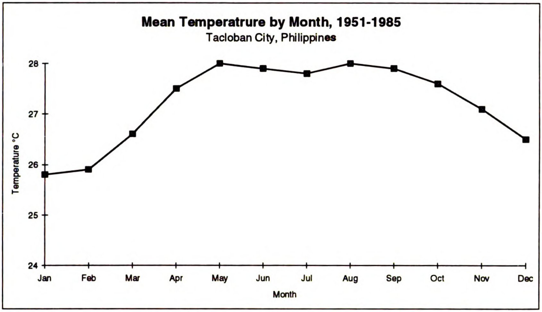
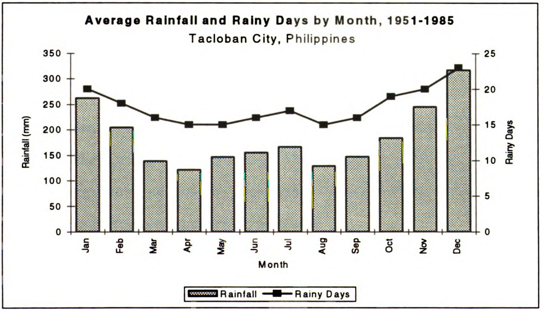
Figure 4.3 **Mean Temperature by Month, 1951-1985**
Tacloban City, Philippines



Source: National Statistics Office. 1990. **Leyte Provincial Profile**. Manila: National Statistics Office. Figure by author.

Figure 4.4 **Average Rainfall and Rainy Days by Month, 1951-1985**
Tacloban City, Philippines



Source: National Statistics Office. 1990. **Leyte Provincial Profile**. Manila: National Statistics Office. Figure by author.

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Fifteen rivers and creeks go through Macanip. These are the Mainit and Taytay rivers and the following creeks: Mamlag, Morokborok, Hagosahis, Sapa, Hambabalod East, Hambabalod West, Tuod, Badiang, Malobago, Campitlucan, Hambabaluray, Palanog, and Binukot. The most important sources of water for rice cultivation are the Mainit and Taytay rivers. According to village informants, water always flows in these two rivers.

The most important surface water feature is the Mainit River. In terms of volume of water flow, it is a secondary river among the rivers of the town of Jaro. The largest river in the town is the Binahaan in the southeast and the Kabayongan in the west. The Mainit river originates from the Alto Peak, a mountain that has an altitude of 1,100 meters above mean sea level. It flows past the village of Canhandugan, another schistosomiasis-endemic area, before reaching Macanip where it streams just west of the main settled area of the village. Within the village, the Mainit River is shallow; in most places it is just less than a foot deep. Thus, swimming is not possible and no bridges are necessary to cross it. Along the edges of this river, the villagers have excavated shallow depressions in which they wash clothes and bathe.

Settlement pattern

As shown in Figure 4.2, Macanip is composed of 9 sub-areas or sitios, which can be regarded as large neighborhood groupings. For management purposes, the sitios were given zone designations and each was placed under a unit or zone leader. The sitio names and their corresponding zone numbers are as follows:

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Sitio Name	Zone Number
Poblacion	1- 5
Talisay	6
San Antonio	7
Cagambahan	8
Morokborok	9
Gapas	10
Hambabalud	11
Cutay-Sapa	12
Guinwalohan	13

The main settlement cluster is located at the intersection of the Pitogo-San Agustin and the municipal road. Macanip's five *poblacion* zones (1 to 5) constitute this cluster, which contains 121 houses occupying a 200 by 500-meter rectangle of land. This cluster contains the village primary school, basketball court, church, and health station. Most village-wide gatherings are held in this area.

Another settlement cluster is in Sitio Gapas, which contains 41 houses crowded in a linear fashion along a 300-meter stretch of the main village road. Farther south along this road are 27 houses of Sitio Guinwalohan that are arranged in a linear pattern. Gapas lies very close to the eastern bank of the Mainit River so much so that part of its land and the main village road were eroded away during a typhoon and consequent flooding in 1991. Guinwalohan is bisected by the Mamlag Creek, which is a tributary of the Taytay River.

The 3 sitios in the north of Macanip are Cagambahan, Talisay, and San Antonio. Cagambahan, so named because it is composed mostly of members of the Gamba clan, lies east of the Mainit River. Fourteen of the 20 houses in this area lie among rice fields. The Campitlucan Creek, which is fed by a spring, is an important surface water feature in this area. Talisay has 14 houses that are located near the Hambabalud Creek. The houses are nestle

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nestled beneath coconut trees. San Antonio has 12 houses: 8 houses in its northern portion are under coconut trees while the 4 houses to the south near the Pitogo-San Agustin Road are among rice fields.

Morokborok and Hambabalud constitute the southeastern third of the village that is mostly under coconut trees. Compared to the other areas of Macanip, the houses in these two sitios are dispersed over a wider area. In Morokborok, only 5 of the 29 houses are among ricefields. The three creeks that run through this sitio are Morokborok, Palanog, and Binukot. All the 11 houses of sitio Hambabalud are under coconut trees. The three creeks that run through this area are Hambabalud, Sapa, and Katamyokan

Slope and elevation of the land

The village of Macanip lies at an elevation of 108.9 meters above mean sea level. The elevation of the land decreases from the southern to the northern part of the village. Between Macanip and its southern neighbor, the village of Canhandugan, the average land slope is 2.9 percent. The topography of the land in the village is flat to undulating. Within the village itself, there are variations in slope. The areas with the higher slopes in the south and southeastern part are used mainly for coconut growing. The level lands in the village are almost entirely under rice cultivation. These lands are located along the main river. As calculated from map measurements, the average slope of the land is 0.9 percent. Because of the gentle slope, the flow of water is sluggish; in certain areas water remains stagnant.

Soils

The soils of the village are a mixture of the San Manuel silt loam and the Palo clay loam (Jaro Municipal Development Staff, 1983). According to Barrera, Aristorenas, and Tingzon (1954), the San Manuel soils, which cover most of the moderately drained flat

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lowland of Leyte, evolved from alluvial deposits. It has a higher proportion of sand than of silt and clay and is fairly rich in organic matter. The water table is 2-4 meters from the surface. In many areas of Leyte, these soils are extensively cultivated for rice, coconuts, bananas, sweet potatoes, peanuts, and vegetables.

The Palo soils, which developed from recent alluvial deposits, are found in much of the eastern lowland plain of Leyte island where schistosomiasis is endemic. It has equal amounts of sand, silt, and clay, and no stones or rocks of any kind are found either on the surface or in the substratum. The surface soil, which is brown clay loam of a fine granular structure, is rich in organic matter from dead grasses and rice straw. This soil seldom cakes or hardens from drying. The water table is usually about 1 m from the surface. It is considered the best soil for agriculture in the island. Lowland rice, coconut, corn, cassava and sweet potatoes are the most common crops cultivated (Barrera, et al.,1954).

The physical environment of the large lowland plain in which the village lies provides preconditions for the persistence of Schistosomiasis japonicum infections. The even distribution of rainfall throughout the year guarantees the presence of numerous perennial, slow-moving waters in which the amphibious *O. h. quadrasi* can persist. The almost flat topography guarantees that worm eggs, hatched miracidia and cercariae are not washed away by increased water flow velocity. The absence of roads and dry trails in the east and southeast of the village means that residents of the hamlets have to traverse trails, irrigation canals, and streams to be able to reach the poblacion and from there the town center of Jaro. This increases opportunities for contact with infected water. Rivers, creeks, and springs are places for washing and bathing and are sources of domestic water supply. Irrigation ditches and small water impoundments are potential snail habitats.

The even distribution of rainfall and the minimal gradient of the land allows the formation of aquatic environments in which humans, animals, the snail host, and the parasite continually converge to perpetuate the schistosomiasis disease system in the village. These environmental characteristics have spawned a rice cultivation system that provides an abundance of opportunities for farmers and their families to be exposed to potentially infected waters.

Socio-economic Characteristics

Population

The census conducted in June 1992 by the Research Institute of Tropical Medicine listed 1,578 inhabitants in Macanip. Males slightly outnumber the females, 51 percent to 49 percent. Macanip has a young population: 40 percent of the inhabitants are under 15 years old (Table 4.2). The village's *poblacion* (Zones 1-5) contains almost 40 percent of its total population. Outside of the *poblacion*, the most populous sitio is Gapas, which contains 17 percent of the village population.

Table 4.2 Population by Sex and Age Group

Age group	Female	Male	Total	Percentage
1-4	85	98	183	11.6
5-9	126	122	248	15.7
10-14	96	112	208	13.2
15-19	56	79	135	8.6
20-29	100	105	205	13.0
30-39	96	95	191	12.1
40-49	77	74	151	9.6
50-59	53	73	126	8.0
60 & above	78	53	131	8.3
Total	767	811	1578	100

Source of Data: RITM Census, June 1992. Data collation by author: RLC.

Like the rest of the municipality, the population of the village has remained constant for some time. Very little in-migration is taking place. Many young adults who have acquired higher levels of education are moving out because the village offers few work opportunities apart from farming. Sixty-seven percent of the respondents in the author's survey were born in Macanip; 85 percent have not moved from their residence within the past 5 years. The population level is maintained by a high birth rate as evidenced by the high proportion of children in the village.

The houses in Macanip are generally grouped along lines that follow kinship and land tenure relationships. Relatives often build their houses close to one another. Thus, any given spot in the village can be identified with a family group. The village was named after the surname of its first settlers who moved in during the latter part of the 19th century. The largest family groups in the village have the following surnames: Macanip, Garrido, Gamba, Artoza, and Cabaltera. There are 326 households with sizes ranging from 1 to 11 members; the mean household size is 4.8. The single-member households are frequently composed of the elderly who opt to live by themselves. Although these elderly people live alone, their houses are usually adjacent to the dwellings of their children or close relatives. Some single-person households are also occupied by mentally impaired adults. Like the elderly, they live near the houses of close kin.

Most of the houses in Macanip are made of light materials like bamboo and wood for walls, floors, and posts and cogon grass and nipa palm leaves for the roof. These houses are built by the family itself with the help of relatives. Families that did not own their houses generally are rice or coconut tenants who live in houses that were provided rent-free by the landlord.

Rice cultivation

Almost one-half of the village land is utilized for rice cultivation. Most of the rice farmers use the high-yielding varieties (HYVs) of rice. This practice started in 1978 when the national government offered incentives to farmers to adopt modern rice cultivation technology under the "Masagana 99" program. The hybrid varieties require greater amounts of inorganic fertilizer, pesticides, and other inputs that all add up to higher production costs. Macanip farmers usually use the 110- to 120-day HYVs of rice such as IR-42, IR-74, or IR-72 that were all developed at the International Rice Research Institute. However, foundation or certified seeds of these HYVs are rarely used due to high costs; instead, second or third generation seeds are planted. Despite numerous incentives of the government for farmers to adopt new rice technologies, farmers in Macanip are still faced with the problem of low productivity because of their inability to apply the required amounts of inorganic fertilizer and pesticides due to lack of funds. According to the Municipal Agricultural Officer, only 6 farmers in Macanip availed themselves of the offer to "buy 2 take 1free bag of fertilizer" during the December-January 1993 planting season.

Because of water constraints, triple-cropping using the 90-day HYV varieties of rice such as IR-64 and IR-66 is seldom practiced. Farmers who insist on using these short-maturing varieties within the regular planting cycle will see their rice crop mature sooner. The problem, however, is that pests like water bugs, rats, and sparrows will converge on their rice fields. Other favorites are local varieties such as "Kaborok" and "Aklan." Farmers say that although the local varieties give lower yields, production costs are not as high. Moreover, they say that the local varieties are more resistant to rice pests and diseases.

In irrigated areas of Sitios Gapas, Guinwalohan, Cutay, and Cagambahan, two croppings per year are possible: the first crop is planted in January or February while the second crop is planted in July or August. The rest of the village's rice areas are rainfed. In these areas, where only one cropping per year is possible, rice is planted in the rainy months of December and January. It is followed by corn that is planted in April to June, or legumes that are planted from March to June.

Several stages are involved in the practice of rice agriculture. Initially, the rice fields are plowed and dikes are constructed or repaired to ensure proper water retention. Farmers who do not own carabaos hire these animals for plowing and harrowing purposes at a cost of 70 pesos per day. Laborers who specialize in dike construction and maintenance are also hired at a wage of 30 pesos per day. A portion of the ricefield is set aside for seed beds, which are prepared by plowing and harrowing before flooding and trampling. Next, the rice seeds are sowed by broadcasting and raked into the soil. After 18 to 20 days, the rice seedlings are ready for transplanting. All members of the family except for the very young and the very old are ordinarily enlisted to help in the transplanting of rice seedlings. Farmers who have many fields hire laborers at the rate of 30 pesos a day, plus meals. Three weeks after transplanting, the farmer enters the field again for fertilizer top-dressing and weeding. During the first two months, the rice field is flooded with water. During the third month, when the rice plants are 50 percent ripe, water is withdrawn from the rice field. Pesticides, weedicides and rodenticides are applied to protect the rice crop when available.

Irrigation

A large part of the rice-growing area of the village is served by with irrigation canals that enable two rice croppings per year. The National Irrigation Administration, a national government agency, has built a canal that streams through Guinwalohan west of the main village road. From Guinwalohan, the canal runs under the village road and waters the rice fields of Gapas east of the Mainit River. This canal is grass-covered and not well-maintained. Water runs through it only after periods of heavy rain. The velocity of water that flows through this canal is retarded by grass growth. In contrast, the farmer-maintained *paods* or small water impoundments and communal irrigation canals are well-maintained. These earthen *paods* and irrigation canals were all built by farmers whose fields will benefit from the additional water. The main irrigation canal gets its water from a *paod* t

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paod that is located at a point along the Mainit river between Sitio Gapas and the Poblacion. This *paod* supplies water to the ricefields immediately east of the *poblacion*, parts of Morokborok and Cagambahan. Another *paod* is located in the south of the village. It draws its water from the Taytay River. This *paod* supplies water to the ricefields of Guinwalohan, Morokborok, and Cutay.

Night irrigation and night fishing

The inadequacy of irrigation water increases the schistosomiasis risk among rice farmers in Macanip. About 31 percent of the respondents of the author's survey go out at night to divert irrigation water for their rice fields. The respondents further indicated that this practice is done 3 to 6 times per week during the planting and growing stages of the rice crop. This practice is especially true among farmers in Zones 9 and 11. There are irrigation canals in these Zones but the water coming from the Mainit and Taytay Rivers are used up in fields that lie near these rivers. The farmers whose fields are in the more distant areas relative to the rivers must wait for dusk for their turn to irrigate their fields. What these farmers do is to close the lateral gates of the irrigation canal leading to other farmers' fields in order to channel the water into their own rice fields. They have to monitor this process because farmers who are similarly situated will want to channel the limited irrigation water into their own fields. The absence of a farmer watching this irrigation process is usually construed as a tacit approval for other farmers to channel the water for their own use. The time that this process is done, which starts from dusk, is a dangerous time in so far as potential schistosomiasis infection is concerned. More than 80 percent of the 78 respondents who said that they engage in night irrigation said that they do so between 6:00 p.m. and 8:00 p.m. Studies conducted by Pesigan, et. al. (1958a) have shown that the greatest risk of infection starts at dusk when about 80 percent of cercariae would have swarmed or emerged from the host snail. Farmers who open or close the irrigation gates at this time are very vulnerable because this activity involves water contact of the feet and hands (See Tables 4.3 and 4.4).

Table 4.3 Number of Respondents Who Engage in Night Irrigation and Night Fishing

	Night Irrigation	%	Night Fishing	%
Yes	78	31	98	39
No	173	69	153	61
Total	251	100	251	100

Source: Author's survey.

Table 4.4 Frequency of Night Irrigation and Night Fishing

Frequency	Night Irrigation	%	Night Fishing	%
Daily	11	14	0	0
Twice/week	18	23	4	4
3-6 times/week	38	48	8	8
Once/week	10	13	12	13
Once/month	0	0	43	45
Twice/month	2	3	28	29
Total	79	100	95	100

Source: Author's survey.

To obtain additional food, almost 40 percent of the respondents engage in night fishing. They usually start night fishing activities between 6 and 7 p.m.. Their method involves using kerosene lamps to attract small crabs and fish as they wade through irrigation canals, rivers, and creeks. Two-thirds of those who engage in night fishing do so once or twice a month. (See Tables 4.3 and 4.4).

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Coconut cultivation

The other half of Macanip's land is planted to coconuts that are intended for copra production. Copra is the the dried white nutmeat interior kernel of the coconut shell from which coconut oil is extracted. The coconut lands are situated along the banks of the Mainit River and in the southeastern portion of the village in Sitios Cutay-Sapa, Morok-borok, and Hambabalod. A sizable number of trees also grow along the banks of the other streams and along the edges of and interspersed among rice fields. Most of the coconut trees have a definite owner and are given distinctive markings of ownership. Very little effort is made towards the care and cultivation of coconut trees. The underbrush is cleared only sporadically, and fertilizer application is not practiced. It requires seven to eight years for a coconut tree to mature and, then it is productive for 50 years or so. Thus, coconut farmers time their plantings of new trees to replace the old ones that are dying.

The common practice in Macanip is to harvest the nuts quarterly. This harvesting work is done by laborers who are paid 6 pesos per 100 nuts. The nuts are gathered in a copra-making place where they are husked to remove the outer cover and then split into two to remove the water inside the nut. They are then smoked and dried for 24 hours over a grill-like structure that uses slow-burning coconut husks. After this drying process, the nut meat is extracted and put into sacks. The sacks are then sold for cash to one of the copra buyers in the village. The shells are collected and sold as cooking fuel. All households in the village use coconut shells for cooking. Old coconut trees that are past the fruit-bearing period are cut and used as coconut lumber.

Family income and expenditure

Income and expenditure patterns in the village show that most families in the village do not earn enough to cover household expenses. To compensate for the deficit, families often borrow money from relatives or moneylenders, promising payment in the form of personal services or rice to be gathered at the next harvest. This practice results in families being in a constant state of indebtedness. Their efforts to engage in more economic activities to pay off debts often increases their exposure to potentially infected waters.

