ISSN 0304-2146

日本熱帯医学会雑誌

Japanese Journal of Tropical Medicine and Hygiene

第15巻 第4号 昭和62年12月15日

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日熱医会誌
Japan. J. T. M. H.　　日本熱帯医学会

Japan. J. Trop. Med. Hyg., Vol. 15, No. 4, 1987, pp. 257-268

CHEMOTHERAPEUTIC CONTROL TRIAL OF *PLASMODIUM FALCIPARUM* WITH A COMBINATION OF CHLOROQUINE AND PRIMAQUINE ON SELECTIVE AGE GROUP IN A COASTAL VILLAGE OF NORTH SUMATRA, INDONESIA

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Received July 29 1987/Accepted October 1 1987

Abstract: Active case detection and treatment of malaria in a selective age group of children up to the age of fifteen was carried out to control malaria in a coastal village in North Sumatra, Indonesia from September 1983 to July 1984. A combination of chloroquine for three days with primaquine for three or five days was more effective than only chloroquine for three days. The spleen rate, the parasite rate of *P. falciparum*, the parasite formula of *P. falciparum* and the parasite density index were reduced by this activity. The parasite rate and the parasite formula of *P. falciparum* did not rise up in July 1984 (12.3% and 14.3%, respectively) without any vector control activities, although the parasite rate used to rise up to 27-61% and the parasite formula of *P. falciparum* was 50-86% in July to September every year (1980-1983). Most of the patients in July 1984 were considered to be recurrent or inadequately treated cases of *P. vivax*. Furthermore the density of *P. falciparum* gametocyte in pre-school children was higher than that in school children. We should pay a special attention to pre-school children to interrupt malaria transmission aiming at the gametocyte stage. Detection of glucose-6-phosphate dehydrogenase (G6PD) deficiency was done at the same time and malaria patient with G6PD deficiency was not given primaquine.

INTRODUCTION

Malaria control programme in these days is facing to some difficulties: drug resistant *Plasmodium falciparum*, insecticide resistant anopheline mosquitoes, behavioral change of the vectors, financial problem and so on. In North Sumatra, Indonesia, there is a report of *Anopheles sundaicus*, which is a vector in a coastal village, Perupuk, having exophilic character and few indoor resting behavior (Ikemoto, 1982). The residual house spraying with DDT could not reduce the parasite rate in Perupuk village, which was explained by the exophilic character and the lack of indoor resting behavior, although *A. sundaicus* in this village was still sensitive to DDT (Karoji, 1982). As malaria control by residual house spraying for adult mosquito is not

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This work was supported by Japan International Cooperation Agency (JICA) as the project for the promotion of health in North Sumatra, which was an international cooperation project between the Republic of Indonesia and Japan.

expected in this village, the other method for larval control, using fishes and larvicides, is now under investigation (Ikemoto *et al.*, 1986; Imai *et al.*, 1987). We plan to apply the method for the field from 1987.

Prior to introduction of the new method for mosquito control, we carried out a trial of case detection and treatment of parasite carrier with chloroquine and primaquine to cut down the transmission of malaria at the gametocyte stage. Between two species of *Plasmodium*, *P. falciparum* and *P. vivax*, we chose *P. falciparum* carrier as the main target, especially its gametocyte carrier. Furthermore we concentrated our activity on the target group of children up to the age of fifteen. For the prevalence and the density of *P. falciparum* gametocyte in young generation are reported to be higher than those in adult in a malaria endemic area (Molineaux and Gramiccia, 1980). Primaquine is effective for clearing *P. falciparum* gametocyte, however, it has a harmful effect such as haemolytic crisis on glucose-6-phosphate dehydrogenase (G6PD) deficient persons. A simple screening test for G6PD deficiency was developed (Fujii *et al.*, 1984) and 3.9% of male was detected as G6PD deficient in North Sumatra (Matsuoka *et al.*, 1986). We carried out malaria detection and G6PD test at the same time in this chemotherapeutic trial.

Materials and Methods

Study area and epidemiological consideration

The study site was Perupuk, a village of farmers and fishermen located at 3°17′ North and 99°31′ East on the northeast coast of Sumatra island, Indonesia. Population size was about 6,000, composing of 13 sub-villages (Lorongs). Two coastal sub-villages (Lorong I and Lorong II) with population size of 1,240 were chosen for this study because of their high parasite rates. The parasite rate increased from June and reached a peak, which was 29.1% in August, and thereafter declined sharply to 6.5% in January (Kanbara and Panjaitan, 1983). The parasite formula of *P. falciparum* also increased in June to September and decreased after October (Matsuoka *et al.*, 1984a) (Table 1).

Table 1 Changes of the parasite rate and the parasite formula of *P. falciparum* in Perupuk village, Indonesia from 1980 to 1983

Year	Low Endemic Season				High Endemic Season			
	Month	No. of blood exam.	Parasite Rate	Parasite formula of *P. falciparum*	Month	No. of blood exam.	Parasite Rate	Parasite formula of *P. falciparum*
1980		ND*	—	—	Aug.†	55	29.1%	56.3%
1981	Jan.†	93	6.5%	16.7%	Sep.‡	67	26.9%	50.0%
1982	Feb.‡	57	10.5%	33.3%	Aug.‡	111	61.3%	79.4%
1983		ND*	—	—	Jul.§	137	40.1%	85.5%

* Malariometric survey was not carried out.
† Data from Kanbara and Panjaitan, 1983.
‡ Data from Itokawa and Panjaitan, 1982.
§ Data from Matsuoka *et al.*, 1984b.

From September 1983 to July 1984, house-to-house survey was carried out for six times and spleen and blood examination was done for four times at an elementary school in Lorong II, which was the sole elementary school in Lorong I and II. The list of families in the two Lorongs was previously prepared by the aid of the heads of each Lorong and the list of the pupils in the elementary school was obtained from the schoolmaster. Since larval control method using fishes and larvicides was studied only in labolatory level during this period, any vector control activty was not carried out.

Chloroquine resistant strain of *P. falciparum* was not found *in vivo* in North Sumatra in 1973 (Dondero *et al.*, 1974), but *in vitro,* the resistant strain had been mentioned in North Sumatra in 1983 (WHO, 1986). Residents can buy chloroquine in pharmacy or dispensary when they need for malaria. Primaquine and the other anti-malarials had, however, never been administered in Perupuk village.

House-to-house visiting

House-to-house survey was carried out every six weeks. The main target was children, especially those up to the age of seven. Its population was 310. They were examined their spleen size on the standing position. History of fever was obtained from their parents. We only examined the blood of the child who had enlarged spleen and/or a history of fever within six weeks. Drug was started to administer to parasite positive child from the next day.

Spleen and blood examination in the elementary school

All pupils attending in the elementary school in Lorong II, which had six grades and about 300 pupils whose age were seven to fourteen, were examined of their spleen and blood every three months. Spleen size was examined on the standing position and blood sample was taken by finger pricks. Two drops of blood were taken; one drop was on a slide glass to prepare a thick film for the examination of malaria parasite and another drop was on cellulose paper for G6PD test. The result was recorded individually together with their name, age, body weight, history of fever, address and their father's name. A brief talk about malaria was given to pupils and anti-malarial drug was started to administer to the pupil of parasite positive within one week after the examination.

Parasite counts

Thick film was stained with 4% Giemsa solution (pH 7.4) after being dried well. Each slide was examined more than 200 microscopic fields under oil immersion before being considered as negative. The number of parasite per 2000 white blood cells was counted and total parasite count was estimated based on an assumption that white blood cell count was 8000 cells per μl of blood. The parasite density index was calculated by the method of Bruce-Chwatt (1958).

G6PD test

When blood was taken for parasite examination, another drop of blood ($\fallingdotseq 20\,\mu l$) was dripped onto pre-treated cellurose paper (P81, Whatman, England), which had been saturated with 100 mM Tris-HCl buffer, pH 6.5, containing 10 mM $MgCl_2$, and dried. The cellurose paper with dried blood was punched out in the size of 6 mm in diameter and G6PD test was carried out by the method as previously described (Fujii *et al.*, 1984; Matsuoka *et al.*, 1986).

Treatment

Medication to the parasite carrier was done by the recipe as follows: on the 1st day 10 mg/kg of chloroquine and 0.25 mg/kg of primaquine, on the 2nd day the same amount as the 1st day, on the 3rd day 5 mg/kg of chloroquine and 0.25 mg/kg of primaquine. To the carrier of *P. vivax* 0.25 mg/kg of primaquine was added for more two days. We started to use primaquine after March 1984; only chloroquine was used by the three-day-schedule before February 1984. On the first treatment day all parasite carrier were given medicine by our medical staffs. After the second day the parasite carrier of under-7-year juvenile was given medicine by their parents, and pupil in the school was given medicine by the school teachers. Primaquine was not used for G6PD deficient individual, bacause there was a possibility of haemolytic crisis to G6PD deficient subjects. Only chloroquine was administered to them.

RESULTS

Pre-school children

The spleen rate of 0–7 years old was the highest at the first house-to-house visiting and decreased after the second visiting (Table 2). It kept at low level until the sixth visiting. The slide positivity rate ranged from 56 to 73% and did not show remarkable change throughout these activities. However, the parasite formula of *P. falciparum* decreased. Because *P. falciparum* and *P. vivax* ratio changed. The number of *P. falciparum* carrier was larger than that of *P. vivax* carrier in the first visiting. In the second and third visiting the number was same, then in the forth to sixth visiting the number of *P. vivax* carrier became higher. The species parasite density index of *P. vivax* decreased. The density of *P. falciparum* gametocyte and the number of its carrier also decreased (Figure 1).

School children

The same tendency was observed in pupils of the elementary school (Table 3). The spleen rate decreased. The parasite rate of *P. falciparum* also decreased. The parasite formula of *P.*

Table 2 Spleen and parasite examination of 0–7 years children obtained by house-to-house visiting in Lorong I and II, Perupuk village from September 1983 to May 1984

Month	No. of spleen exam.	Spleen enlarged (%)	No. of blood exam.	*Plasmodium* Positive Total (%)	*P. fal.*	*P. viv.*	mix	Parasite Formula of *P. fal.* (%)	Species Parasite Density Index of *P. fal.*	*P. viv.*
Sep.-Oct.	30	15 (50.0)	22	14 (63.6)	11	3	0	78.6	5.91	8.00
Nov.	101	14 (13.9)	23	16 (69.6)	8	8	0	50.0	4.88	5.78
Dec.-Jan.	128	15 (11.7)	19	13 (68.4)	6	6	1	53.8	4.14	5.43
Jan.-Feb.	124	10 (8.1)	22	16 (72.7)	1	15	0	6.3	9.00	1.96
Mar.-Apr.	141	12 (8.5)	17	12 (70.6)	4	7	1	41.7	5.40	3.00
Apr.-May	149	6 (4.0)	18	10 (55.6)	3	7	0	30.0	3.00	1.00
Total	673	72 (10.7)	121	81 (66.9)	33	46	2	43.2	5.09	3.51

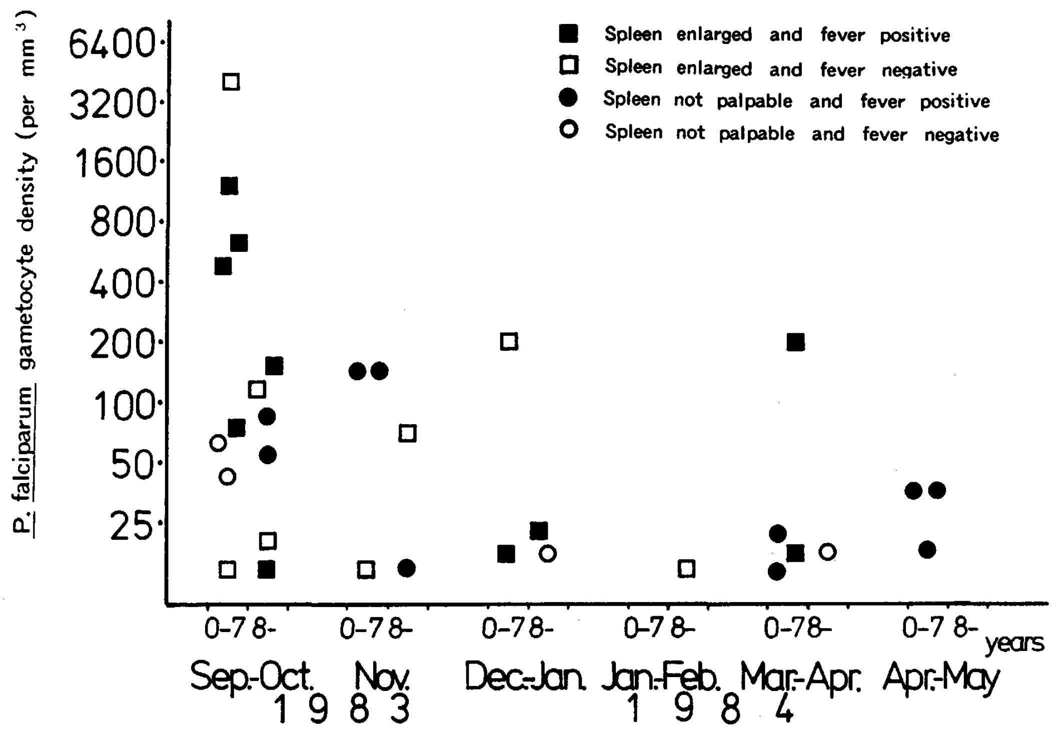

Figure 1 Density of *P. falciparum* gametocyte in the case found by house-to-house visiting in Lorong I and II, Perupuk village. Fever positive (■, ●) means having a history of fever within six weeks; fever negative (□, ○) means no history of fever within six weeks.

