PREVALENCE AND DISTRIBUTION OF INTESTINAL HELMINTHS AND PROTOZOANS IN WESTMORELAND PARISH, JAMAICA

A Thesis

by

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ABSTRACT

PREVALENCE AND DISTRIBUTION OF INTESTINAL HELMINTHS AND PROTOZOANS IN WESTMORELAND PARISH, JAMAICA. (August 1984)

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Between June 1 and July 10, 1983, 1025 blood samples and 703 fecal samples were collected from 1025 individuals in four villages in Western Jamaica. The four villages represent a wide range of social and environmental conditions. Samples were obtained from 15 age groups ranging from under 6 months to over 50 years. Health history data were recorded for each individual to allow close monitoring of sociological health factors. Blood samples obtained from finger pricks were prepared and stained in the field with standard Giemsa. Fecal samples were preserved in standard PVA solution. Separate Harada-Mori filter paper cultures were made to detect for *Strongyloides* infection. Formalin-ether concentration was completed on all PVA preserved specimens. A permanent stained slide using Wheatley's trichrome was prepared from all PVA samples. Six helminths and 7 protozoans were confirmed. *Trichuris trichiura* showed the highest rate for all helminths while *Giardia lamblia* had the highest rates for all protozoans. There were significant differences in parasite prevalences between the four sites. No blood parasites were observed.

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Most of all I would like to thank my wife, Erika, and my parents for standing by me during the last five years of study and for making it possible for me to complete my education.

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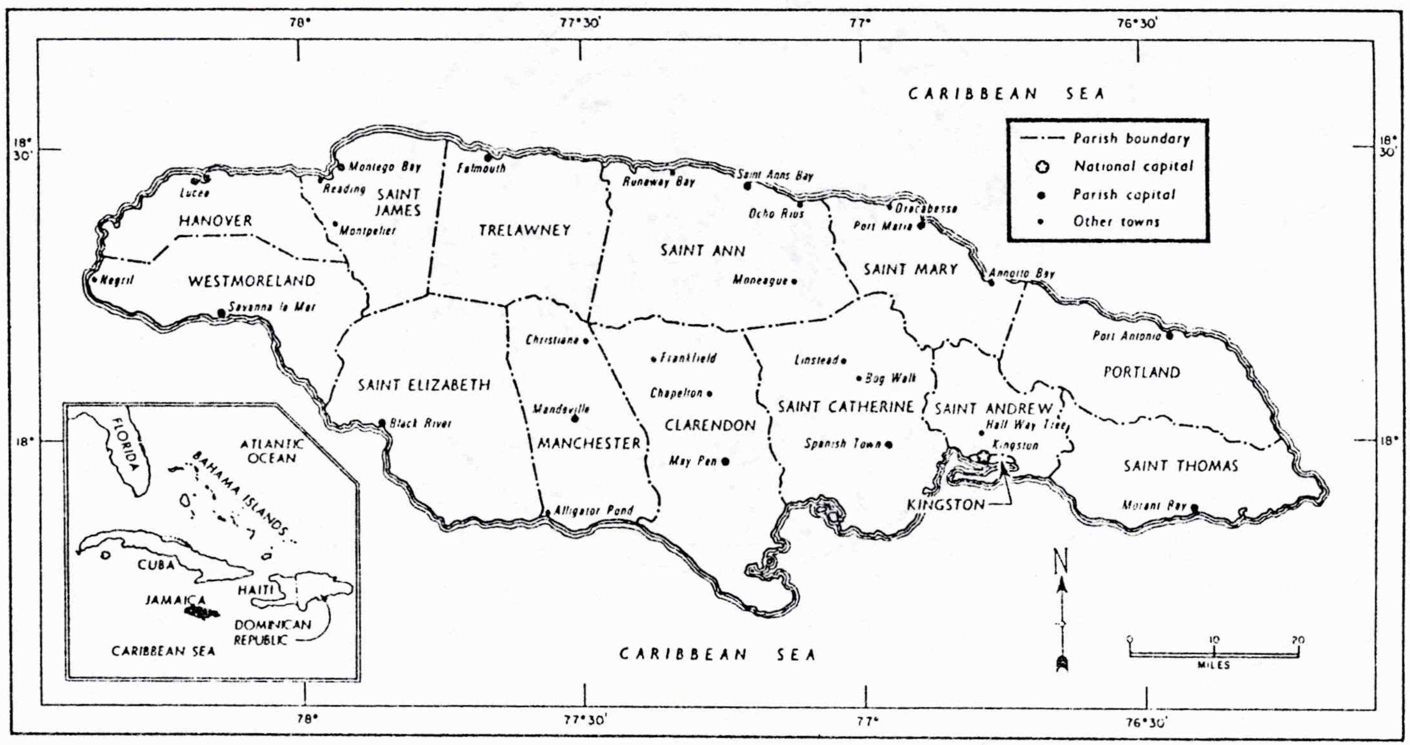
INTRODUCTION

The emerging countries of the Third World face severe problems in their struggle for development. One of the major problems is the generally low level of human health which hinders progress in many regions. Recent United Nations estimates (1981) indicate that the average life expectancy in Africa is 47 years, while the average for the Caribbean is 67 years (World Bank, 1981). Vector-borne parasitic diseases such as malaria, schistosomiasis, filariasis and trypanosomiasis continue to debilitate millions of people each year, while less dramatic, intestinal parasitic infections are of equal concern to the health of the people. Each region of the world has its own individual problems in regard to these parasitic diseases. Information from the World Health Organization (1981) indicates that intestinal parasitic infections have a detrimental effect on the physical and mental development of children, especially among the rural poor of the tropics. The object of this study was to undertake a comprehensive survey of the prevalence and distribution of intestinal and selected blood parasites in four villages in Jamaica.

The Caribbean region contains many independent islands and territories. Development and exploitation of the Caribbean began with the first voyage of Columbus in 1492. Spaniards established themselves throughout the region during the 16th century and were in turn replaced by more powerful French, Dutch and English colonial powers. Most of the development of these newly settled islands was concerned with agriculture, especially the production of sugar cane. The colonial powers imported thousands of Africans and Asians to work on the farms, leading to diverse racial and cultural groups. This movement of culturally different peoples to a new world of diverse geography, climate, soil types, and other physical factors provided a situation suitable for a high concentration of many species of human parasites.

Jamaica is the third largest island of the greater Antilles (Figure 1). It lies between latitude 17°40'N and 18°35'N, and longitude 78°20'W and 76°10'W. The island is approximately 240 km (150 miles) long and 80 km (50 miles) wide with an area of 11396 square km (4400 square miles). Jamaica does not lend itself readily to separation into geographic regions but is usually divided into coastal lowlands and valleys and a large interior plateau of limestone. The uneven plateau is broken by many interior valleys, limestone hills, and two mountain ranges of differing composition and appearance. Elevation varies from sea level on the coastal plain to

Figure 1. Jamaica base map.


CARIBBEAN SEA
Parish boundary
National capital
Parish capital
Other towns
78°
77°30'
77°
76°30'
18° 30'
18°
HANOVER
WESTMORELAND
SAINT JAMES
TRELAWNEY
SAINT ANN
SAINT MARY
PORTLAND
SAINT ELIZABETH
MANCHESTER
CLARENDON
SAINT CATHERINE
SAINT ANDREW
SAINT THOMAS
KINGSTON
Lucea
Negril
Savanna la Mar
Montego Bay
Reading
Montpelier
Falmouth
Runaway Bay
Saint Anns Bay
Ocho Rios
Moneague
Oracabessa
Port Maria
Annotto Bay
Port Antonio
Christiana
Mandeville
Black River
Alligator Pond
Frankfield
Chapelton
May Pen
Linstead
Bog Walk
Spanish Town
Half Way Tree
Kingston
Morant Bay
N
MILES
FLORIDA
ATLANTIC OCEAN
BAHAMA ISLANDS
CUBA
JAMAICA
HAITI
DOMINICAN REPUBLIC
CARIBBEAN SEA

approximately 900 m (3000 feet) on the crest of the plateaus. Peaks exceeding 2220 m (7400 feet) exist in both the Blue Mountains of eastern Jamaica and in the central range (Kaplan et al., 1976). Although Jamaica lies entirely within the tropics, constant sea breezes moderate the temperatures. Maritime tropical climatic conditions prevail in the coastal lowlands where temperatures of over 37.8°C (100°F) are common during the summer months. The temperature during the months of February through April frequently drops to below 21.1°C (70°F). At higher elevations, over 750 m (2500 feet), yearly temperatures average about 20°C (67°F). Rainfall varies substantially in different locations. The overall yearly average of 180.34 cm (71 inches) does not accurately reflect regional variation and irregularity of rainfall. Droughts are frequent during the normally dry summer between June and August. The southwest coastal belt was experiencing a severe dry period during the present study. Rainfall extremes on a yearly average can be as little as 25 cm (10 inches) to 50 cm (20 inches) on the southwest coast to over 381 cm (150 inches) in several mountain areas (Kaplan et al., 1976).

Jamaica's ethnic and cultural groups fall within the usual diversity of the Caribbean. The society is composed primarily of Creoles (90-95%) and non-Creoles, (5-10%). Creoles include blacks (more than 75% of all Jamaicans). Afro-European mixes account for about 15% of the Creole population. Non-Creoles comprise whites of European origin while less than 1% of the non-Creoles are Chinese, East Indian and Syrian. All groups speak one or more variations of English ranging from standard Jamaican, resembling British English, to dialects of Jamaican Creole which in many cases can be difficult to understand for an outsider. A majority of Jamaicans are Christian or members of Afro-Christian sects. Upper and middle class religious practices resemble those of European sister churches, mostly Anglican, Methodist, Baptist, Presbyterian and Roman Catholic. Afro-Christian cults are popular with the rural class. Beliefs in spirits, possessions, sacrifices, divine acts, and witchcraft play a major role in these cults. Several revivalist cults are also practiced such as Rastefariarism, and Zion Revival (Kaplan et al., 1976).

During the British colonial period (1800 to 1962), the island was broken up into 14 administrative districts called parishes. Under the British system of government ministries were formed to deal with the various sectors of internal management. The ministry of health was created to administer all medical activities. Regional hospitals and clinics were built throughout the island,

and staff personnel from doctors to nurses were trained at the University of the West Indies Medical School in Kingston. Today many trained personnel unfortunately leave the island in search of better paying jobs which creates shortages of staff in some areas. The staff of rural clinics are usually women trained as public health aides, nurses, and midwives. These women are well trained, dedicated, and highly respected by their community.

Three parasitic diseases (schistosomiasis, filariasis, and trypanasomiasis) although present in many surrounding islands and countries are not found in Jamaica. Malaria, one of the world's greatest killers, has essentially been eliminated by campaigns against the disease and its vector. Hookworm infections were reduced considerably by the efforts of the Rockefeller Foundation during the 1930's. Yellow fever and other childhood diseases have also been reduced (Kaplan et al., 1976). Government and private medical programs have contributed to the lowering of the overall death rate from 23/1000 in the 1930's to 7.2/1000 in 1973. During this same period infant mortality correspondingly dropped from 32.2/1000 to 26.2/1000, which equates well with the figures for many industralized nations (Kaplan et al., 1976).

The population growth rate of Jamaicans is on the same level as the rest of the Caribbean. Life expectancy is now around 67 years. Age structure information from the late 1970's indicates the following; 46% of the population was under the age of 15 years, 55% under the age of 20, and 68% under age 30 (Kaplan et al., 1976).

Knowledge on the prevalence and distribution of intestinal parasites is of major importance to the public health of Jamaica. Rawlins (1982) mentioned that morbidity due to intestinal parasites continues to be of major concern in Jamaica and that only limited studies have been conducted which do not adequately provide sufficent baseline data. Most recent data from Jamaica comes from studies close to Kingston (Grant et al., 1963 and Grant et al., 1965) and from hospital records (Rawlins, 1982). No comprehensive cross sectional studies have been completed in the last 20 years. Considering the impact these parasites have on early child development (World Health Organization, 1981), it is imperative that more studies be undertaken. After communicating with health authorities and staff from the Zoology Department of the University of the West Indies in Kingston, a decision was reached to initiate a cooperative field study to determine the prevalence and distribution of intestinal parasites from four communities in western Jamaica. Blood samples were also taken to determine the presence of selected blood parasites. The survey team consisted of two graduate students from the Biology Department of Appalachian State University and one graduate student from the University of West Indies.