The main occupation of the working population of the village is farming. Because there is a lag time between the quarterly harvests of coconut and the planting and harvesting of rice, most workers have multiple occupations. The results of the author's survey revealed that only 38 percent of the respondents are owners of the land that they till. Twenty-seven percent are tenants, while 22 percent are laborers. Twenty-nine percent of the laborers among the respondents mentioned plowing and harrowing as their main activity. Thirty-eight percent said that they are mainly engaged in construction and maintenance of dikes.

The productivity of the ricefields in Macanip is low. The reason for this, according to the Municipal Agricultural Officer, is the failure of the farmers to follow the production technician's recommendations to increase agricultural productivity. The recommendations often require higher production costs, which the farmers cannot afford. Moreover, the farmers cannot innovate because they do not own the land that they till. Rice yields vary between 40 to 60 cavans (one cavan = 110 pounds) of unhulled rice per hectare. The value of the harvest is usually just enough to pay off the debts that the farmer has accumulated. Farmers often have to borrow money because very little money or nothing is left for the next planting season. Seventy-three percent of the farmers borrow from local lenders to finance their farming activities. Only 11 percent are self-financed. Fourteen percent, who are mostly tenants, borrow from the owners of the land.

The inhabitants of Macanip are generally poor. The mean family income in the village is P16,746, which is less than half of the national average. The cluster of households in the northwestern portion (Zones 6, 7, and 8) of the village had the lowest mean far

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family incomes (See Table 4.5). Seventy percent of the households had a negative net household income, which means that household expenditures exceeded household income. Only 4 zones showed surpluses in mean family income. The respondents compensate for the deficit by borrowing money from relatives or rendering personal services in return for money or food.

Table 4.5 Family Income and Expenditure by Zone, 1993

Zone	Mean Annual Family Income in Pesos (US $ 1.00 = 25 pesos in 1993)	Number of Families Reporting	Mean Annual Family Expen-diture in Pesos	Number of Families Reporting	Mean Savings/ (Deficit)
1	9,326	23	18,351	23	(9,025)
2	13,112	13	15,833	14	(2,721)
3	31,646	26	26,164	26	5,482
4	22,825	23	16,355	24	6,470
5	35,599	9	28,263	9	7,336
6	10,486	12	18,864	12	(8,378)
7	8,646	9	16,962	9	(8,316)
8	11,673	17	19,054	17	(7,381)
9	16,267	18	18,023	18	(1,756)
10	12,993	51	16,364	51	(3,371)
11	14,944	9	16,992	9	(2,048)
12	13,856	19	15,791	19	(1,935)
13	18,136	19	15,706	20	2,430
Village	16,746	248	18,326	251	(1,580)
Phil.	39,728	10,666	32,214	10,666	7,514

Source: Author's survey. The Philippines' mean family income was taken from the National Statistics Office. **1988 Family Income and Expenditures Survey.**

Most of the family income is consumed by food expenses. Seventy-nine percent of the households have a daily per capita expenditure on food of 10.00 pesos or less. Thirty-five percent of the households spent more than 80 percent of total household expenses on food alone; 47 percent spent between 60 to 80 percent.

Animal husbandry

The most numerous animals are chickens, followed by pigs and dogs in that order. At the time of the survey, there was an average of 1 dog, 3 pigs, and 7 chickens per household. Chickens are usually fed with table scrap, unhulled rice grains, and coconut meat. Table 4.6 shows the number and distribution of animals in Macanip.

The cows in Macanip are raised primarily for the meat market. During the survey, I did not see any cow that is used for farming or dairy purposes. The cows graze mostly in the periphery of the village. Cows are present in only two zones, namely Zone 4 with 8 cows and Zone 13 with 9 cows.

In Macanip, goats are raised only for meat purposes. There were 21 goats in the survey households. Most of the goats are raised in the coconut areas of Macanip. The reason is partly due to the fact that goats may cause extensive damage to the rice crop if they are allowed to graze near ricefields. The highest numbers of goats were found in Zone 10. Zone 12 had the highest number of goats per household of 0.37.

Carabaos are used for plowing the land in rice fields preparatory to planting activities. They are also used to haul harvested nuts to the copra-drying areas of the village and harvested rice grains to the rice mills. Carabaos are taken to carabao wallows and grazing areas twice a day. Farmers habitually wash the mud off of them in streams or irrigation canals after work in the rice field. A total of 132 carabaos was counted in the survey households. Zone 10 claimed the highest number of carabaos but it was Zone 6 that had the highest number of carabaos per household of 0.92. Zone 6 is in the northwestern part of the village. Dogs and cats live in close contact with the village population. Because dogs are allowed to roam freely, dog feces are a common sight around the residential areas of Macanip. A total of 265 dogs was counted in the survey households. The highest number of dogs was found in Zone 10, but it was Zone 7 that had the highest average number of dogs per household (2.78). There were 192 cats, or 16% of the population of the surveyed households. Zone 10 had the highest number of cats. The zone that had the highest average number of cats was Zone 7 with 1.44 cats per household.

Close to half of the surveyed households had 1 or 2 pigs that are tied or allowed to roam freely at the backyard of the house. Their feces are washed down into irrigation canals and streams when it rains. Only 13 percent of the households had more than 6 pigs. Pigs furnish most of the meat for the village. Because of the its high price, however, pork is seldom part of the ordinary family meal. It is reserved for weekends or special occasions. The pig population suffers a precipitous decline in June at the time of the celebration of the barrio fiesta (feast in honor of the village patron saint). During this time, a great number of pigs are slaughtered. Pork is the main fare in each household's banquet.

The total number of pigs in the surveyed households was 761, which is equivalent to two-thirds of the total number of people in the surveyed households. Zone 10 had the most number of pigs. This is mainly due to the higher number of households in this district. The area that had the highest mean number of pigs was Zone 11 with 6.67 pigs per household. People living in the coconut areas of the village generally have more animals per household because of the availability of larger yards and more food in the form of coconut meat.

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Table 4.6 Animal Population Raised in the Survey Households
March, 1993

Zone	No.of surveyed Households	Cow	Duck	Turkey	Goat	Carabao	Dog	Cat	Pig	Chicken
1	23	0	0	0	0	10	17	19	48	178
2	14	0	0	0	1	3	10	18	32	81
3	26	0	20	0	0	16	26	17	83	144
4	24	8	2	6	0	13	18	11	60	73
5	9	0	0	0	0	5	10	8	36	47
6	12	0	3	0	0	11	13	11	37	138
7	9	0	2	2	0	8	25	13	26	115
8	17	0	0	0	0	10	17	12	48	156
9	18	0	0	7	0	6	17	9	52	180
10	51	0	11	0	10	20	49	31	131	203
11	9	0	0	0	2	1	9	9	60	134
12	19	0	2	0	7	16	23	16	70	257
13	20	9	6	8	1	13	31	18	78	185
Total	251	17	46	23	21	132	265	192	761	1891

Source: Author's survey.

Rat population

In Macanip, rats live in the tops of coconut trees from March to June (dry season) and during the planting season from October to December. The rest of the year they live in rice fields. In each coconut tree, a male and female rat would produce between 6 to 8 offspring (Arbas, B., 1994). Using a conservative figure of only 25 coconut trees per hectare, I estimate that there will be 12,500 coconut trees in the 500 hectares of land in the village that is devoted to coconut cultivation. Again using a conservative figure of 5 rats per tree, a rough estimate of 62,500 rats in the village is obtained. This translates to an overall rat density of 62 per hectare, which is in accordance with rat population density estin

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Table 4.7 Uses of Different Sources of Water
March, 1993

Source	Drinking water	%	Washing clothes	%	Bathing	%	Wash animal	%
Mainit River	1	0.4	124	49	106	42	15	23
Taytay River	1	0.4	23	9	25	10	16	24
Mamlag Creek	0	0.0	10	4	7	3	3	5
Morokborok Creek	0	0.0	7	3	6	2	5	8
Hagosahis Creek	0	0.0	2	1	0	0	0	0
Sapa Creek	0	0.0	11	4	11	4	4	6
Hambabalod Creek	0	0.0	9	4	9	4	3	5
Tuod Creek	0	0.0	0	0	0	0	2	3
Badiang Creek	2	0.8	7	3	7	3	1	2
Irrigation Canal	1	0.4	0	0	3	1	13	20
Spring	112	44.6	16	6	22	9	1	2
Communal Water System	0	0.0	2	1	2	1	0	0
Artesian Well/Hand Pump	40	15.9	7	3	9	4	1	2
Open Dug Well	92	36.7	27	11	39	16	0	0
Rain Water Storage Tanks	0	0.0	0	0	0	0	0	0
Others	2	0.8	6	2	5	2	2	3
Total	251	100%	251	100%	251	100%	66	100%

Source: Author's survey.

Sources of water for domestic use

The main sources of drinking water are springs and open dug wells (Table 4.7). These sources have been utilized for as long as the inhabitants of the village remember. Only 16 percent of the households draw their drinking water from artesian wells or manual hand pumps, which are generally privately owned. The government-built piped water system is inoperative. The task of getting drinking water is usually delegated to children. Drinking water is collected from springs and seepages twice a day, once in the morning and another in the late afternoon, customarily by children who use one-gallon containers. They often bathe or play at water collection sites.

The most frequently used surface waters are the Mainit and Taytay rivers. The main reason for this is the proximity of these bodies of water to the *poblacion* and Gapas, which are densely populated. Water is always present in the channels of these rivers. Almost half of the households use the Mainit River for washing clothes and bathing. Ten percent use the Taytay river, while 11 to 16 percent use water from open dug wells. Farmers who wash their farm animals use the Mainit river (23 percent), Taytay river (25 percent), and irrigation canals (20 percent).

Use of toilets

Sixty-nine percent of the households that were surveyed by the author do not have toilets. One-third of those who have no toilets cited high cost as the reason for not having a toilet. Most of the toilets in the village are pit latrines, water-sealed with an unlined septic tank. In 1993, the construction of a toilet of this type requires six man-days of labor, one bag of cement worth 100 pesos, plus 500 pesos for the roof and sides. The total cost would amount to 780 pesos, which is equivalent to 26 days worth of an unskilled farm laborer's wages. Sixty-two percent said that building a toilet is too time-consuming and that it is more convenient to defecate in the open (See Tables 4.8 and 4.9).

The low number of toilets in Macanip partly contributes to the persistence of schistosomiasis in the village. The government had tried to encourage the use of toilets in 1986 by distributing 120 plastic toilet bowls. Funds for this activity came from the Schistosomiasis component of the World Bank-funded Philippine Health Development

Table 4.8 Number of Toilets, 1993

Type of Toilet	Number	%
None	173	69
Pit latrine, water-sealed, unlined septic tank	45	18
Pit latrine, water-sealed, septic tank lined with bamboo or wood	0	0
Pit latrine, water-sealed, septic tank lined with used steel drum	1	0
Pit latrine, water-sealed, septic tank lined with cement	32	13
Antipolo (not water-sealed)	0	0
Pit privy (not water-sealed)	0	0
Total	251	100

Source: Author's survey. According to the 1989 IBON Facts and Figures, 70% of Philippine households had sanitary toilets in 1988.

Table 4.9 Reasons for Not Having a Toilet

Reason	Number	%
Foul odor inside the toilet	0	0
Lot of work to dig pit/tank	24	14
Frequent transfer of residence	30	17
Destroyed during past typhoon (November 1991)	29	17
More convenient to defecate in the open/among bushes	25	14
High cost of materials	57	33
Not interested	7	4
Others	1	1
Total	173	100

Source: Author's survey.

Project. The recipients were expected to construct the rest of the toilet. As an incentive for the recipients to build toilets, the government gave five kilograms of rice. The incentive was not enough, and many of the recipients did not have a strong motivation to build a toilet. Many simply put the toilet bowl aside. Because of resource and personnel limitations, the government failed to monitor the recipients' compliance with the program. For instance, seven years after the distribution of the toilet bowls, I met the sanitary inspector of the town. He said he was in the village to check whether the expected numbers of toilets were actually constructed. The World Bank was at that time conducting an evaluation of the Philippine Health Development Project.

Table 4.10 Usual Defecation Area of Respondents Who Do Not HaveToilets

Area	Number	%
Banks of Mainit River	4	2
Within bushes	120	72
Banks of streams	4	2
Within banana clusters	38	23
Irrigation canals	0	0
Total	166	100

Source: Author's survey.

Based on the author's survey, ninety-five percent of the respondents who have no toilets defecate within bushes or banana clusters (See Table 4.10). Aside from providing privacy to villagers while they are defecating, the bushes and other vegetation shade the feces from the sun and retard the desiccation of the schistosomiasis ova. They do not venture too far from their houses when they defecate at dawn. The area of defecation usually lies within a 25-meter radius from the respondent's residence. Defecating by adults directly on water is rare because of the absence or sparseness of plant cover on or at the edge of irrigation canals, rivers, and creeks. Children, on the other hand, do not require concealment. On many occasions, the author observed children depositing their stools directly into irrigation canals. Thus, human schistosomiasis ova would likely be most abundant near residential clusters. Because of the frequent rainfall in the village, the chances of these ova being washed down toward the village's numerous bodies of water are high. An examination of the distribution of houses in the village could indicate several areas where snail infection may be high due to miracidiae emerging from eggs in human stools. These areas include the confluence of the Morokborok and Binukot Creek in Zone 9, the irrigation canal and Mainit River near Zones 1, 3, and 5, Campitlucan Creek in Zone 8, Hambabalud Creek in Zone 6, Mainit River near Zone 10, and Mamlag Creek near Zone 13.

CHAPTER 5

WATER CONTACT AND RISK OF TRANSMISSION

The transmission of schistosomiasis depends on people having contact with infected surface water. Water contact investigations aid in the understanding of prevalence and intensity of infection in both sexes, different age groups and occupational categories. The knowledge gained in these investigations may then be used in the selection of appropriate control measures and in the evaluation of the effectiveness of a control program. Combined with studies of the snail intermediate host, water contact studies can indicate when and where transmission occurs. This information is an important input to the formulation of plans for snail control. In this chapter, the relative importance of various types of human water contact activity and the types of places where such contacts occur in the *S. japonicum* transmission cycle will be explored. The implications that these types of activity have on control activities will then be discussed.

Description of Water Contact Study Area

The water contact study area is located in the geographical center of Macanip (Figure 5.1). Within this area, a wide range of types of water contact occur. The area contains two of the largest perennial water bodies in the village namely, the Mainit and Taytay rivers. Both of these rivers are used for bathing, washing clothes, collecting drinking water, and playing. Farmers often wash the mud off of their bodies in these rivers before returning home in the late afternoon after a day's work in the rice fields. All the rivers and streams in the study area are also sources of fish and small crabs, which are

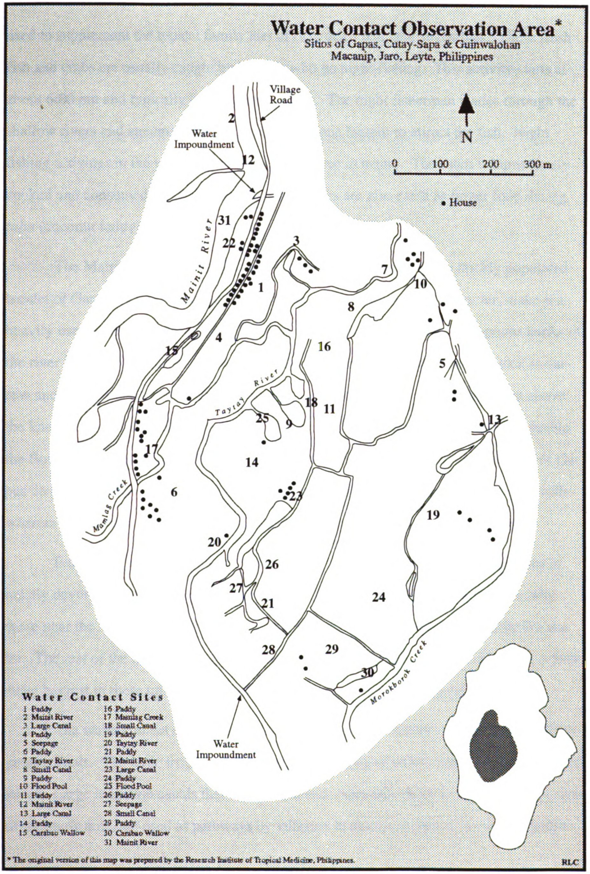

Figure 5.1 Water Contact Observation Area

used to supplement the typical family diet of rice, dried fish, and vegetables. These fresh fish and crabs are usually caught by farmers who go night-fishing. This activity starts at about 6:00 pm and typically lasts for three hours. The night fisherman wades through the shallow rivers and streams carrying a small kerosene lantern to attract the fish. Night fishing activities in the village are mainly subsistence in nature. The catch is immediately cooked and consumed by the family. Fish and crabs are also eaten as finger food during *tuba* (coconut toddy) drinking sessions

The Mainit River is within 25 to 50 meters of the houses in the thickly populated hamlet of Gapas. Its proximity to Gapas, clear waters, and shallow character, make it a heavily used water body throughout the year. The distance between the opposite banks of the river is about 40 meters. However, for most of the year the watercourse itself is narrow and twisting with depths varying between ankle-deep at its shallowest to just above the knee at its deepest. Along its banks there are numerous shallow depressions wherein the flow of water is slow. In these pockets of still or slow-flowing water, residents of Gapas do their laundry, bathe, and play. Also along the river banks, several open dug wells wherein water continuously issues from springs serve as sources of drinking water.

Except for some patches of coconut trees, the water contact observation area is mostly devoted to rice cultivation. The fields in the eastern half of this area, especially those near the rivers, are planted twice a year because of the availability of irrigation water. The rest of the ricefields are rainfed and are therefore planted to rice only once a year. After harvest in these rainfed areas, some farmers plant corn and vegetables.

The water contact observation area is covered by a network of large and small irrigation canals. The large irrigation canals get their supply of water directly from the Mainit River. Large irrigation canals that have a firm bed, especially those in the northern portion of the study area, are used as pathways by villagers in moving between the village *pobla-*

cion and Zones 11 and 12. The small irrigation canals are fed by water from the large irrigation canals and the small streams in the area. Farmers also use these small canals to wash the mud off of their feet and their farm animals.