Table 3 Spleen and parasite examination of pupils in the elementary school of Lorong II, Perupuk village from Oct. 1983 to Jul. 1984

	No. of total examination	Spleen enlarged	*Plasmodium* Positive				Parasite Formula of *P. fal.*	Species Parasite Density Index of	
			Total	*P. fal.*	*P. viv.*	mix		*P. fal.*	*P. viv.*
		(%)	(%)	(%)	(%)	(%)	(%)		
Oct. 1983	292	43 (14.3)	41 (14.0)	33 (11.3)	7 (2.4)	1 (0.3)	82.9	3.11	1.63
Jan. 1984	280	22 (7.9)	35 (12.5)	16 (5.7)	17 (6.1)	2 (0.7)	51.4	1.72	1.89
Apr. 1984	266	1 (0.4)	47 (17.7)	17 (6.4)	29 (10.9)	1 (0.4)	38.3	1.89	1.43
Jul. 1984	228	2 (0.9)	28 (12.3)	3 (1.3)	24 (10.6)	1 (0.4)	14.3	2.00	1.04
Total	1,066	68 (6.4)	151 (14.2)	69 (6.5)	77 (7.2)	5 (0.5)	49.0	2.43	1.44

falciparum remarkably decreased because the number of *P. falciparum* carrier decreased while the number of *P. vivax* carrier did not decrease. The parasite density index decreased. The density of *P. falciparum* gametocyte and the number of its carrier also decreased (Figure 2). The *P. falciparum* gametocyte carrier with high density had a tendency to have enlarged spleen

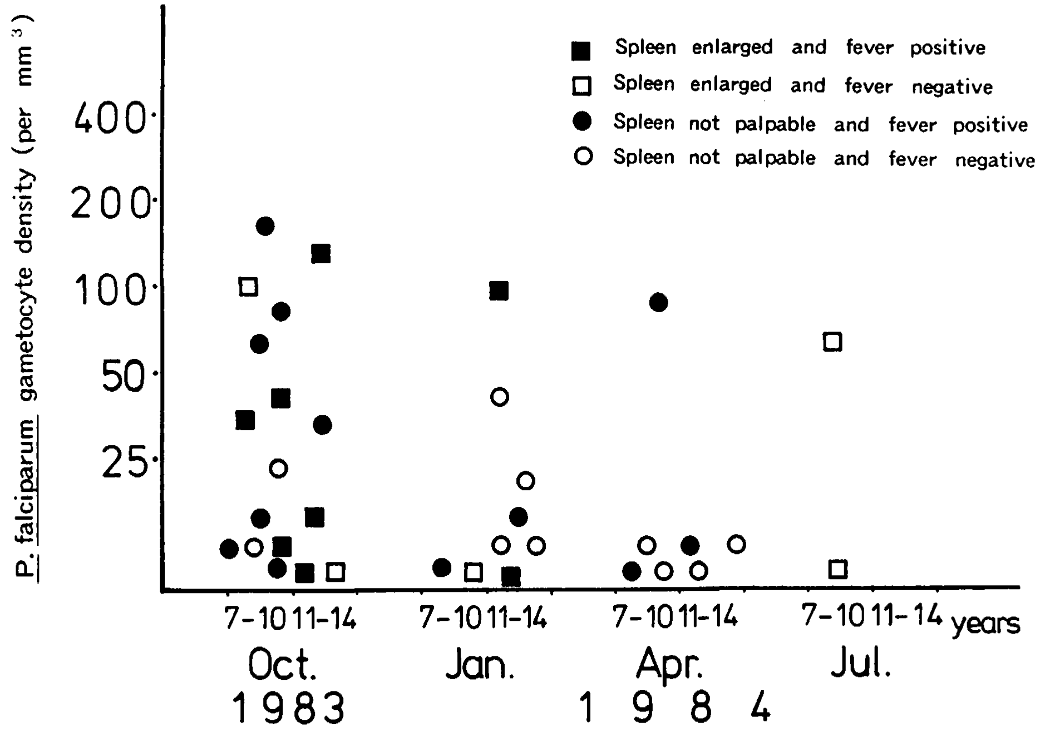

Figure 2 Density of *P. falciparum* gametocyte in the pupil found by blood examination in the elementary school of Lorong II, Perupuk village. Fever positive (■, ●) means having a history of fever within six weeks; fever negative (□, ○) means no history of fever within six weeks.

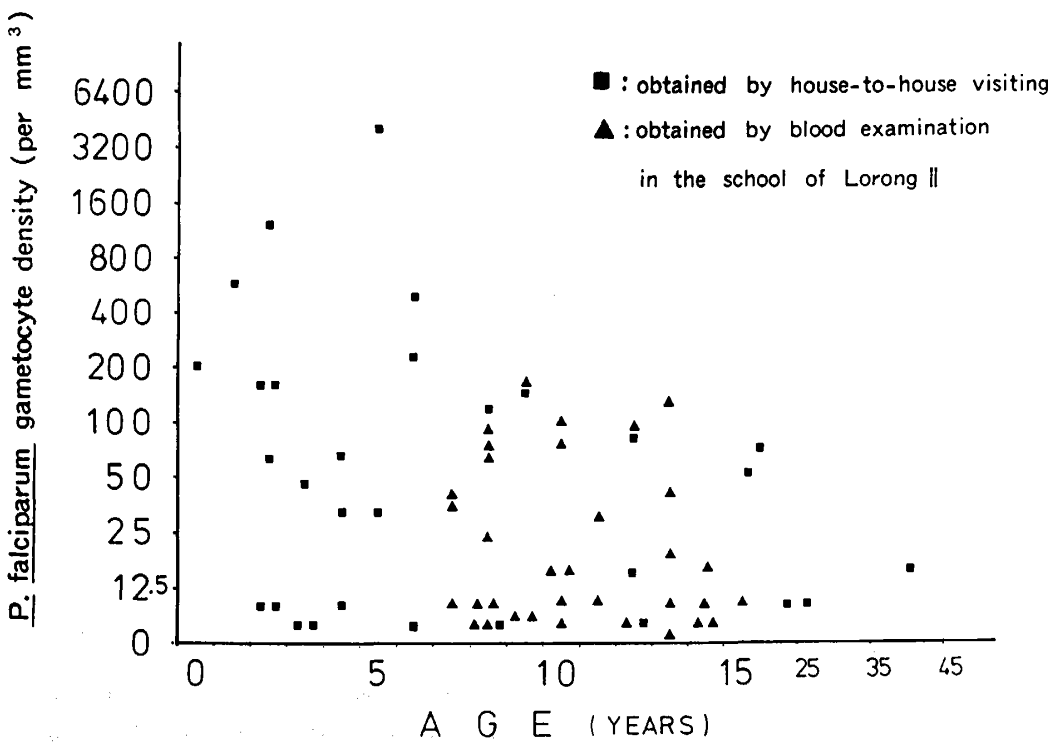

Figure 3 Distribution of *P. falciparum* gametocyte density by age in all cases obtained through the activities from September 1983 to July 1984.

and/or history of fever.

The younger the age, the higher was the gametocyte density of *P. falciparum* (Figure 3). Over 7 years old there was no case having *P. falciparum* gametocyte beyond 200/μl.

Treatment

The effect of therapy to parasite carrier is showed in Table 4. The rate of the cases from positive to positive in Term III (8.8%) was statistically lower than the average conversion rate of the cases from positive to positive in Term I and Term II (29.0%) ($\chi^2=4.13$; $p<0.05$). On the other hand, the rates of the cases from negative to positive in each Term were not different (9.3%, 14.4% and 13.5%, respectively). The majority of the positive cases in each Term were occured in the negative group at three months before.

Table 4 Tri-monthly follow-up of malaria positive and negative case in school children

Period	Result of Initial Blood Examination		Treatment	Result of re-examination of blood after three months					Not exami-ned
				Positive (%)	*P. fal.*	*P. viv.*	mix	Negative (%)	
Term I									
	Negative case	251		20 (9.3)	12	8	0	195 (90.7)	36
Oct. 1983	Positive case	41	Chloroquine	7 (21.2)	4	2	1	26 (78.8)	8
to	*P. falciparum*	33		6 (21.4)	3	2	1	22 (78.4)	5
Jan. 1984	*P. vivax*	7		1 (20.0)	1	0	0	4 (80.0)	2
	mix	1		0	0	0	0	0	1
Term II									
	Negative case	245		29 (14.4)	9	19	1	173 (85.6)	43
Jan. 1984	Positive case	35	Chloroquine	11 (37.9)	6	5	0	18 (62.1)	6
to	*P. falciparum*	16		5 (41.7)	3	2	0	7 (58.3)	4
Apr. 1984	*P. vivax*	17		4 (26.7)	3	1	0	11 (73.3)	2
	mix	2		2 (100)	0	2	0	0	0
Term III									
	Negative case	219		18 (13.5)	2	16	0	115 (86.5)	86
Apr. 1984	Positive case	47	Chloroquine	3 (8.8)	1	1	1	31 (91.2)	13
to	*P. falciparum*	17	and	2 (18.2)	1	0	1	9 (81.8)	6
Jul. 1984	*P. vivax*	29	Primaquine	1 (4.5)	0	1	0	21 (95.5)	7
	mix	1		0	0	0	0	1 (100)	0

P. falciparum gametocyte carriers in the school were followed up of the blood after being given chloroquine and primaquine by the regimen and schedule as described above. No gametocyte was found in the blood on the day 7, 28 and 90 after the treatment (Table 5).

G6PD test

The result of G6PD test was showed in Table 6. Twelve cases were detected to be G6PD deficient in 286 males (4.0%). There was no G6PD deficient in female. One of the twelve cases was *P. vivax* positive. He was treated with only chloroquine for 3 days.

Table 5 Follow-up of *P. falciparum* gametocyte carriers treated with chloroquine and primaquine* in the school of Lorong II, Perupuk village from April to July 1984

Age	Sex	Number of *P. falciparum* gametocyte per μl of blood			
		Day 0	Day 7	Day 28	Day 90
7	F	8	ND**	0	ND**
8	M	4	0	0	0
10	F	4	0	0	0
10	M	80	0	0	0
10	F	8	0	0	0
14	M	8	0	ND**	ND**
14	M	4	0	0	ND**

* All patients were G6PD normal and started to take chloroquine and primaquine from Day 1 by the principle described in Materials and Methods.

** Blood examination was not done.

Table 6 Prevalence of G6PD deficiency in Perupuk village, North Sumatra

Blood Obtained at	Male No. (%)		Female No.	
	G6PD deficient	G6PD normal	G6PD deficient	G6PD normal
House-to-house visits Feb.-May 1984	1 (2.0)	48 (98.0)	0	36
Blood exam. in the school of Lorong II, Apr. 1984	6 (4.2)	137 (95.8)	0	123
Blood exam. in the school of Lorong II, Jul. 1984	5 (4.7)	101 (95.3)	0	121
Total	12 (4.0)	286 (96.0)	0	280

Discussion

Several kinds of approach such as vector control, vaccination, case control and others are considered to control malaria by cutting off the life cycle of the parasite. In case control there is a posibility to administer gametocyticidal drug to gametocyte carrier in order to intercept malaria transmission to mosquito. First of all we found that the carrier of *P. falciparum* gametocyte with high density had a tendency to have enlarged spleen and/or a history of fever prior to several weeks (Figures 1, 2). The density of *P. falciparum* gametocyte in pre-school children was higher than that in elementary school children in this village (Figure 3). Rieckmann *et al.* (1968, 1969) observed sporozoite in salivary gland of *A. stephensi* using human volunteer with *P. falciparum* gametocyte to study the effect of primaquine. After biting blood with *P. falciparum* gametocyte at the density of roughly over 100 per μl of blood, sporozoites were appeared in salivary gland of the mosquitoes. However, under 100 per μl of blood, no sporozote was observed. According to their records, it is important for cutting the life cycle of *P. falciparum* at the gametocyte stage to give medicine to the carriers having gametocyte over 100 per μl in the blood. Thus a special attension should be paid to pre-school children who have a tendency of high gametocyte density to interrupt malaria transmission aiming at the gametocyte stage.

We used primaquine to the carrier of *P. falciparum* gametocyte for three days, and demonstrated the effectivness of primaquine to clear gametocyte in the blood (Table 5). Since we had few cases with the gametocyte density over 100 per μl after we started administering primaquine, we did not follow up those cases. Further study is needed.

We compared the effect of treatment with chloroquine only and with chloroquine and primaquine (Table 4). The rates of the cases from negative to positive were not different in each Term but the rate of the cases from positive to positive in Term III was lower than that in Term I and II. This fact indicates that the condition of new infection and relapse was same in each Term and the effect of the treatment in Term III was better than that in Term I and II. We consider two reasons for this. The first is the effect of primaquine to exoerythrocytic form of *P. vivax*. The administration of primaquine for five days protected relapse of *P. vivax* in some degree. The second reason is the effect of drug combination with chloroquine and primaquine to asexual form of *P. falciparum*. In Perupuk village, chloroquine resistant strain of *P. falciparum* was found *in vitro* in 1983 (WHO, 1986). Drug combination was recommended in treatment of *P. falciparum* cases in the area where chloroquine resistant strain *in vitro* was reported (Onori *et al.*, 1985). Since the resistance to chloroquine *in vivo* was not so severe according to the result in Term I and II, the medication of the combination with chloropuine and primaquine was carried out.

After the case detection and treatment from October 1983 to July 1984 in Perupuk village, the spleen rate, the parasite rate of *P. falciparum*, the parasite formula of *P. falciparum* and the parasite density index were decreased (Tables 2, 3). In July 1984 the parasite rate did not rise up and remained 12.3% with the parasite formula of *P. falciparum* 14.3%. These rates in this season were statistically lower than those of former years ($p<0.005$; $p<0.025$). The majority of the positive cases of *P. vivax* in January, April and July 1984 were occured in the negative group at three months before (Table 4). During three months, reccurence and new infection occured in the negative group. Since the parasite density index of *P. vivax* was low (Table 2, 3), new infection cases might be few, based on the idea that new infection generally showed higher parasitemia than old one (Kanbara and Panjaitan, 1983). Primaquine or the other medicines for exoerythrocytic form of *P. vivax* had not been administered in Perupuk village, most of children had a posibility of reccurence of *P. vivax*. Therefore the parasite rate of *P. vivax* did not decrease within one year. If primaquine is applied routinely, the parasite rate of *P. vivax* will also decrease.

In administering primaquine, we should be careful of haemolysis in G6PD deficient persons. Primaquine is known of this problem, therefore, it is difficult to use primaquine in the field where malaria is endemic with a possibility of high occurance of G6PD deficiency. According to Clyde (1981), in the treatment of malaria of G6PD deficient individuals, primaqine should not be given or it should be administered under supervision with close attention to the dosage and duration of treatment. In the present trial, we established a system of detecting both G6PD deficiency and malaria at the same time in order not to use primaquine for the malaria patients with G6PD deficiency. The G6PD screening method we employed this time needs no special equipment. The procedure is so simple and reading is so easy that hundreds of sample can be tested in one day. If the budget allows, malaria patient had better be examined for G6PD test before taking primaquine. It costs $0.04 for test of one sample.

Case detection and treatment is one of the malaria control method in the area where malaria endemisity is well confined. Perupuk village was composed of 13 sub-villages but the high parasite rate was limited to two or three sub-villages near coast. The vector of *Anopheles sundaicus* was restricted to coastal area and showed patchy distribution along the coastal zone (Kanbara and Panjaitan, 1983). Therefore there is a possibility to control malaria by the case detection and treatment in this village. However these activities must be done periodically because the vector mosquitoes still remained. In Nicaragua, mass drug administration of both chloroquine and primaquine was carried out in the whole country. The incidence rates of *P. vivax* and *P. falciparum* infection were both reduced but the effects were limited. That is, the impact of the treatment on *P. vivax* cases lasted for four months and on *P. falciparum* for seven months (Garfield and Vermund, 1983). To keep the parasite rate at a low level, the activity of the case detection and treatment might be carried out at least two or three times in one year. In this trial, selective age group treatment resulted in a reduction of malaria indices without any vector control activities. Since larval control method using fishes and larvicides is investigated in Perupuk village, the new vector control method and the case detection and treatment will be combined in near future. It will be more effective for control malaria in this village.

Acknowledgements

The authers are grateful to Dr. Helmi Djafar, who was Project Manager and Director of North Sumatra Provincial Health Service; to Dr. R. Takai, Leader of JICA experts team; and to Dr. R. Tampubolon, Deputy Manager of this health project.

