[Jap. J. Parasit., Vol. 31, No. 5, 447-459, Oct., 1982]

Studies on Intestinal Parasitic Infections in Chiang Mai Province, North Thailand

TOMIO YAMAGUCHI*, CHIRASAK KHAMBOONRUANG†,
TAKASHI INABA*, WEN-HSIUNG HUANG*,
KUNIO IHIDA*, YASUNORI FUJIMAKI*, HIROSHI ASANO‡,
PRAYUTH THITASUT† AND SUVAJRA VAJRASTHIRA§

(Received for publication; August 11, 1982)

Key words: intestinal parasites, epidemiology, North Thailand

Introduction

Thailand is situated in the Indochina Peninsula between latitude 5° to 20° and longitude 97° to 105°. On the north is bordered by Burma and Laos, on the west by Burma, on the northeast by Laos, on the east by Cambodia and on the south by Malaysia. Thailand is approximately the size of about 518,000 square kilometers, with a population of 45.5 million.

The country is divided into four regions: the mountainous North, where the temperature in the winter is cool enough to permit cultivation of temperate fruits; the Northeast, a rolling, semi-arid plateaux; the Central region, one of the most fertile rice-growing areas on the earth; and the isthmus of the South which compasses a heterogenous topography with almost daily thunderstorms through most of the year (Fig. 1).

Approximately 80% of the working population is engaged in agriculture practices especially rice cultivation. The climate in Thailand is essentially tropical and humid. Water supply, sewage, and refuse disposal are often poorly organized. In the rural areas, latrines are scarcely used, the villagers usually defecate directly on the ground of the paddy field or into canals or water reservoirs both of which are often used for bathing and washing clothes. Propagation of intestinal parasites is, therefore, faciliated by these habits.

During from July to August, 1981, inhabitants in eight districts of Chiang Mai Province, North Thailand, were surveyed for intestinal parasitic infections using four stool examination techniques. This investigation appeared to be the most exact study ever performed in Thailand from methodological view point.

This work was supported, in part, by a Grant-in-Aid for the Oversea Scientific Survey Project, No. 5641003, from the Ministry of Education, Science and Culture, Japan, and was permitted from the National Research Council of Thailand.

* *Department of Parasitology, Hirosaki University School of Medicine, Hirosaki, Japan.*
† *Department of Parasitology, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand.*
‡ *Department of Bacteriology, Hirosaki University School of Medicine, Hirosaki, Japan.*
§ *Department of Helminthology, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand.*

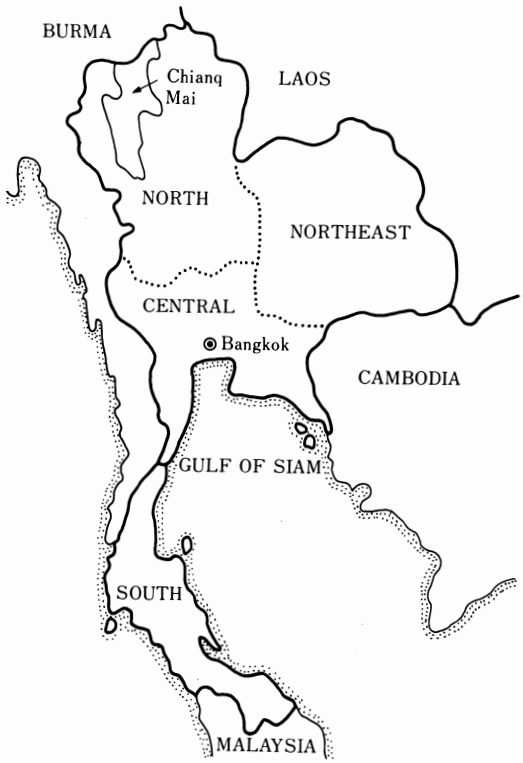

Fig. 1 Map of Thailand showing four regions.

Materials and Methods

Study areas

Chiang Mai Province is located approximately 700 km north of Bangkok, and has about one million of population. Most of the people are farmers or are indirectly dependent of farming. In addition to the cultivation of rice, fruit and vegetable growing, cattle raising and slik or cotton weaving are common.

Eight different villages belonging to 8 districts of the Province, within 40 km from Chiang Mai City, were investigated: Ban Hua Rin, San Pa Tong district; Ban Rai, Hang Dong district; Ban San Sai, Sara Pee district; Ban Puca, San Khamphang district; Ban Nong Chom, San Sai district; Ban Phan Lung, Doi Saket district; Ban Kee lek, Mae Tang district; and Ban Pong Yang, Mae Rim district.

Stool samples

The stool samples were collected in plastic ice cream cups which were distributed to villagers and collected next morning. For stool examination, following four techniques were employed.

Cellophane thick smear technique (Kato and Miura, 1954): Instead of glass coverslip, a piece of cellophane is used in this technique. This technique is recommendable for mass examination because of its simple procedure, high efficacy of finding all kinds of eggs in stool, and low cost of materials.

Magnesium sulfate-brine floatation techcnique: Floatation medium in this technique is composed of 185 g of $MgSO_4$ and 290 g of NaCl into 1,000 ml of water. The medium is able to prevent NaCl crystalization around the tip of the test tube and also to obtain higher specific gravity (1.230) than saturated NaCl (1.200), and enable the higher recovery rate than with saturated NaCl solution.

Formalin-ether centrifugation technique (MGL method, Ritchie, 1948): This technique is applicable for the detection of protozoan cysts as well as helminth eggs in faeces.