In addition to the open dug wells along the Mainit River, drinking water comes from two seepages, and three pitcher pumps in Gapas, two of which are privately-owned. Neighbors often are allowed to get drinking water from the privately-owned pumps, but this access depends on good relations with the owners. The seepage at site 5 serves as drinking water source of some of the residents of Cutay-Sapa while that in site 27 provides drinking water to households in the southern part of Guinwalohan.

Transmission Risk: Snail infection

The patterns of snail infection show that there were more snail-infected sites during the drier period from March to June 1993. Seventy percent, or 24 out of 31 observation sites, harbored infected snails during the drier period. Although there were fewer infected sites during the more rainy period between August to October 1992, snail infection rates were higher. During this period, while only 9 out of 30 sites or 30 percent of the sites contained infected snails, a higher rate of snail infection of between 5 and 7 percent was obtained. This is consistent with findings of previous studies that discovered high snail prevalence rates during the rainy season. The highest rate of infection was in site 3, a large irrigation canal with 7 percent, followed by site 6, a paddy field with 6 percent, site 23 a large irrigation canal with 6 percent and site 29, a paddy field with 6 percent. Between March and June 1993, the sites having the highest snail infection rate were site 21, a paddy field with 7 percent, site 29, also a paddy field with 3 percent, site 13, a large canal with 3 percent, site 1, a paddy field with 3 percent and site 3 a large irrigation canal with 3 percent (See Table 5.1 and Figure 5.2).

Table 5.1 Snail Infection Rate by Season and by Site

Site Number and Description	Number of Snails Collected August-October 1992 (wet season)	% SnailsInfected August-October 1992 (wet season)	Number of Snails Collected March-May 1993 (dry season)	% SnailsInfected March-May 1993 (dry season)
1 Paddy	0	-	600	2.5
2 Mainit River	0	-	168	0.6
3 Large Canal	192	6.8	1407	2.9
4 Paddy	79	0.0	334	1.2
5 Seepage	275	1.5	1579	0.1
6 Paddy	36	5.6	1117	0.3
7 Taytay River	0	-	0	0.0
8 Small Canal	119	0.0	827	0.0
9 Paddy	129	0.0	1868	0.1
10 Flood Pool	58	0.0	1123	0.4
11 Paddy	0	-	488	0.0
12 Mainit River	49	0.0	1435	0.8
13 Large Canal	24	0.0	240	2.5
14 Paddy	0	-	2031	0.7
15 Carabao Wallow	395	1.0	-	-
16 Paddy	0	-	888	1.0
17 Mamlag Creek	84	0.0	1561	0.6
18 Small Canal	0	-	1325	2.3
19 Paddy	11	0.0	1290	0.9
20 Taytay River	0	-	700	0.0
21 Paddy	0	-	583	4.8
22 Mainit River	0	-	384	0.3
23 Large Canal	87	5.7	464	0.9
24 Paddy	130	0.8	464	0.1
25 Flood Pool	279	1.4	1417	0.4
26 Paddy	6	0.0	2640	0.8
27 Seepage	348	0.0	262	0.0
28 Small Canal	0	-	301	0.4
29 Paddy	120	5.8	1174	0.0
30 Carabao Wallow	341	4.7	777	3.0
31 Mainit River	-	-	811	0.4
Total	2762	10.5	15041	15.9

Scurce of Data: Research Instiutre of Tropical Medicine, Philippines. Data collation by author: RLC.

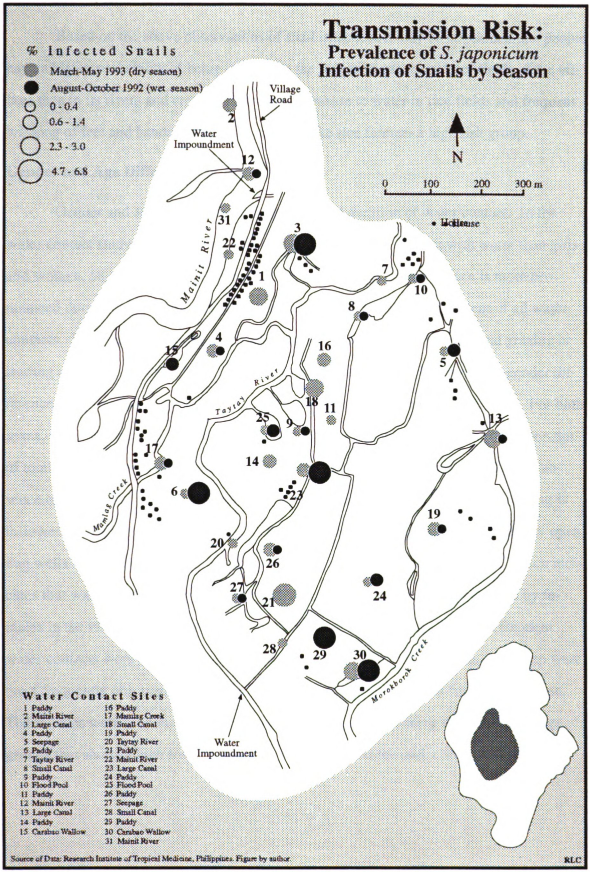

Figure 6.7 Prevalence of *S. japonicum* Infection of Snails by Season

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Based on the above observations of snail infection, it may be concluded that people have a higher probability of being infected in the irrigation canals and rice fields of the village than in its rivers and creeks. Prolonged exposure to water in rice fields and frequent washing of feet and hands in irrigation canals make rice farmers a high risk group.

Gender and Age Differences in Water Contact

Gender and age influences the frequency and duration of water contact. In the water contact study area, boys and men made more frequent contact with water than girls and women, 58 percent to 42 percent (Table 5.2). This gender difference is more pronounced during the planting season wherein males accounted for 62 percent of all water contacts. More males were observed working or walking on rice paddies and grazing or leading carabaos. Because there are more male rice farmers and laborers, this gender difference indicates that occupation may be a determinant of water contact activity. For both sexes, the most frequent type of water contact is crossing, which accounts for 68 percent of total observations. The dense network of streams and canals in the area plus the absence of footbridges at crossing points make contact with water a certainty. Crossing is followed by bathing or washing parts of the body and drawing water from springs or open dug wells. More females were drawing water and washing clothes than males, which indicates that water contact activities that relate to household needs are mainly done by females in the village. Among the different age groups of both sexes, the most frequent water contacts were observed in the 10 to 19 year olds. The males of this age group were most frequently observed working in rice paddies and drawing water for household use. The females were seen mostly drawing water, bathing, and washing clothes. Other age groups that showed high frequencies were the 30-39- and the under 10-year olds. Boys

Table 5.2 Frequency of water contact activities at 31 observation posts by sex and age group

Activity	Males								Females								Total both sexes
	0-9	10-19	20-29	30-39	40-49	50-59	60+	all ages	0-9	10-19	20-29	30-39	40-49	50-59	60+	all ages	
Crossing	160	218	115	193	70	129	32	917	79	167	75	97	68	104	85	675	1592
Grazing, leading cara-baos		1	9	5	14	3	4	36			1		1	1	1	4	40
Drawing wa-ter, drinking	5	22	9	4	3	8	1	36	14	25	2	15	5	10	18	89	141
Gathering vegetables, fishing		1		3	3			7						4	4	8	15
Bathing, washing body	27	23	14	17	17	16		114	10	18	5	20	5	20	11	89	203
Playing, swimming	8	5						13	3	4						7	20
Paddy work		24	8	12	12	16	11	83			2	1	7		1	11	94
Washing clothes	2	1	8	3	2	4		20	2	18	3	21	5	16	10	75	95
Walking in water, wet fallows	13	21	4	23	12	21	5	99	4	2	2	5	2	8	4	27	126
Total	215	316	167	260	133	197	53	1341	112	234	90	159	93	163	134	985	2326

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

below 10 years old had almost twice the number of water contacts compared to girls of the same age category.

Frequency of Different Types of Water Contact Activities by Season

Seasonal differences exist in the frequency of the types of water contact activities. Water contacts that are economic in nature dominate during the planting season. More crossing, paddy work, and walking on water or wet paddy fallows occurs during the planting season than the harvest season. Seventy-two of the 94 observations of paddy work were recorded during the planting season (Table 5.3). During the planting season, a larger portion of the ricelands of the village are planted to rice because water is more abundant. Thus, there is more work-related water contact for rice farmers and laborers. In going to the rice fields where they will work for the rest of the day, farmers frequently must cross streams, and irrigation canals. To reach a rice field located in site 11, for instance, a farmer from Gapas will cross a wet paddy field (site 1), cross an irrigation canal, ford the Taytay River, and cross a small irrigation canal (site 18). The higher frequency of water contacts during the planting season is also due to the higher abundance of rainfall that in turn increases the opportunities for contact with surface water. Higher temperatures and lower rainfall amounts characterize the harvest season. Because the amount of irrigation water decreases, the area planted to rice shrinks. The effect is a diminution in the proportion of economic water contact and an increase in that of contacts that are domestic in nature, such as bathing and washing clothes. As shown in the table, more instances of bathing and washing clothes were recorded during the drier harvest season than the planting season.

Table 5.3 Frequency of water contact activities at 31 observation posts by season

Activity	Planting Season (24 August 1992 to 25 October 1992)								Harvest Season (22 March 1993 to 11 June 1993)								Total both seasons
	0-9	10-19	20-29	30-39	40-49	50-59	60+	all ages	0-9	10-19	20-29	30-39	40-49	50-59	60+	all ages	
Crossing	140	168	150	183	64	147	65	917	99	217	40	107	74	86	52	675	1592
Grazing, leading carabaos	-	1	10	3	6	3	5	28	-	-	-	2	9	1	-	12	40
Drawing water, drinking	6	14	4	16	8	9	8	65	13	33	7	3	-	9	11	76	141
Gathering vegetables, fishing	-	-	-	-	-	4	4	8	-	1	-	3	3	-	-	7	15
Bathing, washing body	10	13	6	8	7	18	2	64	27	28	13	29	15	18	9	139	203
Playing, swimming	2	-	-	-	-	-	-	2	9	9	-	-	-	-	-	18	20
Paddy work	-	21	10	10	8	14	9	72	-	3	-	3	11	2	3	22	94
Washing clothes	-	-	4	5	1	8	-	18	4	19	7	19	6	12	10	77	95
Walking in water, wet fallows	16	15	2	27	14	27	9	110	1	8	4	1	-	2	-	16	126
Total	174	232	186	252	108	230	102	1284	153	318	71	167	118	130	85	1042	2326

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

Frequency of Water Contact by Type of Water Body

Distance to the main river seems to be a major determinant of water contact behavior. Table 5.4 shows that the highest number of water contacts was observed in the Mainit river, which accounted for 37 percent of the total. This is mainly due to its proximity to the main cluster of houses in the water contact observation area. The importance of distance is underscored by the fact that Site 22, which lies closest to the houses among the 4 observation sites, accounts for more than half of all observations along the Mainit River. The 10-19 year olds made the most frequent contact with the Mainit river. Rice paddies ranked second among the most frequented water contact sites. Males outnumbered females in the rice paddies by more than 2 to 1.

Contact with the different water types varied by season. More water contact in the form of bathing and washing clothes takes place in the rivers and creeks during the drier harvest season (Table 5.5). During the planting season, due to rice planting and associated activities, more water contact occurred in paddy fields, large irrigation canals, and seepages and springs. There were no observations in the carabao wallows during the harvest season due to two reasons: the first is that Site 15 was discarded as an observation site during the harvest season; the second is that Site 30 had dried up.

Duration of Water Contact Activities

Most water contacts are only of short duration (Table 5.6). More than 80 percent of all water contacts are less than 2 minutes in length. Although crossing accounted for 68 percent of the total frequency of contact, it made up only 12 percent of the aggregate exposure period of all water contact observations. In contrast, while rice paddy work accounted for only 4 percent of the total frequency of observations, it comprised 38 percent of the total water exposure time. People who were observed doing rice paddy work such as transplanting rice seedlings and those who were washing clothes had the longest average duration of exposure.

Table 5.4 Frequency of water contact activities at 8 water types by sex and age group

Water type	Males								Females								Total both sexes
	0-9	10-19	20-29	30-39	40-49	50-59	60+	all ages	0-9	10-19	20-29	30-39	40-49	50-59	60+	all ages	
Main (Mainit) river	60	165	32	63	40	48	1	409	57	144	15	89	46	58	44	453	862
Small (Taytay) river	39	30	30	42	18	13	7	179	24	28	11	35	8	6	34	146	325
Large irrigation canals	22	38	31	24	12	55	8	190	14	24	13	11	9	27	35	133	323
Small irrigation canals		2		1	3	2	2	10		5		1				6	16
Paddy field	25	43	49	91	51	49	26	334	7	21	41	16	13	29	18	145	479
Seepages & springs	63	28	21	11	9	15	8	155	9	12	6	7	4	23	2	63	218
Flood pools	6	10	4			3	1	24	1				1	4	1	7	31
Carabao wallows				28		12		40			4		12	16		32	72
Total	215	316	167	260	133			1341	112	234	90	159	93	163	134	985	2326

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

Table 5.5 Frequency of water contact at 8 water types by age group and season

Water type	Planting Season (24 August 1992 to 25 October 1992)								Harvest Season (22 March 1993 to 11 June 1993)								Total both seasons
	0-9	10-19	20-29	30-39	40-49	50-59	60+	all ages	0-9	10-19	20-29	30-39	40-49	50-59	60+	all ages	
Main (Mainit) river	48	116	10	69	41	31	12	327	69	193	37	83	45	75	33	535	862
Small (Taytay) river	14	24	22	36	10	9	19	134	49	34	19	41	16	10	22	191	325
Large irrigation canals	17	20	40	27	14	72	34	224	19	42	4	8	7	10	9	99	323
Small irrigation canals	-	-	-	-	-	-	-	-	-	7	-	2	3	2	2	16	16
Paddy fields	26	29	84	82	22	58	29	330	6	35	6	25	42	20	15	149	479
Seepages & springs	63	33	23	10	8	29	6	172	9	7	4	8	5	9	4	46	218
Flood pools	6	10	3	-	1	3	2	25	1	-	1	-	-	4	-	6	31
Carabao wallows	-	-	4	28	12	28	-	72	-	-	-	-	-	-	-	-	72
Total	174	232	186	252	108	230	102	1284	153	318	71	167	118	130	85	1042	2326

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

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Table 5.6 Duration of water contact activities at 31 observation posts

Activity	Number of persons observed	Number of Contacts	Total exposure period min.	Average duration of exposure min.	Range of exposure min.
Crossing	376	1592	1614	1	1-11
Grazing, leading carabaos	15	40	60	2	1-15
Drawing water, drinking	66	141	326	2	1-9
Gathering vegetables, fishing	6	15	153	10	2-22
Bathing, washing body	134	203	1874	9	1-174
Playing, swimming	18	20	254	13	1-72
Paddy work	26	94	4894	53	1-187
Washing clothes	53	95	3351	35	1-203
Walking in water, wet fallows	48	126	280	2	1-60
Total	742	2326	12896	6	

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

Duration of Water Contact: Differences by Season, Type of Activities, and Type of Water Body

The duration of water contact activities generally varied according to season. The largest variation occurred in non-economic water contact activities such as bathing, washing clothes, and playing in water (Table 5.7). Both the frequency and duration of water contact involving these activities increased substantially during the drier harvest season. The total exposure period for bathing, for instance, increased from 280 minutes during the planting season to 5,594 minutes during the harvest season. In contrast both the frequency and duration of rice paddy activities decreased during the harvest season: from 72 observations during the planting season down to 22, and from 3,968 minutes decreasing to 1,016 minutes.

The duration of water contact at different water types reflect the nature of the types of activities that dominate in them (Tables 5.8 and 5.9). The longest duration of water contact, with a two-season average of 12 minutes, occurred in rice paddies where economic activities are dominant. Since the Mainit and Taytay river are mainly used for domestic activities such as bathing and washing clothes, water contacts were of shorter duration with an average of 5 to 6 minutes. The average exposure time of 1 minute in large irrigation canals, flood pools, and carabao wallows indicates that the most dominant form of water contact in these water types is crossing.

A comparison of the duration of water contact by season and types of water shows that average exposure at paddy fields is longer in the planting season than the harvest season (Table 5.9). The opposite is true in the case of exposure at rivers and creeks wherein average harvest season exposure is longer than that in the planting season. More detailed analysis revealed that the durations of water contacts were longer at sites located near houses. During the planting season, above average water contact times were observed at sites 4 (36.3 min.) and 6 (15.5 min.), which are both rice paddies adjacent to house clusters along the village road in Gapas and Guinwalohan.