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インドネシア国北スマトラ州の1村落における小児を対象としたクロロキンとプリマキンによる熱帯熱マラリアのコントロールの試み

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インドネシア国北スマトラ州の海岸に面した1村落で，15歳以下のマラリア患者を集中的に診断・治療することでマラリアのコントロールを試みた。この村には熱帯熱と三日熱マラリアが流行しており，例年7－9月には原虫陽性率は27～61%に上昇し，うち熱帯熱マラリア原虫が50～86%を占める(1980－83)。1983年9月から1984年7月まで，active case detection を6回，学童の集団採血を4回行い，原虫陽性者にクロロキン3日間，プリマキン3日間（熱帯熱）または5日間（三日熱）を投与した。プリマキンの使用にあたっては G6PD のスクリーニングを同時に行い，欠損者には投与しなかった。

11カ月にわたる活動の間に，学童における脾腫率は14.3%から0.9%に，熱帯熱マラリア原虫陽性率は11.6%から1.7%に低下した（p<0.001）。最終的に1984年7月の原虫陽性率は12.3%にとどまり，熱帯熱マラリア原虫はそのうち14.3%であった。この時の原虫陽性者の多くは低い原虫濃度の三日熱マラリアで，再発例または治療不十分例と考えられた。この村では熱帯熱マラリアの生殖母体保有者は低年齢層に多く，その血中濃度も高い傾向であった。小児を対象とした診断・治療活動により生殖母体保有者が効率よく治療され，蚊による伝播も低下したものと考察した。

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LIGHT MICROSCOPIC OBSERVATION OF THE SOCALLED PARENTHESIS-LIKE STRUCTURE OF *PNEUMOCYSTIS CARINII* CYSTS IN SMEARS STAINED BY GOMORI'S METHENAMINE SILVER NITRATE

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Received September 24 1987/Accepted October 24 1987

Abstract: In order to elucidate the morphology of the so-called parenthesis-like structure of *Pneumocystis carinii* cysts, human lungs and bronchoalveolar lavage specimens have been studied light microscopically using Gomori's methenamine silver nitrate stain. The parenthesis-like structures could be seen much more clearly than the cyst walls in the moderately stained organisms. Usually the inside of the structures was weakly stained. Measurements of the cysts were within the range of $4.0–6.8 \times 3.0–5.2\,\mu$m, and those of parenthesis-like structures were $1.6–2.2 \times 0.8–1.8\,\mu$m when 100 cysts with such structures were counted. The side views of the parenthesis-like structures were recognized as the thickened internal parts of the cyst walls. No cysts which had two or more parenthesis-like structures were found. The cysts without parenthesis-like structures were observed in 37.3% of 660 moderately stained cysts. Some parenthesis-like structures were found without distinct cyst walls.

INTRODUCTION

Pneumocystis carinii (Pc) is a causative organism of fatal pneumonia encountered in the patients with congenital immune dysfunction or the recipients of immunosuppressive therapy for malignant neoplasm, organ transplantation or other similar conditions. It also occurs in premature or malnourished infants. Recently, this pneumonia has been recognized to be the most critical complication of acquired immunodeficiency syndrome (AIDS).

Laboratory diagnosis of Pc pneumonia is based on the identification of the causative organism in materials from the patients, usually by demonstrating the existence of the cysts. It is commonly known that Gomori's methenamine silver nitrate (GMS) and toluidine blue-O are reliable for staining the cyst wall (Grocott, 1955; Chalvardjian and Grawe, 1963). GMS in particular, selectively stains the cyst wall and the so-called parenthesis-like structure in dark brown color in strong contrast with the background. The parenthesis-like structure is a characteristic of Pc, hence the presence of this structure strongly suggests that the cyst is Pc. Some investigators suggest that the structure may consist of thickened portions of the cyst wall, but the exact mode of formation and development of the structure still remain unknown (McNeal and Yaeger, 1960; Vavra and Kučera, 1970; Takeuchi, 1980).

The present paper describes the morphology of the Pc cyst, especially the parenthesis-like

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structure, in smears using GMS stain.

Materials and Methods

GMS-stained smears containing Pc were prepared from the following sources. 1. Human bronchoalveolar lavage specimens taken from patients who had had renal transplantation. 2. Human lungs taken from a 23-year-old man who had had myelogenous leukemia. 3. Human lungs taken from patients who had undergone renal transplantation. The air-dried smears were placed in absolute methyl alcohol for 10 minutes and were then stained by the GMS method. The organisms were observed under oil immersion and by enlarged photographs at a magnification of 5,000 times.

Results

From the thousands of specimens observed, some cysts with parenthesis-like structures are presented in Figures 1 to 4. Usually, the staining property of the parenthesis-like structure increases proportionally to that of the cyst wall.

Figure 1 shows the moderately stained organisms in the smears of the lung. The parenthesis-like structures could be seen much more clearly than the cyst walls. In some cysts, however, the parenthesis-like structures were difficult to detect in the organisms because the cyst wall was too strongly stained (arrowheads). Usually the inside of the structures is weakly stained (arrows for some). Measurements of the cysts were within the range of $4.0–6.8 \times 3.0–5.2\,\mu m$, and those of the parenthesis-like structures were $1.6–2.2 \times 0.8–1.8\,\mu m$ when 100 cysts with such structures were counted.

Figure 2 shows side views of the parenthesis-like structures in the smears of the lung. Usually, the side views of the parenthesis-like structures are recognized as the thickened internal parts of the cyst walls (2a, 2b). The parenthesis-like structure can occasionally be seen in a side view of the wrinkled cyst wall but it can never be seen floating freely by itself in the cyst (2c).

Figure 3 shows the spindle-shaped collapsed cysts with the parenthesis-like structures (3a left and 3b) and without the structures (3a right) in the smears of the lung. Usually, the spindle-shaped cysts have one or two longitudinal folded cyst walls from the poles (arrows for

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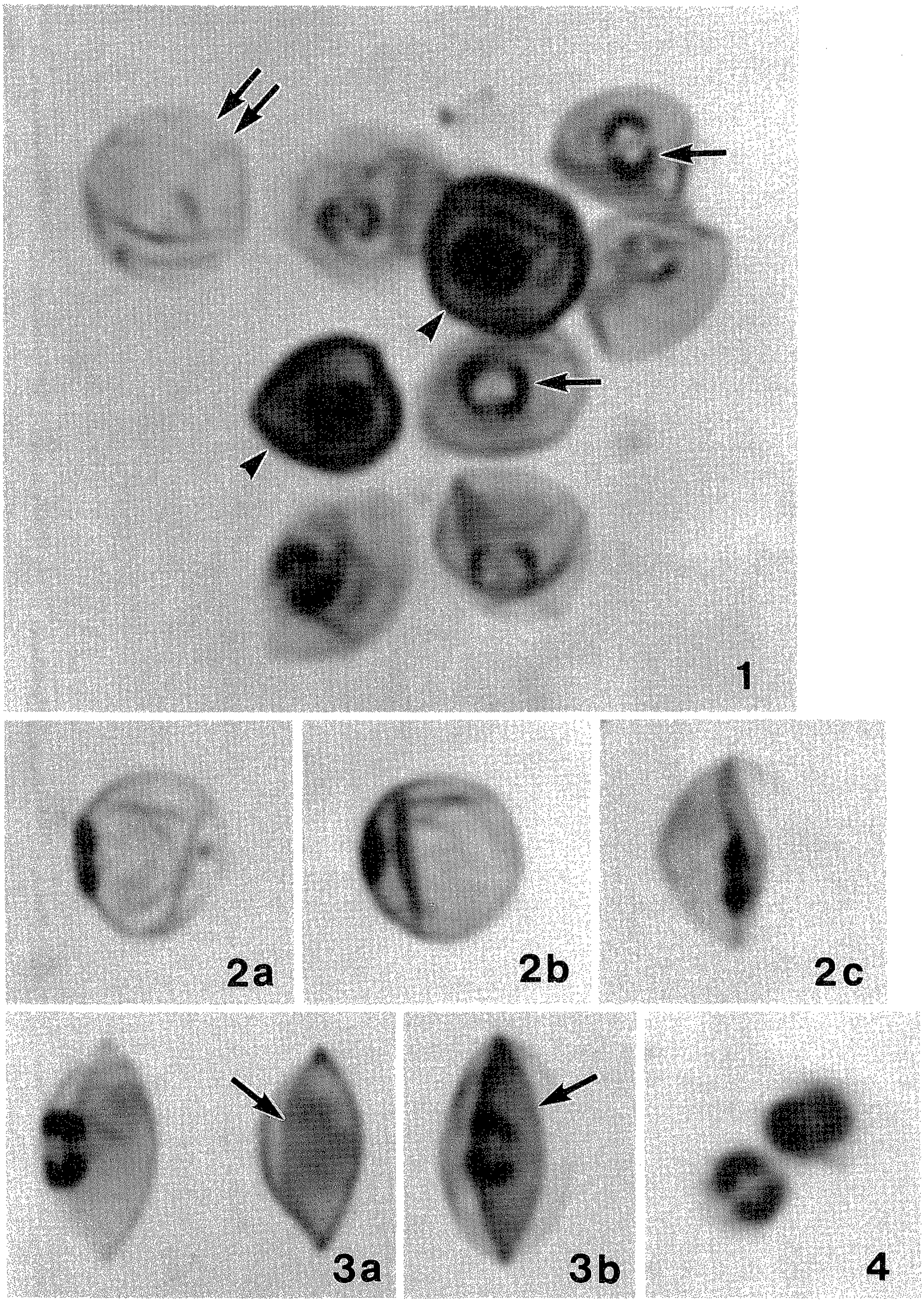
Figure 1 Moderately stained cysts in a lung smear. The parenthesis-like structures could be seen much more clearly than the cyst walls. In some cytsts, the structures were difficult to detect in the strongly stained cysts (arrowheads). Usually, the inside of the structures are weakly stained (arrows for some). The double arrow shows a cyst without parenthesis-like structures. (Gomori's methenamine silver nitrate, $\times 5,000$)

Figure 2a–c The side view of the parenthesis-like structures in a lung smear. They are seen as internal thickened parts of the cyst walls (2a, 2b), and occasionally seen in a side view of the wrinkled cyst wall (2c). (Gomori's methenamine silver nitrate, $\times 5,000$)

Figure 3a, b Spindle-shaped collapsed cysts with parenthesis-like structures (3a left, 3b), and without the structures (3a right) in a lung smear. Usually, these cysts have one or two longitudinal folded cyst walls from the poles (arrows for some). (Gomori's methenamine silver nitrate, $\times 5,000$)

Figure 4 Parenthesis-like structures without distinct cyst walls in a lung smear. (Gomori's methenamine silver nitrate, $\times 5,000$)


1
2a
2b
2c
3a
3b
4

some).

The cysts without parenthesis-like structures (Fig. 1 double arrow, Fig. 3a right) were observed in 37.3% of 660 moderately stained cysts. Figure 4 shows the parenthesis-like structures without distinct cyst walls. Throughout this observation, we could not find any cyst having two or more parenthesis-like structures.

Discussion

Gomori's stain selectively stains the cyst wall and the so-called parenthesis-like structures in brownish black colour with strong contrast to the background (Ruskin, 1982; Sun, 1982). The variety of the staining property (Fig. 1) seemed to depend chiefly on the development of Pc as observed by phase-contrast microscope and Giemsa staining (Shiota, 1984).

Concerning the origin of parenthesis-like structures, Kim *et al.* (1972) double-stained Pc on impression smears of rat lung with methenamine silver and polychrome methylene blue and stated that these parenthesis-like structures seemed to be part of the cyst wall or at least closely related to the cyst wall. The present author (Shiota, 1986) reported in a preliminary study of the double staining of Pc with GMS and Giemsa in paraffin embedded lung sections that the parenthesis-like structures can be mainly seen in empty cysts, but sometimes can be seen in mature cysts that contain intracystic bodies. According to the present studies, parenthesis-like structures obviously correspond to internally thickened parts of the cyst walls. These findings, therefore, suggest that the parenthesis-like structure may develop in the internal parts of cyst walls of immature cysts.

The parenthesis-like structure is a characteristic of Pc, hence the presence of this struture in patient's materials makes it easy to distinguish Pc from the ascospore of fungi that have similar staining property for GMS stain.

Acknowledgements

I sincerely thank Professor Yukio Yoshida, the director of the Department of Medical Zoology, Kyoto Prefectural University of Medicine, Kyoto, Japan, for his interest, guidance, and encouragement throughout this study and his critical reading of this manuscript.

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Gomori's methenamine silver nitrate 染色を行った塗抹標本における *Pneumocystis carinii* 嚢子のいわゆる括弧状構造物の光学顕微鏡的観察

塩 田 恒 三

Gomori's methenamine silver nitrate 染色で *Pneumocystis carinii* の嚢子に特異的に認められる，いわゆる括弧状構造物の形態をより明らかにするために，ヒトの気管支肺胞洗浄液と剖検肺の塗抹標本を光顕的に調べた。適度に染めた個体では括弧状構造物は嚢子壁よりも明瞭に染まり，嚢子100個を調べて嚢子の大きさは 4.0～6.8×3.0～5.2μm で本構造物の大きさは 1.6～2.2×0.8～1.8μm の範囲であった。一般に本構造物の内部は外部よりも淡く染まった。本構造物の側面像は嚢子壁の内部への肥厚部として観察された。2つ以上の本構造物を有する個体は認めなかった。一方，本構造物を有さない嚢子は660個中37.3%に認め，嚢子壁が染め出されずに本構造物のみが染まった個体も少数認められた。患者の喀痰などを用い診断する場合，真菌との鑑別が重要となるが，この括弧状構造物を見出せば自信をもって *P. carinii* と言うことができる。

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Japan. J. Trop. Med. Hyg., Vol. 15, No. 4, 1987, pp. 275-285

CHANGES IN NUTRITIONAL PARAMETERS AND THEIR INTER-RELATIONSHIPS DURING RECOVERY FROM PROTEIN-ENERGY MALNUTRITION IN GHANAIAN CHILDREN

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Received October 11 1987/Accepted November 24 1987

Abstract: Studies were conducted to examine changes in anthropometric parameters and their relationships with energy and nitrogen intakes and nitrogen balance during recovery from protein-energy malnutrition. Eight male Ghanaian children with protein-energy malnutrition, who were on admission in a hospital, formed the subjects. Ages of subjects ranged from 18 to 42 months old. Their mean body weights and heights were 8.5 ± 1.4 kg and 78.4 ± 6.5 cm respectively. These corresponded to 61.9 ± 5.8% of reference body weight for age (RBW/A), 80.0 ± 5.8% of reference body weight for height (RBW/Ht) and 85.6 ± 5.7% of reference height for age (RHt/A). The subjects received dietary treatment in the hospital and showed rapid recovery. They were observed for a period of 4 weeks. Their body weight gain averaged 1.6 ± 0.5 kg. All the anthropometric parameters, with the exception for the abdominal circumference, increased with recovery. Changes in chest, mid-upper arm, thigh, and mid-calf circumferences correlated negatively with the % RBW/A but positively with the energy and nitrogen intakes as well as nitrogen balance. There were a very significant correlation between the nitrogen balance and the change of mid-calf circumference in particular ($r = 0.89$, $p < 0.01$). This study has showed that infants with low % RBW/A, but not with low % RBW/Ht, have high energy intake and positive nitrogen balance and consequently have a high recovery rate as indicated by the changes in their anthropometric measurements.