The four communities studied were in the Parish of Westmoreland in western Jamaica (Figure 2). The four sites provided a diversity of geographic, climatic and socio-economic conditions. Blood slides and fecal samples were collected from individuals in 15 age groups. A public health history (comprised of 13 questions) was compiled for each person (Table I). Results of the study provide the foundation of this thesis. It is hoped the findings will furnish data required to accurately assess the prevalence and distribution of the organisms which continue to undermine the well being of Jamaicans. Hopefully the government of Jamaica will utilize the information provided to set up a treatment and prevention program to reduce and even eliminate some of these diseases.

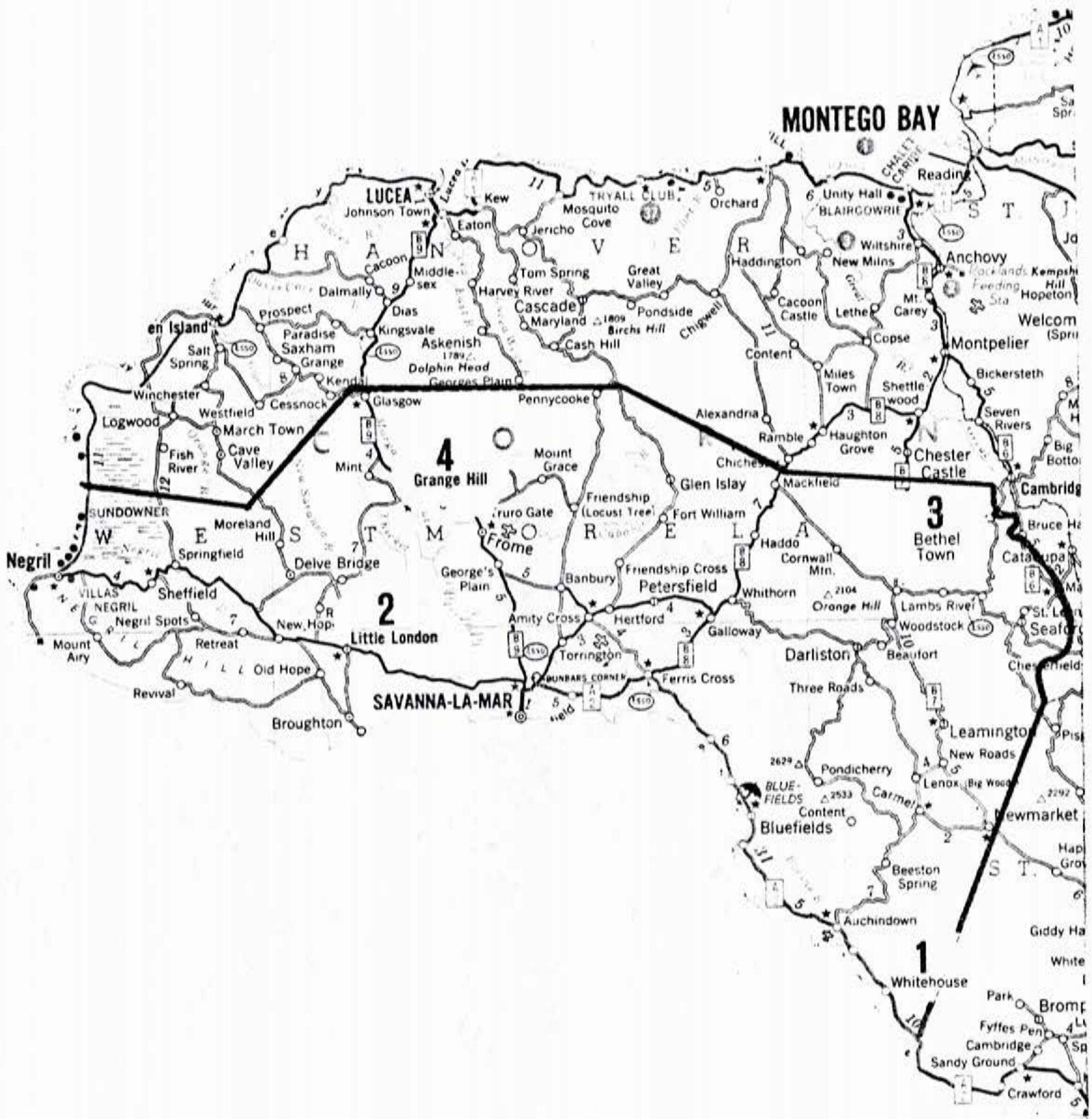
Figure 2. Westmoreland Parish study areas:

(1) Whitehouse,

(2) Little London,

(3) Bethel Town, and

(4) Grange Hill



MONTEGO BAY
LUCEA
Johnson Town
Kew
Eaton
TRYALL CLUB
Mosquito Cove
Orchard
Unity Hall
Jericho
Wiltshire
Haddington
New Milns
Anchovy
Tom Spring
Great Valley
Harvey River
Cascade
Maryland
Birchs Hill
Pondside
Cash Hill
Cacoon Castle
Lethe
Mt. Carey
Copse
Montpelier
Middlesex
Dalmally
Dias
Kingsvale
Askenish
Dolphin Head
Prospect
Paradise
Saxham
Grange
Salt Spring
Kendal
Winchester
Westfield
Cessnock
Glasgow
Georges Plain
Pennycooke
Content
Miles Town
Shettlewood
Bickersteth
Seven Rivers
Logwood
March Town
Cave Valley
Fish River
Mint
4
Grange Hill
Mount Grace
Alexandria
Ramble
Haughton Grove
Chester Castle
Glen Islay
Mackfield
3
Bethel Town
SUNDOWNER
Moreland Hill
Friendship (Locust Tree)
Fort William
Truro Gate
Frome
Haddo
Cornwall Mtn.
Negril
Springfield
Delve Bridge
George's Plain
Banbury
Friendship Cross
Petersfield
Whithorn
Orange Hill
Lambs River
VILLAS NEGRIL
Sheffield
Negril Spots
2
Little London
New Hope
Amity Cross
Hertford
Galloway
Woodstock
Darliston
Beaufort
Mount Airy
Retreat
Old Hope
Torrington
Ferris Cross
Revival
SAVANNA-LA-MAR
DUNBARS CORNER
Three Roads
Broughton
Leamington
New Roads
Pondicherry
Lenox
Carmel
BLUEFIELDS
Content
Bluefields
Beeston Spring
Auchindown
1
Whitehouse
Park
Fyffes Pen
Cambridge
Sandy Ground
Crawford

TABLE I. Personal data compiled for each individual

1. Subject's name and identification number
2. Study site
3. Age
4. Sex
5. Height
6. Weight
7. Type of water supply i.e., communal standpipe, running water in house, etc.
8. Type of sanitation - pit latrine or flush toilet
9. Educational level
10. Ever passed worms?
11. Taken worm medicine?
12. Last treatment
13. What anthelmintic administered?

HISTORICAL REVIEW

According to Ashcroft (1965) the earliest report of intestinal parasitic infections in Jamaica was recorded by Edwards (1793-1801). Edwards described the importance of a disease with intestinal disturbances, debility, anemia, and dropsey, which he surmised was caused by hookworm infection. Ferguson (1892) attributed 10% of all deaths in the public hospital at Georgetown, Guyana to be due to hookworm infection (Ashcroft, 1965). Ashcroft (1965) further points out that the Rockefeller Sanitary Commission and later the Rockefeller Foundation and International Health Commission were formed to help deal with the hookworm problem in the Caribbean. This work, done between 1920-1930, dramatically reduced the level of hookworm infection in many areas although it still exists in the population at varying levels.

Guilbride (1953) summarizes several earlier reports from hospital records and surveys in Jamaica. His report begins with a survey in 1929 showing a 69.5% rate of hookworm infection. In this study more females than males were infected. A 1931 report shows a 67% hookworm rate. Three hundred eighty five children examined from 12 schools in 1935 showed 65% with hookworm, 86% with

Ascaris and 90% with *Trichuris*. Further studies between 1942 and 1947 showed hookworm rates averaging 20% while *Ascaris* averaged 7.2% and *Trichuris* averaged 22%. According to Guildbride (1953), Fesenfeld (1952) in personal communication described a field study that showed 23.3% of adults had diarrhea and 14.1% of the children sampled had *Entamoeba histolytica*. Guildbride (1953) further noted that deaths, in the regional hospital, attributed to helminths were as follows: 1944, 35 deaths; 1945, 67 deaths; and 1946, 50 deaths.

A major work on intestinal protozoa in Jamaica was completed by Young et al. (1955). A total of 2,591 fecal samples were obtained from hospitalized patients and local children all showing symptoms of intestinal problems. Approximately 27% had *Entamoeba histolytica*, 41% *Entamoeba coli*, 43% *Endolimax nana*, 5% *Iodamoeba butschli*, 0.6% *Dientamoeba fragilis*, 14% *Giardia lamblia*, 3% *Chilomastix mesnili* and 0.5% *Trichomonas hominis*.

Beck (1960) examined 23 stool samples from children under 12 years of age at a housing project in Jamaica. Seven parasites were recorded with the following infection rates: *Entamoeba histolytica*, 30.4%; *Entamoeba coli*, 34.7%; *Endolimax nana*, 13.0%; *Iodamoeba butschlii*, 4.3%; *Giardia lamblia*, 34.7%; *Ascaris lumbricoides*, 21.7%; and *Trichuris trichiura* 8.6%.

Beck (1960) further examined 80 fecal samples from persons of different ages and sexes. These were taken at the Kingston hospital and showed the following rates of infection: *E. histolytica*, 10%, *E. coli*, 10%; *E. nana*, 7.5%; *I. butschlii*, 1.2%; *G. lamblia*, 11.2%; *A. lumbricoides*, 6.2%; and *T. trichiura*, 11.2%.

Grant et al. (1963) carried out one of the first major surveys of both helminth and protozoan infections in Jamaica. They obtained a total of 1953 stool samples of which 294 came from Lawrence Tavern, a rural community near Kingston. The remaining 1659 samples were from Bellevue Hospital in Kingston. Besides the parasites recorded by Beck (1960) four additional organisms were observed, *Chilomastix mesnili*, *Balantidum coli*, *Strongyloides stercoralis*, and *Enterobius vermicularis*. *Ascaris*, hookworm and *Trichuris* had the highest incidence of the helminths. Protozoans had rates ranging from 0.1% to 20%.

According to W. Chen in personal communication (1964) to Bras et al. (1964) *Strongyloides stercoralis* was found in a pilot study carried out in a small hill community of Jamaica. Nine hundred people were sampled and 1% were infected. Bras et al. (1964) further described 6 fatal cases and 4 severe cases of *Strongyloides stercoralis* at the University Hospital in Kingston.

Grant et al. (1965) described the results of 1140 stool examinations from children at the Kingston Hospital. Helminths in the order of prevalence were *T. trichiura*, *A. lumbricoides*, and hookworm, while the protozoans in order of prevalence were *G. lamblia*, *E. coli*, *E. nana*, and *E. histolytica*. In a smaller sample of 150 children in the rural community of Lawrence Tavern the incidence of *A. lumbricoides* was greater than *T. trichiura* with hookworm again in third position. *E. coli* replaced *G. lamblia* as the most prevalent protozoan followed by *E. nana* and *E. histolytica*. Concern over the severity of *Amoebiasis* was recorded by Hayes and Ragbeer (1966) who described eight deaths resulting from infections of *E. histolytica*.

Miall et al. (1965) collected fecal samples from 251 males and 260 females aged 35 to 64 years. Stools were examined only for hookworm eggs. A 30.7% prevalence rate was found in men while 12.7% of the women were infected.

Ashcroft et al. (1969) obtained fecal samples from children in four age groups (3 months to 3 years). Two hundred ninety six fecal samples were examined. Helminths were present in 56.7% of three year olds, not common in two year olds, and almost absent in one year old children. The principle parasites were

Ascaris lumbricoides and *Trichuris trichiura*. Hookworm infection was less common while larva of *Strongyloides stercoralis* were seen in two stools. No eggs or segments of tapeworms were observed.