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Walkin water, fallows
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Table 5.7 Duration of water contact activities at 31 observation posts by season

Activity	Planting Season (24 August 1992 to 25 October 1992)				Harvest Season (22 March 1993 to 11 June 1993)			
	Number of observations	Total exposure period min.	Average duration of exposure min.	Range of exposure min.	Number of observations	Total exposure period min.	Average duration of exposure min.	Range of exposure min.
Crossing	917	933	1	1-11	675	681	1	1-4
Grazing, leading carabaos	28	40	1	1-3	12	20	2	1-5
Drawing water, drinking	65	145	2	1-8	76	181	2	1-9
Gathering vegetables, fishing	8	88	11	2-20	7	65	9	2-22
Bathing, washing body	64	280	4	1-45	139	5594	11	1-174
Playing, swimming	2	2	1	1	18	252	14	1-72
Paddy work	72	3968	55	1-87	22	1016	46	3-159
Washing clothes	18	300	17	1-80	77	3051	40	1-203
Walking in water, wet fallows	110	236	2	1-60	16	44	3	1-6
Total	1284	5992	5		1042	6904	7	

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

Table 5.8 Duration of water contact at 8 water types

Water type	Number of persons observed	Number of Contacts	Total exposure period min.	Average duration of exposure min.	Range of exposure min.
Main (Mainit) river	207	862	5088	6	1-203
Small (Taytay) river	99	325	1497	5	1-111
Large irrigation canals	109	323	386	1	1-45
Small irrigation canals	7	16	16	1	1-16
Paddy field	94	479	5578	12	1-187
Seepages & springs	87	218	228	1	1-11
Flood pools	12	31	31	1	1
Carabao wallows	10	72	72	1	1
Total	625	2326	12896	6	

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

Table 5.9 Duration of water contact at 8 water types by season

Water type	Planting Season (24 August 1992 to 25 October 1992)				Harvest Season (22 March 1993 to 11 June 1993)			
	Number of observations	Total exposure period min.	Average duration of exposure min.	Range of exposure min.	Number of observations	Total exposure period min.	Average duration of exposure min.	Range of exposure min.
Main (Mainit) river	327	779	2	1-80	535	4309	8	1-203
Small (Taytay) river	134	218	2	1-8	191	1279	7	1-111
Large irrigation canals	224	286	1	1-45	99	100	1	1-2
Small irrigation canals	-	-	-	-	16	16	1	1
Paddy field	330	4430	13	1-187	149	1148	8	1-159
Seepages & springs	172	182	1	1-11	46	46	1	1
Flood pools	25	25	1	1	6	6	1	1
Carabao wallows	72	72	1	1	-	-	-	-
Total	1284	5992	5	-	1042	6904	7	

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

Frequency of Water Contact at Various Times of the Day

Some differences were observed regarding the time of the different types of water contact (Table 5.10). Crossing was evenly distributed throughout the day. Close to 80 percent of all observations of paddy work were recorded before noon. Farmers start their activities just after sunrise so that most of the work scheduled for the day are accomplished before the sun becomes too hot. Bathing was most frequent before noon while washing parts of the body was most frequent in the late afternoon among farmers returning from work in the fields. The activities that showed a peak in the late afternoon, especially in the harvest season, were drawing water and playing or swimming in the water.

Table 5.10 Frequency of water contact activities at various times of the day

Activity	Before 9:00 am	Between 9:00 am and noon	Between noon and 3:00 pm	After 3:00 pm	Total
Crossing	475	389	330	398	1592
Grazing, leading carabaos	23	3	8	6	40
Drawing water, drinking	37	19	23	62	141
Gathering vegetables, fishing	0	4	7	4	15
Bathing, washing body	53	64	29	57	203
Playing, swimming	5	4	2	9	20
Paddy work	41	31	9	13	94
Washing clothes	25	37	22	11	95
Walking in water, wet fallows	37	41	42	6	126
Total	696	592	472	566	2326

Source of Data: Research Institute of Tropical Medicine, Philippines. Data collation by author: RLC.

CHAPTER 6

PREVALENCE AND INTENSITY OF HUMAN INFECTION

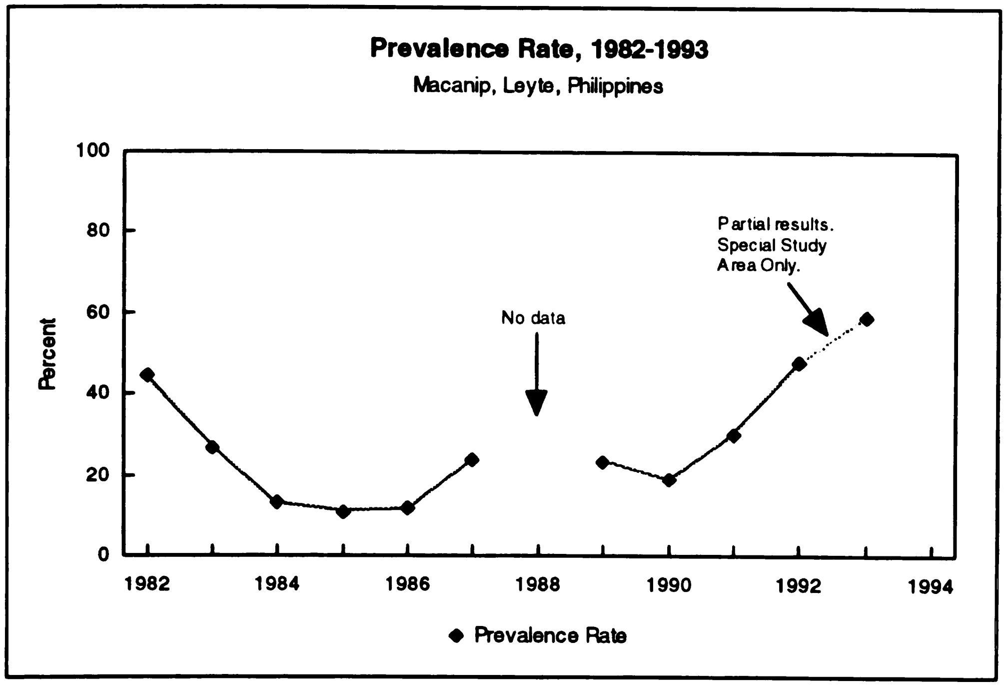
This chapter describes the patterns of human infection in the village using 10 years of parasitological data that were provided by RITM. It shows that although intensity of infection and hence morbidity has been kept in check by annual chemotherapy, the prevalence of the disease has been more difficult to manage. This suggests that the rates of new infections and reinfections are high and that many infected people are being missed by the control strategy of selective chemotherapy. Further analysis reveals relatively high infection rates in the age and sex categories that were shown in the previous chapters to have higher risks.

Prevalence of Schistosomiasis

At the start of RITM treatments in Macanip in 1982, prevalence was 45 percent. Prevalence rates sharply declined in the two years after the onset of annual screening and treatment. These rates seemed to have stabilized by 1985, or 3 years after the start of treatment. Between 1986 and 1990, the prevalence rate gradually increased. Starting in 1990, prevalence sharply increased to the 1992 level of 48 percent, which is higher than it was at the start of RITM treatments in 1982 (Figure 6.1 and Table 6.1).

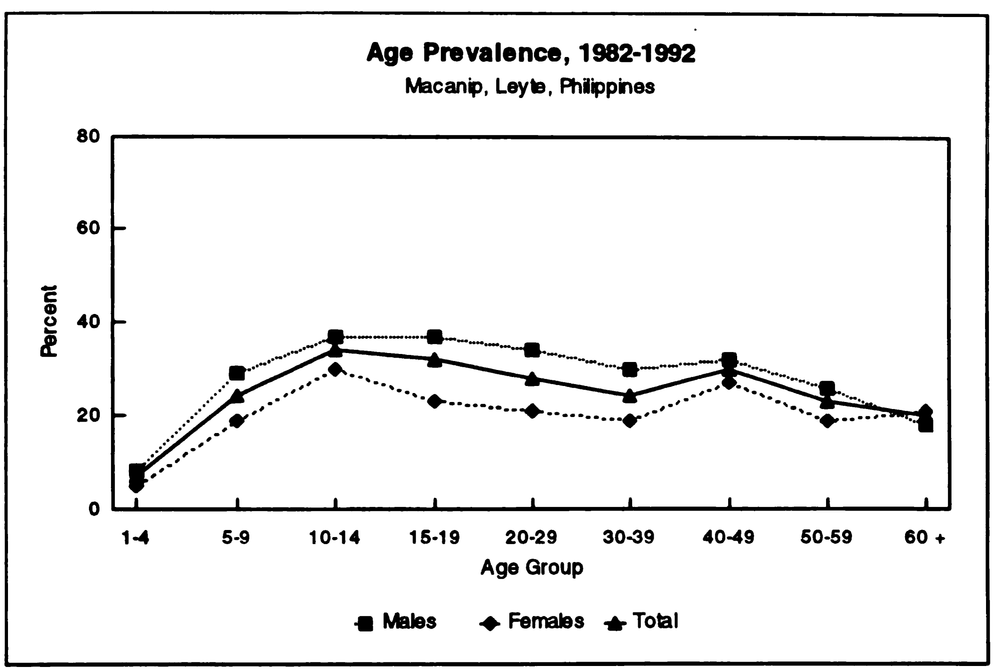
Mean age prevalence rates during the period 1982-1992 indicate that prevalence increases with age until it reaches a peak in the 10-14 year age group. Thereafter, prevalence declines with age except for a secondary peak in the 40-49 age group. Except for the 60+ age group, males have a higher level of prevalence than females. Among males the highest prevalence rates occur in the 10-14 and the 15-19 age groups. (Figure 6.2 and Table 6.2).

Figure 6.1 Prevalence Rate, 1982-1993



Source of data: Research Institute of Tropical Medicine, Philippines. Figure by author: RLC.

Figure 6.2 Age Prevalence, 1982-1992



Source of data: Research Institute of Tropical Medicine, Philippines. Figure by author: RLC.

Age prevalence rates in 1992 show that the older age groups have higher prevalence levels, the peak being in the 30-39 age group. The males follow this pattern. Among females, the pattern follows the 10-year average in which prevalence peaks in the 10-14 age group. Among males, the pattern is similar (Figure 6.3 and Table 6.3).

There seems to be no discernible spatial pattern or clustering of prevalence rates among the zones of Macanip. The 10-year average shows that Zone 13 in the southern portion of Macanip has the highest prevalence. Ranking second is the group composed of Zones 6, 7, 10, 4, and 9, which have prevalence rates ranging from 27 to 31 percent. In 1992, there were 7 zones out of 13 which had prevalences of 50 percent or above. These are Zones 13, 7, 12, 4, 6, 10, and 9 (Table 6.4).

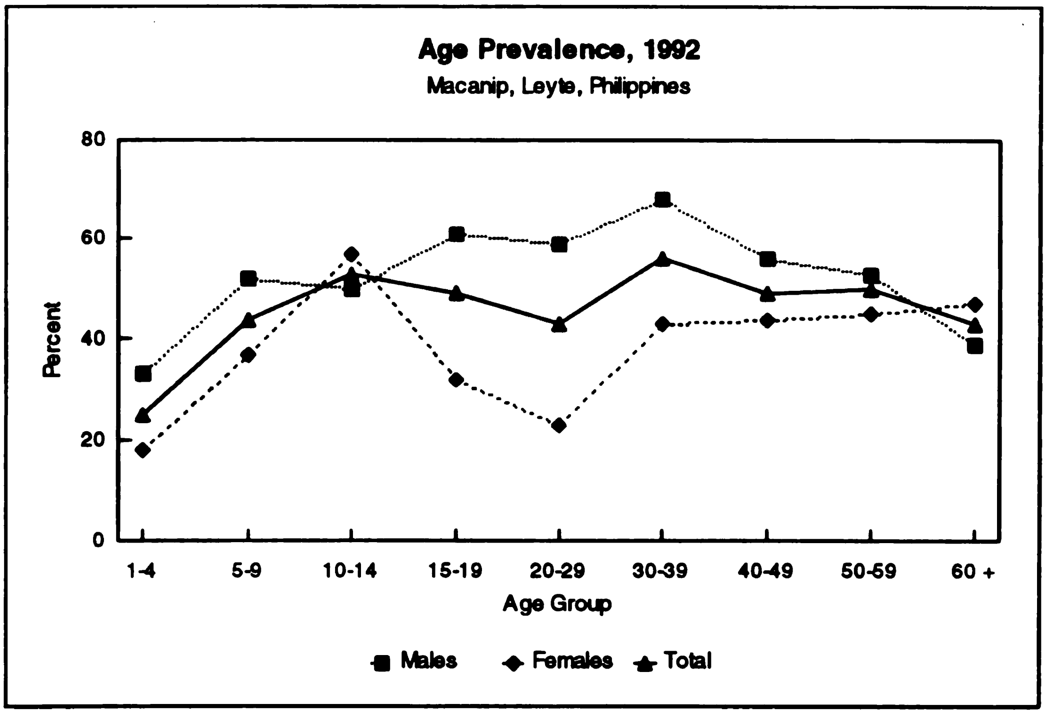
Intensity of Infection

The annual changes in the pattern of prevalence and infection are reflective of the continuous battle between annual treatments and schistosomiasis reinfection in Macanip. The egg load of infected persons in 1982 was 59 eggs/g stool, followed by a steep drop in 1983 and 1984. Infection rates rose again in 1985, only to be followed by a general downward trend between 1986 to 1991. In 1992, mean egg loads of infected persons rose again to 34 eggs/g stool. Partial results from the 1993 screening and treatments that cover the water contact study area show a sharp decrease to only 13 eggs/g stool (Figure 6.4). These results cannot be extrapolated to the whole village because the study area has received special attention from RITM in terms of information dissemination and inducements to participate in the water contact study. The low egg load may be reflective of the high degree of participation of the inhabitants of the study area in RITM's screening and chemotherapy program.

The ten-year average shows that in general intensity rises in parallel with prevalence in the age groups between 1 and 14 years. The peak intensity among males occurred in the 10-14 age group and in women in the 15-19 age group (Figure 6.5). In 1992, however, the patterns of prevalence and intensity of infection were dissimilar: while age prevalence generally followed the 10-year average, intensity of infection differed because the highest levels were found in the 1-4 age group (Figure 6.6). In 1992, infected individuals in Zone 11 had the highest mean intensity of infection, followed by Zones 13, 12, and 10 (Table 6.5).

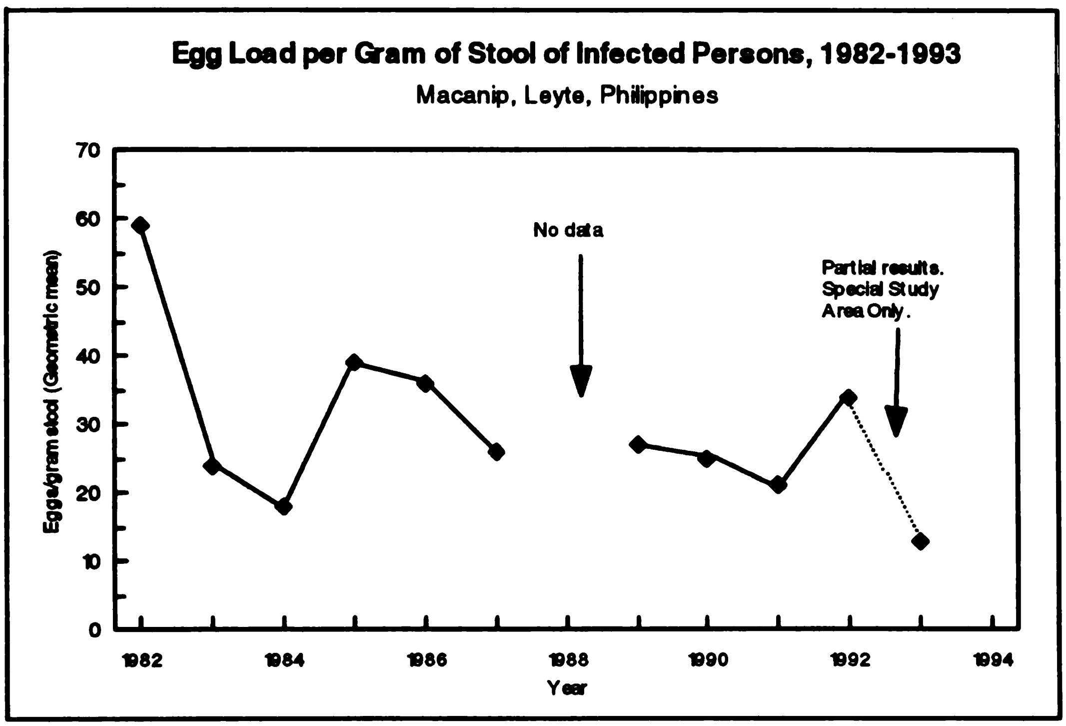
Annual chemotherapy has kept the intensity of infection to relatively low levels. More than half of the population was uninfected in 1992, 41% were lightly infected (10-100 eggs/g stool), 6% were moderately infected (101-400 eggs/g stool), and only 1.6% suffer from heavy infection (>400 eggs/g stool).

Figure 6.3 Age Prevalence, 1992



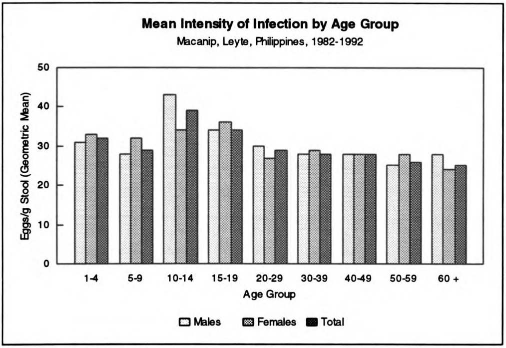
Source of data: Research Institute of Tropical Medicine, Philippines. Figure by author: RLC.

Figure 6.4 Intensity of Infection, 1982-1993



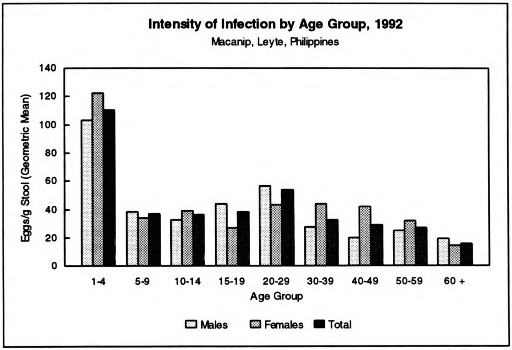
Source of data: Research Institute of Tropical Medicine, Philippines. Figure by author: RLC.

Figure 6.5 Intensity of Infection by Age Group



Source of data: Research Institute of Tropical Medicine, Philippines. Figure by author: RLC.

Figure 6.6 Intensity of Infection by Age Group, 1992



Source of data: Research Institute of Tropical Medicine, Philippines. Figure by author: RLC.