Filter paper-culture technique (Harada and Mori, 1955): This method is useful for demonstration of larvae of hookworm, *Trichostrongylus* spp. and *Strongyloides stercoralis.*

Results

Prevalence of intestinal parasitic infections in 8 districts of Chiang Mai Province

A total of 3,012 faecal samples of the inhabitants from 8 villages in the 8 districts of Chiang Mai Province were examined. The result of stool examinations showed that 2,312 or 76.76% out of 3,012 subjects were found to harbour parasites. The overall infection rates of people with respective parasites were as follows: *Ascaris lumbri-*

coides, 0.30%; hookworm, 47.74% (*Necator americanus* was the only species of hookworm recognized by use of culture method); *Trichuris trichiura,* 19.50%; *Enterobius vermicularis,* 0.66%; *Strongyloides stercoralis,* 6.27%; *Rhabditis* spp., 1.10%; *Opisthorchis viverrini,* 37.01%; and *Taenia* spp., 2.69%. Cysts of *Entamoeba coli* 7.64%; *Entamoeba histolytica,* 1.20%; *Endolimax nana,* 1.39%; *Iodamoeba bütschlii,* 0.60%; *Giardia lamblia,* 4.35%; and *Chilomastix mesnili,* 0.03%. The detection rates of infection by each techniques were 59.4% by cellophane thick smear, 46.3% by floatation, 49.3% by centrifugation, and 42.1% by culture, respectively (Table 1).

The lowest prevalence of parasitic infection was 54.6% (Doi Saket district) compared with the other districts where prevalence rates varied between 60.3% (San Khamphang district) and 91.0% (Mae Rim district) (Fig. 2).

The prevalence of hookworm was the highest in Ban Pong Yang, Mae Rim district (82.3%) and the lowest in Ban Phan Lung, Doi Saket district (11.2%). *Opisthorchis viverrini* showed the highest in Ban Kee Lek, Mae Tang district (65.1%) and the lowest in Ban Pong Yang, Mae Rim district (5.3%) where is an only mountainous village in this survey (Table 2).

Detection rates of helfinth ova or larvae in 1,724 samples examined simultaneously by 4 techniques

The detection rates of main helminth species by each technique were as follows: by cellophane smear method, 63.0% for hookworm, 73.9% for *T. trichiura,* and 81.0% for *O. viverrini;* by floatation method, 69.0% for hookworm, 67.1% for *T.*

Table 1 Prevalence of intestinal parasitic infections in 8 districts of Chiang Mai Province, according to technical procedurs

( ) : %

No. examined	SM 2,920	FL 2,190	SE 2,815	CU 2,062	Total 3,012
No. positive	1,734(59.4)	1,013(46.3)	1,389(49.3)	868(42.1)	2,312(76.76)
Helminthes					
Ascaris lumbricoides	7(0.2)	5(0.2)	3(0.1)	0	9(0.30)
Hookwomr	1,001(34.3)	792(36.2)	299(10.6)	733(35.5)	1,438(47.74)
Trichuris trichiura	427(14.6)	317(14.5)	255(9.1)	0	588(19.50)
Enterobius vermicularis	7(0.2)	14(0.6)	1(0.03)	0	20(0.66)
Strongyloides stercoralis	0	2(0.1)	7(0.2)	186(9.0)	189(6.27)
Rhabditis spp.	3(0.1)	2(0.1)	8(0.3)	32(1.6)	33(1.10)
Opisthorchis viverrini	847(29.0)	36(1.6)	777(27.6)	0	1,110(37.01)
Taenia spp.	46(1.6)	8(0.4)	20(0.7)	0	81(2.69)
Protozoa					
Entamoeba coli			230(8.2)		230(7.64)
Entamoeba histolytica			36(1.3)		36(1.20)
Endolimax nana			42(1.5)		42(1.39)
Iodamoeba bütschlii			18(0.6)		18(0.60)
Giardia lamblia			131(4.7)		131(4.35)
Chilomastix mesnili			1(0.03)		1(0.03)

SM: Cellophane thick smear technique.
FL: Magnesium sulfate-brine floatation technique.
SE: Formalin-ether centrifugation technique.
CU: Filter paper-culture technique.