Rawlins (1982) compiled the most recent data available on changing patterns of intestinal parasites over an extended period of time. This study was taken from Kingston hospital records over an 18 year period. It indicates an overall reduction in prevalence of most intestinal parasites. Hookworm prevalence decreased steadily from a maximum of 8.7% in 1964 to a minimum of 1.0% in 1978. *Ascaris lumbricoides* peaked at 9.0% in 1973 and fell to 4.5% in 1979. *Trichuris trichiura* increased from 9.6% in 1964 to a maximum of 24.1% in 1973, but fell to 11.1% in 1979. The prevalence of *Strongyloides stercoralis* ranged from 1.8% in 1964 to 0.6% in 1974, and has since fluctuated between these two values. *Giardia lamblia* had its maximum occurrence in 1964 (9.2%) and its minimum in 1967 (4.3%). The 10-29 year old groups possessed the heaviest hookworm load. *A. lumbricoides*, *T. trichiura* and *G. lamblia* were most common in the 1-5 year old groups with prevalence declining sharply outside this age group. *S. stercoralis* was at its peak in the 40-49 year old group while *Enterobius vermicularis* and *Taenia saginata* occurred at low frequencies. *Entamoeba coli* (6.1%) was the most common non-pathogen, and *Entamoeba histolytica* had not been recorded in the hospital for many years.

Data from other islands in the region provide important comparative information. Several large scale studies on the prevalence of intestinal parasites have been done in Puerto Rico. Greenberg and Ferguson (1971), collected 6,086 stool samples from 6 year olds in 18 municipalities of Puerto Rico. The overall prevalence of infection with *Ascaris* was 13.4%, 12.1% for hookworm and 74.7% for *Trichuris*. Little differences in prevalence was found between males and females. A second study of 1000 people by Knight et al. (1973) showed that trichuriasis was the most common parasitic infection, having an overall prevalence of 56%. It reached 80% in the 5-14 year old age groups. Eleven percent of the population harbored hookworm and the 15-19 year old age group showed a peak prevalence of 26%. *Entamoeba coli* was found in 11% of the population, while the prevalence of *Ascaris lumbricoides*, *Strongyloides stercoralis* and *Balantidium coli* was less than 2%. Ancelle et al. (1982) completed an epidemiological study on Martinique and Guadeloupe in the French West Indies. Stools from 7494 people were collected. More than half the population was infected by at least one pathogenic species. Prevalence rates varied according to housing standards, water supply, and sanitation.

A two year study by Henry (1981) on the island of St. Lucia provided a comparison of sanitation levels and parasitic infection. Seventy-five babies in each of three valleys were studied for two years. The valleys had different types of water supplies and latrine facilities, whereas socio-economic conditions were similar. Results showed that the prevalence of diarrhea and intestinal helminths were reduced as sanitation improved. *Ascaris* and *Trichuris* infection dropped 30 to 50% respectively after water supplies and pit latrines were installed.

One of the largest studies undertaken in the Commonwealth Caribbean took place in the 1980's. This was organized by the Pan American Health Organization with all analysis done at the Caribbean Epidemiological Center in Trinidad. Tikasingh (1981) presented the first results from the study which is still underway. Two thousand seven hundred children from eight countries aged 5 and 9 were selected for the study. One stool sample was collected from each child. *Trichuris trichiura* (47%), *Ascaris lumbricoides* (27%) and hookworm (6%) were the most common helminths.

Enterobius vermicularis had a 1% rate while less than 1% of the children were infected with *Strongyloides stercoralis*. For individual countries the rate for *Trichuris* ranged from 17% in Guyana to 88% in Dominica. The majority of the countries had high rates of infestation. *Ascaris* had a similar range of prevalence with 2% in Antigua and 83% in Belize. The highest hookworm prevalence was recorded in Belize, (62%) followed by Trinidad (12%) and Guyana (7%).

SITE DESCRIPTIONS

Four communities in the Parish of Westmoreland were chosen by the Ministry of Health as the sites for this study (Figure 2). This parish was selected because of the diversity of geography, climate, and the low mobility of the human population. Environmental and social variables of each town are described below. Some of the following information came by personal communication (1983) from the Ministry of Surveys, Jamaica.

A. Whitehouse

1. Population - 9,400
2. Altitude - 15.25 m (50 ft)
3. Locality - coastline
4. Average yearly rainfall - 101.6 cm (40 in) Drought conditions prevailed at the time of study
5. Average humidity - 15-20% (June and July)
6. Daily temperatures June and July - over 37.8°C (100°F)
7. Soil type - alluvial sands, gravels, and clay
8. Population livelihood - fishing, animal husbandry, and agriculture
9. Most isolated village of the study

B. Little London

1. Population - 7,736
2. Altitude - 15.25 m (50 ft)
3. Locality - 8.58 km (3 miles) inland
4. Average yearly rainfall - 127 cm (50 in)
5. Average humidity - 30-50% (June and July)
6. Daily temperatures June and July - over 37.8°C (100°F)
7. Soil types - alluvial sands, gravel, and clay
8. Population livelihood - agriculture, blue collar jobs, factory work
9. Town is only 9.6 km (6 miles) from parish capitol

C. Bethel Town

1. Population - 9,955
2. Altitude - over 305 m (1000 ft)
3. Locality - 16 km (10 miles) inland
4. Average yearly rainfall - over 254 cm (100 in)
5. Average humidity - 90% (June and July)
6. Daily temperatures June and July - 26.7°C-32°C (80-90°F)

7. Soil type - limestone soils, loams, and clay in valleys
8. Population livelihood - agriculture and animal husbandry
9. Area is well watered hilly region with diversity of vegetation

D. Grange Hill

1. Population - 13,424
2. Altitude - 30.5 m (100 ft)
3. Locality - 11.2 km (7 miles) inland
4. Average yearly rainfall - 203.2 cm-228.6 cm (80-90 inches)
5. Average humidity - 50% (June and July)
6. Daily temperatures for June and July - 35°C (95°F)
7. Soil types - red fertile soils, loams, and clay
8. Population livelihood - Labor in sugar cane fields, factory labor in sugar cane processing plants, and some animal husbandry
9. Area is well watered with abundant vegetation

MATERIALS AND METHODS

Field Procedures

Each community (town) selected for the study had a local public health clinic staffed by both aides and nurses. In all cases these local public health persons were women. Before starting work in each town, a meeting was held with the staff of each clinic to explain the requirements of the study and to elicit opinions on how best to initiate the study within the community. This was necessary because each village had its own unique problems. Public health aides went with the survey team to both the basic school (ages 3-5) and the local primary school (ages 5-14) to explain the study to the principals and teachers. Agreement was reached on how to get the children to respond and how to best organize them into the required age groups. When all arrangements were completed the survey team returned to start work. The daily field procedures were as follows. The survey team would arrive at a given school at opening time, around 9 o'clock, where a room was provided for processing the children. Two public health aides were responsible for assisting the children in the completion of a public health questionnaire containing 13 variables (Table I). The aides would also keep order and help with any unruly or frightened children. Each child entered the room and provided a finger prick blood sample, was given a piece of candy, and was handed a plastic fecal sample collecting bag with his or her number and name attached. The child was instructed by one of the survey team or aides in how to provide the stool sample. The next morning stool samples were returned and processed. Blood samples were then collected and slides prepared. The slides were briefly checked and then prepared for transport to Appalachian State University for further study. Children younger than school age and adults were processed on selected days at the local clinic.

Laboratory Procedures

Seven hundred and three stool samples were collected from individuals at four sites and placed in plastic bags. These samples represented individuals from 15 age groups. A subsample of fecal material was placed in a 30 ml plastic container with 10 ml of polyvinyl alcohol (PVA) solution and thoroughly mixed. PVA solution preserves and fixes all helminth eggs, protozoan cysts and trophozoites, allowing permanent stained slides to be prepared at a later date. The samples were also prepared for shipment to Appalachian State University. A random subsample of 140 fresh fecal samples was cultured using the Harada-Mori filter paper technique (Garcia and Ash, 1975). This technique was used to detect and differentiate *Strongyloides stercoralis* larvae from other helminths. Fecal material was spread on a filter paper strip in which one end was suspended in water. Larval forms then migrated to the water source after 3-7 days enabling them to be preserved and then identified. The whole process through preservation was carried out in the field. Preserved samples were sent back to Kingston where they were analyzed. All other samples were prepared and observed using two standard laboratory procedures. First, a portion of all PVA preserved samples, approximately 1 gm, was run through the Ritchie-Formalin-Ether Sedimentation process (Ritchie, 1948). This method of concentration works on the principle of a specific gravity difference between a 10% formalin solution and ether. When centrifuged the solution separated most light plant and fecal debris from heavier helminth ova and protozoan cysts which remained on the bottom.

To each PVA preserved sample a volume of 6 ml of 0.85% physiological saline was added and thoroughly mixed. Approximately one half the volume of the sample in suspension was passed through a coarse strainer then through a 200 μm stainless steel filter to remove large unwanted fecal debris. The resultant suspension containing approximately 1 gm of fecal matter was poured into a 15 ml centrifuge tube which was then filled with saline solution. The sample was spun for two minutes at 1500 rpm, the supernatant decanted, and the step repeated if the solution was not fairly clear. Ten ml of 10% formalin was added to the sediment, shaken, and allowed to stand for 5 minutes. Three ml of ether was then added. The tube was stoppered and the sample thoroughly shaken. The cover was removed and the sample spun again at 1500 rpm for 2 minutes. At the end of this step a fecal debris plug was forced between the formalin and ether at the top of the tube with a small amount of sediment remaining at the bottom. The plug was removed and the remaining fluid decanted. Some fluid remained and drained back down the tube and mixed with the sediment. A micro pipet was then used to remove approximately 1/10 ml of sediment which was then placed on a 1 X 3 inch slide. One drop of Lugols iodine was mixed in with the sample and a 22 X 40 mm cover slip was placed over the sample. The slide was then ready for microscopic examination. All slides were scanned at 100X magnification and all helminth ova and cysts of *Giardia lamblia* were identified and counted. These counts were converted to total egg and cysts per ml of concentrated sample in order to produce a rough estimate of intensity. During the scanning, presumptive determinations were made for protozoan cysts of *Entamoeba coli*, *Entamoeba histolytica*, and *Chilomastix mesnili*.

A staining technique was required to differentiate and confirm the presence of protozoan trophozoites and cysts. The Wheatley Trichrome stain, developed in 1951, was used in order to bring out the required internal nuclear structure of trophs and cysts (Texas Dept. of Health, 1983). A calibrated grid was used to make size measurements of all organisms. The differentiation between the larger *E. histolytica* and the smaller *E. hartmanii* were based on the following standardized dimensions: cysts over 10μm and trophs over 12μm were classified as *E. histolytica* (Texas Dept. of Health, 1983).

PVA samples were again processed as above but formalin-ether steps were left out. The suspension was spun down for two minutes and the supernatant removed. A micro pipet was used to obtain a small sample from the bottom of the sediment which was spread on a 1 X 3 inch slide and allowed to dry overnight on a slide warmer at a temperature of 37°C. The following morning the slide was run through the trichrome staining procedure as follows:

1.	70% alcohol plus iodine	15 min.
2.	70% alcohol	4 min.
3.	70% alcohol	4 min.
4.	Trichrome stain	8 min.
5.	90% alcohol, acidified	10 sec. wash
6.	95% alcohol	Quick wash
7.	95% alcohol	5 min.
8.	Carbol-xylene	7 min.
9.	Xylene	10 min.
10.	Coverslip placed using permount	

All slides were systematically scanned under oil immersion, 1000X, and all protozoan trophs and cysts recorded.

One thousand twenty five thin blood films were made in the field from finger pricks to detect any trypanosomal, malarial or filarial parasites. Stock liquid Giemsa stain produced by Fisher was mixed as follows, 2 parts stain with 50 parts water at a pH of 7. Films were fixed in the field in methyl alcohol for one minute, then later stained for 25 minutes in Giemsa stain. They were then washed off and permitted to dry. The slides were all scanned at a magnification of 100X and 450X.

RESULTS AND DISCUSSION

One thousand twenty five people were recruited in this survey to provide stool specimens. Of the 703 (68.5%) people who submitted specimens 296 (42.1%) were male and 407 (57.9%) were female. Of the people submitting stool specimens 63.7% were infected with at least one parasite. Thirteen intestinal parasites were recorded - 6 helminths and 7 protozoans. The three major helminths were, in order of overall prevalence, *Trichuris trichiura* (44.6%) *Ascaris lumbricoides* (10.6%) and hookworm (5.4%). Differentiation between the hookworms *Necator americanus* and *Ancylostoma duodenale* cannot be determined by egg morphology. Human infection with *Trichostrongylus* sp. (1.2%) was recorded for the first time in Jamaica. A random subsample of 140 fresh cultures were prepared to identify larvae of *Strongyloides stercoralis* which demonstrated a rate of 3.6%. Only five cases of *Taenia* sp. (0.7%) were observed (Table II).