Table 6.1 Prevalence and Intensity of *S. japonicum* Infection by Gender and by Year, 1982-1992,Macanip, Jaro, Leyte, Philippines

Year	Males			Females			Total		
	No. exam.	% infect.	Mean eggs/g stool *	No. exam.	% in-fect.	Mean eggs/g stool *	No. exam.	% infect.	Mean eggs/g stool *
1982	262	48	140 ± 22 (63)	231	40	115 ± 24 (53)	493	45	130 ± 16 (59)
1983	247	29	40 ± 5 (26)	225	25	35 ± 8 (22)	472	27	38 ± 4 (24)
1984	221	14	25 ± 7 (16)	198	12	43 ± 20 (20)	419	13	33 ± 9 (18)
1985	244	13	72 ± 17 (42)	230	8	50 ± 13 (33)	474	11	64 ± 12 (39)
1986	301	16	69 ± 19 (38)	264	7	79 ± 34 (33)	565	12	72 ± 17 (36)
1987	322	31	69 ± 14 (24)	280	16	90 ± 29 (28)	602	24	76 ± 13 (26)
1989	335	27	46 ± 8 (26)	288	19	44 ± 6 (27)	623	23	45 ± 5 (27)
1990	341	21	45 ± 9 (24)	322	17	41 ± 6 (25)	663	19	43 ± 6 (25)
1991	356	35	44 ± 7 (23)	323	25	34 ± 8 (19)	679	30	40 ± 5 (21)
1992	290	54	85 ± 16 (33)	257	41	71 ± 10 (36)	547	48	79 ± 10 (34)
All years	2919	29	71 ± 5 (31)	2618	21	64 ± 6 (30)	5537	25	68 ± 4 (30)

* Mean arithmetic egg counts/g stool of infected individuals ± SE (geometric mean)
Source of data: Research Institute of Tropical Medicine, Philippines. Data collation and calculations by author: RLC.

Table 6.2 Prevalence and Intensity of *S. japonicum* Infection by Gender and Age, 11-Year Means, 1982-1992 , Macanip, Jaro, Leyte, Philippines

Age group (yrs)	Males			Females			Total		
	No. exam.	% in-fect.	Mean eggs/g stool *	No. exam.	% in-fect.	Mean eggs/g stool *	No. exam.	% in-fect.	Mean eggs/g stool *
1-4	240	8	70 ± 22 (31)	223	5	52 ± 14 (33)	463	7	64 ± 15 (32)
5-9	551	29	64 ± 10 (28)	480	19	67 ± 11 (32)	1031	24	65 ± 8 (29)
10-14	405	37	104 ± 16 (43)	345	30	95 ± 22 (34)	750	34	100 ± 13 (39)
15-19	194	37	96 ± 29 (34)	114	23	86 ± 32 (36)	308	32	93 ± 23 (34)
20-29	281	34	79 ± 21 (30)	242	21	50 ± 13 (27)	523	28	69 ± 14 (29)
30-39	400	30	61 ± 11 (28)	419	19	55 ± 13 (29)	819	24	59 ± 9 (28)
40-49	425	32	54 ± 8 (28)	358	27	50 ± 7 (28)	783	30	52 ± 6 (28)
50-59	296	26	40 ± 5 (25)	275	19	57 ± 18 (28)	571	23	46 ± 8 (26)
60 +	127	18	42 ± 9 (28)	162	21	37 ± 6 (24)	289	20	39 ± 5 (25)
Total	2919	29	71 ± 5 (31)	2618	21	64 ± 6 (30)	5537	25	68 ± 4 (30)

* Mean arithmetic egg counts/g stool of infected individuals ± SE (geometric mean)
Source of data: Research Institute of Tropical Medicine, Philippines. Data collation and calculations by author: RLC.

Table 6.3 Prevalence and Intensity of *S. japonicum* Infection by Gender and Age, 1992, Macanip, Jaro, Leyte, Philippines

Age group (yrs)	Males			Females			Total		
	No. exam.	% in-fect.	Mean eggs/g stool *	No. exam.	% in-fect.	Mean eggs/g stool *	No. exam.	% in-fect.	Mean eggs/g stool *
1-4	9	33	143 ± 66 (103)	11	18	125 ± 25 (122)	20	25	136 ± 37 (110)
5-9	53	52	110 ± 36 (38)	49	37	64 ± 20 (34)	101	44	92 ± 23 (37)
10-14	52	50	63 ± 17 (33)	44	57	94 ± 33 (39)	96	53	78 ± 18 (36)
15-19	28	61	123 ± 69 (44)	19	32	53 ± 30 (27)	47	49	105 ± 51 (38)
20-29	27	59	208 ± 112 (57)	22	23	64 ± 30 (43)	49	43	174 ± 86 (54)
30-39	34	68	66 ± 30 (28)	30	43	72 ± 21 (44)	64	56	68 ± 20 (33)
40-49	36	56	28 ± 7 (20)	41	44	80 ± 26 (42)	77	49	53 ± 13 (29)
50-59	34	53	38 ± 10 (25)	22	45	53 ± 18 (32)	56	50	44 ± 9 (27)
60 +	18	39	23 ± 5 (19)	19	47	22 ± 11 (14)	37	43	22 ± 6 (16)
Total	290	54	85 ± 16 (33)	257	41	71 ± 10 (36)	547	48	79 ± 10 (34)

* Mean arithmetic egg counts/g stool of infected individuals ± SE (geometric mean)
Source of data: Research Institute of Tropical Medicine, Philippines. Data collation and calculations by author: RLC.

Table 6.4 Prevalence and Intensity of *S. japonicum* Infection by Gender and by Zone, 11-Year Means, 1982-1992, Macanip, Jaro, Leyte, Philippines

Zone	Males			Females			Total		
	No. exam.	% infect.	Mean eggs/g stool *	No. exam.	% infect.	Mean eggs/g stool *	No. exam.	% infect.	Mean eggs/g stool *
1	375	30	74 ± 12 (35)	308	18	42 ± 7 (25)	683	25	64 ± 8 (31)
2	209	21	63 ± 19 (29)	204	20	46 ± 8 (30)	413	21	54 ± 11 (29)
3	372	24	47 ± 9 (24)	373	9	50 ± 16 (22)	745	16	48 ± 8 (23)
4	293	29	87 ± 16 (36)	246	26	72 ± 15 (32)	539	28	81 ± 11 (34)
5	129	26	47 ± 15 (25)	169	16	38 ± 9 (24)	298	20	43 ± 9 (24)
6	132	41	77 ± 17 (38)	168	24	88 ± 22 (40)	300	31	82 ± 14 (39)
7	135	32	59 ± 17 (28)	96	25	45 ± 11 (26)	231	29	54 ± 12 (27)
8	194	26	54 ± 14 (26)	182	20	64 ± 14 (35)	376	23	58 ± 10 (29)
9	217	27	60 ± 13 (29)	185	28	62 ± 21 (28)	402	27	61 ± 12 (28)
10	385	35	71 ± 18 (29)	320	23	40 ± 6 (24)	705	29	60 ± 12 (27)
11	64	20	101 ± 66 (34)	44	18	286 ± 231 (54)	108	19	172 ± 96 (41)
12	276	28	94 ± 22 (33)	216	24	117 ± 27 (48)	492	26	103 ± 17 (38)
13	138	41	83 ± 30 (36)	107	39	45 ± 9 (26)	245	40	67 ± 18 (32)
All zones	2919	29	71 ± 5 (31)	2618	21	64 ± 6 (30)	5537	25	68 ± 4 (30)

* Mean arithmetic egg counts/g stool of infected individuals ± SE (geometric mean). Source of data: Research Institute of Tropical Medicine, Philippines. Data collation and calculations by author: RLC.

Table 6.5 Prevalence and Intensity of *S. japonicum* Infection by Gender and by Zone, 1992, Macanip, Jaro, Leyte, Philippines

Zone	Males			Females			Total		
	No. exam.	% infect.	Mean eggs/g stool *	No. exam.	% infect.	Mean eggs/g stool *	No. exam.	% infect.	Mean eggs/g stool *
1	42	60	73 ± 29 (30)	30	33	25 ± 5 (21)	72	49	59 ± 21 (27)
2	19	37	43 ± 11 (32)	22	41	46 ± 10 (34)	41	39	44 ± 7 (34)
3	38	39	47 ± 25 (20)	34	18	97 ± 77 (24)	72	29	61 ± 28 (22)
4	26	69	104 ± 41 (39)	24	46	64 ± 39 (27)	50	58	89 ± 29 (34)
5	19	42	22 ± 6 (19)	18	39	47 ± 26 (24)	37	40	34 ± 12 (21)
6	8	62	94 ± 62 (34)	15	53	151 ± 81 (53)	23	56	101 ± 52 (36)
7	15	73	94 ± 62 (34)	9	44	40 ± 18 (26)	24	62	80 ± 45 (32)
8	16	44	44 ± 18 (30)	18	28	18 ± 4 (16)	34	35	33 ± 11 (23)
9	16	62	59 ± 24 (35)	15	47	46 ± 12 (33)	31	55	54 ± 15 (34)
10	38	68	127 ± 67 (40)	34	41	79 ± 26 (44)	72	56	110 ± 44 (41)
11	10	10	-- (60)	5	40	105 ± 45 (95)	15	20	90 ± 30 (81)
12	31	52	173 ± 79 (56)	20	75	87 ± 22 (51)	51	61	131 ± 42 (53)
13	12	67	38 ± 10 (30)	13	61	102 ± 36 (60)	25	64	70 ± 20 (43)
All zones	290	54	85 ± 16 (33)	257	41	71 ± 10 (36)	547	48	79 ± 10 (34)

* Mean arithmetic egg counts/g stool of infected individuals ± SE (geometric mean). Source of data: Research Institute of Tropical Medicine, Philippines. Data collation and calculations by author: RLC.

CHAPTER 7

DISEASE PERCEPTION AND CONTROL

One of the important components of a schistosomiasis control program is the education of the public regarding the disease. The design of this education program should be based on the knowledge, attitudes, and practices of the people in the target area. This will make the control program relevant and acceptable to the people. This chapter, which is based on the author's survey, examines the villagers' perceptions of schistosomiasis and its impact, their knowledge of transmission and control processes, and their attitudes toward the disease, control measures, and the control program. Later, it attempts to show the relationship between these factors and the persistence of schistosomiasis in the village.

The hierarchical political structure of the village seemed to have been used effectively to inform villagers about the arrival of the RITM medical team and to disseminate information about schistosomiasis. Under this system, information is first presented to the leaders of each of the 13 zones in the village who then fan out to disseminate the information to residents in their respective zones. As shown in Table 7.1, seventy-two percent of the respondents learned about schistosomiasis through this organized group process while twenty-seven percent said that they learned about it through their own initiatives. At the time of the author's field survey, the local elementary school was not disseminating information on schistosomiasis to schoolchildren. Since school-age children are the most vulnerable age group to schistosomiasis infection, efforts must be made to incorporate schistosomiasis education in the school curriculum.

Table 7.1 Source of Information on Schistosomiasis

	Number	Percentage
Individual approaches	68	27%
Community organization or group process	179	72%
Mass media	2	1%
Total	249	

Source: Author's survey: $N = 251$

Through radio broadcasts, the respondents are well-informed about national and regional affairs. Most of the households have a battery-operated transistor radio that are tuned in to radio broadcasts emanating from radio station transmitters in nearby Tacloban City. Table 7.2 shows that for news and information regarding village and local affairs, the respondents rely principally on their friends and neighbors. For news regarding the rest of the country, the respondents rely heavily on the radio. For village affairs, a secondary source of information are elected village officials. For town and provincial affairs, the secondary sources of information are town officials, employees of national agencies, and the radio.

Since villagers rely heavily on neighbors and radio for news, schistosomiasis control programs should be designed so that information can be channeled through leaders of neighborhood units and by way of radio advertisements. Reliance on neighbors for news is the result of the fact that the neighborhood groupings in the village are based on kinship lines. Thus, the neighborhood or unit leader is usually trusted and relied upon for information. The RITM's method of enlisting the support of unit leaders and its success in getting the villagers to cooperate in its annual screenings and treatment provides further evidence of the efficacy of using neighborhood groupings as the basis of information dissemination for control programs. The author's survey revealed that radio soap operas are favorite listening fare. Since the coverage area of the radio stations airing these soap operas is mostly endemic for schistosomiasis, the Department of Health could persuade writers to include schistosomiasis awareness in the script.

Table 7.2 Sources of Information Regarding Local and National Affairs

	Village affairs	Town & Province	Rest of the country
Friend/Neighbor	74.5	67.5	9.6
Unit (hamlet) leader	7.6	2.4	-
Elected village officials	17.9	6.0	0.8
Town crier	-	0.8	-
Town officials	-	10.8	1.6
Radio	-	12.4	84.3
Television	-	-	2.8
Newspapers	-	-	0.8
Total	100%	100%	100%

Source: Author's survey: $N = 251$

The majority of the respondents are aware that schistosomiasis is not directly transmitted . However, the notion of the transmission cycle is unclear (Table 7.3). This finding implies that the respondents do not see their own roles in the perpetuation of the transmission cycle. Moreover, it suggests that the respondents will not understand and hence, fail to cooperate with control programs that aim to break the weakest link in the chain of transmission or stop the disease through multiple points of intervention in the transmission cycle. Thus, control programs should make sure that the notion of the cyclical nature of schistosomiasis is understood by the target population.

Table 7.3 Can Schistosomiasis be Transferred Directly from One Person to Another?

No	12.4%
Yes	4.0%
Don't know	27.1%
Not sure	1.6%
Not directly	55.0%

Source: Author's survey: $N = 251$

As shown in Table 7.4, almost two-thirds think that animals, especially dogs, transmit schistosomiasis. These people think that schistosomiasis is acquired when people step on the feces of infected dogs. The presence of blood in the dog's stools are regarded as an indicator of schistosomiasis infection. One-third of the respondents know that tiny snails are somehow involved in the schistosomiasis transmission process. But even this small number of people do not know the exact nature of the snail's involvement in disease transmission. The idea of the involvement of snails came mostly from observing snail collectors of the RITM research team do their work. The manner by which the snail *Oncomelania quadrasi* transmits the disease is virtually unknown. A quarter of the respondents are aware of the existence of the parasitic worm and its role in schistosomiasis infection. The local term for the parasitic worm is "sistom," a minute worm that cannot be seen by the naked eye that enters the body through wounds and roots of leg hair.

Table 7.4 Knowledge of the Elements of the Transmission Cycle

	Free recall	Prompted	Don't know	Not sure	Total
Parasitic worm	25.5	31.5	37.1	6.0	100%
Tiny snails	29.9	20.3	45.0	4.8	100%
Animals	63.3	4.0	30.7	2.0	100%

Source: Author's survey: $N = 251$

The respondents are aware that schistosomiasis is acquired in wet areas (Table 7.5). Streams and creeks are at the top of the ranking of responses regarding infection sites. More than two-thirds of the respondents mentioned these places as areas where schistosomiasis infection may be acquired. Coming in second with almost the same percentage of responses were the main (Mainit) river and rice paddies. This "awareness" is partly the result of the on-going (at the time of the survey) water contact study of RITM. Numbered metal plates on stakes or nailed to coconut trees near water contact sites were seen by the villagers as an indicator that the site is hazardous in terms of schistosomiasis infection. Idle rice fields came in last in the ranking, which is indirect proof that respondents associate schistosomiasis with water contact. This is because idle rice fields in the village are dry, with most being situated in areas that cannot be reached by irrigation water.

Table 7.5 Knowledge on Places Where Schistosomiasis is Acquired

	Free recall	Prompted	Don't know	Not sure	Total
Rice Paddies	41.4	21.1	35.1	2.4	100%
Irrigation and Drainage Canals	25.5	39.0	31.9	3.6	100%
Main (Mainit) River	42.4	15.6	34.8	7.2	100%
Streams	72.5	4.4	22.3	0.8	100%
Creeks	67.7	7.2	23.5	1.6	100%
Idle Rice Fields	6.8	44.6	42.6	6.0	100%
Intermittent Waterways	31.9	29.4	34.0	4.7	100%

Source: Author's survey: $N = 251$

Close to two-thirds of the respondents know that infection starts when a very small worm that cannot be seen by the human eye penetrates the skin (Table 7.6). They do not know what the cercariae look like. Many of the respondents said that cercariae enter the human body through the pores of the skin.

Table 7.6 Awareness that Schistosomiasis is Acquired through Cercarial Penetration of the Skin

Free recall	64.9%
Prompted	4.4%
Don't know	27.5%
Not sure	3.2%

Source: Author's survey: $N = 251$

Avoidance of water contact and proper disposal of human wastes are seen as important measures to avoid schistosomiasis (Table 7.7). Forty-six percent think that the use of toilets will help prevent schistosomiasis; 45 percent think that the avoidance of bathing in infested streams ought to do it. The idea of prevention of schistosomiasis through regular toilet use is the consequence of past government campaigns to provide latrines to the village. The problem is that because of their unawareness of the transmission cycle, most villagers do not understand the links between toilet use and schistosomiasis control. The use of rubber boots as a way of preventing schistosomiasis was mentioned by 43 percent of the respondents. This is partly the result of the fact that field observers of the Research Institute of Tropical Medicine (RITM) go around the village wearing rubber boots issued by the RITM.

Very few (2.8 percent) view an improvement of farming practices as instrumental in the prevention of schistosomiasis. This is attributable to their ignorance of the elements and processes involved in the transmission cycle. Irrigation canals are not regularly maintained and regular weeding of ricefields is neglected. The result is that Oncomelania snails are often seen on grassy sides of irrigation canals and rice paddy dikes. Thus, although they have a vague idea that schistosomiasis may be acquired by working in ricefields, their ignorance of the transmission process renders them helpless to do anything to prevent the infection.

Table 7.7 Knowledge on How to Avoid or Prevent Schistosomiasis

	Free recall	Prompted	Don't know	Unsure	Total
Stool examination	11.6	59.0	28.7	0.8	100%
Snail control	18.3	53.4	27.5	0.8	100%
Improved farming practices	2.8	62.9	33.1	1.2	100%
Prevent bathing in infected streams	45.0	33.1	21.5	0.4	100%
Use toilets	46.2	30.7	22.7	0.4	100%
Control stray animals	14.7	55.4	29.5	0.4	100%
Build foot bridges	35.1	38.2	26.7		100%
Provide domestic water supply	16.7	55.8	27.5		100%
Health education	16.7	54.6	28.7		100%
Wear rubber boots	43.4	26.3	28.7	1.6	100%

Source: Author's survey: $N = 251$

Fifty-three percent of the respondents treat themselves at home for ordinary ailments like cough, ordinary fever, minor body aches, and superficial wounds (Table 7.8). This behavior of self-medication is abetted by the easy availability of non-prescription drugs. These drugs for the treatment of minor illnesses are sold in small *sari-sari* (variety) stores in the village. Twenty-six percent go to the Village Health Center, which opens once a week when a government-employed midwife holds clinic. The health center is underutilized because many villagers think that it will be useless to seek treatment in a health center where needed drugs are often not available.