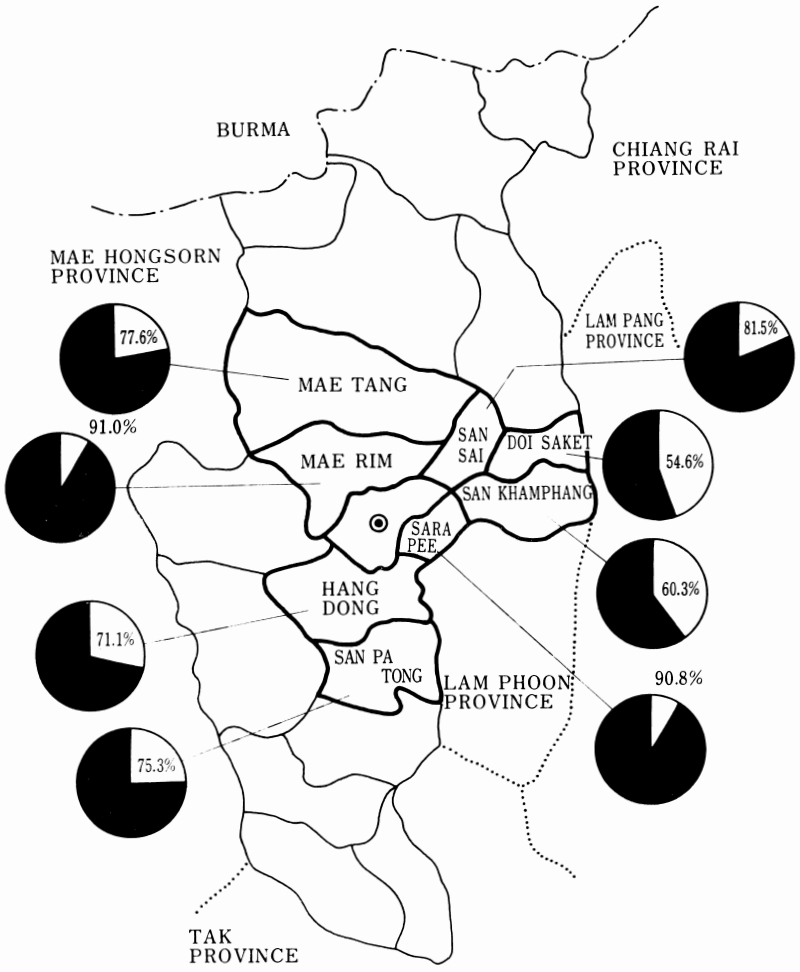

Fig. 2 Prevalence of intestinal parasitic infections in 8 districts of Chiang Mai Province (July-August, 1981).

trichiura, and 4.9% for *O. viverrini*; by centrifugation method, 21.0% for hookworm, 43.7% for *T. trichiura*, and 78.0% for *O. viverrini*; and by culture method, 70.0% for hookworm, 100% for both *S. stercoralis* and *Rhabditis* spp., respectively. From the results mentioned above, formalin-ether centrifugation technique *per se* was not good as other techniques for the detection to helminth ova (Table 3).

Incidence of parasitic infections according to sex and age

The overall prevalence of intestinal parasitic infections appeared to be slightly higher in males than in females. The infection rate of hookworm, *S. stercoralis* and *O. viverrini* were predominent in males (Table 4).

Hookworm was the most prevalent intestinal helminth. The overall prevalence rate was 48%, in which 51.0% in males with a peak of 58% in the twenties and 45% in females with peaks of 51% in both twenties and fourties. Prevalence curves by age group showed relatively low levels in

Table 2 Prevalence of intestinal parasitic infections in 8 districts of Chiang Mai Province (July-August, 1981)

( ) : %

District	San Pa Tong	Hang Dong	Sara Pee	San Khamphang	San Sai	Doi Saket	Mae Tang	Mae Rim	Total
No. examined	700	425	346	242	373	251	241	434	3,012
No. Positive	527(75.3)	302(71.1)	314(90.8)	164(60.3)	304(81.5)	137(54.6)	187(77.6)	395(91.0)	2,312(76.76)
Helminthes									
Ascaris lumbricoides	1(0.1)	0	1(0.3)	0	3(0.8)	0	0	4(0.9)	9(0.30)
Hookworm	356(50.9)	139(32.7)	212(61.3)	57(23.5)	157(42.1)	28(11.2)	132(54.8)	357(82.3)	1,438(47.74)
Trichuris trichiura	255(36.4)	47(15.6)	145(41.9)	3(1.2)	132(35.4)	4(1.6)	0	2(0.2)	588(19.50)
Enterobius vermicularis	2(0.3)	0	3(0.9)	3(1.2)	3(0.8)	6(2.4)	1(0.4)	2(0.5)	20(0.66)
Strongyloides stercoralis	32(4.6)	25(5.9)	12(3.5)	8(3.3)	26(7.0)	38(15.1)	27(11.2)	21(4.8)	189(6.27)
Rhabditis spp.	10(1.4)	2(0.5)	3(0.9)	1(0.4)	2(0.5)	4(1.6)	4(1.7)	9(2.1)	33(1.10)
Opisthorchis viverrini	103(14.7)	195(45.9)	243(70.2)	112(46.3)	216(57.9)	66(26.3)	157(65.1)	23(5.3)	1,115(37.01)
Taenia spp.	12(1.7)	3(0.7)	5(1.4)	4(1.4)	6(1.6)	8(3.2)	5(2.1)	38(8.8)	81(2.69)
Protozoa									
Entamoeba coli	68(9.7)	22(5.2)	32(9.2)	13(5.4)	21(5.6)	15(6.0)	9(3.7)	46(10.6)	230(7.64)
Entamoeba histolytica	15(2.1)	1(0.2)	5(1.4)	1(0.4)	1(0.3)	1(0.4)	4(1.7)	8(1.8)	36(1.20)
Endolimax nana	7(1.0)	5(1.2)	2(0.6)	0	0	0	5(2.1)	23(5.3)	42(1.39)
Iodamoeba bütschlii	6(0.9)	1(0.2)	1(0.3)	2(0.8)	2(0.5)	3(1.2)	2(0.8)	1(0.2)	18(0.60)
Giardia lamblia	47(6.7)	17(4.0)	7(2.0)	5(2.1)	13(3.5)	11(4.4)	8(3.3)	23(5.3)	131(4.35)
Chilomastix mesnili	0	1(0.2)	0	0	0	0	0	0	1(0.03)

Table 3 Detection rate of helminth ova or larvae on 1,724 samples examined simultaneously by 4 technical methods

( ) : %

Parasites	Total No. of positive	No. of positive by			
		SM	FL	SE	CU
Ascaris lumbricoides	4	2(50.0)	2(50.0)	1(25.0)	0
Hookworm	942	593(63.0)	650(69.0)	198(21.0)	659(70.0)
Trichuris trichiura	371	274(73.9)	249(67.1)	162(43.7)	0
Enterobius vermicularis	9	2(22.2)	8(88.9)	0	0
Strongyloides stercoralis	157	0	0	3(1.9)	157(100.0)
Rhabditis spp.	22	1(4.5)	1(4.5)	1(4.5)	22(100.0)
Opisthorchis viverrini	586	475(81.1)	29(4.9)	451(78.0)	0
Taenia spp.	34	28(82.4)	5(14.7)	6(17.6)	0

SM: Cellophane thick smear technique.
FL: Magnesium sufate-brine folatation technique.
SE: Formalin-ether centrifugation technique.
CU: Filter paper-culture technique.