Seven protozoan parasites were recorded. Of the pathogenic forms the flagellate, *Giardia lamblia* had the highest overall prevalence of protozoans (17.2%), followed by *Entamoeba histolytica* with a 5.1% rate. The remaining five protozoans in order of overall

TABLE II. Parasite prevalence (%) by site

HELMINTHS

	Ascaris lumbricoides	Hookworm	*Trichuris trichiura*	*Tricho-strongylus*	*Strongyloides stercoralis*	*Taenia*
Whitehouse	6.6	1.2	45.2	3.6	0.6	0.0
Little London	2.7	2.7	39.9	0.7	1.4	0.0
Bethel Town	18.8	5.5	49.1	0.9	0.0	0.9
Grange Hill	11.1	11.7	42.7	0.0	1.2	1.8
Overall	10.6	5.4	44.6	1.2	3.6	0.7

PROTOZOANS

	Giardia lamblia	*Entamoeba histolytica*	*Entamoeba hartmanii*	*Entamoeba coli*	*Endolimax nana*	*Chilomastix mesnili*	*Iodamoeba butschlii*
Whitehouse	21.7	6.0	1.8	15.7	16.9	6.0	9.0
Little London	12.2	2.7	5.4	6.8	7.4	1.4	11.5
Bethel Town	17.9	6.9	5.5	15.6	15.6	6.0	10.6
Grange Hill	16.4	4.1	2.9	15.8	8.2	4.7	14.6
Overall	17.2	5.1	3.9	13.8	12.4	4.5	11.4

prevalence were *Entamoeba coli* (13.8%), *Endolimax nana* (12.4%), *Iodamoeba butschlii* (11.4%), *Chilomastix mesnili* (4.5%), and *Entamoeba hartmanii* (3.9%) (Table II).

During the course of the lab work several other parasites were noted but not recorded. These included several species of plant nematodes, one specimen of *Enterobius vermicularis*, one observation each of the protozoans *Dientamoeba fragilis* and *Trichomonas hominis*. No blood parasites were observed.

No significant differences were observed regarding the prevalence of parasites in male and female hosts.

The total parasite prevalence as well as a comparison of each of the four sites is compiled in Table II. The prevalence of helminth infection varies considerably between the four sites, however, *Trichuris trichiura* which had the highest rate for any parasite also had the most even distribution among the four sites. Bethel Town had the highest rate of *T. trichiura* (49.1%) while Little London had the lowest (39.9%). Infection with *Ascaris lumbricoides* ranged from a low of 2.7% in Little London to a high of 18.7% in Bethel Town. Grange Hill (11.1%) had a higher rate than Whitehouse (6.6%). Hookworm infections were highest in Grange Hill (11.7%) while Bethel Town (5.5%)

had the second highest rate. Whitehouse and Little London had low rates of 1.2% and 2.7% respectively. Whitehouse had the highest rate for *Trichostrongylus* (3.6%) while Little London and Bethel Town showed rates of 0.7% and 0.9% respectively. The 3.6% rate for *Strongyloides stercoralis* was based on 140 random subsamples taken from all four sites. This may not accurately depict a true picture of prevalence among the different sites. Three cases of *Taenia* sp. infection were observed in Grange Hill and two from Bethel Town (Table II).

Environmental factors may be partially responsible for the high rates of several helminths. The survival of helminth ova and larvae depend on many factors, especially temperature, humidity, rainfall, soil type and shade. Hot dry conditions in which soil are exposed to direct sunlight is usually detrimental to helminth ova and larvae. Bethel Town, at an altitude of over 305 m (1000 ft) has the highest average rainfall, humidity, and the most abundant vegetation of any of the sites. Average daily temperature was also the lowest of any site. The soil conditions here are more suitable for ova and larval survival than those in Whitehouse and Little London. This is especially true with respect to soil type, moisture content, and shade provided by vegetation. Bethel Town also had the lowest overall standards of water supply and sanitation. The population of this community is primarily involved in agriculture and animal husbandry and consequently a large proportion of time is spent in and around fields and pastures which may be contaminated by human feces. The highest rate of *Ascaris lumbricoides* (18.8%) was recorded here (Table II).

The highest rate for hookworm (11.7%) was recorded in Grange Hill. This community is involved in sugar cane production and processing with a major portion of the land utilized as sugar cane fields. The fields are well irrigated and shaded which provides the environment needed for ova and larval development. Laborers spend up to eight hours a day in the fields. Human defecation frequently takes place in these fields as sanitation facilities such as pit latrines may be several miles away. Hookworm larvae enter humans by direct skin penetration, therefore contact with contaminated soil is required for the transmission of the parasite. Many members of the community continually pass through sugar cane fields during their daily routines. This, coupled with inadequate footware, permits hookworm larvae to have frequent contact with the host.

Two towns, Whitehouse and Little London showed the lowest infection rate with *Ascaris lumbricoides* and hookworm. Whitehouse is directly on the coast and is one of the hottest and driest areas of Jamaica. Small amounts of vegetation permit direct sunlight to fall on the sandy soil. Average daily temperatures (June-July) are over 37.8°C (100°F) while humidity is frequently lower than 15%. Little London has a similar environment, however, this community is more developed than any of the other sites with most of the population involved in activities other than agriculture. These factors provide a generally less suitable environment for ova and larval survival, however this fact does not provide an explanation for such high rates of *Trichuris trichiura* which have similar requirements for survival. There is a possibility that the locally available worm medicines are effective for *A. lumbricoides* and not *T. trichiura*.

Trichostrongylus sp. are characteristically common parasites of various herbivorous animals. Human infection is usually acquired by the ingestion of food or water contaminated by the infective larvae, although the larvae can penetrate the skin as in hookworm infections. Whitehouse and Bethel Town are areas of large scale animal husbandry. In some families goats and young cattle are permitted within the living area thus providing suitable conditions for transmission.

The rate of 3.6% for *Strongyloides stercoralis* may not provide us with a true picture of prevalence as only 140 subsamples were collected; however, the rate obtained from this study is much higher than previously reported.

Taenia spp. were observed from ova found in stools. Most tapeworm infections are determined by finding proglottids of the worm in the fecal sample. These cases are simply incidental findings. Ashcroft (1965) indicates that infection with most tapeworms is rare in this region due to the normally limited consumption of beef or pork and when meat is eaten it is very well cooked.

The prevalence of protozoan parasites among the four sites showed a more even distribution than did the helminths (Table II). These organisms are transmitted by ingestion of cysts in contamined water or food. *Giardia lamblia* demonstrated the highest rate of infection in Whitehouse (21.7%). The remaining sites also had high rates - Bethel Town (17.9%), Grange Hill (16.4%), and Little London (12.2%). The prevalence rate in Whitehouse is quite high in most age groups indicating a possible communal source of infection such as water supply. This town is the most isolated of the four communities studied and has restricted water supplies provided by strategically placed communal stand-pipes. These might provide conditions for large scale transmission. Water supplies at local primary schools were in constant use by children. Children were frequently observed playing in and around running water troughs. The children would play in the school yard, get their hands dirty, and run over to the trough and drink water with their dirty hands. Constant splashing would permit direct transfer of water from the hands and mouth of each child to other children. Open pit toilets were stationed nearby. Children would use the toilet, then immediately run over to the water trough, have a drink of water, then rinse off their hands. Most of the pit toilets had no materials available to wipe off excrement. Toilets were filled with excrement, in some cases to within inches of the seat. Flies and cockroaches were in abundance. All these factors would play a major role in the transmission of *G. lamblia* as well as the other protozoans and some helminths. *Entamoeba histolytica* was recorded in each site with Bethel Town (6.9%) having the highest rate (Table II). This organism has not been recorded in the hospital lab in Kingston for over five years. *E. histolytica* along with other protozoans is capable of explosive outbreaks. Dangerous extra-intestinal cases of *E. histolytica* can also occur. A permanent stained slide is required to confirm identification of this organism. Lack of recent recordings might indicate the infrequent use of routine staining procedures. Walsh (1983) mentions that many laboratories are not able to accurately identify *E. histolytica*. This certainly could be a reason for a dearth of reports for *E. histolytica*.

The remaining five protozoans can in some cases produce clinical symptoms and must be differentiated from *E. histolytica* and other protozoans so that correct treatment can be administered. They are all transmitted via the same route and are important indicators of overall sanitary practices.

Multiple infections of the host by various parasites can complicate clinical diagnosis and make treatment more difficult. Sixty four percent of the people sampled were infected by at least one parasite while 35.3% were infected by at least two parasites and the remainder, 17.7% infected by at least three parasites. One ten year old boy had eight parasites which included three helminths and five protozoans

(Table III). The relationship between certain parasites was examined. There was a significant relationship with certain parasites occurring together. All parasites were compared with each other using a Chi Square test (df = 1; $P < 0.05$). There was a significant relationship between *A. lumbricoides* and *T. trichiura* ($X^2 = 40.8$; df = 1; $P < 0.05$). *A. lumbricoides* and *E. histolytica* were also strongly associated ($X^2 = 6.6$; df = 1; $P < 0.05$). *T. trichiura* showed a strong relationship with hookworm ($X^2 = 8.1$; df = 1; $P < 0.05$) and *G. lamblia* ($X^2 = 9.6$; df = 1; $P < 0.05$). Hookworm had a strong relationship with *S. stercoralis* ($X^2 = 5.9$; df = 1; $P < 0.05$).

Intensity of infection was determined by making total egg and cyst counts from a standardized subsample from a known weight of concentrated fecal matter (Table IV). Egg and cyst density provides some information on the number of adult worms and protozoa in the host which is important in determining a correct treatment program. Egg and cyst counts were completed and each individual was placed in a category of density of infection as compiled by Rawlins (1982). Egg numbers of three helminths, *Ascaris lumbricoides, Trichuris trichiura,* and hookworm as well as cysts of *Giardia lamblia* were counted and placed in these categories. Sixty nine percent of

TABLE III. Multiple infections (%) by site

	Number of Parasites								
	0	1	2	3	4	5	6	7	8
Whitehouse	37.4	28.3	12.7	10.8	6.6	3.6	0.6	0.0	0.0
Little London	42.6	31.8	18.9	4.7	1.3	0.0	0.0	0.0	0.7
Bethel Town	31.7	26.1	19.7	10.6	6.4	3.2	1.8	0.5	0.0
Grange Hill	35.7	28.1	18.7	6.4	6.4	4.1	0.0	0.6	0.0
Overall	36.3	28.3	17.6	8.4	5.4	2.8	0.7	0.3	0.1

TABLE IV. Parasite intensity of infected individuals

Parasites		Categories (Numbers of eggs or cysts per ml of concentrated stool) 1	2	3	4	5	Total
		<100	100-4,999	5,000-49,999	50,000-100,000	>100,000	
Ascaris lumbricoides	individuals infected	20	12	35	6	2	75
	% of individuals infected	26.7%	16.0%	46.7%	8.0%	2.6%	
		<100	100-499	500-999	1,000-2,000	>2,000	
Hookworm	individuals infected	29	9	0	0	0	38
	% of individuals infected	76.4%	23.6%	---	---	---	
		<100	100-999	1,000-999	10,000-30,000	>30,000	
Trichuris trichiura	individuals infected	174	114	17	6	3	314
	% of individuals infected	55.5%	36.3%	5.4%	1.9%	0.9%	
		<1,000	1,000-4,999	5,000-49,999	50,000-100,000	>100,000	
Giardia lamblia	individuals infected	18	3	19	14	67	121
	% of individuals infected	14.8%	2.5%	15.7%	11.6%	55.4%	

Categories 1 and 2 - light infection

Category 3 - moderate infection

Categories 4 and 5 - heavy infection

the people infected with the above four parasites had a light infection (Categories 1 and 2), while 12.9% had a moderate infection (Category 3), the remainder (17.8%) had a heavy infection (Categories 4 and 5). Of the 121 people infected with *Giardia lamblia*, 81 or 66.9% had a heavy infection (Table IV). Density of eggs for the remaining helminths was low with only a few eggs seen on any given slide. Cysts and trophozoites from the remaining six species of protozoans were recorded but not counted.