Table 7.8 Place of Treatment for Ordinary Illnesses

	Number	%
Stay at home/self-medication	134	53
Village health center	66	26
Private doctor in Jaro	20	8
Hospitals or doctors in Tacloban	2	1
Local healer	13	5
Rural Health Unit in Jaro	14	6
Carigara District Hospital	1	0
Palo Schistosomiasis Hospital	0	0
Others	1	0
Total	251	100%

Source: Author's survey: $N = 251$

Most of the respondents are willing to travel a longer distance to avail themselves of the services of a competent doctor that will be there when needed (Table 7.9). For non-ordinary illness and emergency cases, thirty percent of the respondents go to a private doctor in the center of town, 25 percent go to the larger hospitals and doctors in Tacloban City, while only 6 percent go to the Rural Health Unit (RHU) in the town center.

The diagnosis and treatment of schistosomiasis is not ordinarily within the competence of ordinary doctors. Furthermore, the drug of choice for the treatment of schistosomiasis is not available in drug stores. It can only be obtained from government health centers after a determination is made that a person is positive for schistosomiasis ova. It is therefore not surprising that ninety-two percent of the respondents go to the annual RITM-sponsored examination and treatments at the Macanip Elementary School (Table

7.10). Five percent go to the Schistosomiasis Research and Training Center in Palo, while only 2 percent go to the RHU in Jaro.

Sixty-two percent of the respondents who have at one time or another tested positive for parasite eggs said that they sought treatment after experiencing symptoms that they perceived to be related to schistosomiasis. In the event that RITM stops its treatments due to financial constraints, 96 percent of the respondents said that they will continue to submit stools for examination in Palo or the RHU in Jaro poblacion.

Table 7.9 Place of Treatment for Non-ordinary or Emergency Illnesses

	Number	%
Stay at home/self-medication	4	2
Village health center	0	0
Private doctor in Jaro	75	30
Hospitals or doctors in Tacloban	62	25
Can't say (no emergency case yet)	30	12
Local healer	15	6
Rural Health Unit in Jaro	39	16
Carigara District Hospital	24	10
Palo Schistosomiasis Hospital	1	0
Others	1	0
Total	251	100%

Source: Author's survey: $N = 251$

Table 7.10 Place of Treatment for Perceived Schistosomiasis Symptoms

	Number	%
Stay at home/self-medication	1	0
Village health center	2	1
Private doctor in Jaro	0	0
Hospitals or doctors in Tacloban	0	0
Village school, during RITM visits	221	92
Local healer	0	0
Rural Health Unit in Jaro	4	2
Carigara District Hospital	1	0
Palo Schistosomiasis Hospital	12	5
Total	241	100%

Source: Author's survey: $N = 251$

Schistosomiasis, although perceived as a problem, is ranked low in the hierarchy of problems demanding attention in the village (Table 7.11). In the survey, the respondents were asked to name the most important problems of the village. The results showed that the respondents are most concerned about environmental sanitation, the lack of cooperation and unity, and peace and order. The control of schistosomiasis in the village will involve creating an awareness for the need to change behavior patterns. The majority of the respondents had attained a certain degree of "problem awareness" in so far as schistosomiasis is concerned. However, the awareness has not been translated into desired action or change in behavior. This could be the result of the perception that schistosomiasis is a disease that is non-lethal and an effective cure is available through the annual chemotherapy program of the government. Rosenfield (1990) succinctly states that this kind of perception "... may lead the individual to decide that the disease is not serious enough to warrant changing behavior, and, therefore, even though the person at risk may be fully aware of the etiology of the disease and its impact, he or she will continue to engage in disease transmitting behavior..."

Table 7.11 Most Important Problems of Village

	Number	% of Responses	% of N=212 Persons
Low income/livelihood	68	11.7	32.1
Peace and order	78	13.4	36.8
Food	20	3.4	9.4
Schistosomiasis	29	5.0	13.7
Health of residents	36	6.2	17.0
Roads	64	11.0	30.2
Irrigation	30	5.2	14.2
Village leadership	45	7.8	21.2
Unity	72	12.4	34.0
Environmental sanitation	98	16.9	46.2
Others	40	6.9	18.9
Total	580	100.0	

Source: Author's survey: $N = 212$

The survey revealed that majority of the people of the village were generally knowledgeable about schistosomiasis. This is undoubtedly the result of the annual visits of the research team from the Research Institute of Tropical Medicine. However, there were gaps regarding their knowledge of how the disease is transmitted and controlled. Although people know that schistosomiasis is acquired through water contact, they still continued to frequent potentially infected bodies of water. The role of the snail intermediate host in the transmission of the disease is not generally known. Toilets, even if in existence, were underutilized. This is partly due to the absence of a proximate source of water for flushing purposes. Many of the toilets that were built in 1986 as part of the schistosomiasis component of the Philippine Health Development Project were destroyed by the strong winds of a 1991 typhoon. These toilets were never repaired because of the expense involved and the lack of a strong motivation to do so.

Although the respondents know that animals such as dogs and pigs are somehow involved in schistosomiasis transmission, the exact role that they play remains vague to them. Very few of the respondents in the study area knew that animals such as dogs and pigs can act as reservoir hosts of schistosomiasis. Most respondents think that schistosomiasis is acquired when a person accidentally steps on the feces of infected dogs. Following this reasoning, they think that one way to avoid the disease is to avoid stepping on feces of dogs and pigs or wear protective footwear.

The apathy of the respondents regarding schistosomiasis prevention efforts can be traced to: (1) poverty, (2) the perception that schistosomiasis is not a serious disease, (3) dependence on chemotherapy, and (4) unawareness of critical elements of the transmission cycle. Because of their subsistence level of living, the respondents indicated that they had no choice but to work in what they know to be potentially infected rice fields. The absence of piped water supply forces villagers to collect water for domestic use in springs and open dug wells in the village. Only three households were able afford hand pumps. Because more than two-thirds of the household income of most families is spent on food alone, the purchase of materials for the construction of latrines is low on their priorities. The second reason has to do with the nature of schistosomiasis as a disease involving successful parasitism. It is not usually fatal or even serious, and as Warren (1973) has pointed out, "studies on morbidity have found remarkably little evidence of overt disease in most areas." Indeed, among the 10 leading problems of the village, schistosomiasis ranked last. The third reason, dependence on chemotherapy, stems from the awareness among the villagers that Biltricide (praziquantel) is given free every year by the medical team of the Research Institute of Medicine to those who are found positive for schistosomiasis ova. Thus, even if they acquire the infection, they know that they can avail of free treatment when the medical team arrives. The last reason, ignorance of critical elements of the transmission cycle, is the reason why people do not see themselves as agents that contribute to the perpetuation of the disease. Thus, children are not trained about safe defecation habits and adults are not predisposed to construct toilets. Similarly, ignorance of the role of snails in the transmission cycle is the reason why villagers have not given snail control activities the required high priority.

Chapter 8

CONCLUSIONS AND RECOMMENDATIONS

By using the model of the schistosomiasis transmission cycle as a heuristic device, this study has identified the elements involved in the transmission cycle of Schistosomiasis japonicum in the village and analyzed how each might contribute to the persistence of the disease. The inferences that were made in this study about the relationship between persistence of the disease in the village and the elements of the transmission cycle are based on previous research on each of these elements. Although data limitations preclude a more assertive statement regarding correlation and cause and effect relationships, this study has shown that human schistosomiasis infection in Macanip is associated with hazardous human behavior, favorable environmental characteristics, presence of snail intermediate hosts, and presence of animal hosts. The rest of this chapter presents this study's conclusions and recommendations with respect to the postulated relationships that were presented in Chapter 3.

The transmission of schistosomiasis is associated with favorable environmental characteristics such as slow-flowing water, even distribution of rainfall throughout the year, and shade-providing vegetation.

The physical environment of the large lowland plain in which the village lies provides preconditions for the persistence of Schistosomiasis japonicum infections. The even distribution of rainfall throughout the year guarantees the presence of numerous perennial, slow-moving waters in which the amphibious *O. h. quadrasi* can persist. The almost flat topography guarantees that worm eggs, hatched miracidia and cercariae are not washed away by increased water flow velocity. The absence of roads and dry trails in the east and southeast of the village means that residents of the hamlets have to traverse wet trails, irrigation canals, and streams to be able to reach the "poblacion" and from there the town center of Jaro. This increases opportunities for contact with infected water. Rivers, creeks, and springs are places for washing and bathing and are sources of domestic water supply. Irrigation ditches and small water impoundments are potential snail habitats.

The even distribution of rainfall and the minimal gradient of the land allows the formation of aquatic environments in which humans, animals, the snail host, and the parasite continually converge to perpetuate the schistosomiasis disease system in the village. These environmental characteristics have spawned a rice cultivation system that provides an abundance of opportunities for farmers and their families to be exposed to potentially infected waters.

The timing of treatments in Macanip may have to be re-studied so as to avoid the period of highest rainfall. Annual screening and treatment occur early in the first quarter of each year, which overlaps with the maximum rainfall period in the area. Snail infection data gathered in human water contact sites in the village show that snails have a higher rate of infection during the planting season when rainfall amounts are higher. Previous studies in Leyte have shown that the greatest danger of infection to mammalian hosts occurs during periods of high rainfall. The treatment of people who are infected or reinfected during this period may be ineffective because the drug of choice, praziquantel, has little effect against immature schistosomes (Jordan and Webbe, 1993). For community treatment with praziquantel to achieve its intended maximum impact, the drug should be given when transmission is low or absent (Sturrock, 1993). The result of the on-going water contact studies would provide a guide regarding the timing of the treatments.

Although the annual treatments appear to be successful in reducing the worm burden in the population, schistosomiasis still persists because of the high probability of reinfection in the many waterways and rice paddies of the village. The strategy should include measures to reduce human exposure to potentially infected water. My analysis of water contact data furnished by RITM showed a high frequency of water contacts that are of very short duration. This is primarily due to the large number of waterways that must be forded when going from one point of the village to another. In these situations, the diminution of the probability of infection by the short duration of water exposure is offset by the high frequency of water contact during the day. To reduce the potential for infection or reinfection, the villagers should increase the number of foot bridges at canal and stream crossings. Materials for these foot bridges such as coconut tree trunks abound in the village.

The transmission of schistosomiasis is associated with contamination of water bodies by human feces.

This study has shown that schistosomiasis is maintained in part through contamination of water bodies by ova-bearing human feces. This is due to the absence of toilets in more than two-thirds of the houses in the village. This situation is aggravated by the fact that the availability of a toilet does not mean that it is always used. One factor that works against toilet use is the inconvenience of collecting water for flushing from a water source that may be some distance from the dwelling. Small children are prone to defecate wherever it is convenient. This could be anywhere from the house front and backyard to the nearest irrigation canal. One would therefore expect that schistosome eggs that are contributed by children would be distributed according to the settlement pattern of the village. The adult need for concealment while defecating results in a more focal distribution of schistosome eggs contributed by adults. In both cases, the schistosome ova eventually are washed into the dense network of waterways of the village. This process is facilitated by frequent rainfall that blankets the village.

Changing the defecation habits of the people in the village would be a very difficult task. Previous studies have shown that reducing environmental contamination through basic sanitation such as latrines has had poor results (Webbe, 1988). It seems that a significant change in basic sanitation habits of the people can only happen when the general level of economic prosperity in the village is increased. People who are pre-occupied with the daily struggle to make a living at the subsistence level will not have the time and luxury to think of building and using nice household conveniences like toilets. Higher levels of education that are a part of economic prosperity would also mean a higher rate of usage of toilets.

Community action could also be another approach to persuade people to use toilets. Based on prior experience in the village, no amount of government-supplied toilets can make the people use latrines unless the impetus to do so comes from the village itself. The village has already proven that it is capable of effective community action when it won a nationwide contest in 1957 for being the cleanest village in the country. The success of this community action was attributed to the leadership of a village school teacher who mobilized the school children and their parents to clean up and beautify the village. Thus, community action to encourage the use of toilets could be pursued by any of the local non-political organizations like the Parent-Teachers Association and the Farmers' Association.

The transmission of schistosomiasis is associated with agricultural practices that favor the O. quadrasi population.

The persistence of the O. quadrasi population in the village is partly due to the poor or non-maintenance of irrigation canals. I observed that snails prefer the grassy sides of dikes in rice paddies and irrigation canals. In canals that are not maintained at all and which are therefore covered with grass, snails could be seen clinging to stalks and blades of grass. The snails use the grass and overhanging vegetation to protect themselves from higher surface temperatures during midday. In instances where the velocity of water flowing through irrigation canals becomes intolerable, the snails retreat and cling to the grassy sides and walls of the canal.

The elimination of the snail intermediate host appears to be the only measure that would lead to complete disappearance of schistosomiasis in the village. This is because it would halt the chain of infection in both the human host and the animal reservoir. Mollusciciding, environmental modification, and improved agricultural practices are some of the options that are available. The slow velocity of water flow in the meandering streams in the village might pose a problem to snail control efforts. The study of Yasuraoka (1989) in Northern Bohol discovered that although combined vegetation removal and mollusciciding appeared successful in eliminating and reducing the snail population in most swamps, it did not yield satisfactory results in meandering streams.

To make the irrigation canals of the village unsuitable for the snail host, the local irrigation association or farmers' association should look into the feasibility of canal lining and improved channel design. Aside from providing more water for crops, canal lining results in higher water velocities and less aquatic vegetation which in turn would result in less snails. With the help of engineers form the National Irrigation Administration, farmers could improved channel design of canals. Since changing the gradient could be impractical, an alternative would be to make the channel cross-section narrower and deeper (Webbe, 1988).

The transmission of schistosomiasis is associated with hazardous water contact behavior.

The lack of a safe domestic water supply has led to hazardous water contact behavior that contributes to the persistence of infection in the village. Young children are given the task of collecting drinking water in open dug wells and springs. They often play in the water while going about this task. The task of water collection is usually done twice a day, once in the morning and another in the late afternoon. Water contact observations showed that during the harvest season, drawing water and playing or swimming in the water were activities that peaked in the late afternoon. Water contact in the afternoon is more risky because by that time most of the cercariae would have swarmed out from infected snails.

Next to playing in the water by children, water contact that is related to work in the rice fields carries with it a high risk of acquiring the infection. Rice farmers of all age groups have the longest duration of water exposure. On the average, rice paddy work lasts for 53 minutes per exposure, and there can be several exposures in a day. Among rice farmers, hired laborers and those who specialize in construction and maintenance of dikes face higher risks. These people stay in the rice paddies longer during the start of the planting season. Dike construction and maintenance laborers are at high risk because they work the part of the rice fields that are favored locations of O. quadrasi snails. High infection risks also occur among farmers who irrigate their fields at night. Because of the limited amount of irrigation water, these people have to wait until the evening for their turn to irrigate their fields. Again, they face higher risks because of the presence of a higher number of cercariae in surface waters at this time of the day.

The persistence of schistosomiasis is associated with inadequate knowledge about the schistosomiasis transmission cycle.

Serious gaps exist in so far as the villagers' knowledge of the schistosomiasis transmission cycle is concerned. Although most of the people who were interviewed knew that schistosomiasis is acquired through water contact, they were unaware of the role of animal reservoirs and snail intermediate hosts. Furthermore, they were unaware of the concept of a schistosomiasis transmission cycle. Schistosomiasis persists in part because people, by their lack of knowledge, ignore the zoonotic aspects of the disease.

The option of mass chemotherapy and its acceptability to the community must be studied. Experience has shown that unless this strategy is thoroughly explained to the community, it may encounter some resistance in the village. In the water contact study area where mass chemotherapy is being implemented in connection with studies of reinfection, this author observed that a number of people refused to participate because they wanted to make sure that they were positive to schistosome ova first before taking praziquantel tablets. Results of the screening were delayed and could not be relayed to the study population.

Health authorities should work with villagers in coming up with a sustained control strategy that will be carried out through the primary health care system. This approach involves stimulating the active involvement of the community to assist schistosomiasis control personnel in the planning, implementation, and monitoring of control programs. The primary health care worker will play a critical role by collaborating with the control team in the diagnostic and treatment surveys and by assisting in including schistosomiasis control in health education programs. (WHO, 1985).

The strategy of selective population chemotherapy in the village may have to be reassessed by planners and implementors of the control program. Previous studies have demonstrated the possibility that lightly infected individuals may not be excreting eggs at all at the time of screening. These people will be missed by targeted chemotherapy that selects for treatment only those people with ova in their stools. The problem is aggravated by individuals who do not participate in the annual screening and treatment by RITM. These people have the potential of maintaining the transmission in the village even if chemotherapy is successful in all individuals who underwent screening.

The persistence of schistosomiasis is associated with the inability of the control program to interrupt the zoonotic cycle of the parasite.

Macanip has a high population of pigs and dogs that can act as reservoirs of infection. Both of these animals are allowed to roam freely in the backyards of houses. It is therefore common to see the animals' feces lying around the yards of houses. These are washed down into nearby canals and streams when it rains. Although the pig population suffers a precipitous drop in June in connection with the village *fiesta*, the reduction in transmission would probably be minimal because the *fiesta* coincides with the dry season.

The role of field rats in the maintenance of transmission in the village has been virtually ignored by the present control program. This is unfortunate because previous studies have demonstrated that next to man, the field rat is the most important host of *Schistosomiasis japonicum* in the area (Hinz, 1985). The schistosome disease prevalence in field rats is high throughout the year -- from 70% to 95%. Compounding the problem is the fact that field rats multiply rapidly, they obtain their food from ricefields, and they defecate several times in 24 hours (Cabrera, 1976).

The rat population is estimated to be 40 times the human population in the village, which gives them a very high potential for maintaining the infection in the village. Thus, even if there is a 100% compliance by villagers in both mass chemotherapy and the use of toilets, schistosomiasis transmission will still be maintained through the field rat. In the event that annual screening and chemotherapy in the village is discontinued for any reason, humans will most certainly be reinfected.

The persistence of schistosomiasis is associated with poverty.