Table 4 Prevalence of intestinal parasitic infections in 8 districts of Chiang Mai Province, according to sex

( ) : %

No. examined	Male 1,469	Female 1,529	Unknown 14	Total 3,012
No. positive	1,160(79.0)	1,142(74.7)	10(71.9)	2,312(76.76)
Helminthes				
Ascaris lumbricoides	2(0.1)	7(0.5)	0	9(0.30)
Hookworm	744(50.6)	689(45.1)	5(35.9)	1,438(47.74)
Trichuris trichiura	285(19.4)	298(19.8)	5(35.9)	588(19.50)
Enterobius vermicularis	2(0.1)	18(1.2)	0	20(0.66)
Strongyloides stercoralis	106(7.2)	83(5.4)	0	189(6.27)
Rhabditis spp.	19(1.3)	14(0.9)	0	33(1.10)
Opisthorchis viverrini	578(39.3)	526(34.4)	6(42.9)	1,110(37.01)
Taenia spp.	40(2.7)	41(2.7)	0	81(2.69)
Protozoa				
Entamoeba coli	99(6.7)	130(8.5)	1(7.1)	230(7.64)
Entamoeba histolytica	16(1.1)	20(1.3)	0	36(1.20)
Endolimax nana	23(1.6)	19(1.2)	0	42(1.39)
Iodamoeba bütschlii	5(0.3)	13(0.9)	0	18(0.60)
Giardia lamblia	67(4.6)	64(4.2)	0	131(4.35)
Chilomastix mesnili	0	1(0.1)	0	1(0.03)

children under 9 years, and the tendency in increase after childhood (Fig. 3).

The incidence of *T. trichiura* infection was highest in the teen-agers particularly in this age group of females (36%). The difference in incidence among both sexes was not definite.

As indicated in Fig. 3, 37% of the peopie were found infected with *O. viverrini*. There is an increase in incidence of infection from low age group to adulthood with a peak of 51% in males of 60 years and over.

As shown in Fig. 4, the incidence of S.

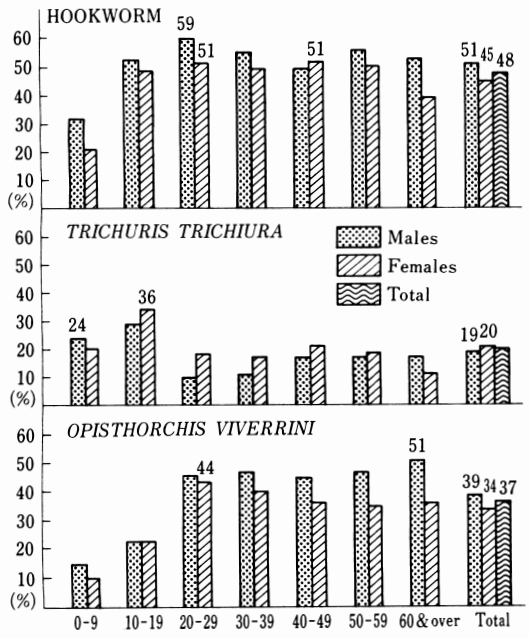

Fig. 3 Incidence of parasitic infections according to sex and age group (1).

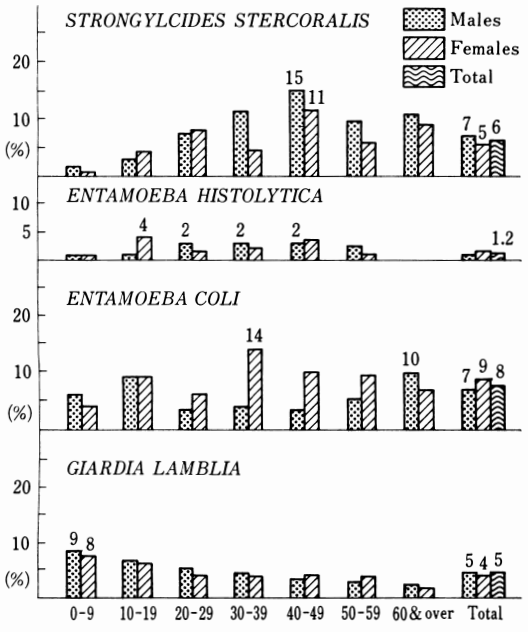

Fig. 4 Incidence of parasitic infections according to sex and age group (2).

stercoralis infection was shown to increase with age up to the age group of 40 to 49, with a peak of 15% in male at fourties, and decrease in older individuals. Males (7%) had a higher incidence than females (5%).

As indicated in Fig. 4, only 1.2% of samples examined were found to be infected *E. histolytica* in each age group to fifty. The differences of incidence by sex and age were not clear.