An important question when considering prevalence rates is to determine at what age an individual becomes first infected with a specific parasite. Table V displays this information and provides a comparison between all the parasites recorded in this study and at what age the parasite first appeared in the population. *Giardia lamblia* appeared before the age of six months in Whitehouse while infection in Bethel Town and Grange Hill started in the 6-18 month group. The earliest infection with *Giardia* in Little London was in the 19-33 month group. Of the helminths, *Trichuris trichiura* was the first to appear in the youngest members of the population. In two villages, Bethel Town and Grange Hill, infection started in the 6-18 month group while at Whitehouse and Little London infection first occurred

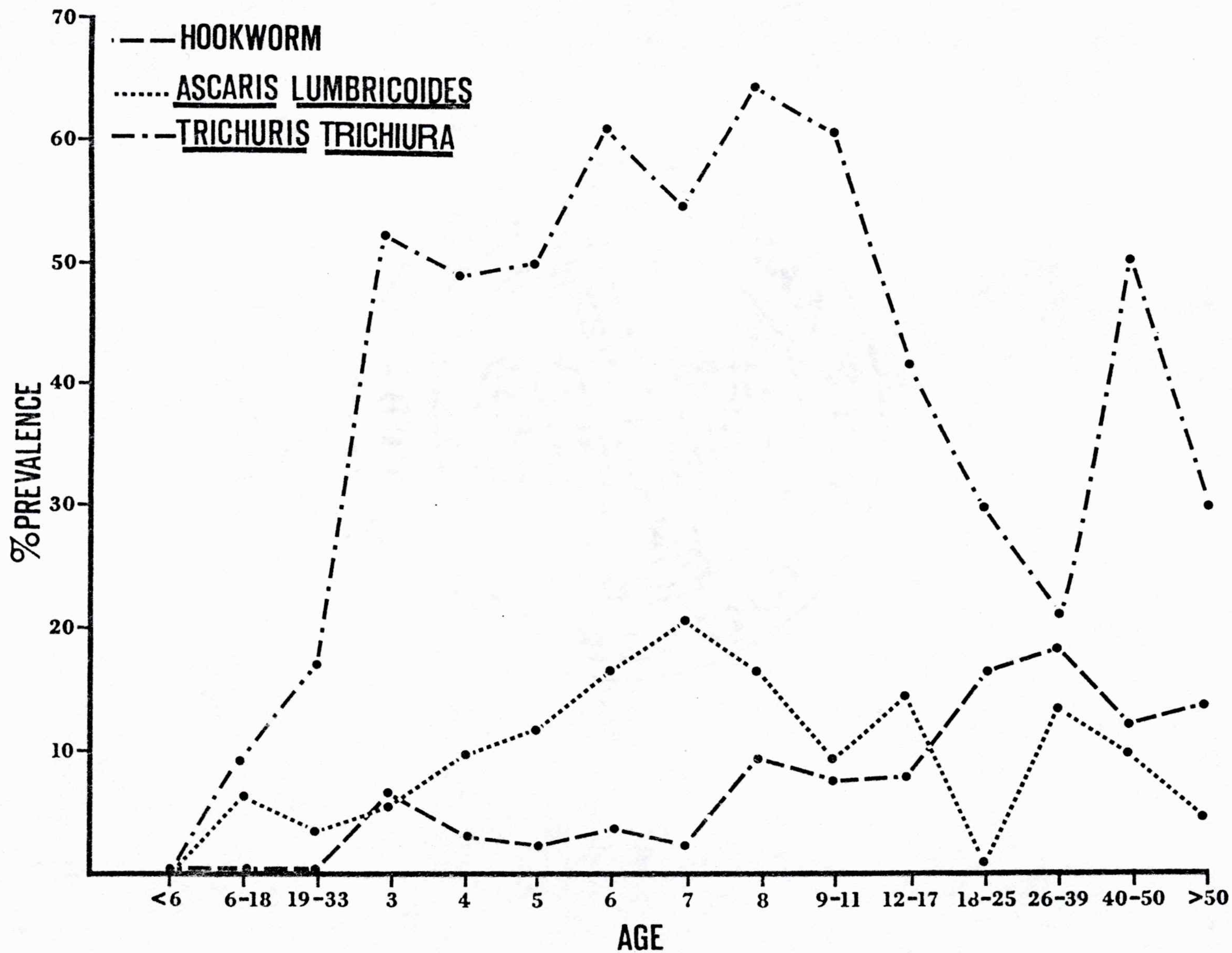
TABLE V. Age of the host when parasite first appears

	Whitehouse	Little London	Bethel Town	Grange Hill
Ascaris lumbricoides	5 yrs	8 yrs	6-18 mos	6-18 mos
Hookworm	8 yrs	4 yrs	7 yrs	3 yrs
Trichuris trichiura	3 yrs	3 yrs	6-18 mos	6-18 mos
Trichostrongylus	4 yrs	12-17 yrs	5 yrs	------
Strongyloides stercoralis	9-11 yrs	4 yrs	------	26-39 yrs
Taenia	------	------	8 yrs	19-33 mos
Giardia lamblia	<6 mos	19-33 mos	6-18 mos	6-18 mos
Entamoeba histolytica	5 yrs	9-11 yrs	3 yrs	5 yrs
Entamoeba hartmanii	6 yrs	4 yrs	3 yrs	9-11 yrs
Entamoeba coli	5 yrs	19-33 mos	3 yrs	19-33 mos
Chilomastix mesnili	6-18 mos	19-33 mos	3 yrs	3 yrs
Endolimax nana	4 yrs	4 yrs	3 yrs	4 yrs
Iodamoeba butschlii	5 yrs	4 yrs	3 yrs	3 yrs

at three years of age. Infection with *Ascaris lumbricoides* started in the 6-18 month age groups in Bethel Town and Grange Hill but did not start until 5-8 years of age in Whitehouse and Little London. Hookworm infection usually started later in life, however, a case in Grange Hill appeared in a three year old. *Entamoeba histolytica* first occurred in a three year old in Grange Hill. The other parasites first appeared anywhere from the 6-18 month old groups in some villages to the 12 to 17 year old group in other villages (Table V).

Prevalence of *Trichuris trichiura, Ascaris lumbricoides* and hookworm, by age group, is demonstrated in Figure 3. *Trichuris* prevalence rates rose rapidly to a rate of over 50% in the 3 year old age group and peaked at slightly over 65% in the eight year old groups. There was a steep decline in prevalence beginning with the 12-17 year age groups dropping to a low of less than 25% in the 26-39 year old groups. Infections with *Ascaris* rose less sharply and peaked at 20% in the 7 year old group. There was an uneven decline in prevalence through the older age groups with a drop to 5% in the over 50 year old class. Hookworm prevalence increased slowly and peaked in the 26-39 year old group (Figure 3).

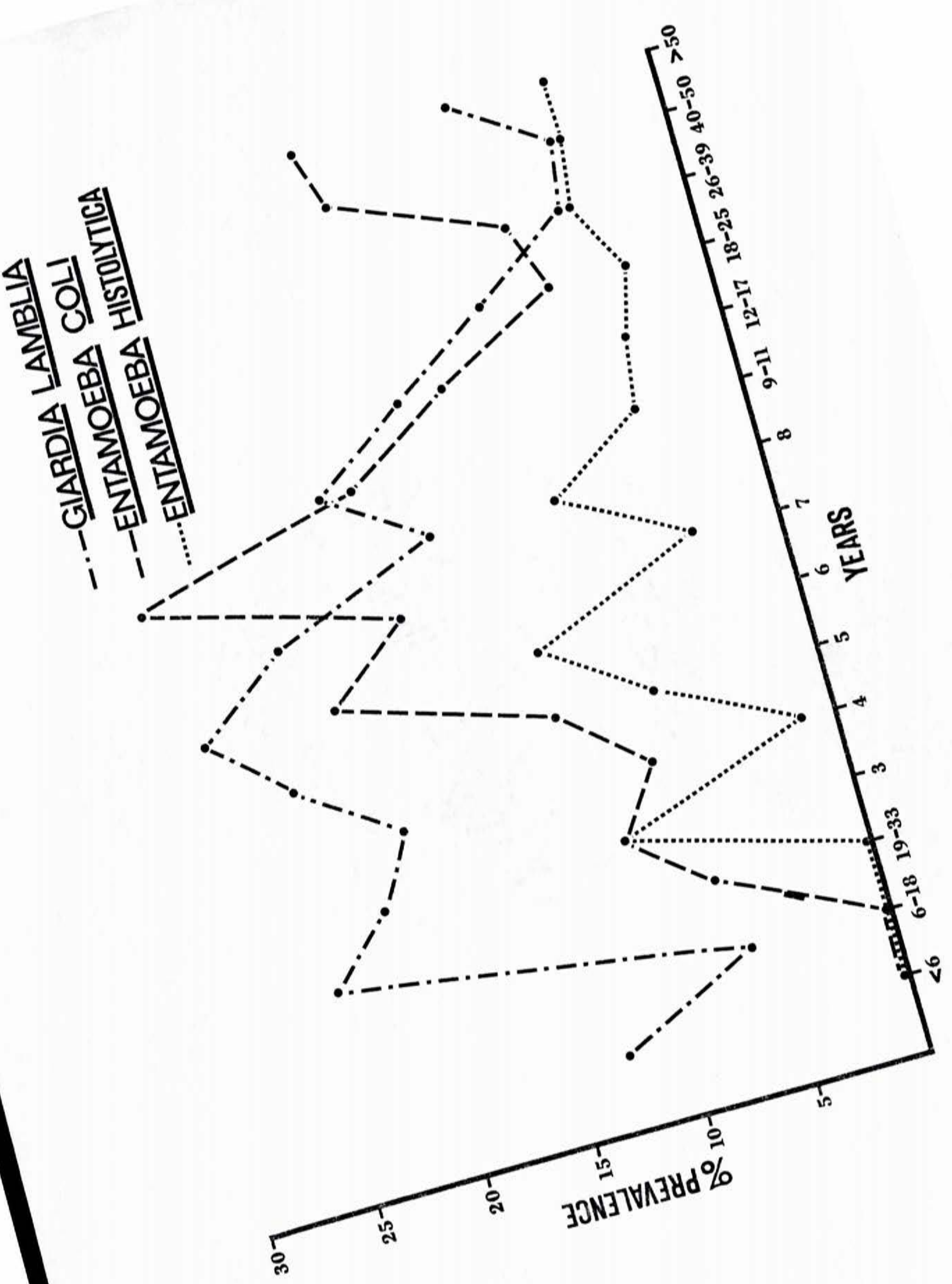
Figure 3. Prevalence and age distribution of Hookworm, *Ascaris lumbricoides*, and *Trichuris trichiura*.


HOOKWORM
ASCARIS LUMBRICOIDES
TRICHURIS TRICHIURA
%PREVALENCE
70
60
50
40
30
20
10
AGE
<6
6-18
19-33
3
4
5
6
7
8
9-11
12-17
1d-25
26-39
40-50
>50

Infection with *Giardia lamblia, Entamoeba histolytica* and *Entamoeba coli* were also compared by age group (Figure 4). *Giardia* prevalence increased sharply from the 6-18 month group to a high of 23% in the 19-33 month groups with a small decline until age four. It then rises sharply to a high of 27% in the six year old class. There was a steady decline to a low of about 8% in the 40-50 year olds. *Entamoeba histolytica* had an erratic prevalence rate with several sharp rises occurring from the 19-33 month old group, reaching a high of 12% in the 6 year olds. After this age there was a general decline to about 4% in the remaining age groups. *Entamoeba coli* had a sharp and steady climb from the 6-18 month age leveling off at 27% in the 8 year olds. The rate dropped to 8% in the 18-25 year old group.

The general trend in age distribution is for the higher rates to occur in young children between the ages of 3-11 (Figures 3 and 4). This seems reasonable considering the general lack of cleanliness practiced by young children. Only in hookworm infection (Figure 3) was there a steady rise in prevalence in the older age groups which might reflect difference in social and work related factors.

Figure 4. Prevalence and age distribution of *Giardia lamblia*, *Entamoeba coli*, and *Entamoeba histolytica*.


GIARDIA LAMBLIA
ENTAMOEBA COLI
ENTAMOEBA HISTOLYTICA
% PREVALENCE
5
10
15
20
25
30
YEARS
<6
6-18
19-33
3
4
5
6
7
8
9-11
12-17
18-25
26-39
40-50
>50

When a comparison is made between those individuals who get their water from different sources some interesting results are seen. Sixty-six percent (384 of 585 individuals) who get their water from communal standpipes are infected with at least one intestinal parasite. For those individuals who possess running water in the house the infection rate is 53.7% (51 of 95 individuals). This is a significant difference (Table VI).

When similar comparisons are made between persons who use pit latrines and water closets one also finds significant differences (Table VII). There is a 54.4% (68 of 125 individuals) infection rate for those persons who utilize water closets. For those persons using pit latrines the infection rate is 65.7% (375 of 571 individuals).