The statement that schistosomiasis is a disease of the rural poor is valid in Macanip. Poverty is the reason why people cannot build their own domestic water supply. Poverty is also the reason why people are not able to acquire a higher level of education that will make them realize the necessity of using toilets for defecation. Poverty in the village is revealed by the fact that 70% of the households had a negative net household income, meaning that household expenditures exceeded regular household income. They compensate for this deficit by borrowing money from relatives or rendering personal services, which may increase their infection risk, in return for money or food. An example of this income-supplementing activity is *prendis* in which an individual weeds a farmer's rice field during the growing season for free in return for the privilege of participating in the harvest and getting a share of the rice yield. Another widely used practice to supplement the food on the family table is night fishing in which the farmer wades through rivers and streams carrying a lamp that attracts fish. This practice exposes the individual to a high risk of infection because in the early evening cercariae from infected snails would be swarming in streams in search of mammalian hosts.

The transmission of schistosomiasis is associated with the absence of a safe domestic water supply.

As previously noted, only 16 percent of the households draw their drinking water from artesian wells or privately owned manual handpumps. The rest of the households get their drinking water from springs and open dug wells. The task of washing clothes bring women in contact with the Mainit River and other streams two to three times per week. The potential for infection brought about by a longer duration of exposure is mitigated by the fact that this activity is done in the morning when infection risk is lower.

Providing safe water supplies in the village will give added protection, especially to women and children. Although set in a different environment and culture, some lessons may be drawn from the St. Lucia project in the Caribbean. The results of the project indicated that improved domestic water supplies reduced schistosomiasis transmission. After installation of domestic water supplies, water contact studies showed a 97 percent reduction in the number of persons utilizing river water for all purposes. In addition, because of decreased human contact with river water fewer snails were infected in the project area (Jordan, Woodstock, Unrau, and Cook, 1975). The Riche Fond studies in St. Lucia have demonstrated that when health education and adequate alternative water sources are made available, customs can be changed and children can be taught to stay out of rivers. Thus, the number of hand pumps and artesian wells in the Macanip needs to be increased to give people better access to safe water. Public laundries should be built where women can wash clothes and socialize at the same time. If there is a free free-flowing supply of spring water , shallow pools could be built in these public laundries wherein children who accompany their mothers can bathe and play.

The results of this study suggest that schistosomiasis infection may be significantly reduced by supplementing the annual chemotherapy conducted by RITM with locally-initiated programs to improve agricultural practices and providing safe water supplies. The evidence has shown that the age and occupational groups that are engaged in rice farming are at the greatest risk. Water contact observations indicate that these groups may be acquiring the infection in ill-maintained irrigation canals and ricefields.

Existing institutions in the village need to be tapped to control schistosomiasis. The most organized, active and financially able organization in the village that is in a position to provide local counterparts to the national government's schistosomiasis control efforts is the *Samahang Nayon* (Farmer's Association). What needs to be done is to impress upon the members of this group that economic upliftment and schistosomiasis control is attainable through improved farming practices such as regular weeding of ricefields and maintenance of irrigation canals. These practices will make the ricefields and irrigation canals unsuitable environments for the snail host.

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APPENDIX

MACANIP SCHISTOSOMIASIS SURVEY

(The author formulated, pre-tested, and administered this interview schedule to 251 respondents between February and June 1993.)

Good morning/afternoon/evening. My name is Renato Cerdeña. I am presently undertaking a study of schistosomiasis in Macanip. I will be interviewing a sample of people in your barangay. You have been chosen as one of the respondents. I will appreciate your cooperation. Rest assured that your responses will be held in the strictest confidence. *Maupay nga aga/kulop/gab-i ha iyo. Ako hi Renato Cerdeña. Hapag kayana nagkakamay-ada ako hin pag-aram han schistosomiasis dinhi ha Macanip. Mamamakiana ako hin mga tawo dinhi ha iyo barangay ug usa ka han akon napili. Ug an imo kooperasyon in akon ginlalauman. Pagtapod la nga an aton pagiistoryahan in aton la ug diri magawas ha publiko.*

Block 1: Identifying Information

1.1 Respondent Number ____________________________
1.2 House Number ____________________________
1.3 Zone Number ____________________________
1.4 Name of Interviewer ____________________________
1.5 Name of interpreter ____________________________
1.6 Place of interview ____________________________
1.7 Date of interview ____________________________
1.8 Time started ____________________________
1.9 Time finished ____________________________
1.10 Language of interview ____________________________

Block 2: Background data

2.1 Name ____________________________________

2.2 Gender

___0__female ___1__ male

2.3 Civil Status *Inasaw-an ka ba?*

___0__ single ___1__ married ___2__ widow/widower ___3__ separated

2.4 How old were you on your last birthday? *Pera an imo idad han imo guioorhe-e nga birthday?*

______ CODE EXACT NUMBER OF YEARS

2.5 Where were you born? *Diin ka katawo?*

___0__ same barrio
___1__ other barrio, within town
___2__ another town, within the province
___3__ other province, within Island of Leyte or Eastern Visayas
___4__ other province, outside Island of Leyte or Eastern Visayas

2.6 Have you moved within the last five years? *Ha sakub han lima katuig, binmalhin ka ba hin pag-okoy o pareho man diin ka tikang san-o ka pag-okoy dinhi?*

___0__ no
______ yes
___1__ same barrio
___2__ other barrio, within town

___3__ another town, within the province
___4__ other province, within Eastern Visayas (e.g. Samar provinces, Southern Leyte)
___5__ other province, outside Eastern Visayas

2.7 What is the highest grade that you have completed? *Ano nga grado an imo natapos?*

___0__ none
___1__ primary (Grade 1-2)
___2__ secondary (Grade 3-4)
___3__ intermediate (Grade 5-6)
___4__ high school (1-3)
___5__ high school graduate
___6__ part college
___7__ college graduate
___8__ vocational

Block 3: Living Conditions

3.1 Is your home *An imo ba inookyan nga balay, imo ba kalugaringun, plityado, o kun nalungun ka la?*

___0__ your own ___1__ rented ___2__ shared with others

3.2 Do you own the land on which your home is built? *Kalugaringun mo ba inin tuna nga imo guinbalayan?*

___0__ no ___1__ yes

3.3 Construction materials of dwelling unit *Anu nga materyales an imo ginamit pagbalay*

___0__ cogon/bamboo
___1__ wood
___2__ wood/concrete
___3__ scrap/barong-barong

3.4 What fuel do you use for cooking *Ano an imo ginagamit nga paagi (sungo) ha pagluto?*

___0__ electricity
___1__ kerosene
___2__ liquid petroleum gas
___3__ wood and coconut shells

3.5 Do you have a toilet *May ada ba niyo kasilyas?*

___0__ none PROCEED TO QUESTION 3.6
______ yes PROCEED TO QUESTION 3.9
___1__ pit latrine, water-sealed, unlined septic tank
___2__ pit latrine, water-sealed, septic tank lined with bamboo or wood
___3__ pit latrine, water-sealed, septic tank lined with used drum
___4__ pit latrine, water-sealed, septic tank lined with cement
___5__ antipolo
___6__ pit privy

3.6 Why don't you have a toilet *Kay ano nga waray kamo kasilyas?*

___0__ foul odor inside toilet
___1__ lot of work to dig pit/tank
___2__ frequent transfer of residence
___3__ destroyed during past typhoon (November 1991)
___4__ more convenient to defecate in the open/among bushes
___5__ high cost of materials
___6__ not interested

3.7 Where do you defecate *Diin kamo na-uro*?

___0__ banks of Mainit River
___1__ within bushes
___2__ banks of streams (specify) ________________
___3__ within banana tree clusters
___4__ irrigation canals

3.8 How far is your usual defecation area from your house *Ano kahirayo iton imo kaudganan nga pag-uro tikang ha imo balay*?

___0__ 25 meters or less
___1__ 51 to 100 meters
___2__ 26 to 50 meters
___3__ more than 100 meters

3.9 What is your main source of water for drinking and cooking? IF SOURCE IS POTENTIALLY INFECTED WATER, ASK RESPONDENT TO SPECIFY FREQUENCY AND DURATION OF WATER CONTACT PER DAY *Diin kamo naalog hin tubig para pag-inom ngan pagluto* (Mainit, busay, irrigation canal, sapa) IPAKIANA ITON KAIHA HITON KAHULOS DIDTO HA TUBIG NGAN KUN PIRA KABESES.

	H_20 Contact	Frequency	Duration
___0__ Mainit river	______	______	______
___*__ Stream (specify) ________________	______	______	______
___9__ Irrigation canal	______	______	______
__10__ spring	______	______	______
__11__ communal water system	______	______	______
__12__ artesian well/manual handpump	______	______	______
__13__ open dug well	______	______	______
__14__ rain water storage tanks	______	______	______
__15__ other (specify) ________________			

* Streams:	(1) Taytay	(3) Morokborok	(5) Sapa	(7) Tuod
	(2) Mamlag	(4) Hagosais	(6) Hambabalod	(8) Badiang
Frequency:	(0) once/day	(2) 3x+/day	(4) 2x/week	(6) once/month
	(1) 2x/day	(3) once/week	(5) 3-4x/week	(7) 2x/month
Duration:	CODE NUMBER OF MINUTES			

3.10 What is the source, or where do you (or your wife) launder your clothes IF SOURCE IS POTENTIALLY INFECTED WATER, ASK RESPONDENT TO SPECIFY FREQUENCY AND DURATION OF WATER CONTACT PER DAY) *Diin kamo pamumunak?* (Mainit, *busay*, irrigation canal, *sapa*) IPAKIANA ITON KAIHA HITON KAHULOS DIDTO HA TUBIG NGAN KUN PIRA KABESES?

	H_20 Contact	Frequency	Duration
___0__ Mainit river	______	______	______
___*__ Stream (specify) ______________	______	______	______
___9__ Irrigation canal	______	______	______
__10___ spring	______	______	______
__11___ communal water system	______	______	______
__12___ artesian well/manual handpump	______	______	______
__13___ open dug well	______	______	______
__14___ rain water storage tanks	______	______	______
__15___ other (specify) ________________			

* Streams:	(1) Taytay	(3) Morokborok	(5) Sapa	(7) Tuod
	(2) Mamlag	(4) Hagosais	(6) Hambabalod	(8) Badiang

Frequency:	(0) once/day	(2) 3x+/day	(4) 2x/week	(6) once/month
	(1) 2x/day	(3) once/week	(5) 3-4x/week	(7) 2x/month

Duration: CODE NUMBER OF MINUTES

3.11 What is the source / where do you (and other family members) bathe? IF SOURCE IS POTENTIALLY INFECTED WATER, ASK RESPONDENT TO SPECIFY FREQUENCY AND DURATION OF WATER CONTACT PER DAY) *Diin kamo nakarigo*? (Mainit, *busay*, irrigation canal, *sapa*) IPAKIANA ITON KAIHA HITON KAHULOS DIDTO HA TUBIG NGAN KUN PIRA KABESES*?*

	H_20 Contact	Frequency	Duration
___1__ Mainit river	______	______	______
___*__ Stream (specify) ______________	______	______	______
___9__ Irrigation canal	______	______	______
__10___ spring	______	______	______
__11___ communal water system	______	______	______
__12___ artesian well/manual handpump	______	______	______
__13___ open dug well	______	______	______
__14___ rain water storage tanks	______	______	______
__15___ other (specify) ________________			

* Streams:	(1) Taytay	(3) Morokborok	(5) Sapa	(7) Tuod
	(2) Mamlag	(4) Hagosais	(6) Hambabalod	(8) Badiang
Frequency:	(0) once/day	(2) 3x+/day	(4) 2x/week	(6) once/month
	(1) 2x/day	(3) once/week	(5) 3-4x/week	(7) 2x/month

Duration: CODE NUMBER OF MINUTES

3.12 What is the source, or where do you wash your farm animals, if any? IF SOURCE IS POTENTIALLY INFECTED WATER, ASK RESPONDENT TO SPECIFY FREQUENCY AND DURATION OF WATER CONTACT PER DAY *Diin ka paghuhugas han imo ig-uruma nga hayop?* (Mainit, *busay*, irrigation canal, *sapa*) IPAKIANA ITON KAIHA HITON KAHULOS DIDTO HA TUBIG NGAN KUN PIRA KABESES*?*

	H_20 Contact	Frequency	Duration
___1__ Mainit river	______	______	______
___*__ Stream (specify) ______________	______	______	______
___9__ Irrigation canal	______	______	______
__10___ spring	______	______	______
__11___ communal water system	______	______	______
__12___ artesian well/manual handpump	______	______	______
__13___ open dug well	______	______	______
__14___ rain water storage tanks	______	______	______
__15___ other (specify) ________________			

* Streams:	(1) Taytay	(3) Morokborok	(5) Sapa	(7) Tuod
	(2) Mamlag	(4) Hagosais	(6) Hambabalod	(8) Badiang
Frequency:	(0) once/day	(2) 3x+/day	(4) 2x/week	(6) once/month
	(1) 2x/day	(3) once/week	(5) 3-4x/week	(7) 2x/month

Duration: CODE NUMBER OF MINUTES

3.13 What is your approximate expenditure for *Ha imo pagkarkulo, pira an imo nagagastos para han masunod nga mga butang*

	Daily	Weekly	Monthly	Yearly
1. food *pagkaun-pagsura*	______	______	______	______
2. health/medicine *medisina*	______	______	______	______
3. clothing *panapton*	______	______	______	______
4. household utensils	______	______	______	______
5. electricity/lighting *pagsuga*	______	______	______	______
6. education *pagpaiskuwila*	______	______	______	______
7. leisure/socials *paglibang-libang*	______	______	______	______
8. reading materials *barasahun*	______	______	______	______
9. transportation *transportasyon*	______	______	______	______
10. savings *hinipos*	______	______	______	______

Block 4: Livelihood and Income

4.1 What is your present occupation or farmer status? *Ha pagkayana, ano iton imo kabutangan komo mag-uruma*?

___0__ farmer-owner *may kalugaringon nga umhanan*
___1__ farmer-leaseholder *nagpliplíti*
___2__ farmer-tenant *saop*
___3__ farmer-laborer *magpasuruhol*
___4__ combination of above *kombinasyon han nga tanan*
___5__ others

4.2 Do you own rice land *May kalugaringon ka nga hagna*?

___0__ no
______ yes
  ___1__ less than or equal to 0.5 hectares
  ___2__ more than 0.5 but less than 1.0 hectare
  ___3__ more than 1.0 hectare

4.3 Do you own coconut land *May kalugaringon ka nga lugitan*?

___0__ no
______ yes
  ___1__ less than or equal to 0.5 hectares
  ___2__ more than 0.5 but less than 1.0 hectare
  ___3__ more than 1.0 hectare

4.4 Do you own land planted to corn and rootcrops

___0__ no
______ yes
  ___1__ less than or equal to 0.5 hectares
  ___2__ more than 0.5 but less than 1.0 hectare
  ___3__ more than 1.0 hectare

FOR ANSWERS TO QUESTIONS 4.5, 4.6 & 4.7, FILL OUT THE APPROPRIATE COLUMNS IN THE TABLE ON PAGE 10. COLUMNS 1-3 OF THE SAME TABLE SHOULD BE FILLED OUT BEFORE THE INTERVIEW. GET DATA FROM CENSUS LIST.

4.5 Who among your household members earn a living? *Hin-o ha imo miyembro hin pamilya in may pakabuhi?*

4.6 What is the primary (and secondary, if any) occupation of each of these members who earn a living? *Ano iton ira primero nga pakabuhi ngan hiton iba pa nira nga pinagkakakitaan?*

4.7 What is the approximate income gained in the practice of these occupations? *Ha imo panhunahuna, pira iton ira kinikita tikang hini nga ira pakabuhi?*

IF RESPONDENT MENTIONS CROP FARMING AS PRIMARY OR SECONDARY OCCUPATION, ASK HIM/HER TO ANSWER THE QUESTIONS 4.8 TO 4.10.