E. coli was the most common protozoan cyst seen in the present survey. Differences of incidence by sex and age were not constant in the various age groups, although females appeared to be shown a higher incidence (9%) than males (7%).

The incidence of *G. lamblia* infection was highest in the age group under 9 years, 9% in male and 8% in female, and decreased with age. The difference of incidence by sex was not constant.

Discussion

North region of Thailand consists of 9 Provinces, namely: Chiang Rai, Chiang Mai, Lamphoon, Lampang, Mae Hongsorn, Prae, Nan, Tak, and Phayao. However, there is a little critical information on the prevalence of parasitic diseases in this region, though Chiang Mai is the only Province in which a significant number of parasitic survey have been carried out.

Protozoa

It was found from the literature review that reports of protozoan infection have usually been a byproduct of surveys for helminthic infections, and it is therefore likely that the prevalence rate would be estimated lower than the real value.

The presence of protozoan infection in Chiang Mai was first observed by Kerr (1916). He reported finding amoebic cysts in the stool of adult male prisoners, and the prevalence of *E. histolytica* was 0.9%

and *E. coli* was 0.6%. He also found trophozoite of *Entamoeba* with the prevalence rate of 23.1% but he was not able to identify the species. For intestinal flagellates, he reported the finding of *Giardia lamblia* cysts and *Trichomonas hominis* with a prevalence rate of 1.0% and 2.6%, respectively.

After the first report of Kerr in 1916 it appears that no parasitic survey has been reported from the north of Thailand until 1968 when Yasmuth and his coworkers reported results their study on people of one village of Sara Pee district of Chiang Mai Province. The occurrence of protozoan infections was as follows: *Entamoeba coli,* 8.5%; *E. histolytica,* 1.0%; *Iodamoeba bütschlii,* 1.0%; *Endolimax nana,* 0.7%; and *Giardia lamblia,* 3.1% (Yasmuth *et al.,* 1968).

An extensive survey of the same district was conducted one year later by Na Bangxang and his associates (1969). They examined stool samples from six villages and reported that the infection rates were as follows: *E. coli,* 14.2%; *E. histolytica,* 2.2%; *I. bütschlii,* 2.8%; *E. nana,* 1.8%; and *G. lamblia,* 3.7%. In 1969, there were two reports concerning the prevalence of intestinal parasitic infections from another area, Phayao Province. Manning *et al.* (1969) while looking for a new focal area of *Fasciolopsis buski* infection also examined stool samples of the natives. They reported their findings as *E. coli,* 6.8%; *I. bütschlii,* 0.3%; *E. nana,* 3.3%; and *G. lamblia,* as high as 8.0%. In addition, Papasarathorn *et al.* (1969) while studying the epidemiology of *Ascaris* infection found that the prevalence rates of protozoan infections were as follows: *E. coli,* 12.6%; *E. histolytica,* 6.3%; *E. nana,* 3.3%; and *G. lamblia,* 5.5%.

In 1973, Thitasut *et al.* reported results of an extensive survey on people for intestinal parasites in 6 districts of Chiang Mai Province. The total number of stool samples was 2,653. The infection rates of individual protozoa were as follows: *E. coli,* 8.3%; *E. histolytica,* 1.2%; *I. bütschlii,* 1.4%; *E. nana,* 1.7%; and *G. lamblia,* 2.0%.

Khamboonruang *et al.* (1978) while studying a new focal area of paragonimiasis in Mae Chan district of Chiang Rai Province, also examined 910 stool samples of the villagers. They found that the prevalence of the protozoan infection was as follows: *E. histolytica,* 1%; *E. coli,* 6.0%; *E. nana,* 0.3%; and *G. lambia,* 4.9%.

In the present study, a total of 3,012 stool samples were collected from eight districts of Chiang Mai Province, of which 2,815 were examined by formalin-ether centrifugation technique. The prevalence rates of protozoan infections were as follows: *E. coli,* 8.2%, *E. histolytica,* 1.3%; *E. nana,* 1.5%; *I. bütschlii,* 0.6%; *G. lamblia,* 4.7%; and *C. mesnili,* 0.03% (Table 1).

The most important protozoan pathogen would be *Entamoeba histolytica.* Prevalence rates of *E. histolytica* are rather low, ranged from 0.9% to 6.3%, appearing from the review in north Thailand. Generally, intestinal amoebiasis is asymptomatic and severe amoebic dysentery is uncommon. However, amoebic liver abscess is very common in the northern Thailand and rupture of amoebic abscess into pleural cavity is also frequently found.

Of the intestinal flagellate infections, *Giardia lamblia* was found to be the most common flagellate in north Thailand. The prevalence rates ranged from 1.0% to 8.0%. In the available literature nothing was mentioned about the relationship between the parasite and the clinical symptoms and signs such as malabsorption syndrome, diarrhea, abdominal pain etc. However, a subclinical type of malnutrition is frequently found in children in north Thailand. It is possible that giardiasis may play some role in this condition because of the incidence of *G. lamblia* was highest in the

under 9 years of age group (Fig. 4).

For intestinal ciliate infection, balantidial dysentery caused by *Balantidium coli* is rare. Kluklin and Khamboonruang (1964) reported only one case of balantidiasis in Chiang Mai.