Each individual parasite is also compared using the same criteria as above (Table VIII). Over 4% (4 of 95 individuals) who had running water in their house were infected with *Ascaris lumbricoides* while 11.8% (69 of 585 individuals) of the infected persons got their water from communal standpipes ($X^2 = 4.89$; df = 1; $P < 0.05$). The other parasites showed no significant relationship with different water supplies (Table VIII). A significant relation was found with

TABLE VI. Comparison of parasitic infection between individuals with running water in the house and standpipe

	Infected with any parasite and running water in the house		Infected with any parasite and standpipe	
	Number	%	Number	%
Whitehouse	34/59	57.6%	69/106	65%
Little London	5/10	50.0%	71/121	58.7%
Bethel Town	8/15	53.3%	140/200	70%
Grange Hill	4/11	36.4%	104/158	65.8%
Total	51/95	53.7%	384/585	66%

$$X^2 = 5.06 \ (df = 1;\ P < 0.05)$$

TABLE VII. Comparison of parasitic infection between individuals with flush toilets and pit latrine

	Infected with any parasite and flush toilet		Infected with any parasite and pit latrine	
	Number	%	Number	%
Whitehouse	35/61	57.3%	68/103	66%
Little London	11/19	58%	71/125	56.8%
Bethel Town	10/22	45.5%	138/195	71%
Grange Hill	12/23	52.2%	98/148	66.2%
Total	68/125	54.4%	375/571	65.7%

$X^2 = 5.61$ (df = 1; $P < 0.05$)

TABLE VIII. Species of parasites versus water supply

Parasite	Running water in house and number and % infected	Standpipe and number and % infected	χ^2 (df = 1; P < 0.05)
1. *Ascaris lumbricoides*	4/95 = 4.2%	69/585 = 11.8%	4.89*
2. Hookworm	5/95 = 5.3%	32/585 = 5.5%	0.002
3. *Trichuris trichiura*	36/95 = 37.9%	267/585 = 45.6%	1.98
4. *Trichostrongylus*	1/95 = 1.05%	5/585 = 0.85%	0.034
5. *Strongyloides stercoralis*	1/95 = 1.05%	3/585 = 0.51%	0.352
6. *Taenia*	0/95 = 0.0%	5/585 = 0.85%	1.42
7. *Giardia lamblia*	12/95 = 12.63%	105/585 = 17.95%	1.60
8. *Entamoeba histolytica*	4/95 = 4.2%	31/585 = 5.3%	0.181
9. *Entamoeba hartmanii*	3/95 = 3.16%	23/585 = 3.93%	0.284
10. *Entamoeba coli*	12/95 = 12.63%	82/585 = 14.02%	0.112
11. *Chilomastix mesnili*	4/95 = 4.2%	29/585 = 4.95%	0.264
12. *Endolimax nana*	11/95 = 11.60%	74/585 = 12.65%	0.080
13. *Iodamoeba butschlii*	10/95 = 10.52%	68/585 = 11.62%	0.090

*Significant

both *Ascaris lumbricoides* and *Trichuris trichiura* when comparing their rate of infection in regard to persons using water closets and persons using pit latrines (Table IX). In the case of *A. lumbricoides* 4% (5 of 125 individuals) of the persons with water closets were infected, while 12.25% (70 of 571 individuals) of the persons with pit latrines were infected ($X^2 = 7.25$; df = 1; $p < 0.05$); with *Trichuris trichiura* 46.8% (267 of 571 individuals) of the persons with pit latrines were infected while 35.2% (44 of 125 individuals) of the persons with water closets were infected ($X^2 = 5.53$; df = 1; $P < 0.05$) (Table IX).

Three questions which may be of some interest were asked the participants in the study. These were: (1) Have you ever passed worms? (Table Xa) (2) Have you taken worm medicine at sometime in your life? (Table Xb) (3) When did you last take worm medicine? (Table Xc). Stephenson (1980) suggested that such questions posed to members of a community might provide information on the prevalence of *A. lumbricoides* and omit the need for frequent fecal analysis. Persons who claimed to have passed worms (29.9%) showed significantly higher infection rates (74.2%) with both *Ascaris lumbricoides* and *Trichuris trichiura* than those who claimed they

TABLE IX. Species of parasite versus sanitation

Parasite	Pit latrines and number and % infected	Flush toilet and number and % infected	χ^2 (df = 1; P < 0.05)
1. *Ascaris lumbricoides*	70/571 = 12.25%	5/125 = 4%	7.25*
2. Hookworm	32/571 = 5.6%	6/125 = 4.8%	0.116
3. *Trichuris trichiura*	267/571 = 46.76%	44/125 = 35.2%	5.53*
4. *Trichostrongylus*	9/571 = 1.58%	0/125 = 0.0%	1.98
5. *Strongyloides stercoralis*	4/571 = 0.70%	1/125 = 0.80%	0.012
6. *Taenia*	4/571 = 0.70%	1/125 = 0.80%	0.012
7. *Giardia lamblia*	104/571 = 18.21%	16/125 = 12.80%	2.67
8. *Entamoeba histolytica*	30/571 = 5.25%	6/125 = 4.8%	0.038
9. *Entamoeba hartmanii*	25/571 = 4.40%	3/125 = 2.40%	1.01
10. *Entamoeba coli*	79/571 = 13.84%	17/125 = 13.60%	0.004
11. *Chilomastix mesnili*	28/571 = 4.90%	5/125 = 4.00%	0.178
12. *Endolimax nana*	74/571 = 12.96%	12/125 = 9.6%	1.04
13. *Iodamoeba butchlii*	68/571 = 11.91%	12/125 = 9.6%	0.520

*Significant

TABLE Xa. Response to question: Have you ever passed worms?

Ever Passed Worms

Site	No		Yes		Total Sample
Whitehouse	77	(46.4%)	43	(25.9%)	166
Little London	75	(50.7%)	42	(28.4%)	148
Bethel Town	54	(24.8%)	90	(41.3%)	218
Grange Hill	72	(42.1%)	35	(20.5%)	171
No. and total % who answered	(278)	39.5%	(210)	29.9%	703
No. and total % infected	(127)	45.7%	(156)	74.2%	

TABLE Xb. Response to question: Have you ever taken medication for worms?

Ever Taken Medication

Site	No		Yes		Total Sample
Whitehouse	40	(24.1%)	79	(47.6%)	166
Little London	52	(35.1%)	54	(36.5%)	148
Bethel Town	21	(9.6%)	167	(76.6%)	218
Grange Hill	35	(20.5%)	60	(35.1%)	171
Total No. and % who answered	(148)	21.1%	(360)	51.2%	703

TABLE Xc. Response to question: When was last dose of anthelmintic administered?

Last Dose

	One Month or Less		Between One and Two Months		Over Six Months		Total Sample
Whitehouse	5	(3.0%)	10	(6.0%)	61	(36.7%)	166
Little London	5	(3.4%)	3	(2.0%)	42	(28.4%)	148
Bethel Town	12	(5.5%)	51	(23.4%)	62	(28.4%)	218
Grange Hill	5	(2.9%)	14	(8.2%)	30	(17.5%)	171
Total No. and % who answered	(27)	3.8%	(78)	11.1%	(195)	27.7%	703
Total No. and % infected	(11)	40.7%	(44)	56%	(149)	76.4%	

had not passed worms (39.5%) but had an infection rate of (45.7%). Confidence intervals for percentages are not overlapping (Table Xa). These questions only provide an indication of the presence of these parasites in the population.

The study shows that 51.2% of all persons in the survey claim to have taken worm medicine at sometime in their life while 21.1% claim not to have taken any medicine (Table Xb). This information can be further broken down into three categories: those which have taken worm medicine in the last month before the survey, those who have taken medicine at least a month but not over 2 months before the survey, and those who have taken worm medicine over 6 months before the survey. The results show that 40.7% (11 of 27) of those individuals claiming to have taken a dose less than a month before the survey were infected by at least one helminth species (Table Xc). Eight (72.7%) of the 11 infected people were infected with *Trichuris trichiura* while 3 (27.3%) were infected with other helminths. Fifty-six percent (44 individuals) of the persons who claimed to have taken medicine, at least 1 month but not more than two months before the survey, were infected by at least one helminth parasite. Eighty-two percent (36 individuals) of these persons were infected with *T. trichiura* while 15.9% had *A. lumbricoides*. Of the persons who had not taken a dose of worm medicine (195) in over 6 months it was shown that 76.4% (149 individuals) had at least one helminth parasite. Sixty-eight percent (102 individuals) of these had *T. trichiura* while 20.1% (30 individuals) had *A. lumbricoides* and 8% (12 individuals) had hookworm. The remaining individuals had other helminths. This information indicates that continued and rapid re-infection is occurring and that random dosing of worm medicine is not having any permanent effect. Some form of systematic dosing should be used to control infections of *Ascaris*, *Trichuris*, and hookworm. Recent work by the World Health Organization (1981) in Liberia indicates that dosing with Pyrantel Pamoate every three months during a one year period gave a 95% and 96% cure rate for *Ascaris* and *Trichuris* respectively, however this was not satisfactory for hookworm infection which required dosing with Mebendazole (Vermox). This systematic dosing gave a 81% cure rate. There is no reason why local health clinics in Jamaica can not organize systematic dosing of school children.

A comparison of this study with data compiled by Rawlins (1982) from 1970 through 1981 is shown for *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm, and *Giardia lamblia* (Figures 5-8). Data from Rawlins study came from hospital records in Kingston and showed an overall decline in prevalence of the four organisms recorded. Infection rates from this rural study are significantly higher than for any period during Rawlins (1982) study. Only hookworm infection rates were similar in 1982 (Figures 5-8). Most hospital data comes from patients referred by doctors or from persons displaying clinical symptoms. Hospital records might not accurately depict the true prevalence rates country wide and one would expect a decline in prevalence in a rapidly developing community like Kingston.

The prevalence of helminth infections in this study is compared to four other studies in the region (Greenburg and Ferguson, 1971; Tikasingh, 1981; Ancel et al., 1981; and Rawlins, 1982) (Table XI). It should be pointed out that Tikasingh's study included only 5 and 9 year olds.

The rate for *A. lumbricoides* in this study (10.6%) was lower than the average rate of eight commonwealth Caribbean countries (13.4%) as compiled by Tikasingh (1981). Several sites in each study had much higher infection rates than the average. *Trichuris trichiura* rates were similar in all islands except Puerto Rico where the rate was the highest 74.7% (Greenburg and

Figure 5. Comparison of hospital records of *Ascaris lumbricoides* infection in Kingston (Rawlins, 1982) with results from the present study (1983).