4.8 How much is the total production cost in the cultivation of your primary and secondary crop in one year? *Pira iton imo ginagasto ha pag-uma kada tuig pareho man an imo nagagasto hadton iba pa nimo nga buruhaton ha pag-uma?* CODE AMOUNT PER CROPPING IN THE CASE OF RICE AND AMOUNT PER QUARTER IN THE CASE OF COPRA. IF RESPONDENT IS A FARM LABORER, PROCEED TO QUESTION 4.11

___________ rice (___ primary ___ secondary)
______ harrowing and plowing *pag-arado/pagsurod*
______ cleaning/construction of dikes *panhawan/panagaytay*
______ transplanting *paggani/pagtanum*
______ seeds *gahi*
______ food *pagkaun*
______ farm inputs, e.g. fertilizer, pesticides, herbicides

___________ copra (___ primary ___ secondary)
______ climb and harvest coconuts *panaka*
______ remove coconut husk *pagbunot*
______ food *pagkaun*
______ others

4.9 What rice varieties do you plant?

_0_ high-yielding, certified seeds ________________ ________
_1_ high-yielding, 2nd or 3rd generation seeds____________ ________
_2_ native/local varieties ________________ ________

4.10 Where do you source your capital for crop production? *Diin ka nakuha hin panggastos hiton imo pagtrabaho ha imo umhanan?*

___0__ local lenders ___3__ farmers cooperative
___1__ rural bank ___4__ self-financed
___2__ landowner (in case of tenants) ___5__ others (specify)

4.11 What are your main activities as a laborer? *Komo maguruma nga nagpapasuhol, ano iton imo trabaho kun ikaw an nagpapasuhol?*

___0__ plowing and harrowing ___3__ transplanting
___1__ weeding ___4__ combination of above
___2__ construction and maintenance of dikes and irrigation canals

4.12 What animals do you own and how many Ano ngan pipira iton imo mga hayop? *Pipira iton hinigtan ngan kinudal ngan pipira iton layaw?*

Total		Number loose	Number tied or in pens
______	cats	______	______
______	dogs ______	______	
______	pigs	______	______
______	carabaos	______	______
______	chicken	______	______
______	goats	______	______
______	turkeys	______	______
______	cows	______	______
______	ducks	______	______
______	none		

4.13 Do you engage in night fishing? If yes, please specify usual time and duration per week *Tigpanulo ka ba hin isda o bako, ngan nakakapira kabeses hiton usa ka semana ngan ano kaiha?*

___0__ no
______ yes

___________ frequency
___________ usual time
___________ duration

Frequency:	(0) daily	(2) 3-6x/week	(4) once/month
	(1) 2x/week	(3) once/week	(5) 2x/month

Usual time: USE *7:00 PM* FORMAT

Duration:	(0) 1 hour or less	(2) >2 to 3 hours
	(1) >1 to 2 hours	(3) >3 hours

4.14 Do you usually secure irrigation water at night? *Nagpapatubig ka ba hiton imo hagna kon gab-i ngan kon ikaw in nagbubuhat hini pira kabeses hiton usa kasemana ngan ano kaiha?*

______ no
______ yes

___________ frequency
___________ usual time
___________ duration

Frequency:	(0) daily	(2) 3-6x/week	(4) once/month
	(1) 2x/week	(3) once/week	(5) 2x/month

Usual time: USE *7:00 PM* FORMAT

Duration:	(0) 1 hour or less	(2) >2 to 3 hours
	(1) >1 to 2 hours	(3) >3 hours

Block 5: Health-seeking behavior

5.1 Where do you go for consultation or treatment of ordinary illnesses like colds, coughs, fever, diarrhea, and small wounds? *Hin-o imo dinadaop para magpakonsulta o magpabulong kun nagkakamay-ada ka sakit sugad hin hiranat, ubo, trangkaso, pag-uro-uro o gudti nga samad?*

___0__ stay at home/self-medication ___4__ local healer
___1__ barangay health center ___5__ RHU in Jaro town proper

___2__ Private doctor in Jaro
___3__ hospitals or doctors in Tacloban
___6__ Carigara District Hospital
___7__ Palo Schisto Center

5.2 Where do you go for treatment of non-ordinary or emergency cases? *Diin ka napabulong kun nagkakamay-ada ka diri ordinaryo, grabe, o kun apeke nga pagbati hin sakit ug panhinabuha lawas?*

___0__ stay at home/self-medication
___1__ barangay health center
___2__ Private doctor in Jaro
___3__ hospitals or doctors in Tacloban
___4__ cannot say (no emergency case yet)
___5__ local healer
___6__ RHU in Jaro town proper
___7__ Carigara District Hospital
___8__ Palo Schisto Center

5.3 Where do you go for consultation and treatment of what you suspect to be symptoms of schistosomiasis? *Diin ka napakiana o napabulong kun ha imo kalugaringon natahap ka nga may ada ka sakit nga schistosomiasis?*

___0__ stay at home/self-medication
___1__ barangay health center
___2__ Private doctor in Jaro
___3__ hospitals or doctors in Tacloban
___4__ Macanip Elementary School, during visitations of RITM doctors
___5__ local healer
___6__ RHU in Jaro town proper
___7__ Carigara District Hospital
___8__ Palo Schisto Center

5.4 How did you learn that you had schistosomiasis? *Ano nga paagi nga nahabaro ka nga may ada ka sakit nga schistosomiasis?*

___0__sought treatment RITM/RHU/Palo Schisto Center after experiencing symptoms *dida han kahuman mo pagpakonsulta ha RITM/RHU-Jaro/Palo Schisto Center ug pag-abat hin pangilal-an hin ka may sakit nga schistosomiasis*

___1__submitted stools to RITM/RHU/Palo Schisto Center even without experiencing symptoms *kahuman mo paghatag hin baya para maeksamen ha RITM/RHU-Jaro/Palo Schisto Center bisan waray ka pagtahap hin pagkamay-ada sakit nga schistosomiasis*

5.5 In case RITM cannot continue its stool examinations and treatments because of budget limitations, will you go to the RHU in Jaro or Palo Schisto Center every year for stool examinations and/or treatment? *Panangiitan diri na magpadayon hin pamulong hin schistosomiasis an RITM tungod hin mga rason, mapaeksamen ka ba o mapabulong ha RHU ha Jaro o ha Palo Schisto Center kada tuig?*

___0__ no ___1__ yes

5.6 Are you participating (meaning submitting stools and/or taking Biltricide) in the program of treatment of schistosomiasis by RITM? In what years did you participate? *Naapi ka ba hin pagpa-eksamen ha baya o pag-tomar hin Biltricide hiton kanan RITM pamulong hiton schistosomiasis, ngan kakan-o nga tuig?*

___0__ no (PROCEED TO QUESTION 5.7)
___1__ yes (PROCEED TO QUESTION 5.8)

___1982	___1986	___1990
___1983	___1987	___1991
___1984	___1988	___1992
___1985	___1989	___1993

TO INTERVIEWER: Which of the following best describes the respondent's recall of the instances (years) of stool submission and treatment?

___0__ remembered easily
___1__ remembered, but with some difficulty
___2__ remembered, but with great difficulty
___3__ did not remember years

5.7 Why are you not participating? (PROCEED TO 5.10) *Kay ano nga waray ka umapi hin pagpabulong?*

___0__ I have not experienced any of the known symptoms of schistosomiasis
___1__ I was alienated because of what I perceive to be preference given to non-Macanip residents in the treatment of cases
___2__ I am not interested in treatment
___3__ I was not properly informed about the program
___4__ I am too busy
______ I go to other places/doctors for treatment
    ___5__ local healer
    ___6__ barangay health center
    ___7__ RHU in Jaro town proper
    ___8__ Private doctor in Jaro
    ___9__ Carigara District Hospital
    __10__ Palo Schisto Center
    __11__ hospitals and/or doctors in Tacloban

5.8 Did you submit stools to RITM for examination last year and this year (1992 and 1993)? *Nag-hatag ka ba hin baya para maeksamen han tuig 1992 ug 1993?*

1992 __0__No __1__Yes
1993 __0__No __1__Yes

5.9 Did you take medicine (Biltricide) last year and this year? *Nag-tomar ka ba hadton 1992 ug 1993?*

1992 __0__No __1__Yes
1993 __0__No __1__Yes

FOR THE FOLLOWING QUESTION, FILL OUT THE APPROPRIATE COLUMNS IN THE TABLE IN PAGE 10. INDICATE YEAR/S (DATES) OF STOOL SUBMISSION AND/OR TREATMENT.

5.10 Since 1982, in which years have each of your household members submitted stools and / or been treated with anti-schistosomiasis drugs? *Tikang hadton 1982, hin-o han imo miembro han pamilya in nagpaeksamen hin baya ha RITM ngan hin-o ha ira in nagpabulong hin schistosomiasis ug ano nga tuig?*

Block 6: Knowledge about schistosomiasis

6.1 Please tell me your your sources of information about schistosomiasis. *Diin ug ha kankanay ka habaro han sakit nga schistosomiasis?*

__0__ individual approaches __3__ mass media
__1__ community organization or group process

ACQUISITION

SITES OF ACQUISITION

6.2 In which places does one acquire schistosomiasis? *Diin nga lugar in usa nga tawo nakakakuha hin sakit nga schistosomiasis?*

	free recall (0)	prompted (1)	don't know (2)	notsure (3)
rice paddies	____	____	____	____
irrigation and drainage canals	____	____	____	____
Mainit River	____	____	____	____
streams ______________	____	____	____	____
creeks ______________	____	____	____	____
idle rice fields	____	____	____	____
intermittent waterways	____	____	____	____

MODE OF ENTRY

6.3 How does "schistosomiasis" (cercariae) enter the body? *Paunan-o nasulod an schistosomiasis ha aton lawas?*

	free recall (0)	prompted (1)	don't know (2)	notsure (3)
skin penetration	____	____	____	____

TRANSMISSION

6.4 Can schistosomiasis be transferred directly from one person to another? *Natapon ba an sakit nga schistosomiasis ha igkasi tawo pareho hin tuberculosis*

__0__no __2__don't know
__1__yes __3__not sure
__4__not directly, but through a transmission cycle

ELEMENTS OF TRANSMISSION CYCLE

6.5 What are the elements of the transmission cycle? *Ano nga mga hayop o mananap diin puwede omokoy o mabuhi an schistosomiasis?*

	free recall (0)	prompted (1)	don't know (2)	notsure (3)
parasitic worm	____	____	____	____
tiny snails	____	____	____	____
animals (pigs, rats, dogs, carabaos)	____	____	____	____
humans	____	____	____	____

Name	Age	Gend	RLT	RLT1	Year Stool	Year Treat	Primary Occupation	Secondary Occupation	Primary Income	Secondar Income

CONTROL

6.6 What should one do to avoid or prevent schistosomiasis? *Ano an mga sadang naton buhaton basi kita diri masakit hin schistosomiasis?*

	free recall (0)	prompted (1)	don't know (2)	notsure (3)
have your stools examined	___	___	___	___
snails should be controlled	___	___	___	___
improved farming practices	___	___	___	___
prevent people especially children from bathing in infested streams	___	___	___	___
use toilets	___	___	___	___
control stray animals	___	___	___	___
build foot bridges over canals and creeks	___	___	___	___
provide adequate water supply for bathing, laundering and safe drinking water	___	___	___	___
health education so that people can protect themselves	___	___	___	___
wear rubber boots	___	___	___	___

6.7 How do you get news/information about affairs concerning Macanip, Jaro & Leyte and the rest of the Philippines? *Ano nga mga bagay an iyo nakukuhaan hin inpormasyon hin bisan ano nga panhinabo ha sakob han Macanip, Jaro, Leyte, ug ha bug-os nga Pilipinas?*

	Macanip	Jaro & Leyte	rest of the Phil.
(0) friend/neighbor	___	___	___
(1) unit leader	___	___	___
(2) elected barangay officials	___	___	___
(3) town crier	___	___	___
(4) municipal, provincial, national officials or employees	___	___	___
(5) radio	___	___	___
(6) television	___	___	___
(7) newspapers	___	___	___

Block 7: Community rating

7.1 In your opinion, is your barangay, when compared to other barangays ... *Kun an iyo barangay, tanding han iba nga barangay, ha imo pagsabut, ano an iyo kabutangan (ha pagpakabuhi)?*

__0__ more prosperous *mauro-upay* __2__ of about average prosperity *maupay*
__1__ less prosperous *diri maupay*

7.2 What would you consider as the three most important problems of your barangay? If respondent is hesitant, ask alternate question: What three areas of concern should the barangay council devote its attention to? *Ha imo pagkita, ano an tulo nga nangunguna nga problema han barangay? Ano iton tulo nga bagay nga sadang tagan hin pagtagad han barangay council para ha kauswagan han barangay?*

	1st mentioned	2nd mentioned	3rd mentioned
(0) .poverty/low income	_____	_____	_____
(1) livelihood	_____	_____	_____
(2) peace and order	_____	_____	_____
(3) food	_____	_____	_____
(4) schistosomiasis	_____	_____	_____
(5) health of residents	_____	_____	_____
(6) roads	_____	_____	_____
(7) irrigation	_____	_____	_____
(8) barangay leadership	_____	_____	_____
(9) unity	_____	_____	_____
(10) env'tal sanitation	_____	_____	_____

Block 8: Attitudes and outlook

8.1 (SHOW LADDER TO RESPONDENT) Here is a drawing of a ladder. It has 10 rungs. Assuming that the 10th rung represents the best position in life while the 1st rung represents the worst, on which rung would you place yourself at present? *I-ini in litrato hin hagdan nga may ada napulo nga balitang. Kun an ika-napulo nga balitang nakumponer han gimauupayi an pakabuhi ug an primero nga balitang amo an makuri an kinabuhi, ha pagkayana, diin nga balitang ka nahamumutang?*

__10__
__9__I
__8__I
__7__I
__6__I
__5__I
__4__I
__3__I
__2__I
__1__I

8.2 On which rung would you say you were 5 years ago? *Ha imo hunahuna, diin ka nahamumutang nga balitang ha sakob han nakalabay nga lima katuig?*

_____

8.3 On which rung do you think you will be 5 years from now? *Pagkatapos hin lima katuig tikang yana, ha imo panhunahuna, hain ka hini nga balitang mahamumutang*

_____

8.4 At present, do you think you have opportunities to improve your life? *Ha pagkayana nga imo pagsabut, may ada ka ba oportunidad nga mapauswag an imo pakabuhi?*

__0__ none __2__ maybe or not sure __4__ many
__1__ few __3__ don't know

8.5 If you earn a substantial amount of money, what three things do you want to acquire within the next 5 years? *Kon magkamay-ada ka sadang nga salapi sakob hiton tiarabot nga lima katuig, ano iton tutulo nga bagay nga imo guinhuhuna-hunaan pagpalita?*

	1st mentioned	2nd mentioned	3rd mentioned
(0) farmland	_____	_____	_____
(1) carabao/s	_____	_____	_____

(2) motorcycle	_____	_____	_____
(3) sing-along/karaoke	_____	_____	_____
(4) better house	_____	_____	_____
(5) television	_____	_____	_____
(6) radio	_____	_____	_____
(7) refrigerator	_____	_____	_____
(8) bed	_____	_____	_____
(9) sewing machine	_____	_____	_____
(10) kerosene/electric stove	_____	_____	_____
(11) electric fan	_____	_____	_____
(12) sala set	_____	_____	_____
(13) farm equipment	_____	_____	_____
(14) toilet	_____	_____	_____

Block 9: Community participation

9.1 Are you a member of any barangay organization within Macanip? *Miembro ka ba hin bisan ano nga organisasyon dinhi hini nga barangay? Ano nga organisasyon?*

__0__ no PROCEED TO QUESTION 9.3
_____ yes PROCEED TO QUESTION 9.2

__1__ Samahang Nayon	__5__ BAPA
__2__ Women's Welfare	__6__ Barangay Health Workers
__3__ Out of School Youth	__7__ Medalla Milagrosa
__4__ Samahang Kabataan	__8__ ISA

9.2 What is the degree of your involvement in these organizations? *Kun usa ka nga miembro hin organisasyon, tipaunan-o katim-os an imo pag-api?* PROCEED TO QUESTION 9.6

__0__ never involved *diri ka napartisipar*
__1__ some activities *nabulig hiton iba nga aktibidades*
__2__ most activities *kaudganan nabulig ka hiton aktibidades*
__3__ all activities *nga tanan nga aktibidades*

9.3 Are you interested in joining a barangay organization? *Kun diri ka miembro, interesado ka ba hin pagin miembro hin organisasyon?*

__0__ no PROCEED TO QUESTION 9.4
__1__ yes PROCEED TO QUESTION 10.1

9.4 Why are you not yet a member? Kay ano nga waray ka naapi?

__0__ too busy or don't have time *damo in trabaho ug waray panahon*
__1__ but don't know which to join *diri maaram kun diin aapi*
__2__ not invited *waray nagiimbitar*
__3__ but have feelings of inadequacy, ashamed, not fitted *naawod ug may pagturaw nga diri hiya angay maging miembro*

9.5 If you were made to choose among the following barangay organizations, which would you join? *Kun papipili-on ka pag-api hinin masunod nga mga organisasyon, diin mo gusto magin miembro?*

__0__ Samahang Nayon	__4__ BAPA
__1__ Women's Welfare	__5__ Barangay Health Workers
__2__ Out of School Youth	__6__ Medalla Milagrosa
__3__ Samahang Kabataan	__7__ ISA

9.6 Which barangay association could effectively be used to control schistosomiasis? *Hini nga mga organisasyon, hain in may kapasidad pag-kontrol han schistosomiasis?*

__0__ Samahang Nayon	__4__ BAPA
__1__ Women's Welfare	__5__ Barangay Health Workers
__2__ Out of School Youth	__6__ Medalla Milagrosa
__3__ Samahang Kabataan	__7__ ISA

Block 10: Attitudes and perceptions toward schistosomiasis

10.1 Here is the drawing of the ladder again. Assuming that the 10th rung represents the best position in terms of how you feel (the condition of your body) vis-a-vis schistosomiasis and the 1st rung represents the worst, on which rung would you place yourself at present? *Ilni na liwat in litrato hin hagdan nga may mga balitang, nga diin an ika napulo in narepresentar han gimauupayi nga pamalatian han imo lawas bahin han sakit nga schistosomiasis, pareho man an primero nga balitang an narepresentar han gimakokorehi nga pamalatian han imo lawas bahin han sakit nga schistosomiasis. Dida hini yana nga panahon, diin mo mahamumutang an imo kalugaringon?*

__10__
__9__I
__8__I
__7__I
__6__I
__5__I
__4__I
__3__I
__2__I
__1__I

10.2 On which rung would you say you were 11 years ago, before the start of treatments by RITM? *Dinhi hini nga hagdan, diin ka nga balitang namumutang onse anyos san-o magtikang pamulong an RITM?*

_____

10.3 On which rung do you think you will be 5 years from now, with the continuation of RITM's treatments? *Kun ha sakob pa hin lima katuig, magpadayon pamulong an RITM, ha imo panhunahuna diin ka hini nga balitang mahamumutang?*

_____

10.4 On which rung do you think you will be 5 years from now, without RITM's treatments? *Kun ha sakob hin lima katuig diri na mamulong an RITM, ha imo panhunahuna diin ka hini nga balitang mahamumutang?*

_____

10.5 Will you please tell me your feelings or attitudes toward schistosomiasis? *Ha imo kalugaringon nga pagpaino-ino, alayon pagsumat han imo panghunahuna ug pamatasan bahin han sakit nga schistosomiasis?*

AFTER THE INTERVIEW, SAY:

Thank you very much for sharing your precious time with me. Should I need additional information in the future, are you willing to be interviewed again? *Salamat hin madamo han imo iginhatag nga panahon para hini nga pamakiana. Unta an imo pagtagad ha akon magin amola gihapon kun ha orhi nga panahon manginahanglan pa ako hin dugang nga impormasyon tikang ha imo?*

_____no _____yes

Interviewer's Assessment

Which of the following best describes the respondent's attitude toward the interview?

_____ interested _____ indifferent
_____ antagonistic _____ hesitant/frightened
_____ inquisitive/suspicious

Which of the following best describes the establishment of rapport?

_____ easily established
_____ established, but with some difficulty
_____ established, but with great difficulty
_____ never established

Which of the following best describes the interview conditions?

_____ very noisy and/or with many distractions
_____ some noise and/or distraction
_____ quiet and/or no distraction

INTERVIEWER'S NOTES