Helminthes

Kerr (1916) seems to be the first who reported the finding of intestinal helminthic infection in the northern Thailand. He examined 230 stool samples of male prisoners in Chiang Mai Jail by simple direct smear after the administration of anthelminthic drug. The most common helminthic infection was found to be hookworm. He identified the worm as *Necator americanus* in 94.3% of these individuals, and 14.8% of these were *Ancylostoma* species: identified mostly as *A ceylanicum* and also a very few were *A. duodenale.*

This is the only investigation that had attempted to exactly identify the species of adult hookworm infecting man in the northern Thailand. In this report, the other helminthic infections were as follows: *Ascaris lumbricoides,* 58.2%; *Enterobius vermicularis,* 50.5%; *Strongyloides stercoralis,* 18.3%; *Trichuris trichiura,* 28.3%; *Opisthorchis viverrini,* 17%; and *Taenia saginata,* 58.3%.

Sadun (1953, 1955) had conducted an extensive survey throughout the country by direct smear method. For the northern Thailand a total of 1,219 children of 17 schools in 5 Provinces, 5 to 16 years old of both sexes, were examined. He reported that *A. lumbricoides* was the dominant pathogenic parasite with an overall average of incidence 32%. *T. trichiura,* hookworm and *S. stercoralis* were less common, their overall prevalence being 10, 8, and 4%, respectively. *O. viverrini* was found to be present in every Province with prevalence rate of 4%.

Vajrasthira and Harinasuta (1955) continued the work of Sadun by extending the number of the specimens up to 263, 703 for the whole country. The stool samples of 5,914 from 8 Provinces of the north were examined, and again, *A. lumbricoides* was found to be the predominant with an average prevalence rate of 25%. Presence of hookworm infection was an overall average of 20%. *T. trichiura, Taenia* spp., *S. stercoralis* and *Fasciolopsis buski* were less common, with an overall average of 7, 1.5, 1 and 0.03% infected, respectively. *O. viverrini* was found to exist in every Province with an overall average as high as 15%.

Yasmuth *et al.* (1968) examined a total of 292 stool specimens from one village of Sara Pee district in Chiang Mai Province. They reported that predominant intestinal parasites were *A. lumbricoides,* hookworm and *O. viverrini* with an overall averages of 13, 17 and 20%, respectively. *S. stercoralis, T. trichiura* and *F. buski* were less common with an average incidence of 5.3% and 1%, respectively. In this investigation the formalin-ether concentration method was used. They also observed the prevalence of *E. vermicularis* and *Taenia* spp. with the average of 0.7 and 2.4%, respectively.

Manning *et al.* (1969) reported their findings on intestinal helminthic infections from Ban Mae Ing of Jane district in Phayao Province. The objective of the study by Manning *et al.* was to delineate the endemic area of fasciolopsiasis. They examined a total of 337 stool samples by formalin-ether centrifugation technique. No *F. buski* eggs were found, however, they reported the finding of the following intestinal helminthic parasites: *A. lumbricoides,* 21%; hookworm, 9%; *S. stercoralis,* 7.4%; *T. trichiura,* 4.4%; *O. viverrini,* 2.4%; *E. vermicularis,* 2.4%; and Taenia spp., 1.5%.

Papasarathorn *et al.* (1969) studied the prevalence of intestinal parasites and epidemiology of ascariasis in the same area.

They examined a total of 238 stool samples by the formalin-ether centrifugation technique. Their results, of particular interest, were different from the report of Manning *et al.* The dominant intestinal parasites were *A. lumbricoides, T. trichiura* and *O. viverrini* with an overall average of 60.0, 52.5 and 34.0%, respectively. *F. buski* was found to be as high as 7.1%, whereas Manning *et al.* did not find any. *S. stercoralis,* hookworm, *Taenia* spp., and *E. vermicularis* were less common, with an average of 9.3, 5.0, 4.0, and 1.0%, respectively.

An extensive survey of intestinal parasitic infections in Chiang Mai was carried out by Thitasut *et al.* (1973). A total of 2,653 samples were collected from 6 districts were examined by the formalin-ether concentration method. The results revealed that *O. viverrini* and hookworm were the prevalent parasitic infections, with an overall average of 25.0 and 24.3%, respectively. *A. lumbricoides, S. stercoralis, T. trichiura* and *F. buski* were less common, with an overall average incidence of 9.2, 6.0, 5.2, and 0.2%, respectively. In the same study, *E. vermicularis* and *Taenia* spp. were found with the prevalence rate of 1.2 and 2.1%, respectively.

In 1978, Khamboonruang *et al.* while investigating for a new endemic area of paragonimiasis in Mae Chan district of Chiang Rai Province also observed the prevalence of other intestinal parasites in relation to *Paragonimus.* A total of 910 stool specimens were examined by the formalin-ether centrifugation method. They reported that the most common intestinal parasites were *O. viverrini,* hookworm, and *A. lumbricoides,* with an overall average of 40.0, 30.4, and 26.1%, respectively. *S. stercoralis* and *T. trichiura* were less often encountered with an overall average of 9.0 and 0.3%, respectively. Infection with *E. vermicularis* was 1.8% and 1.2% for *Taenia* spp.

Present study appeared to be the most exact study ever performed in Thailand, in regard to the methods used for examination. A total of 3,012 stool samples, collected from 8 districts in Chiang Mai Province, were examined in the months of July and August, 1981. The prevalence of hookworm and *O. viverrini* infections were rather high, with an overall average of 47.7 and 37.1%, respectively. *T. tricchiura* infection was also common with the average of 19.5%. *S. stercoralis* and *A. lumbricoides* were found less common, with the average of 6.3 and 0.3%, respectively. In this series, *E. vermicularis* and *Taenia* spp. eggs were found with a prevalence rate of 0.7 and 2.7%, respectively. *Rhabditis* spp. were found only after culture with an incidence of 1.1%.