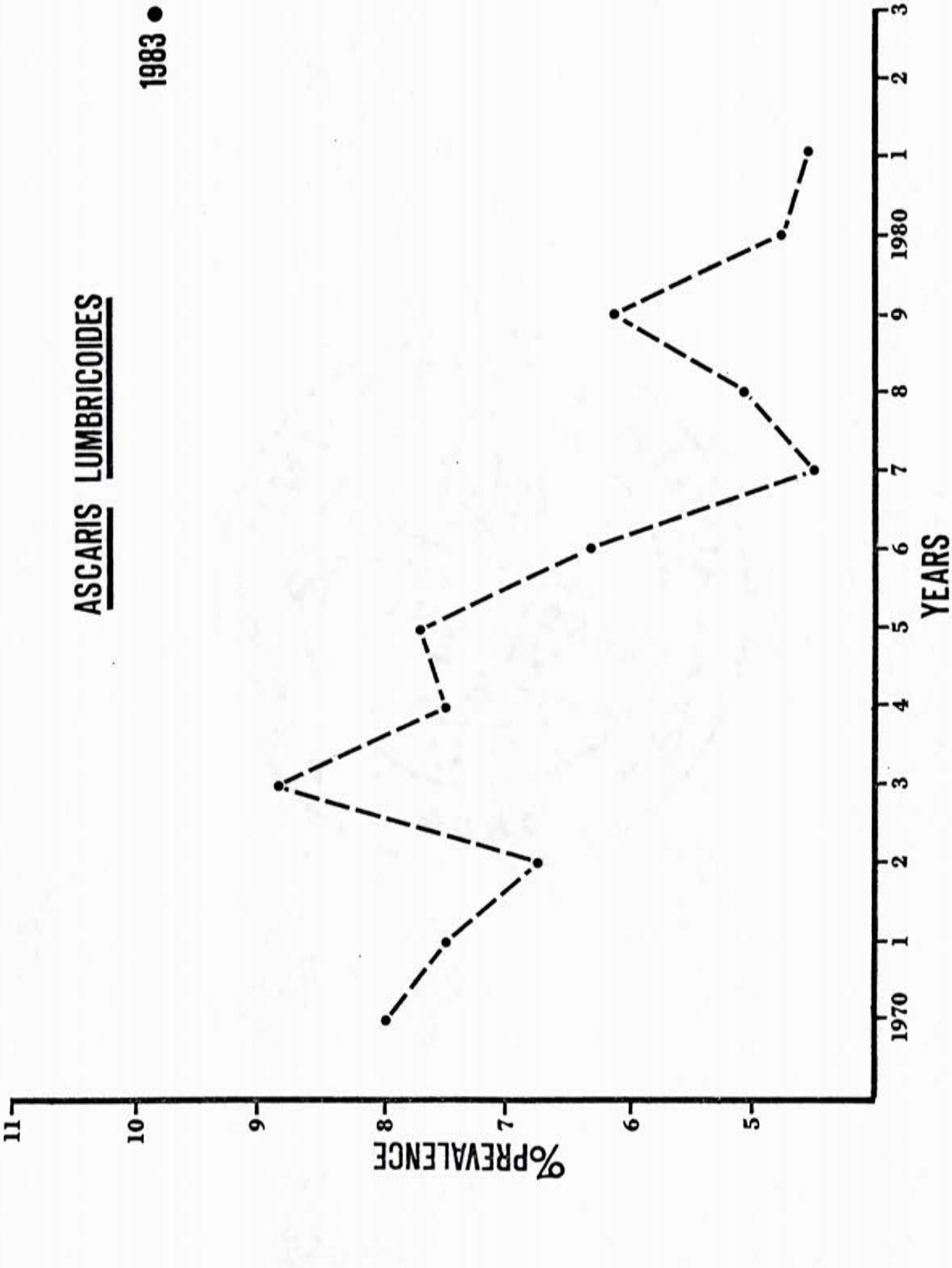
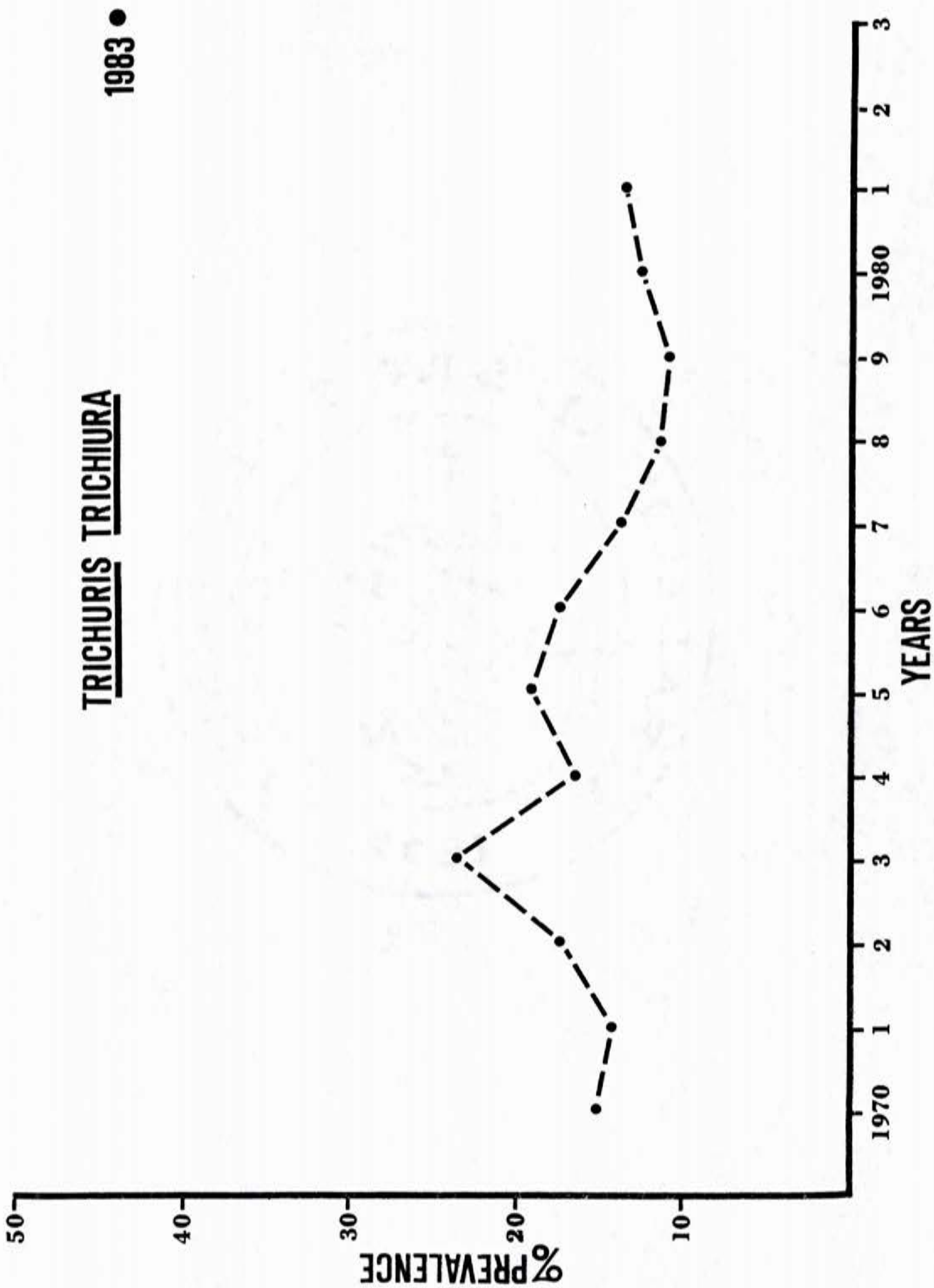

ASCARIS LUMBRICOIDES
1983 ●
%PREVALENCE
11
10
9
8
7
6
5
YEARS
1970
1
2
3
4
5
6
7
8
9
1980
1
2
3

Figure 6. Comparison of hospital records of *Trichuris trichiura* infection in Kingston (Rawlins, 1982) with results from the present study (1983).



TRICHURIS TRICHIURA
1983 ●
%PREVALENCE
50
40
30
20
10
1970
1
2
3
4
5
6
7
8
9
1980
1
2
3
YEARS

Figure 7. Comparison of hospital records of hookworm infection in Kingston (Rawlins, 1982) with results from the present study (1983).

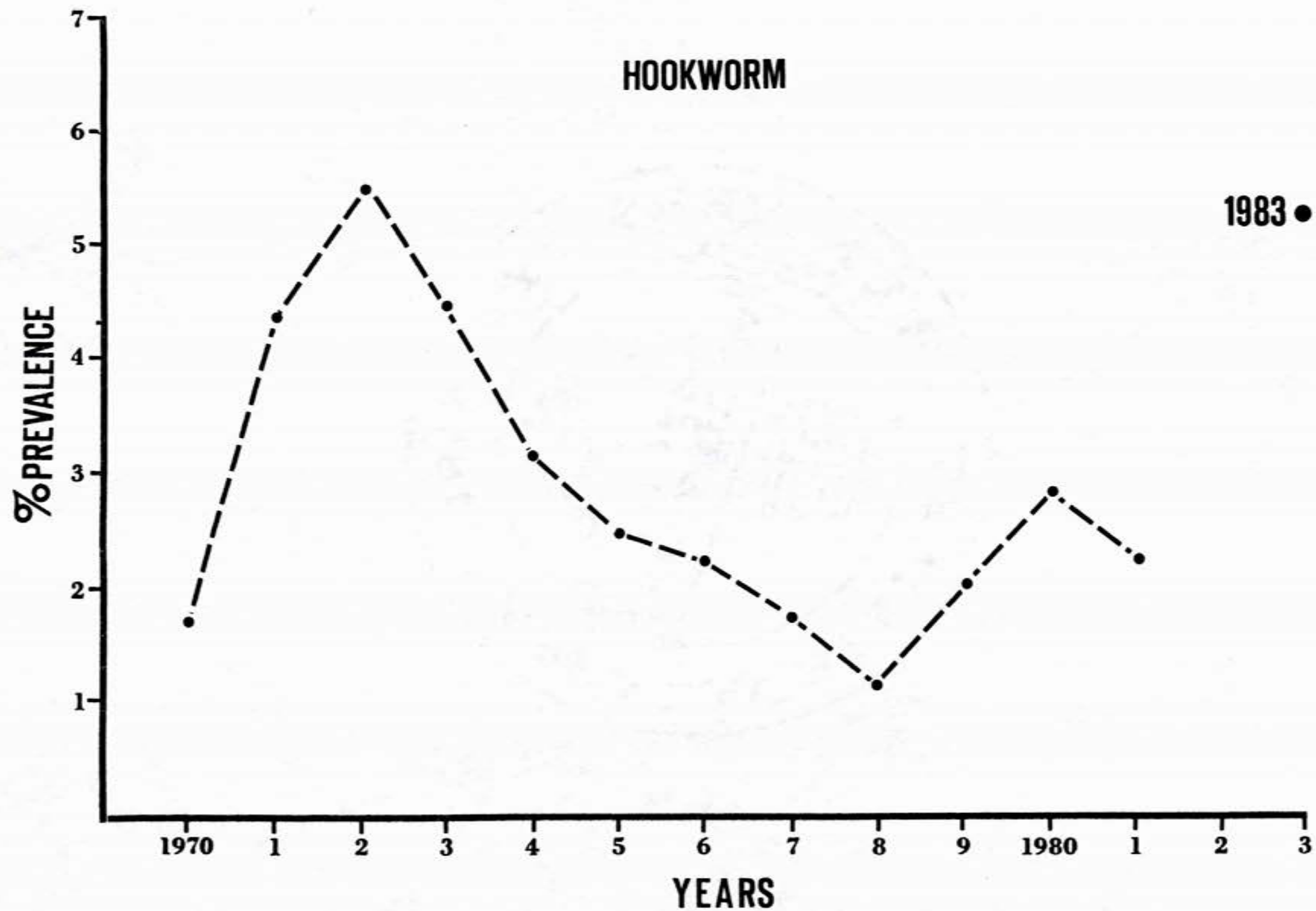

HOOKWORM
1983
%PREVALENCE
7
6
5
4
3
2
1
1970
1
2
3
4
5
6
7
8
9
1980
1
2
3
YEARS

Figure 8. Comparison of hospital records of *Giardia lamblia* infection in Kingston (Rawlins, 1982) with results from the present study (1983).