INTRODUCTION

Malnutrition and its associated diseases rank high among the major causes of infant mortality in the developing countries. The World Health Organization has estimated that in the developing countries, around 2% of young children show severe protein-energy malnutrition (PEM) while about 20% show mild to moderate forms (Truswell, 1985). Even if malnutrition is not the direct cause of death of infants in these countries, it clearly contribute to the prevalence and

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This study was supported by the Japanese International Cooperation Agency and the Government of Ghana.

severity of some communicable diseases (Chandra, 1980). In addition, malnutrition has been reported to be the cause of delay of both physical and brain development in certain instances (Winick and Rosso, 1969; Chase and Martin, 1970). Malnutrition and disease associated with it, therefore, constitute a major problem to children in developing world.

In the developing countries, children with nutritional disease such as protein-energy malnutrition are admitted into hospital, where they are usually given diet therapy. In order to assess the progress and the effectiveness of treatment it is important to determine the nutritional status of such patients before, during and after the prescribed treatment. Various parameters such as nutrient intakes, nitrogen balance, blood biochemistry and anthropometric measurements are used in the assessment of nutritional status. However, in the developing countries biochemical tests and nitrogen balance studies are not commonly used in hospital, particularly in remote areas. On the other hand, the anthropometric measurements, which can be carried out easily without any special skills and equipment are available for use in most of these countries. Therefore, it is necessary in advancing the usefulness of the anthropometric parameters to clarify any relationships that exit between the parameter and other relevant variables. Many studies have been carried out on blood assays and on anthropometric measurements in PEM patients (Young *et al.*, 1978; Forse and Shizgal, 1980; Chen *et al.*, 1980; Khan, 1986; Cooper and Heired, 1982), but only few have been done to examine the relationships between anthropometric parameters and the energy and nitrogen intakes and the nitrogen balance of infants recovering from protein-energy malnutrition. The purpose of the studies reported on in this paper was to investigate the above relationships in Ghanaian PEM patients.

PROCEDURE

Subjects and diets

The study was carried out in 8 Ghanaian infants with protein-energy malnutrition who were on admission at the Princess Maries Louis Hospital in Accra, Ghana. Consent was obtained from the parents or guardians of each subject after detailed explanation of various procedures. The protocol for this study was approved by the Scientific and Technical Committee of the Noguchi Memorial Institute for Medical Research, University of Ghana.

The ages of the subjects ranged from 18 to 42 months. Their mean body weights and heights were 8.5 ± 1.4 kg and 78.4 ± 6.5 cm, corresponding to $61.9 \pm 5.8\%$ of reference body weight for age (RBW/A) and $85.6 \pm 5.7\%$ of reference height for age (RHt/A), respectively, as shown in Table 1. None of the subjects had edema.

Diets for the subjects were formulated and quantitatively prepared by a dietician and served only from the hospital kitchen throughout the 4-week period of observation. They took the meals every 3 hours from 6 : 00 a.m. to 9 : 00 p.m. Table 2 shows the daily intakes of foods and nutrients during the study period. Food intake was estimated by weighing each subject's servings before and after meals. Energy and protein intakes for each of the subjects were calculated using a table of food composition published by the Food Research Institute in Ghana (Eyeson and Ankrah, 1975). Nitrogen intake was obtained by dividing the protein intake by 6.25, nitrogen-coefficient.

Table 1 Initial body weight and height and the percentages of reference values in the Ghanaian infants with protein-energy malnutrition[a]

Subject Co.	Age	Body weight	% RBW/A[b]	Height	% RHt/A[c]	% RBW/Ht[d]
	mo	kg	%	cm	%	%
1	36	8.3	56.8	75.0	77.7	84.7
2	42	9.8	62.4	80.0	80.7	89.9
3	27	8.0	61.1	74.5	82.8	81.6
4	24	8.8	69.8	78.2	89.2	83.8
5	18	6.8	59.1	72.2	87.6	74.7
6	20	6.3	53.3	74.0	87.9	65.6
7	36	10.2	69.9	92.5	95.9	72.9
8	40	9.6	62.7	81.1	83.0	86.5
mean		8.5	61.9	78.4	85.6	80.0
SD		±1.4	±5.8	±6.5	±5.7	±8.2

a. The percentages of reference values were calculated on the basis of those presented by WHO; WHO (1979), Measurement of Nutritional impact: A guideline for the measurement of nutritional impact of supplementary feeding programs aimed at vulnerable groups. WHO/FAO/79.1.
b. Reference body weight for age.
c. Reference height for age.
d. Reference body weight for height.

Table 2 Daily intake of foods and nutrients during the study period

Food intake (g/day)		Energy and nutrient intakes (/day)	
Koko[a]	615–899	Energy (kcal)	1,527–2,085
Yam	143–197	Protein (g)	28–43
Bread	0–30	Lipid (g)	21–44
Rice	120–194	Crude fiber (g)	4.5–5.0
Stew-1[b]	85–213	Calcium (mg)	1,199–1,601
Stew-2[c]	70–78	Phosphorus (mg)	851–1,055
Wheat soy milk	226–315		
Egg	0–50		
Tuna	8–23		
Sugar	40		
Milk powder	10–30		

a. One of traditional dishes. Prepared from corn dough and like porridge.
b. Ingredients; egg plants, tomatoes, onions, beans and oil.
c. Ingredients; Tomatoes, onions, beans and oil.

Measurements

Anthropometric measurements taken at the beginning and the end of the observation periods included body weight, height and mid-upper arm, chest, thigh, mid-calf and abdominal circumferences as well as the total skin fold of the subscapula, the suprailiac and the triceps. Measurements were done three times before breakfast in the morning by the same person and the mean values recorded. Body weight was measured every morning before breakfast. Twenty-four hours urine and faeces were collected for each subject for 4 consecutive days at the beginning of the study and the last 4 days of the 4 weeks of observation period. Urine and faeces were collected using urine bags and diapers. In case where faeces could not be completely removed from the diaper, fecal weight was estimated by subtracting the initial weight of the diaper from that of the diaper with faeces. Faeces were dried at 105°C for 24 hr and ground into a powder. The energy content was then determined using a bomb calorimeter (SHIMAZU, CA-4). Urinary and fecal nitrogen were determined by the Kjeldahl method.

RESULTS

Body weight gain

Body weight increased in all the subjects after dietary treatment. Table 3 shows the body weight, the weight gain and the recovery rate for each of the subjects after 4 weeks of dietary treatment. The recovery rate presented is the ratio of the body weight gain to the initial body weight. This affords a meaningful comparison since the effects of differences in individual body weights are eliminated. The mean body weight gain for the period was 1.6±0.5 kg, ranging from 1.2 to 2.6 kg, and the recovery rate averaged 7.6±2.3%, with a range of 4.7 to 12.5%. The body weight as a percentage of RBW/A increased from 62 to 73% while that of reference body weight for height (RBW/Ht) showed a rise from 80 to 96% during the period of observation.

Table 3 Body weight, body weight gain and the percentages of reference body weight for age and height after 4 weeks of dietary treatment

Subject Co.	Body weight (BW)	BW gain[a]	% RBW/A[b]	% RBW/Ht[c]	Recovery rate[d]
	kg	kg	%	%	%
1	9.7	1.4	65.5	99.0	6.5
2	11.0	1.2	69.6	100.9	4.7
3	10.6	2.6	79.7	108.2	12.5
4	10.3	1.5	80.5	98.1	6.5
5	8.3	1.5	70.9	91.2	8.5
6	7.6	1.3	63.3	79.2	7.9
7	12.2	2.0	82.4	87.1	7.5
8	11.3	1.7	72.9	101.8	7.0
mean	10.1	1.6	73.1	95.7	7.6
SD	±1.5	±0.5	±7.1	±9.3	±2.3

a. Difference between initial body weight and final body weight after 4 weeks of dietary treatment.
b. Reference body weight for age. Values were calculated on the basis of the reference value by WHO; WHO (1979), Measurement of nutritional impact: A guideline for the measurement of nutritional impact of supplementary feeding programs aimed at vulnerable groups. WHO/FAO/79.1.
c. Reference body weight for height. Values were calculated based on the reference by WHO.
d. Ratio of body weight gain for 4 weeks to the initial body weight.

Energy intake and fecal energy

The energy intake and fecal energy were shown in Table 4. The mean energy intake increased from about 1,600 kcal at the beginning to about 1,900 kcal at the end. This rise in energy intake was proportional to the body weight gain, thus the energy intake per kg body weight was constant. The energy intake through the period of the study was markedly high as compared to that of normal children of same age, who are expected to take about 1,000 to 1,500 kcal (Joint FAO/WHO/UNU Expert consultation, 1985).

Table 4 Energy and nitrogen utilization at the beginning and after 4 weeks of dietary treatment

	1st period[a]	2nd period[b]
Energy intake[c] (kcal/kg/day)	195±38[d]	198±48
Fecal energy[e] (kcal/kg/day)	20± 7	15± 4
Fecal energy/energy intake[f] (%)	10.2±2.4	8.0±1.5
N intake (g/kg/day)	0.59±0.09	0.56±0.08
Urinary N (g/kg/day)	0.19±0.04	0.20±0.05
Fecal N (g/kg/day)	0.21±0.06	0.17±0.04
N-balance (g/kg/day)	0.21±0.08	0.20±0.09
Apparent N-utilization[g] (%)	34.9±12.3	33.4±12.6

a. Initial 4 days of observation.
b. Final 4 days of observation.
c. Calculated using food intake and a table of food composition (10).
d. Means±SD for 8 subjects.
e. Measured by a bomb calorimeter.
f. Fecal energy as percentage of energy intake.
g. N-balance as percentage of N-intake.

Fecal energy was also very high, being 167±54 kcal/day at the beginning and 151±23 kcal/day at the end of the study. The ratio of fecal energy to energy intake was lower at the end than at the start, indicating that energy uptake was slightly improved with the recovery process.

Although the subjects tended to keep in the beds at the beginning of the dietary treatment, they gradually became active with recovery.

Nitrogen balance

Table 4 also shows the daily nitrogen intake, urinary and fecal nitrogen and nitrogen balance. The mean nitrogen intake at the initial and final stages of the studies were 0.59±0.09 g/kg BW and 0.59±0.08 g/kg BW, corresponding to about 3.7 g and 3.5 g of protein/kg BW respectively. The daily excretion of nitrogen through faeces was very high ranging from 0.17 to 0.21 g/kg BW. This was lower at the end of the studies than it was at the beginning. There was no difference, however, in the nitrogen balance between the two periods. The nitrogen balance at each phrase was a positive value of about 0.2 g/kg BW. Apparent nitrogen utilization, presented as the ratio of the nitrogen balance to the nitrogen intake, did not change with recovery from the malnourished state.

Changes in anthropometric parameters

Figure 1 shows the changes in anthropometric parameters during the 4 weeks of dietary treatment. All parameters, with the exception of the abdominal circumference, increased in all the subjects. The initial average values for each anthropometric parameter and the average change noticed for each during the period of observation were: chest circumference, 46.3±3.1 and 1.9±1.4 cm; mid-upper arm circumference, 11.8±1.3 and 2.1±1.3 cm; thigh circumference, 17.8±2.0 and 5.0±1.1 cm; mid-calf circumference, 13.9±1.4 and 2.3±1.5 cm; abdominal circumference, 50.8±2.2 and 1.0±2.5 cm; total skin-fold thickness (subscapula, suprailiac and triceps), 10.1±4.2 and 21.7±3.6 mm, respectively.

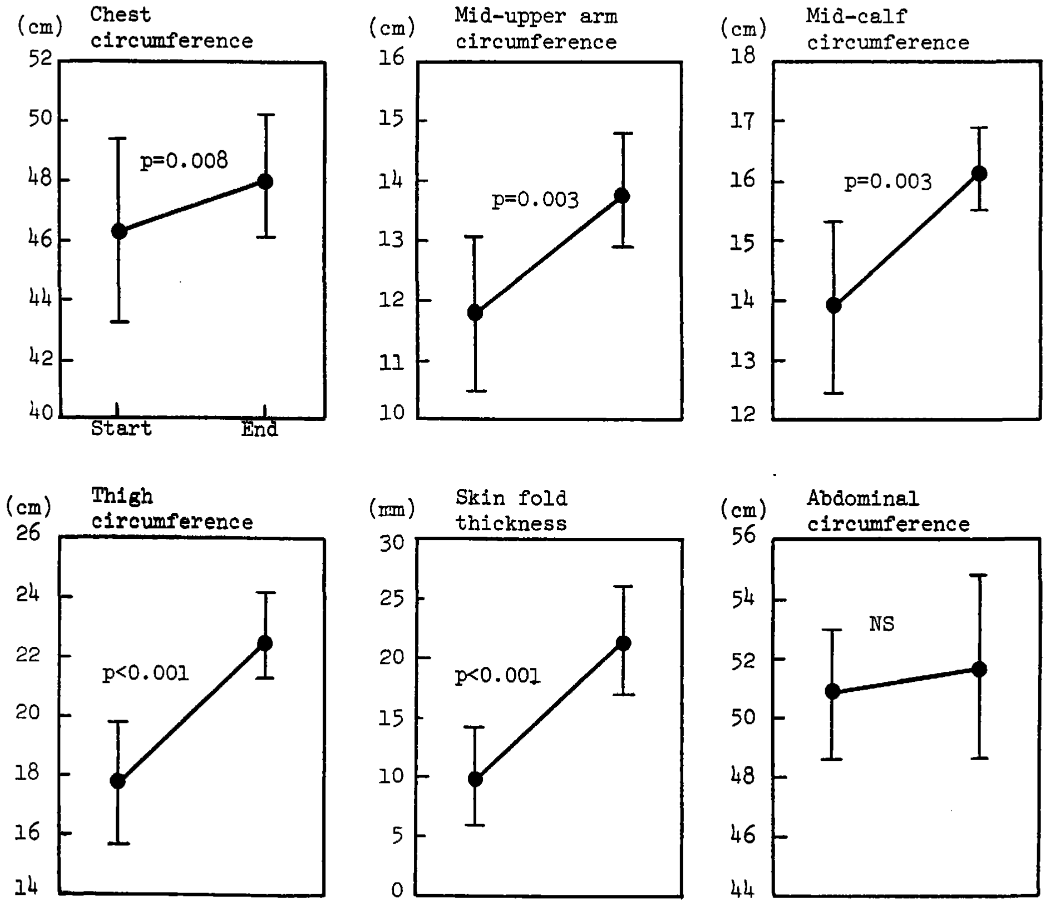

Figure 1 Changes in anthropometric measurements during 4 weeks of dietary treatment. Data were obtained at the beginning and after 4 weeks of dietary treatment. Values are means±SD for 8 subjects. Skin fold thickness is the total value of subscapula, suprailiac and triceps. Value of p is 2-tail probability by Student's paired t-test; NS, no significant.

Correlations of energy intake and nitrogen balance with body weight indexes

Table 5 shows the correlations of energy intake, nitrogen intake and nitrogen balance per kg body weights with body weight indexes. The energy intake, nitrogen intake and nitrogen balance per kg body weights all showed significant negative correlation with body weight and %

Table 5 Correlations of energy intake, nitrogen intake and nitrogen balance with body weight indexes

	Energy intake (/kg)	N-intake (/kg)	N-balance (/kg)
1st period			
Body weight (BW)	−0.72*[a]	−0.65*	−0.39
Recovery rate[b]	0.57	0.36	−0.42
% RBW/A[c]	−0.70*	−0.80**	−0.54
% RBW/Ht[d]	−0.11	−0.04	0.19
2nd period			
BW	−0.88**	−0.69*	−0.64*
Recovery rate	0.11	−0.10	−0.01
% RBW/A	−0.85**	−0.90**	−0.85**
% RBW/Ht	−0.36	−0.20	−0.09

a. Values are Pearson's correlation coefficient; *, $p<0.05$; **, $p<0.01$.
b. Ratio of the body weight gain during 4 weeks of dietary treatment to the initial body weight.
c. Reference body weight for age.
d. Reference body weight for height.