To summarize the intestinal helminthic infections in the northern Thailand, the parasites will be discussed individually.

Ascaris lumbricoides: The prevalence of *A. lumbricoides* infection in the early reports was rather high, ranging from 59 to 9%. However, in the present study of 1981, the infection rate was with the average of only 0.3%. It is postulated that this probably resulted from mass treatment of intestinal helminthic infections with the local berries "Maklua" (*Diopyros mollis*) under the Helminthiasis Control and Eradication Project, Department of Communicable Disease and Control, Ministry of Public Health, Thailand. Another obtained anthelminthic drugs, especially, "Piperazine" from the drug store without any prescription.

Trichuris trichiura: The prevalence of infection with this nematode in the north is variable. In some Provinces the infection rate was as high as 52%, whereas in other it was only 0.3%. Therefore, the infection rate would vary depending upon the area selected for survillance.

Enterobius vermicularis: From the review of the literature, the infection rates ranged from 0.7 to 2.8%, except that re-

ported by Kerr in 1916. He examined the stool samples for the adult worms after giving anthelminthic drug and found the infection rate was as high as 50% in the male prisoners which were the subjects of his study. Thereafter, however, an attempt had never been made to determine *Enterobius* infection in the north. Therefore, the prevalence of this infection is underestimated.

Hookworm: Hookworm infection is common throughout the north of Thailand, ranging from 95 to 5%. The infection rate was higher in rural areas than in urban areas. This difference is mainly due to the habits of defecating directly into the fields and walking with bare feet while working in the paddy fields in the rural area. The habits of the population are favorable for the dissemination of the parasite.

It was found that *Necator americanus* was by far the most prevalent hookworm species parasitizing humans in the north. In the present study, *N. americanus* was the only species of hookworm identified after culture. Anaemia in the people of the north is also common and it is believed that hookworm infection may play some role among other causes of anaemia such as malnutrition.

Strongyloides stercoralis: In contrast to hookworm infection, *S. stercoralis* infection was much lower. In all reports, except one by Kerr in 1916, the prevalence rate was below 10%, ranging from 1 to 9%.

Opisthorchis viverrini: In earlier investigation, liver fluke infection was much lower than in recent studies. In the present study in Chiang Mai Province the prevalence rate was 37%. The natives in the north are very fond of eating raw fish in typical Thai dishes called "Larb-pla" and "Koi-pla". In addition, individuals from the infected population from northeast of Thailand which is considered to be the endemic area of liver fluke infection has immigrated to the north. The liver fluke infection will be one of the major problems in the northern Thailand in the future.

Fasciolopsis buski: Fasciolopsiasis is common in central Thailand. In the north, there are many reports of finding characteristic egg of *F. buski* in the stool, although the adult worm has never been found. Since the egg of *F. buski* is similar to those of *Fasciola hepatica* or *Echinostoma* spp., it is possible that most of the cases reported as *F. buski* may have been *Fasciola* or *Echinostoma* infection. It is worthwhile to mention that fascioliasis in cattle and water buffaloes in the northern Thanland is very common. People in the north are very fond of eating raw liver from these animals. So, the egg of *Fasciola* would also be consumed and excreted into the faeces.

Cestodes: Taeniasis is very common in the north of Thailand. Although, the reported prevalence of infection is rather low possibly due to the application of inadequate examination technique for this purpose. *Cysticercus bovis* and *Cysticercus cellulosae* are very commonly found in slughter houses. The people in the north also very fond of eating raw beef and pork, so-called, "Larb" and "Nahm". This is may explain why taeniasis saginata is common. However, it is of interest that taeniasis solium is very rare in contrast to, *Cysticercus cellulosae* which is very common infection of human in this area.

In conclusion, the most common intestinal protozoan infection in the northern Thailand is non-pathogenic amoeba. The prevalence rate of pathogenic amoeba, *Entamoeba histolytica,* is lower, although the extra-intestinal amoebiasis, especially amoebic liver abscess is fairly common. The intestinal flagellate infection, *Giardia lamblia* is frequently seen. The intestinal ciliate infection is rare. As for intestinal helminthic infections, hookworm and liver

fluke, *Opisthorchis viverrini* infections are the most common with considerably high prevalence rate. The most common species of hookworm parasitizing man is *Necator americanus*. *Ascaris lumbricoides* infection was very common and now the prevalence rate is much lower. *Strongyloides stercoralis* and *Trichuris trichiura* infections are found scattered throughout in the northern Thailand with variable prevalence rates of the infection. The most common tapeworm infection is found to be *Taenia saginata*. *Taenia soilum* is rarely found. In contrast, the infection by the larval stage of the worm, cysticerosis, are very common in man.

Summary

From July to August 1981, A total of 3,021 stool samples were collected randomly from natives of 8 districts of Chiang Mai Province. The purpose of the study was to survey the incidence of intestinal parasites using four different techniques, namely: cellophane thick smear, magnesium sulfate-brine floatation, formalin-ether concentration and filter paper-cultivation. The results revealed that the infection rate of intestinal parasites was 76.76%. The incidence of protozoan cysts was: *Entamoeba histolytica*, 1.20%; *Entamoeba coli*, 7.64%; *Endolimax nana*, 1.39%; *Iodamoeba bütschlii*, 0.60%; *Giardia lamblia*, 4.35%; and *Chilomastix mesnili*, 0.03%. For the incidence of helminthic infection, the results were: Hookworm, 74.74%; *Trichuris trichiura*, 19.50%; *Strongyloides stercoralis*, 6.27%; *Ascaris, lumbricoides*, 0.30%; *Rhabditis* spp., 1.10%; *Enterobius vermicularis*, 0.66%; *Opisthorchis viverrini*, 37.10%; and *Taenia* spp., 2.69%. *Necator americanus* was the only species of hookworm found as identified by the culture.