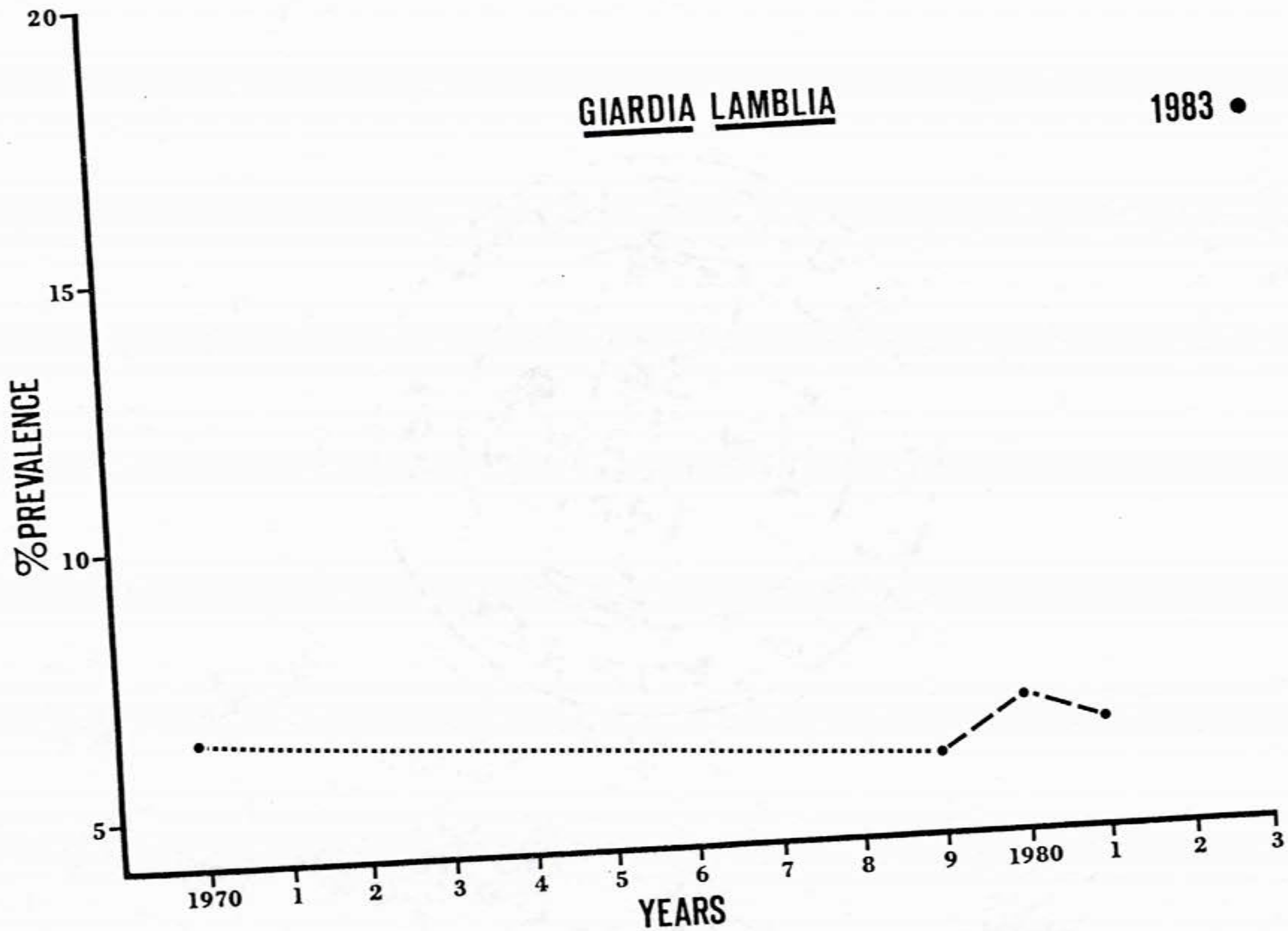

GIARDIA LAMBLIA
1983
%PREVALENCE
20
15
10
5
1970
1
2
3
4
5
6
7
8
9
1980
1
2
3
YEARS

TABLE XI. Overall helminth prevalence from five Caribbean studies (%)

Study	*Ascaris lumbricoides*	Hookworm	*Trichuris trichiura*	*Trichostrongylus*	*Strongyloides stercoralis*	*Taenia*
1 Present Study, 1983	10.6	5.4	44.6	1.2	3.6	0.7
2 Rawlins, 1982	4.7	2.1	13.6	0.0	0.8	0.0
3 Ancell, et al, 1982	8.0	16.0	37.0	0.0	5.0	0.0
4 Tikasingh, 1981	27.0	6.0	47.0	1.0	1.0	0.0
5 Greenberg, 1971	13.4	12.1	74.7	0.0	0.0	0.0

1 Present study, 1983. Westmoreland Parish, Jamaica. 703 samples.
2 Rawlins, 1982. Hospital records from UHWI, 1981. 3000 samples.
3 Ancell et al, 1982. Guadeloupe and Martinique. 6967 samples.
4 Tikasingh, 1981. Commonwealth Caribbean (8 countries). 2256 samples.
5 Greenberg & Ferguson, 1981. Puerto Rico. 6086 samples.

Ferguson, 1981). The rate for *Trichostrongylus* sp. in this study was only slightly higher (1.2%) in Jamaica than that recorded by Tikasingh (1981). The rate for *S. stercoralis* in Jamaica ranked second to the rate in the French Islands (Ancel et al., 1982). *Taenia* infections were not recorded in any of the other studies.

Protozoan prevalence from the study is also compared with results from four other surveys (Young et al., 1955; Beck, 1960; Grant et al., 1965; and Rawlins, 1982) (Table XII). *Giardia lamblia* prevalence from this study (17.2%) is considerably higher than previously recorded except for Beck's (1960) work. *Entamoeba histolytica* had a much higher prevalence in previous studies but most of these were recorded from hospital cases in which doctors requested fecal examinations since dysentary had been diagnosed. *Entamoeba coli* was well represented in each study with a much higher rate observed by Young et al. (1955); Grant et al. (1965) and Beck (1960). *Endolimax nana* had a high rate (43%) according to the study by Young et al. (1955) while the present study showed a 12.4% rate. *Chilomastix mesnili* and *Iodamoeba butchlii* each had much higher rates in the present study than previously recorded.

TABLE XII. Overall protozoan prevalence from five Jamaican studies (%)

Study	*Giardia lamblia*	*Entamoeba histolytica*	*Entamoeba hartmanii*	*Entamoeba coli*	*Endolimax nana*	*Chilomastix mesnili*	*Iodamoeba butschlii*
1 Present Study, 1983	17.2	5.1	3.9	13.8	12.4	4.5	11.4
2 Rawlins, 1982	6.3	0.0	0.0	6.1	0.0	0.0	0.0
3 Grant et al, 1965							
-Hospital	8.4	1.0	0.0	6.8	3.5	0.0	0.0
-Rural	10.7	8.0	0.0	32.7	9.3	0.0	0.0
4 Beck, 1960							
-Housing Project	34.7	30.4	0.0	34.7	13.0	0.0	4.3
-Hospital	11.2	10.0	0.0	10.0	7.5	0.0	1.2
5 Young et al, 1955	14.0	27.0	0.0	41.0	43.0	3.0	5.0

1 Present Study, 1983. Westmoreland Parish, Jamaica. 703 samples.

2 Rawlins, 1982. Hospital records from UHWI, 1981. 3000 samples.

3 Grant et al, 1965. Hospital samples from UHWI; rural samples from Lawrence Tavern, Jamaica. 1290 samples.

4 Beck, 1960. Hospital samples from University College Hospital; samples from Hermitage housing project in Kingston. 103 samples.

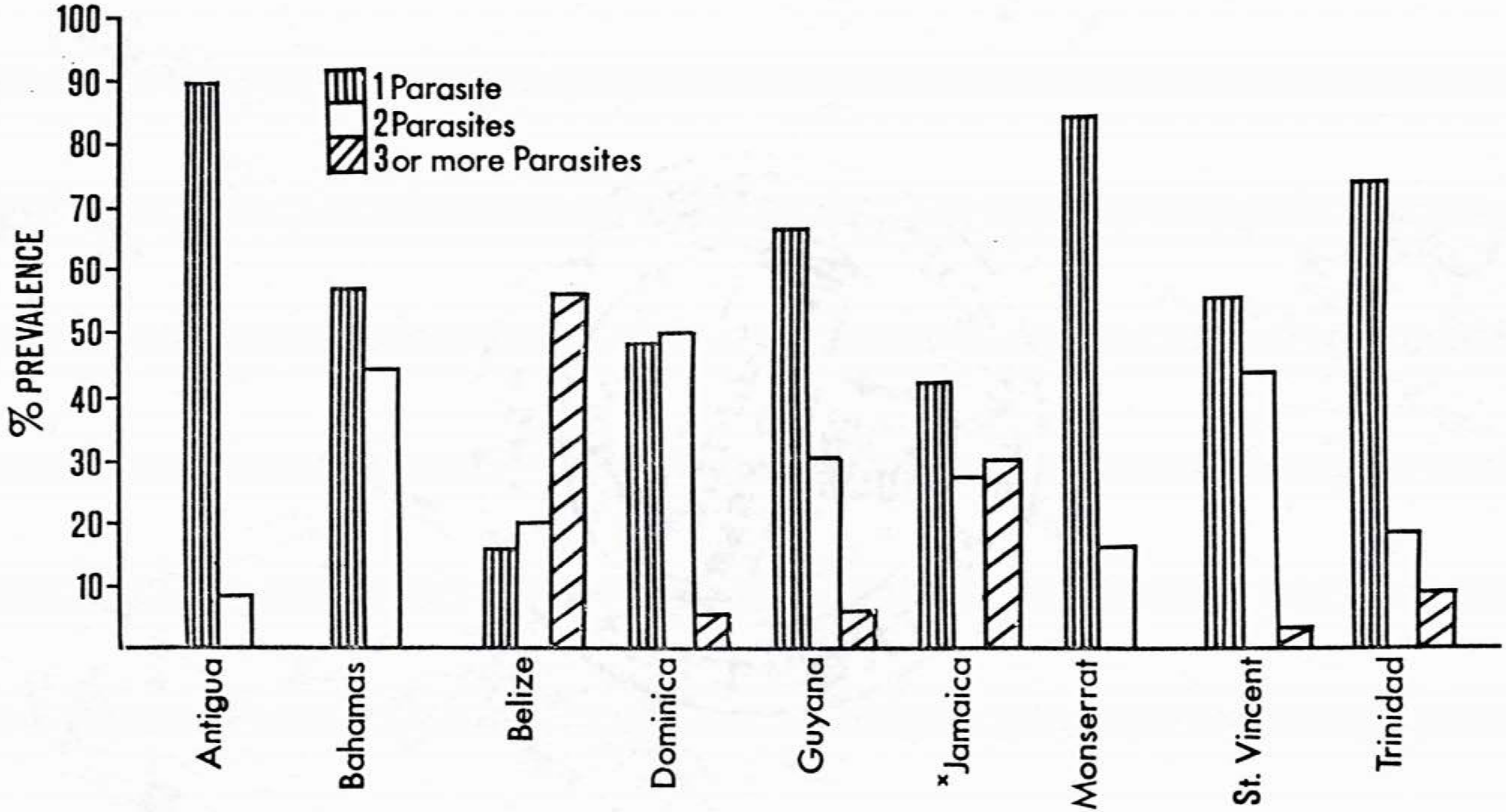
5 Young et al, 1955. Kingston, Jamaica. 2591 samples.

A comparison of multiparasitism in school children in this study is made with children in other regions of the Caribbean (Tikasingh, 1981). Data from this study includes children from the age of 4 through 11 years while data from the remaining countries comes from 5 and 9 year olds (Figure 9). In single parasitic infections Jamaica ranked eighth while Antigua had the highest rate of single infection. In double infections Jamaica ranked fifth while Dominica held first place. In situations where individuals were infected with three or more parasites Jamaica ranked second only to Belize. The distribution between those individuals infected with one, two, or three or more parasites is more even in Jamaica than other countries.

The transmission of intestinal protozoan and helminthic infection follows different mechanisms depending on the species of parasite and the local environmental conditions. Prevention, in order to be effective, must take into consideration the natural cycles of parasites and the particular ecological, social, and cultural circumstances that exist in a community or social group.

Principles of prevention can be broken down into three major components - sanitation, health education, and community participation. Programs developed in

Figure 9. Multiparasitism in school children from eight Caribbean countries (Tikasingh, 1981) compared to Jamacian children in the present study (1983). The 1981 study included only 5 and 9 year olds while the 1983 study included 4 through 11 year olds.



% PREVALENCE
100
90
80
70
60
50
40
30
20
10
1 Parasite
2 Parasites
3 or more Parasites
Antigua
Bahamas
Belize
Dominica
Guyana
×Jamaica
Monserrat
St. Vincent
Trinidad

each region must be comprehensive and cover the most basic aspects of sanitation and prevention, such as provision for safe water supplies, proper latrine location and construction along with maintenance and safe waste disposal. From a personal standpoint, the use of shoes, improvement of hygiene such as constant washing of hands and proper cooking of all meats and fish products can dramatically decrease parasite prevalence.

These factors alone cannot completely eliminate parasitic infection, therefore the need for systematic mass chemotherapy must be incorporated in a comprehensive program. This reduces the human sources of infection within the community. Community participation must be promoted by local leaders and a well developed system of health education must be in place in each household and community.

The basic infrastructure of rural clinics in Jamaica could be put to more effective use if the staff had some basic training in preventive techniques needed to control parasitic infection. The staff of these clinics are respected members of the community and could play a major role in health education. Each clinic could, with minimum additional financing, be responsible for organizing and administering a systematic chemotherapy program and should be able to monitor parasitic infection through the collecting of fecal samples which could be analyzed at the clinic by an appropriately trained staff member. This study can easily be followed and duplicated after a one year dosing program carried out at 3 month intervals. The records for each individual are on file at the local clinic. The modification of human habits is the most important but, at the same time, the most difficult component to alter. Through a well developed public health education program occurring in schools, homes and communities, the prevalence of human intestinal parasitic infection can be greatly reduced or even eliminated.

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VITA

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