Table 6 Correlations of body weight indexes, energy and nitrogen intakes and nitrogen balance with the changes of anthropometric measurements during recovery from PEM

	Changes of anthropometric measurements					
	Chest circ.[a]	Mid-upper arm circ.	Thigh circ.	Mid-calf circ.	Abdomen circ.	Skin fold[b]
1st period						
Body weight	−0.76*[c]	−0.45	−0.68*	−0.54	0.40	−0.02
Recovery rate[d]	0.37	0.27	0.56	0.08	0.08	0.25
% RBW/A	−0.68*	−0.75*	−0.67*	−0.79*	0.43	−0.14
% RBW/Ht	−0.32	−0.02	−0.14	−0.24	0.26	0.10
Energy intake (/kg)	0.55	0.74*	0.66*	0.42	0.06	0.27
N-intake (/kg)	0.48	0.80*	0.56	0.48	−0.04	0.18
N-balance (/kg)	0.31	0.18	0.54	0.42	−0.15	−0.29
2nd period						
Body weight	−0.73*[b]	−0.47	−0.61	−0.56	0.43	−0.01
% RBW/A	−0.48	−0.57	−0.37	−0.71*	0.45	−0.01
% RBW/Ht	−0.14	−0.08	−0.15	−0.21	0.32	0.23
Energy intake (/kg)	0.78*	0.74*	0.68*	0.81**	−0.60	0.27
N-intake (/kg)	0.67*	0.77*	0.63*	0.80**	−0.63*	0.40
N-balance (/kg)	0.75*	0.77*	0.69*	0.89**	−0.67*	0.48

a. Circ. is an abbreviation of circumference.
b. Total skin fold thickness of subscapula, suprailiac and triceps.
c. Pearson's correlation coefficient; *, $p<0.05$; **, $p<0.01$.
d. Ratio of body weight gain for 4 weeks to the initial body weight.

RBW/A but not with the rate of body weight gain and the % RBW/Ht. The energy intake and nitrogen balance per kg body weights tended to be higher in the subjects with lower body weight and % RBW/A.

Correlations of body weight indexes, energy intake and nitrogen balance with changes in anthropometric parameters

Correlations of body weight indexes, energy intake and nitrogen balance per kg body weights with changes in the various anthropometric parameters during recovery from malnutrition are presented in Table 6. While there were significant negative correlations between the initial body weight and changes in chest and thigh circumferences, the % RBW/Ht did not show any significant correlations with changes in any of the anthropometric parameters. There were, however, significant negative correlations between the % RBW/A and changes in chest, mid-upper arm, thigh and mid-calf circumferences. These results indicate that the increases in the anthropometric parameters were larger in subjects with lower body weight and % RBW/A.

The energy and nitrogen intakes and the nitrogen balance, at the second phase in particular, correlated positively and significantly with the changes in chest, thigh and mid-calf circumferences, indicating that these increases promoted body growth. Particularly the change of the mid-calf circumference showed a very significant correlation with the nitrogen balance ($r=0.89$, $p<0.01$). On the other hand, the changes of abdominal circumference were correlated negatively with the nitrogen intake and nitrogen balance.

Discussion

The daily recommended allowance for energy for children aged 2 to 3 years is about 100 kcal/kg/day (11). The subjects in this study showed a high energy intake of about 190 kcal/kg/day and a mean body weight gain of 1.6 kg per subject over the period of observation. Waterlow *et al.* (1961) have reported of a linear relationship between energy intake and the rate of body weight gain during recovery from PEM. The same relationship has also been demonstrated by other researchers (Ashworth *et al.*, 1968; Graham *et al.*, 1963). In catch-up growth during recovery from PEM, it is not uncommon to observe a rate of weight gain 20 times that of normal children of the same age, especially in children receiving over 200 kcal/kg/day and 4 to 5 g protein/kg/day (Picou, 1981). Although the results presented did not show any significant correlation between the energy intake and body weight gain, they are consistent with the above observation in that the children showed very high energy intake and their anthropometric measurements increased proportionally with the energy intake. This clearly demonstrates that the energy intake had influence on the recovery rate in these subjects. The lack of correlation between the energy intake and body weight gain may probably be due to the small number of subjects studied.

Ashworth *et al.* (1969) have reported that in PEM children food intake did not reduce until their body weight had reached the normal range. It was observed in this study that the subjects continued to have a high energy intake of about 190 kcal/kg/day even 4 weeks after dietary treatment although their % RBW/A was still low of about 70%, whereas their % RBW/Ht was close to 100%. This probably suggests the existence of the regulatory mechanism which controls body weight during catch-up growth. This may be further supported by the fact that the energy intake, nitrogen balance and increases in anthropometric measurements were higher in the subjects with lower % RBW/A.

The daily recommended allowance for protein is about 2.0 g/kg/day for 2 to 3 years old children (Joint FAO/WHO/UNU Expert consultation, 1985). It has been reported that very remarkable results were obtained when 3 years old PEM subjects were given high protein of about 3 to 5 g/kg/day (Whitehead, 1973). The subjects in this study were given about 3.6 g protein/kg/day. It was, however, observed that a large amount of nitrogen was excreted in their stool, thus causing the value for the nitrogen balance to be low. This probably might have been due to either an impaired absorption during the period of dietary treatment or some kind of gastrointestinal problem.

The study showed that the PEM children with marked delayed growth and poor muscle mass had a high food intake and nitrogen retention and consequently had greater development of muscle over the period of dietary treatment. Thus during rapid catch-up growth in the subjects studied regardless of the depressed absorption of nitrogen, the quantity of nitrogen absorbed would be efficiently utilized for protein synthesis in the body.

The determination of nitrogen balance is very useful in obtaining information on the utilization of dietary protein. It is also generally believed to be useful in the assessment of untritional status during recovery from PEM (Shizgal, 1986). It is, however, not easy to carry out nitrogen balance for clinical purposes and field surveys. The significant correlation of the change in the anthropometric measurements with the nitrogen balance support that the change would be used as an index for nitrogen utilization during recovery from PEM. Out of the anthropometric measurements studied, the mid-calf circumference correlated highly with the nitrogen balance. Although when compared with the other parameters the mid-calf circumference is less likely to be influenced by the nutrition of the subject, our data suggest that in spite of the slight change observed, the mid-calf circumference could be a very sensitive index for assessing increases in body protein and nitrogen retention during recovery from PEM. Thus in addition to the mid-upper arm and thigh circumference, the change of the mid-calf circumference could also be used to assess recovery from malnutrition. Further studies are, therefore, required to be done on the usefulness of the mid-calf circumference in the assessment of recovery from malnutrition using a larger sample size.

Acknowledgments

We wish to express our sincere thanks to the staff of the Nutrition, Chemical Pathology and Haematology units of Noguchi Memorial Institute for Medical Research, University of Ghana, for their excellent technical assistance. We are also grateful to Dr. F. C. Grant and Mr. M. F. Raibeiro, former director and executive secretary respectively of Noguchi Memorial Institute for Medical Research for their useful advise. Finally we wish to thank the director, Dr. H. C. Y. Odoi and the other members of staff at the Princess Marie Louis Hospital, Accra, for their assistance during the course of the studies.

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ガーナ人小児における蛋白質・エネルギー欠乏症からの回復時の各種栄養パラメーターの変化とそれらの相互関係

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蛋白質・エネルギー欠乏症 (PEM) からの回復過程における人体計測値の変化およびそれらとエネルギー摂取，窒素摂取，窒素出納との関連性について，PEM で入院中のガーナ人小児 (男子，18－42カ月) を対象として調べた。観察初期の体重，身長はそれぞれ 8.5±1.4 kg，78.4±6.8 cm。それらは，WHO による同年齢の標準体重値 (RBW/A) の 61.9±5.8%，同年齢の標準身長 (RHt/A) の 85.6±5.7% に相当した。被験者は，観察期間中約 190 kcal/kg のエネルギーと約 3.6 g/kg の蛋白質 (0.58 gN/kg) を摂取し，順調な回復を示した。4 週間で 1.6±0.5 kg の体重増加が認められた。しかし，その時の RBW/A 比は，73.1±7.1% とまだ低い状態にあった。腹囲を除く総ての人体計測値 (胸囲，腿囲，上腕囲，フクラハギ囲，皮脂厚) が増加し，そして，これらの増加度 (皮脂厚を除く) は RBW/A 比と負の相関関係，エネルギー摂取，窒素摂取，窒素出納とは正の相関関係にあった。特にフクラハギ囲の増加度は窒素出納と非常に高い相関性が認められた ($r=0.89$, $p<0.01$)。これらは，PEM 回復時の摂取窒素の体内利用あるいは体蛋白質蓄積の指標として，フクラハギ囲の変化を測定することの意義を示唆するものである。また，以上の結果より，RBW/A 比の低い小児の方が，エネルギー摂取，窒素摂取，窒素出納が高く (いずれも体重あたりで)，かつ人体計測値の上昇度合いも高い傾向にあった事が明確となった。RHt/A 比はいずれのパラメーターとも有意な相関が認められなかった。

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Japan. J. Trop. Med. Hyg., Vol. 15, No. 4, 1987, pp. 287-290

INTESTINAL PARASITIC INFECTIONS AMONG CHILDREN OF A PRIMARY SCHOOL IN CHIANG MAI CITY, NORTHERN THAILAND

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Received February 9 1987/Accepted September 20 1987

Abstract: Fecal samples were examined in 117 children, ranging in ages from 8 to 14, in a primary school in Chiang Mai City, north Thailand. The positive rate of all parasitic infections was 23.9%. Hookworms were the most prevalent parasite (17.1%), followed by *Trichuris trichiura* (5.1%), *Strongyloides stercoralis* (3.4%), *Entamoeba coli* (1.7%), *Entamoeba histolytica* (0.9%) and *Opisthorchis viverrini* (0.9%). No *Ascaris lumbricoides* was found, mainly because of individual treatment with drugs.

INTRODUCTION

Thailand, located between 5° and 20° north latitude, is a country in tropical climate. Chiang Mai is the second biggest city in this country with a population of about 1.2 million and is situated near the northwest border. Parasitic infections in the indigenous population have been so far investigated in many occasions and it has been shown that many parasitic diseases are endemic in this area. However, an unexpected low incidence (0.3%) of ascariasis in this Province was reported for the first time in 1982 (Yamaguchi *et al.*). Therefore, it was intended to prove the prevalence of ascariasis in comparison with other intestinal parasitic infections. For this purpose, stool samples were examined in children in Chiang Mai City, and the present paper deals with the results of this investigation.

MATERIALS AND METHODS

Description of study area: Chang Kian primary school, downtown of Chiang Mai City. The school consisted of 6 grades or 369 children (190 male and 179 female).

Subjects: One hundred and seventeen children at ages from 8 to 14, underwent stool examination.

Stool was examined for parasites by direct fecal smear, flotation method using saturated NaCl and formalin-ether sedimentation techniques.

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RESULTS

Out of 117, 28 samples or 23.9% were found positive for parasites. Hookworms were most prevalent (17.1%), followed by *Trichuris trichiura* (5.1%) and *Strongyloides stercoralis* (3.4%) (Table 1). Mix infections were found in 6 children; 4 were infected with hookworm and *T. trichiura* and 2 were with *T. trichiura* and *Entamoeba coli*. *Opisthorchis viverrini* was detected in only one, and no *Ascaris lumbricoides* was seen in this survey. The detection rates of infection by each technique were 6.8% by direct smear, 20.5% by flotation method, and 15.4% by formalin-ether technique, respectively (Table 1). Table 2 shows prevalence rates of parasitic infections according to age groups. Positive rates of hookworm gradually increased by the age. Age-depended tendencies of prevalence were not clear in other parasitic infections.

Table 1 Positive numbers of parasitic infections in each method

Parasite	Detection methods			Total (%)**
	DS	FL	FE*	
Hookworms	1	18	10	20 (17.1)
Ascaris lumbricoides	0	0	0	0 (0.0)
Trichuris trichiura	2	6	2	6 (5.1)
Strongyloides stercoralis	4	0	2	4 (3.4)
Entamoeba coli	0	0	2	2 (1.7)
Entamoeba histolytica	0	0	1	1 (0.9)
Opisthorchis viverrini	0	0	1	1 (0.9)
Total	8	24	18	28 (23.9)

* DS=direct fecal smear; FL=flotation method; FE=formalin-ehter sedimentation technique.
** % positive to 117 children examined.

Table 2 Positive rates (%) of parasitic infections for different age groups

Parasite	Age			Total (n=117)
	8–9 (n=23)	10–11 (n=50)	12–14 (n=44)	
Hookworms	8.7	18.0	20.5	17.1
A. lumbricoides	0	0	0	0.0
T. trichiura	0	6.0	6.8	5.1
S. stercoralis	4.3	4.0	2.3	3.4
E. coli	0	2.0	2.3	1.7
E. histolytica	4.3	0	0	0.9
O. viverrini	0	2.0	0	0.9
Total	17.4	26.0	25.0	23.9

Discussion

Our survey showed that soil-transmitted helminthiases except for ascariasis were still prevalent in school children in the center of Chiang Mai City (Tables 1, 2). It was noted that no ascariasis was found in this survey. This district had been reported as one of higly endemic areas for ascariasis; 32% of children in northern Thailand had *Ascaris lumbricoides* (Sadun, 1953); 60.0% of adults in Phayao (Papasarathorn *et al.*, 1969); and 9.2% in Chiang Mai (Thitasut *et al.*, 1973). In this survey, we confirmed low prevalence of ascariasis firstly reported by Yamaguchi *et al.* (1982) in this area. They postulated that this low rate was the result of the treatment of patients with local berries "Maklua" (*Diopyros mollis*) following the campaign of Ministry of Public Health, Thailand, and individual treatment with piperazine which was easily available in city drug stores.

To the contrary, other soil-transmitted helminths, such as hookworms, *T. trichiura* or *S. stercoralis* have not yet been eliminated in this district. Out of 3,012 persons in this Province, 76.76% were parasite-positive, including 47.74% for hookworms (Yamaguchi *et al.*, 1982). According to unpublished data by Jarrat (committed by WHO) in Doi Taw (rural area of Chiang Mai Province), 29.9% out of 187 children in primary schools were positive for intestinal parasites, including 13.9% for hookworms, 4.3% for *Giardia lamblia,* 3.7% for either *S. stercoralis* or *O. viverrini,* and so forth. Positive rates of hookworms and *S. stercoralis* were similar to our data. However, his data were obtained by means of direct smear method only, therefore, it is highly likely that more parasite-positive children would have been detected if samples were examined by a few different methods simultaneously as we did (Table 1). In any case, hookworms were the most prevalent and widely spread among children in this area. Furthermore, the increasing rates of prevalence according to ages were observed in our survey (Table 2), as the same as in Yamaguchi's survey (1982).