The comparative study of the methods used for detecting protozoan cysts and helminthic eggs suggested that the cellophane thick smear technique was the best for detecting helminth eggs. However, protozoan cysts were not able to be demonstrated by this technique. The magnesium sulfate-brine floatation technique was found to be very useful in detecting hookworm eggs. The formalin-ether concentration tecchnique was suitable for the detection of intestinal helminthic eggs (especially *Opisthorchis viverrini*) as well as protozoan cysts. The cultivation technique was the only method used for successful species differentiation of hookworm. This method also was the most satisfactory for detection of *Strongyloides stercoralis* larvae when compared to the abovementioned techniques.

References

1) Kerr, W. F. J. (1916): Intestinal parasites in Northern Siam. Trans. R. Soc. Trop. Med. Hyg., 9, 82–89.
2) Khamboonruang, C., Hongsbhanich, L., Pan-in, S. and Sukhawat, K. (1978): Paragonimiasis: A survey for a new endemic area in the northern region of Thailand. A final report submitted to the National Research Council of Thailand, pp. 43.
3) Kluklin, K. and Khamboonruang, C. (1964): Balantidiasis: Report of a case. Chiang Mai Med. Bull., 3, 7–12.
4) Manning, G. S., Sukhawat, K., Viyanant, V., Subhakul, M. and Lertprasert, P. (1969): *Fasciolopsis buski* in Thailand with comments on other intestinal parasites. J. Med. Ass. Thailand, 52, 906–914.
5) Na Bangxang, H., Sivasomboon, C., Yasmuth, C., Kanchanop, T. and Thitasut, P. (1969): A survey of parasitic infection in Sarapee district, Chiang Mai, Thailand. Chiang Mai Med. Bull., 8, 119–134.
6) Papasarathorn, T., Julalerk, P., Julalerk, V., Viboonwat, C., Kiatvut, A. and Rotchanapremsuk, C. (1969): Incidence of intestinal parasitic infection and epidemiology of *Ascaris* at Tambol Dong Jane, Phayao district, Chiang Mai Province. J. Med. Ass. Thailand, 52, 311–321.
7) Sadun, E. H. (1953): Intestinal helminthic infections in Thailand. J. Med. Ass. Thailand, 36, 101–120.

8) Sadun, E. H. (1955): Studies on *Opisthorchis viverrini* in Thailand. Am. J. Hyg., 62, 81–115.

9) Sadun, E. H. (1955): Studies on the distribution and epidemiology of hookworm, *Ascaris*, and *Trichuris* in Thailand. Am. J. Hyg., 62, 116–155.

10) Thitasut, P., Na Bangxang, H., Yasmuth, C., Sivasomboon, C. and Doege, T. C. (1973): A survey of intestinal parasite, Chiang Mai, Thailand. Chiang Mai Med. Bull., 12, 99–123.

11) Vajrasthira, S. and Harinasuta, C. (1957): Studies on helminthic infections in Thailand. 1. Incidence, distribution, and epidemiology of seven common intestinal helminths. J. Med. Ass. Thailand, 40, 309–339.

12) Yasmuth, C., Thitasut, P., Na Bangxang, H., Sivasomboon, C., Kanchanop, T. and Suwanphanich, P. (1968): The prevalence of intestinal parasites in village number 3, Tambol Sarapee, Sarapee district, Chiang Mai, Thailand. Chiang Mai Med. Bull., 7, 109–119.

タイ国北部チエンマイ県における腸管内寄生虫の調査成績

山口富雄　稲葉孝志　黄　文雄　石田邦夫　藤巻康教
（弘前大学医学部寄生虫学教室）
CHIRASAK KHAMBOONRUANG　PRAYUTH THITASUT
（チェンマイ大学医学部寄生虫学教室）
浅野宏司
（弘前大学医学部細菌学教室）
SUVAJRA VAJRASTHIRA
（マヒドール大学熱帯医学部蠕虫学教室）

1981年7月～8月の間，タイ国北部チエンマイ県において一般住民の寄生虫保有状況を検査した．この調査は，4つの検査法を同時に行ったことから，これまでタイ国において行われてきた腸管内寄生虫の調査成績のうちでは，最も正確なものといえる．検査法としては，セロファン厚層塗抹法，硫苦食塩水浮遊法，ホルマリン・エーテル遠心沈殿法および沪紙培養法の4法を用いた．

チエンマイ県の8地区から集めた総数3,012検体について検査を行ったが，そのうち原虫類の検出成績は次のとおりである．大腸アメーバ 7.64%，赤痢アメーバ 1.20%，小形アメーバ 1.39%，ヨードアメーバ 0.60%，ランブル鞭毛虫 4.35%，メニール鞭毛虫 0.03%．また，蠕虫類としては，鉤虫およびタイ肝吸虫は全体として，それぞれ 47.74% および 37.10% と高率の寄生を認めた．鞭虫は 19.50%，糞線虫 6.27%，蛔虫 0.3%，蟯虫 0.66%，条虫（*Taenia* spp.）2.69% であった．*Rhabditis* 類の幼虫は，培養によってだけ証明され 1.10%，また，培養で検出された鉤虫幼虫は，すべてアメリカ鉤虫と同定された．