The prevalence rate of *T. trichiura* appeared to be vary from one place to another. In our data, *T. trichiura* was the second prevalent parasite with an infection rate of 5.1%, while children in Doi Tow (Jarrat's data) had none. According to Yamaguchi's data (1982), prevalence were different from village to village ranging from 41.9% to 0%, in an average of 19.5%.

S. stercoralis showed apparently a low prevalence rate in this survey as we could find the larvae only by direct smear method. Therefore, more strongyloidiasis would have been detected if the Harada-Mori culture method were used. Strongyloidiasis seems to be one of important parasitic diseases in this area, because not only of it's pathogenicity but also of resistance to eradication (Sato, 1986).

In conclusion, low prevalence of ascariasis and high prevalence of other soil-transmitted helminths seem to be the present status of parasitic disease in northern Thailand. The discrepancy of prevalence between ascariasis and other soil-transmitted helminthiases is an issue to be solved since, in general, the prevalence rates of both ascariasis and trichuriasis are diminished in parallel with the improvement of sanitary conditions or treatment (Seo and Chai, 1986).

O. viverrini, which is one of the food-transmitted parasites, also is common in northern Thailand. It was reported that a prevalence rate was 25.0% in Chiang Mai (Thitasut *et al.*, 1973), 40% in Chiang Rai (Khamboonruang *et al.*, 1978) and 37.01% (Yamaguchi *et al.*, 1982). This parasitic infection occurs only at area where fresh water fish is eaten in raw, and therefore, the prevalence rate is localized according to the local food habits. Among children in urban areas, however, the habits to eat fish in raw appears to be diminished.

ACKNOWLEDGEMENTS

We wish to express our appreciation to Dr. Chirasak Khamboonruang, Prof. of Department of Parastitology, Faculty of Medicine, Chiang Mai University for his skillful comments and suggestions, to Misses Anchalee, Treeyaphan, Siriporn, Jariya, and Viral for their kind assistance in Chiang Mai, and to Prof. Hiroshi Takeuchi and Prof. Hiroshi Ohtomo for their arrangements to our group.

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北部タイ，チェンマイ市の１小学校の腸管寄生虫感染

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北部タイに位置するチェンマイ市の１小学校の８歳から14歳の生徒の117人の検便を行い腸管寄生虫の感染状況を調査した。その結果，23.9%の生徒に感染が認められた。中でも，鉤虫症が最も多く，17.1%を占めた。続いて鞭虫が5.1%，糞線虫3.4%，大腸アメーバ1.7%，赤痢アメーバ，タイ肝吸虫の各0.9%であり，土壌伝搬性寄生虫がほとんどを占めた。しかし，興味深いのは，回虫卵が全く検出されなかったことである。これは市販薬による自己治療によるものと考えられた。

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THE MOSQUITO FAUNA OF THAILAND (DIPTERA: CULICIDAE): AN ANNOTATED CHECKLIST

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Received August 5 1987/Accepted August 20 1987

Abstract: A comprehensive and updated checklist for the mosquitoes of Thailand has been compiled from scattered literature in addition to our own collections during 1983-1984 mosquito surveys in this country. In total 384 taxa of mosquitoes can be counted with valid distribution records: *Anopheles* 65 spp., *Aedes* 100 spp., *Armigeres* 22 spp., *Heizmannia* 16 spp., *Culex* 80 spp., *Topomyia* 14 spp., *Tripteroides* 13 spp., *Uranotaenia* 39 spp., *Toxorhynchites* 8 spp., and other genera 27 spp. Among them 249 spp. (64.8%) are common with Malaysian mosquito fauna, 113 spp. (29.4%) with Philippine fauna, and 44 spp. (11.5%) with Japanese fauna. Only 54 spp. (14.1%) are not known outside Thailand. References for collection or distribution and larval breeding places have been given to each taxon.

INTRODUCTION

A large number of original papers and monographs on the mosquitoes of Thailand have been published by many entomologists after extensive surveys. Most of these publications, however, are concerned with only a limited area or taxonomic group, such as a single subgenus, genus or subfamily of mosquitoes from Thailand or Southeast Asia. Barnes (1923) recorded 18 anopheline mosquitoes from Thailand. Barraud and Christophers (1931) published the first literature on both anopheline and culicine mosquitoes of Thailand (cited from Thurman, 1959). The "annotated list of Culicinae collected in Siam" by Causey (1937a) included 67 mosquito species and collection records. Sandhinand (1951) reported anophelines from Chiang Mai, northern Thailand, and Iyengar (1953) listed 64 species of mosquitoes from south Thailand including 15 new records. Iyengar and Menon (1956) provided revision on 4 spp. and 2 additional spp. with detailed notes and descriptions.

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This study was supported in part by Grants-in-Aid for Overseas Scientific Survey in 1983-1984, Nos. 58041058 and 5904352 from the Ministry of Education, Science and Culture, Japanese Government. The surveys were carried out with the permission of the National Research Council of Thailand.

Thurman (1959) reported 57 species of Thai mosquitoes including 13 new species. However, mosquitoes belonging to the major genera of *Anopheles, Aedes, Culex, Uranotaenia* and some minor genera were not included in this important work. As an appendix, she also arranged the names of the mosquitoes previously reported by various entomologists from Thailand into separate lists entitled: "prior to 1950" (107 spp.), "between 1950 and 1956" (57 spp.), "during 1957" (67 spp.) and "new record for 1958" (24 spp). Thus, all the mosquitoes counted became 255 spp. though some of them were later synonymized or invalidated.

Scanlon and Esah (1965) recorded a total of 84 species of mosquitoes from the foot to the summit of Doi Pui, Chiang Mai, northern Thailand. Gould *et al.* (1968) also recorded a total of 78 mosquito taxa from a small island of south Thailand. Names of a number of Thai mosquitoes are scattered among pages in a large catalog of mosquitoes of the world (Knight and Stone, 1977), its supplements (Knight, 1978b; Ward, 1984), and a list of Southeast Asian mosquitoes (Apiwathnasorn, 1986).

Entomological teams of the U.S. Army Medical Component, AFRIMS, Bangkok, Thailand, also conducted extensive surveys for many years in Thailand. Scanlon *et al.* (1968) published a useful annotated checklist of the *Anopheles* of Thailand including 12 new distribution records. The collection record by Gould *et al.* (1968) involved many new distribution records for Thailand, although they did not point this out, and these records were not added to the world catalog by Knight and Stone (1977) nor to its supplement by Knight (1978). Extensive surveys in Thailand by members of AFRIMS have also revealed some new species and several new distribution records of Thai mosquitoes. Some of them has been published by Harbach *et al.* (1986) and by Rattanarithikul and Green (1986).

Since 1981, extensive surveys on Southeast Asian mosquito fauna from a view point of phylogeny have been carried out by a Japanese research team: in 1981–1982 for the Philippines, in 1983–1984 for Thailand, and in 1986 for Malaysia, in cooperation with appropriate governmental offices and universities of each country. Prior to undertaking each field survey, we prepared a preliminary checklist of mosquitoes (Tsukamoto, unpublished). After field collections and taxonomic studies on new materials, we published collection records (Miyagi *et al.*, 1985, 1986) and a revised checklist of the mosquitoes of the Philippines (Tsukamoto *et al.*, 1985). Some specimens collected from Thailand during the 1983–1984 surveys still remain unidentified because of lack of detailed descriptions in earlier literature or lack of adequate redescription.

In spite of such a large quantity of scattered literature, no updated and comprehensive checklist for Thai mosquitoes alone has yet been published. It must be, therefore, convenient for field entomologists to arrange all of the Thai fauna in a single list. Although the style is still preliminary and revisions are anticipated by the addition of new materials in the near future, we believe it necessary and useful to prepare such a comprehensive and updated checklist of all the mosquito fauna of Thailand.

Materials and Methods

In addition to earlier original descriptions of new species or redescriptions (individual references are not cited here because of their number and availability in the world catalog), records of Thai mosquitoes listed by Causey (1937), Iyengar (1953), Iyengar and Menon (1956), Thurman (1959), Scanlon and Esah (1965), Gould *et al.* (1968), Scanlon *et al.* (1968) and Miyagi *et al.* (1986) are major sources of the present paper as well as the following monographs which were useful in checking synonymies, larval breeding places, collection locality or distribution: for genus *Anopheles*—Peyton and Scanlon (1966), Reid (1968), Scanlon *et al.* (1968), Rattanarithikul and Harrison (1973), and Harrison (1980); for genus *Aedeomyia*—Tyson (1970a); for genus *Aedes*: subgenus (*Aedimorphus*)—Reinert (1973a) and Huang (1977b); (*Ayurakitia*)—Reinert (1972); (*Bothaella*)—Reinert (1973c); (*Christophersiomyia*)—Abercrombie (1977); (*Diceromyia*)—Reinert (1970, 1973b); (*Edwardsaedes*)—Reinert (1976c); (*Mucidus*)—Tyson (1970b); (*Paraedes*)—Reinert (1981); (*Rhinoskusea*)—Reinert (1976b); (*Scutomyia*)—Reinert (1985); (*Stegomyia*)—Huang (1972, 1977a, 1979); (*Verrallina*)—Delfinado (1967) and Reinert (1974); for genus *Armigeres*—Macdonald (1960); for genus *Heizmannia*—Mattingly (1970); for genus *Culex*—Bram (1967), and subgenus (*Culex*)—Sirivanakarn (1976); (*Culiciomyia*)—Sirivanakarn (1973, 1977a); (*Eumelanomyia*)—Sirivanakarn (1972); (*Lophoceraomyia*)—Sirivanakarn (1977b); for genus *Orthopodomyia*—Zavortink (1971); for genus *Tripteroides*—Delfinado and Hodges (1968), Mattingly (1981); for genus *Uranotaenia*—Peyton (1977) and Peyton and Klein (1970); for genus *Toxorhynchites*—Steffan *et al.* (1980). The terms "type-data" and "distribution" from each literature were checked and names of mosquitoes collected in Thailand were compiled into a list.

The sequence of subfamilies, genera, and subgenera was taxonomically arranged following that of the world catalog of mosquitoes for the convenience of readers, and each species within a subgenus or a genus was arranged alphabetically. References for collection records in Thailand and larval breeding places are also given for convenience to field entomologists. Abbreviations of each genus and subgenus are those proposed by Reinert (1975).

RESULTS AND DISCUSSION

Checklist

Before the preparation of this manuscript, a total of more than 460 species and subspecies or varieties of mosquitoes had been recorded from Thailand. Among them, however, about 80 of these are now considered invalid as synonyms, misidentifications and/or doubtful records. Table 1 lists a total of 384 valid and undescribed or unidentified taxa, including 65 spp. of genus *Anopheles,* 100 spp. of genus *Aedes,* 22 spp. of genus *Armigeres,* 16 spp. of *Heizmannia,* 80 spp. of genus *Culex,* 14 spp. of genus *Topomyia,* 13 spp. of genus *Tripteroides,* 39 spp. of genus *Uranotaenia,* 8 spp. of genus *Toxorhynchites,* and 27 spp. of other genera. Without any taxonomic discussion nor collection records, Apiwathnasorn (1986) prepared a booklet of a list of 871 mosquito species in Southeast Asia. From this list we can count 342 spp. of mosquitoes which occur in Thailand.

To save space in Table 1, some references for distribution record in Thailand are expressed in abbreviated forms. Each species recorded only from Thailand is considered to be endemic and is followed by an asterisk (*).

Taxonomic Changes and Synonyms

Names of about 35 mosquito taxa previously recorded from Thailand have been synonymized or the name of their genus or subgenus changed. Each synonym once recorded in Thailand is shown in parentheses under each valid species name in the present checklist. Changes in genus or subgenus name are also given in this table. More recently the subgenus

Table 1 Mosquito fauna of Thailand

Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
	Family CULICIDAE		
	Subfamily ANOPHELINAE		
Anopheles (*Anopheles*)			
1. *aberrans* Harrison & Scanlon, 1975	H&S75	Shaded forest areas: stream margins, stream pools, rock pools, springs, seepage pools, elephant footprints	M
2. *argyropus* (Swellengrebel, 1914)	Thurman59, S&E65, Scanlon *et al.* 68, H&S75	Rice fields, deep seepages, large deep swamps	M
3. *asiaticus* Leicester, 1908	Scanlon *et al.* 68, H&S75	Bamboos (stump, internode, split)	M
4. *baezai* Gater, 1933	Iyengar53, Scanlon *et al.* 68, H&S75	Coastal areas: shaded pools, ditches	M, P
5. *barbirostris* Van der Wulp, 1884	Barnes23, Causey37a, Iyengar53, T&T55, S&E65, H&S75	Foothills: newly planted rice fields, open ground pools, stream pools, river margins, ditches	M
6. *barbumbrosus* Strickland & Chowdhury, 1927	I&M56, T&T55, S&E65, H&S75	Hilly areas: rice fields, ground pools, edges of slow-moving streams	M
7. *bengalensis* Puri, 1930 (as *An. aitkenii bengalensis*)	Scanlon *et al.* 68, H&S75 (Sandhinand51, Thurman59)	Shaded ground pools beside streams, rock pools, springs	M, P, J
8. *bulkleyi* Causey, 1937*	Causey37b, H&S75	Tree holes	
9. *campestris* Reid, 1962	Scanlon *et al.* 68, H&S75	Rice fields, marshes, canals, stream margin pools, hoof-prints	M
10. *crawfordi* Reid, 1953	Scanlon *et al.* 68, H&S75	Foothills: clear water rice fields, ground pools, seep-ages, slow-moving stream pools	M
11. *donaldi* Reid, 1962	Scanlon *et al.* 68, H&S75	Shaded swamps, concrete tanks	M
12. *fragilis* (Theobald, 1903)	Scanlon *et al.* 68, H&S75	Shaded small streams, pools, swamps	M, P
13. *gigas* Giles, 1901 (as *An. g. formosus*; *g. sumatrana*)	Scanlon *et al.* 68, Reid68 (Thurman59)	High elevation: grassy seepages, small stream pools	M
14. *hodgkini* Reid, 1962	Gould *et al.* 68, Scanlon *et al.* 68, H&S75	Shaded clear cool water: large marshes, large ponds, rock pools, ditches	M
15. *insulaeflorum* (Swellengrebel & Swellengrebel de Graaf, 1919)	Thurman59, Scanlon *et al.* 68, H&S75	Foothills: stream pools, shaded stream edges	M

16. *interruptus* Puri, 1929 (as *An. annandalei* or *An. a. interruptus*)	R&H73, H&S75 (Thurman59, S&E65)	Heavy forest: tree holes	M
17. *kyondawensis* Abraham, 1947	R&H73, H&S75	Hilly jungle: shaded small shallow pools along stream sides	
18. *lesteri paraliae* Sandosham, 1959	Gould *et al.* 68, Scanlon *et al.* 68, H&S75	Cool clean water, rice fields	M
19. *letifer* Sandosham, 1944	I&M56, Scanlon *et al.* 68, H&S75	Stagnant water	M
20. *montanus* Stanton & Hacker, 1917	Gould *et al.* 68, Scanlon *et al.* 68, H&S75	Hilly forest side: shaded pools, small swamps	M
21. *nigerrimus* Giles, 1900 (=*An. indiensis* Theobald, 1903)	Iyengar53, T&T55, Thurman59, S&E65, Scanlon *et al.* 68, H&S75 (Thurman59, Scanlon *et al.* 68)	With floating water plants: deep ponds, swamps, rice fields	M
22. *nitidus* Harrison, Scanlon & Reid, 1973	Harrison *et al.* 73, H&S75	Foothills: rice fields, cool still water, swamps, jungle bogs, large rock pools, stream pools, road-side ditches, elephant footprints	M
23. *palmatus* (Rodenwaldt, 1926)	Thurman59, Scanlon *et al.* 68	Shaded edges of forest streams	M
24. *peditaeniatus* (Leicester, 1908)	Thurman59, S&E65, Gould *et al.* 68, H&S75	Grassy ponds, ground pools, swamps rice fields	M, P
25. *pollicaris* Reid, 1962	Scanlon *et al.* 68, H&S75	Shaded forest pools	M
26. *pursati* Laveran, 1902	Gould *et al.* 68, H&S75	With water lettuce: deep cool ponds	M
27. *roperi* Reid, 1950	Scanlon *et al.* 68, H&S75	Shaded pools, swamps, ditches	M
28. *separatus* (Leicester, 1908)	Iyengar53, Scanlon *et al.* 68, H&S75	Shaded edges of brackish water, swamps	M
29. *sinensis* Wiedemann, 1828 (as *An. hyrcanus sinensis*)	Barnes23, S&E65, Scanlon *et al.* 68, Gould *et al.* 68, H&S75 (Sandhinand51, Iyengar53)	Open sunny water: rice fields, fallow pools, grassy ponds	M, J
30. *sintonoides* Ho, 1938	Scanlon *et al.* 68, H&S75	Tree holes, tree stumps, cut bamboos, artificial containers	M
31. *stricklandi* Reid, 1965	R&H73, H&S75	Low land: seepages, drains, hoofprints	M
32. *tigertti* Scanlon & Peyton, 1967*	S&P67, H&S75	Inland crab holes	
33. *umbrosus* (Theobald, 1903)	Iyengar53, Scanlon *et al.* 68, H&S75	Dense swamp-forest: shaded pools of peaty water	M, P
34. *whartoni* Reid, 1963	R&H73, H&S75	Various stagnant water	M

Continued

Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
Anopheles (*Cellia*)			
35. *aconitus* Doenitz, 1902	Barnes23, Causey37a, Iyengar53, T&T55, S&E65, Scanlon *et al.* 68, Harrison80	Grassy marshes, rice fields, rock pools, Nipa swamps, large pits, stream pools, ditches	M
36. *annularis* Van der Wulp, 1884 (=*An. fuliginosus* Giles, 1900)	Causey37a, Iyengar53, T&T55, Gould *et al.* 68, Scanlon *et al.* 68, (Barnes23)	Rice fields, ditches, pond margins, stream margins	M, P
37. *balabacensis introlatus* Colless, 1957	Scanlon *et al.* 68, R&H73	Southern peninsular areas: small temporary ground pools, muddy animal wallows, hoofprints	M
38. *culicifacies* Giles, 1901	Barnes23, Causey37a, Sandhinand51, T&T55, Harrison80	Irrigation channels, rain pools, river bed pools, wells	
39. *dirus* Peyton & Harrison, 1979 (as *An. balabacensis*) (as *An. leucosphyrus* or *An. l. balabacensis*)	P&H79 (Many workers) (Barnes23, Causey37a, Sandhinand51, Thurman59)	Forested foothills: footprints, stream bed pools, stream edge pools, rock pools, shaded small shallows pools, seepages, wheel ruts, pits, bamboo stumps, hollow logs	M
40. *dravidicus* Christophersi, 1924 (as *An. maculatus*)	R&G86 (Many workers)	Foothills: ground pools, ditches, small streams, seepages	
41. *hackeri* Edwards, 1921	Scanlon *et al.* 68, R&H73	Split or cut bamboos, Nipa axils, ground pools, tree holes, rock holes	M, P
42. *indefinitus* (Ludlow, 1904)	R&H73, H&S75	Grassy pools, ponds, ditches	M, P
43. *jamesii* Theobald, 1901	Barnes23, Thurman59, Scanlon *et al.* 68	Still water with vegetation, river bed pools, springs, surface wells, ponds, swamps	M
44. *jeyporiensis* James, 1902	Sandhinand51, T&T55, S&E65, Harrison80	Slow running water, river margins, grassy ditches, rice fields, swamps	M
45. *karwari* (James, 1902)	Barnes23, Causey37a, S&E65, Scanlon *et al.* 68	Seepages, slow stream pools	M, P
46. *kochi* Doenitz, 1901	Barnes23, Causey37a, Sandhinand51, T&T55, S&E65, Scanlon *et al.* 68, Gould *et al.* 68	Open small muddy water: ruts, hoofprints, buffalo wallows	M, P
47. *maculatus* Theobald, 1901	Causey37a, Gould *et al.* 68, Scanlon *et al.* 68, R&G86	Foothills: ground pools, ditches, springs, seepages, small pools	M, P

48. *minimus* Theobald, 1901	Causey37a, Scanlon *et al.* 68, Harrison80	Hilly stream margins, stream pools, seepage pools, rock pools	M, J
49. *nivipes* (Theobald, 1903)	R&H73, Klein *et al.* 84	Grassy edges of rice fields, pools, ponds, swamps	M
50. *notanandai* Rattanarithikul & Green, 1986* (as *An. maculatus*)	R&G86 (Many workers)	(as in *An. maculatus*)	
51. *pampanai* Buettiker & Beales, 1959	Scanlon *et al.* 68	Slow-moving stream margins	
52. *philippinensis* Ludlow, 1902	Causey37a, Iyengar53, S&E65, Gould *et al.* 68, Scanlon *et al.* 68	Ground pools, grassy edges of rice fields, ponds, swamps, slow-moving water	M, P
53. *pseudojamesi* Strickland & Chawdhury, 1927 (=*An. ramsayi* Covell, 1927)	(Causey37a, Sandhinand51, T&T55, Scanlon *et al.* 68)	Pond margins, sqamps, blocked ditches	M
54. *pseudowillmori* (Theobald, 1910) (as *An. maculatus*)	R&G86 (Many workers)	(as in *An. maculatus*)	
55. *pujutensis* Colless, 1948	Scanlon *et al.* 68	Shaded ground pools, rock pools	M
56. *riparis macarthuri* Colless, 1956	Scanlon *et al.* 68	Stream edges, rock pools, seepages	M
57. *sawadwongporni* Rattanarithikul & Green, 1986* (as *An. maculatus*)	R&G86 (Many workers)	(as same as *An. maculatus*)	
58. *splendidus* Koidzumi, 1920 (as *An. maculipalpis*)	Sandhinand51, S&E65, Scanlon *et al.* 68, (Barnes23)	Pools, streams, marshes	
59. *stephensi* Liston, 1901	Thurman59, Scanlon *et al.* 68	Sunny small ground pools, wells, artificial containers	
60. *subpictus* Grassi, 1899 (=*An. rossii* Giles, 1899)	Causey37a, Iyengar53, S&E65, Gould *et al.* 68, Scanlon *et al.* 68, (Barnes23)	Muddy pools, polluted water, brackish water, mangrove swamps	M, P
61. *sundaicus* (Rodenwaldt, 1925) (as *An. ludlowi*)	Iyengar53, Gould *et al.* 68, Scanlon *et al.* 68, (Barnes23)	Sunlit brackish pools with algae, mine pools	M
62. *tessellatus* Theobald, 1901 (as *An. punctulatus*)	Causey37a, Iyengar53, S&E65, Scanlon *et al.* 68, (Barnes23)	Shaded pools, rice fields, ditches, dirty stagnant water, sumps, springs	M, P, J
63. *vagus* Doenitz, 1902	Causey37a, Sandhinand51, Iyengar53, S&E65, Gould *et al.* 68, Scanlon *et al.* 68	Open muddy pools, ditches, shaded pools, hoofprints	M, P
64. *varuna* Iyengar, 1924	Thurman59, Scanlon *et al.* 68, Harrison80	Stagnant water, ponds, ditches, irrigation canals	
65. *willmori* (James. 1903)	R&G86	(as in *An. maculatus*)	

Continued

Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
	Subfamily CULICINAE		
Aedeomyia (*Aedeomyis*)			
66. *catasticta* Knab, 1909 (as *Aedomyia venustipes*)	I&M56, Thurman59, Tyson70a (Causey37a, Iyengar53)	With *Spirogyra*: swamps, pools, ponds, rice fields	M, P
Aedes (*Aedimorphus*)			
67. *alboscutellatus* (Theobald, 1905)	Thurman59, Reinert73a	Flood pools, stream pools, jungle pools, rock pools	M, P, J
68. *caecus* (Theobald, 1901)	Causey37a, Gould *et al.* 68, Reinert73a	Partially shaded pools, footprints, buffalo wallows, artificial containers	M, P
69. *culicinus* Edwards, 1922	Reinert73a	Partially shaded flood pools	
70. *mediolineatus* (Theobald, 1901)	Iyengar53, S&E65, Reinert73a	Flood pools, rice fields, footprints	M
71. *orbitae* Edwalds, 1922	Reinert73a	Temporary flood pools, muddy pools, shaded elephant footprints	M
72. *pallidostriatus* (Theobald, 1907)	Thurman59, Reinert73a	Open ground pools, rice fields, seepages, ditches	M
73. *pampangensis* (Ludlow, 1905)	Reinert73a	Small flood pools, large wheel tracks, grassy rain pools	P
74. *pipersalatus* (Giles, 1902)	Reinert73a	Small unshaded flood pools	
75. *vexans* (Meigen, 1830)	Causey37a, S&E65, Gould *et al.* 68, Reinert73a	Flood pools, rice fields, swamps, ditches, ponds	M
(as *Ae. taeniorhynchoides*)	(Iyengar53, Thurman59, S&E65)		
76. *vittatus* (Bigot, 1861)	Thurman59, S&E65, Gould *et al.* 68, Huang77	Rock pools, concrete pools, log holes, bamboo stumps, artificial containers	M
Aedes (*Alanstonea*)			
77. *treubi* (De Meijere, 1910) (as *Armigeres treubi*)	Mattingly60 (Causey37a, Thurman59)	Bamboo internodes	
Aedes (*Ayurakitia*)			
78. *griffithi* Thurman, 1954*	Thurman59, Reinert72	High elevation: banana and *Pandanus* axils	
79. *peytoni* Reinert, 1972*	Reinert72	Hilly areas: *Pandanus* axils, bamboo internodes	
Aedes (*Bothaella*)			
80. *eldridgei* Reinert, 1973*	Reinert73c	Mountainous terrains: small rock pools	

81. *helenae* Reinert, 1972*	Reinert73c	Mountainous terrains: small rock pools, bamboos (split, stump, cup)	
Aedes (*Cancraedes*)			
82. *indonesiae* Mattingly, 1958	Mattingly58	Crab holes	
83. *kohkutensis* Mattingly, 1958*	Mattingly58	——	
84. sp. (near *thurmanae*)	Miyagi *et al.* 86	Brackish crab holes	
Aedes (*Christophersiomyia*)			
85. *annulirostris* (Theobald, 1905)	Thurman59, Abercrombie77	Tree holes, water butts, log holes	
86. *ibis* Barraud, 1931	Abercrombie77	Stream rock pools, tree holes	M, P
87. *thomasoni* (Theobald, 1905)	Abercrombie77	Tree holes	
Aedes (*Diceromyia*)			
88. *iyengari* Edwards, 1923	Thurman59, S&E65, Reinert70	Bamboo stumps, tree holes	
89. *pseudonummatus* Reinert, 1973*	Reinert73b	Tree holes	
90. *scanloni* Reinert, 1970*	Reinert70	Tree holes	
91. *whartoni* Mattingly, 1965	Reinert70	Bamboos (split, internode, stump)	M
Aedes (*Edwardsaedes*)			
92. *imprimens* (Walker, 1860)	Causey37a, Gould *et al.* 68, Reinert76c	Flood pools, temporary ground pools, buffalo wallows	M, P
Aedes (*Finlaya*)			
93. *albolateralis* (Theobald, 1908)	Thuman59, S&E65	Tree holes, bamboo stumps	M
94. *alboniveus* Barraud, 1934	S&E65	Tree holes, bamboos	
95. *albotaeniatus* (Leicester, 1904)	Gould *et al.* 68	Bamboos	M
96. *assamensis* (Theobald, 1908)	Causey37a, S&E65	Bamboo stumps	
97. *aureostriatus* (Doleschall, 1857)	Thurman59, S&E65, Gould *et al.* 68	Tree holes, bamboo stumps, artificial containers	M
98. *chrysolineatus* (Theobald, 1907)	Causey37a, S&E65, Knight68	Tree holes, rock holes, bamboo stumps, Taro leaf axils, artificial containers	M
99. *elsiae* (Barraud, 1923)	Thurman59, S&E65	High elevation: rock pools, artificial containers	M
100. *feegradei* Barraud, 1934	S&E65	Tree holes	
101. *flavipennis* (Giles, 1904)	Gould *et al.* 68	Banana leaf axils	M, P

Continued

Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
102. *formosensis* Yamada, 1921 (=*Ae. pallirostris*)	S&E65, Gould *et al.* 68, Knight68, (S&E65)	Taro and banana leaf axils	M
103. *harinasutai* Knight, 1978*	Knight78a	——	
104. *harveyi* (Barraud, 1923)	Thurman59, S&E65, Knight68	Tree holes, bamboo stumps, rock pools, coconut shells	M
105. *hegneri* Causey, 1937*	Causey37b, Thurman59	Rock pools	
106. *khazani* Edwards, 1922	Thurman59, S&E65	High elevation: tree holes	
107. *macfarlanei* (Edwards, 1914)	Thurman59, S&E65	Rock pools, rock holes	
108. *niveus* (Ludlow, 1903)	Causey37a, S&E65	Tree holes, bamboos	M, P
109. *poicilius* (Theobald, 1903) (as *Ae. poecilus*)	Thurman59, Gould *et al.* 68 (Iyengar53)	Banana leaf axils	M, P
110. *pseudotaeniatus* (Giles, 1901)	S&E65, Gould *et al.* 68	Tree holes, rock pools, artificial containers	
111. *pulchriventer* (Giles, 1901)	Miyagi *et al.* 86	High elevation: fallen tree holes	
112. *saxicola* Edwards, 1922	Causey37a, S&E65, Knight68	Rock pools, tree holes	M, P
113. *shortti* (Barraud, 1923)	S&E65	High elevation: rock pools	
114. *simlensis* Edwards, 1922	Causey37a	Tree holes	
115. *togoi* (Theobald, 1907)	Gould *et al.* 68	Coastal rock pools, artificial containers	M, J
Aedes (Isoaedes)			
116. *cavaticus* Reinert, 1979*	Reinert79	Caves: shallow pools, fresh, clear temporary, unmoving, cold water	
Aedes (Lorrainea)			
117. *amesii* (Ludlow, 1903) (=*Ae. (Skusea) furvus* Edwards, 1928)	Thurman59, Gould *et al.* 68 (Causey37a)	Brackish swamps, Nipa stumps and leaf axils	M, P
118. *fumidus* Edwards, 1928	Gould *et al.* 68, Miyagi *et al.* 86	Brackish rock pools, Nipa stumps, coconut shells, jars	M, P
Aedes (Mucidus)			
119. *laniger* (Wiedemann, 1820)	Tyson70b	Ditches, marsh pools	M, P
120. *quasiferinus* Mattingly, 1961	Tyson70b	Rice fields, ditches	M

Aedes (*Neomelaniconion*)			
121. *lineatopennis* (Ludlow, 1905)	Iyengar53, Thurman59, S&E65	Ponds, ditches, rice fields, swampy grounds	M, P, J
Aedes (*Ochlerotatus*)			
122. *pulchritarsis* (Rondani, 1872)	Thurman59	Tree holes	
123. *vigilax* (Skuse, 1889)	Causey37a	Brackish swamps	M, P, J
Aedes (*Paraedes*)			
124. *ostentatio* (Leicester, 1908)	Reinert81	Jungle pools	M, P
125. *thailandensis* Reinert, 1976*	Reinert76a	Fresh water crab holes	
Aedes (*Rhinoskusea*)			
126. *longirostris* (Leicester, 1908)	Causey37a, Reinert76b Reinert85	Brackish crab holes, ground poools, brackish rock pools	M, P
Aedes (*Scutomyia*)			
127. *albolineatus* (Theobald, 1904) (as subgenus *Stegomyia*)	Gould *et al.* 68	Tree holes, sago leaf axils, rock holes, coconut shells, artificial containers	M, P
Aedes (*Stegomyia*)			
128. *aegypti* (Linnaeus, 1762)	Causey37a, Iyengar53	Artificial containers, water tanks	M, P, J
129. *albopictus* (Skuse, 1894)	Causey37a, Iyengar53, Gould *et al.* 68, Huang72	Outdoor artificial containers, bamboo stumps	M, P, J
130. *annandalei* (Theobald, 1910)	Thurman59, S&E65, Gould *et al.* 68, Huang77a	Bamboos (stump, internode)	
131. *craggi* (Barraud, 1923)	Huang77a	Mountainous areas: bamboos (stump, split), tree holes	
132. *desmotes* (Giles, 1904)	Thurman59, Huang77a	Bamboos (internode, split, stump), tree holes	M, P
133. *edwardsi* (Barraud, 1923)	Gould *et al.* 68	Tree holes	
134. *gardnerii imitator* (Leicester, 1908)	Huang77a	Log holes, tree holes, bamboo stumps, water jars	M
135. *malikuli* Huang, 1973	Huang73, Huang77a	Bamboos (internode, stump), tree holes	
136. *novalbopictus* Barraud, 1931	Thurman59, Huang72	Tree holes, bamboo internodes	
137. *patriciae* Mattingly, 1954	Huang72	Tree holes, stump holes	M
138. *perplexus* (Leicester, 1908) (as *Ae. mediopunctatus*)	Huang73, Huang77a, Knight78b (S&E65, Gould *et al.* 68)	Bamboos (stump, internode), tree holes, log holes	M

Continued

Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
139. *pseudalbopictus* (Borel, 1928)	Huang72	Bamboos (internode, split, stump, cup, pot), tree holes	M
140. *scutellaris malayensis* Colless, 1962	Thurman59, Huang72, Colles73	Rock pools, rock holes, water jars, bamboo cups, tree holes	M
141. *seatoi* Huang, 1969*	Huang69, Huang72	Bamboos (pot, cup, stump) artificial containers	
142. *subalbopictus* Barraqud, 1931	Thurman59, S&E65, Gould *et al.* 68	Tree holes, bamboos (stump, internode)	
143. *w-albus* (Theobald, 1905)	Causey37a, S&E65, Huang77a	Tree holes, hollow logs, artificial containers	M
Aedes (*Verrallina*)			
144. *adustus* Laffoon, 1946	Reinert74	Small ground pools, wheel ruts, ditches, footprints	M, P
145. *andamanensis* Edwards, 1922	S&E65, Reinert74	Shaded muddy ruts, residual pools	M
146. *atrius* Barraud, 1928	Reinert74	Stream bed pools, puddles	
147. *butleri* Theobald, 1901	Causey37a, Iyengar53, Reinert74	Coastal swamps, brackish ground pools, hoofprints, small ditches	M, P
148. *clavatus* Barraud, 1931	Reinert74	Rock pools, crab holes, flood pools, stream pools	
149. *cretatus* Delfinado, 1967	Delfinado67, Reinert74	Flood pools, small ground pools, stream margin pools	
150. *cyrtolabis* Edwards, 1928	Reinert74	Jungle pools, mangroves, shaded ditches	M
151. *dux* Dyar & Shannon, 1925 (=*Ae. sigmoides* Barraud, 1928)	Causey37a, Reinert74 (Iyengar53)	Ground pools, footprints, marshy depressions	M, P
152. *gibbosus* Delfinado, 1967	Delfinadi67, Reinert74	Rain water pools, flood pools	M
153. *hispidus* Delfinado, 1967*	Delfinado67, Reinert74	——	
154. *incertus* Edwards, 1922	Reinert74	Flood pools, seepage pools, stream bed pools	M
155. *indecorabilis* (Leicester, 1908)	Reinert74	Small jungle pools	M
156. *latipennis* Delfinado, 1967*	Delfinado67, Reinert74	Small ground pools, flood pools	
157. *lugubris* Barraud, 1928	Reinert74	Marshy ground pools	M
158. *notabilis* Delfinado, 1967	Delfinado67, Reinert74	——	
159. *phnomus* Klein, 1973	Reinert74	——	
160. *protuberans* Delfinado, 1967*	Delfinado67, Reinert74	——	
161. *pseudodiurnus* (Theobald, 1910)	K&S77	——	

162. *sohni* Reinert, 1974	Reinert74	Paddles	M
163. *torosus* Delfinado, 1967*	Delfinado67, Reinert74	Seepage pools	
164. *uncus* (Theobald, 1901)	Iyengar53, Reinert74	Temporary ground pools, jungle pools	M, P
165. *vallistris* Barraud, 1928	I&M56, Reinert74	Jungle pools, large wells	
166. *yusafi* Barraud, 1931 (=*Ae. siamensis* Delfinado, 1968)	Reinert74 (Delfinado68)	——	
Armigeres (Armigeres)			
167. *aureolineatus* (Leicester, 1908)	Thurman59, S&E65	Coconut shells	M, P
168. *bhayungi* Thurman & Thurman, 1958*	T&T58	——	
169. *jugraensis* (Leicester, 1908)	Thurman59, Gould *et al.* 68	Bamboos	M
170. *kesseli* Ramalingam, 1987 (as *Ar. durhami*)	Ramalingam87 (Thurman59, S&E65, Gould *et al.* 68)	Artificial containers, bamboo stumps	M
171. *kuchingensis* Edwards, 1915	Causey37a, Thurman59	Ground pools, rock pools, water receptacles	M
172. *malayi* (Theobald, 1901)	Iyengar53, Thurman59, S&E65, Gould *et al.* 68	Flower cups of *Sepria himalayana*, coconut shells, tree holes, bamboo stumps	M, P
173. *subalbatus* (Coquillett, 1898)	Thurman59, S&E65, Gould *et al.* 68	Artificial containers, bamboo stumps, coconut shells	M, P, J
174. *theobaldi* Barraud, 1934	Thurman59, S&E65	Ginger flower bracts	
175. (*Arm.*?) *obturbans* (Walker, 1859)	Causey37a, Iyengar53	Highly polluted water: tree holes, bamboo stumps, artificial containers	M
Armigeres (Leicesteria)			
176. *annulipalpis* (Theobald, 1910)	Iyengar53, Thurman59, Gould *et al.* 68	Bamboos (stump, split)	
177. *annulitarsis* (Leicester, 1908)	Causey37a, Iyengar53, S&E65	Young bored bamboo internodes, bamboo stumps	M
178. *balteatus* Macdonald, 1960	Macdonald60, Gould *et al.* 68	Dead bamboo internodes	M
179. *dentatus* Barraud, 1927	Thurman59, S&E65	Young bamboo internodes, bamboo stumps	M
180. *digitatus* (Edwards, 1914)	Causey37a, Thurman59, Gould *et al.* 68	Bored bamboo internodes, tree holes	M, P
181. *dolichocephalus* (Leicester, 1908)	Thurman59, S&E65	Young bored bamboo internodes	M
182. *flavus* (Leicester, 1908)	Causey37a, Thurman59, S&E65, Gould *et al.* 68	Bamboos (stump, internode, split), tree holes	M, P

Continued

Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
183. *inchoatus* Barraud, 1927	Causey37a, Thurman59	Dead bamboo internodes	M
184. *longipalpis* (Leicester, 1904) (=*Ar. cingulatus* Leicester, 1908)	Thurman59, S&E65 (Thurman59)	Bamboos (split, bored internode)	M
185. *magnus* (Theobald, 1908)	Iyengar53, S&E65	Bamboos (stump, internode), tree holes	M, P
186. *omissus* (Edwards, 1914)	Thurman59, S&E65	Bamboos (internode, split, stump), Taro leaf axils	M, P
187. *pectinatus* (Edwards, 1914)	Gould *et al.* 68	——	M. P
188. *vimoli* Thurman & Thurman, 1958*	T&T58	——	
Heizmannia (*Heiamannia*)			
189. *aureochaeta* (Leicester, 1908)	Causey37a, Thurman59, S&E65, Mattingly70	Hilly areas: tree holes, bored bamboo internodes	M
190. *chengi* Lien, 1968	Mattingly70	Forested hills: tree stumps	
191. *communis* (Leicester, 1908)	S&E65, Mattingly70	Bored bamboo internodes	M
192. *complex* (Theobald, 1910) (=*Hz. stonei* Mattingly, 1957)	Causey37a, Thurman59, Mattingly70, (Thurman59)	Bamboos, tree holes	M
193. *covelli* Barraud, 1929	Causey37a, S&E65, Mattingly70	Tree holes, coconuts, bamboo stumps, artificial containers	
194. *demeilloni* Mattingly, 1970	Mattingly70	Bamboo stumps	
195. *macdonaldi* Mattingly, 1957	Mattingly70	Bamboos (split, bored, stump)	M
196. *mattinglyi* Thurman, 1959 (as *Hz. viridis*)	Thurman59, S&E65, Mattingly70 (Thurman59)	——	
197. *persimilis* Mattingly, 1970	Mattingly70	Tree holes	M
198. *propinqua* Mattingly, 1970	Mattingly70	Tree holes, bamboo stumps	M
199. *proxima* Mattingly, 1970*	Mattingly70	Tree holes, bamboos (split, stump)	
200. *reidi* Mattingly, 1957	Thurman59, S&E65, Mattingly70	Tree holes, bamboos (internode, stump), banana trees, ground pools, rock pools, crab holes	M
201. *scanloni* Mattingly, 1970*	Mattingly70	——	
202. *scintillans* Ludlow, 1905	Mattingly70	Tree holes, bamboo internodes, banana leaf axils	M, P

Heizmannia (*Mattinglyia*)			
203. *achaetae* (Leicester, 1908) (as *Haemagogus achaetae*) (as *Hz. stonei*)	Thurman59, Mattingly70 (Causey37a) (Thurman59)	Tree holes, fallen coconut leaves	M
204. *thelmae* Mattingly, 1970*	Mattingly70	Bamboo	
Udaya			
205. *argyrurus* (Edwards, 1934) (as *Paraedes* (*Udaya*) *argyrurus*)	Thurman59, S&E65 (Macdonald57)	Fallen split bamboos	M
Culex (*Culex*)			
206. *alienus* Colless, 1957	Bram67, Sirivanakarn76	Wells, ground pools, puddles	M
207. *alis* Theobald, 1903 (=*Cx. neolitoralis* Bram, 1967)	Sirivanakarn76 (Bram67, Gould *et al.* 68)	Salt marshes: brackish rock pools, large tree holes	M, P
208. *barraudi* Edwards, 1922	Thurman59, S&E65, Bram67, Sirivanakarn76	High elevation: streams, roadside ponds	
209. *bitaeniorhynchus* Giles, 1901	Causey37a, Bram67, Sirivanakarn76	With *Spirogyra*: ponds, ditches, rice fields	M, P, J
210. *fuscocephala* Theobald, 1907 (=*Cx. fuscitarsis* Barraud, 1924)	Causey37a, Iyengar53, Thurman59, S&E65, Bram67, Gould *et al.* 68, Sirivanakarn76 (Thurman59)	Small pools, footprints in rice fields	M, P, J
211. *gelidus* Theobald, 1901	Causey37a, S&E65, Bram67, Sirivanakarn76	Open ground pools, puddles, rice fields, muddy ponds	M, P
212. *hutchinsoni* Barraud, 1924	Thurman59, Bram67, Sirivanakarn76	Pools, rock holes, stream pools, elephant tracks, drum cans	M, P
213. *infula* Theobald, 1901	Sirivanakarn76	With green algae: ground pools, stream edges	M, P
214. *jacksoni* Edwards, 1934	Miyagi *et al.* 86	High elevation: forest ponds	J
215. *longicornis* Sirivanakarn, 1976*	Sirivanakarn76	——	
216. *mimeticus* Noe, 1899	Causey37a, Miyagi *et al.* 86	High elevation: rock pools, stream pools	M, J
217. *mimulus* Edwards, 1915	Iyengar53, Bram67, Sirivanakarn76	Stream pools, rock holes, sumps, hoofprints	M, P
218. *murrelli* Lien, 1968	Sirivanakarn76	Rock pools, ground pools	M
219. *perplexus* Leicester, 1908	Bram67, Sirivanakarn76	Sumps, swamps, stream pools, stream margins, ground pools	M, P

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Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
220. *pseudosinensis* Colless, 1955	Thurman59, Bram67, Sirivanakarn76	With *Spirogyra*: stagnant pools, ground pools, stream margins	M
221. *pseudovishnui* Colless, 1957	S&E65, Bram67, Sirivanakarn76	Ditches, rice fields, ponds, sumps, stream ground pools	M, J
222. *quinquefasciatus* Say, 1823 (=*Cx. fatigans* Wiedemann, 1828)	Causey37a, S&E65, Bram67, Sirivanakarn76	Ground pools, ditches, ponds, artificial containers	M, P, J
223. *sinensis* Theobald, 1903	Thurman59, S&E65, Bram67, Sirivanakarn76	With green algae: puddles, ponds, ditches, rice fields, stream pools	M, P, J
224. *sitiens* Wiedemann, 1828	Causey37a, Bram67, Sirivanakarn76	Coastal ground pools, salt marshes	M, P, J
225. *tritaeniorhynchus* Giles, 1901	Causey37a, S&E65, Bram67, Sirivanakarn76	Grassy ground pools, ponds, rice fields, swamps	M, P, J
226. *vishnui* Theobald, 1901 (=*Cx. annulus* Theobald, 1901)	Causey37a, Iyengar53, Bram67, Sirivanakarn76 (S&E65, Gould *et al.* 68)	Open ground pools, puddles, ditches, rice fields, hoofprints	M, P
227. *whitei* Barraud, 1923	Thurman59, Bram67, Sirivanakarn76	Hilly ground pools	M, P
228. *whitmorei* (Giles, 1904)	Causey37a, S&E65, Bram67, Sirivanakarn76	Ground pools, ponds, grassy ditches, rice field, slow-moving stream margins	M, P, J
Culex (*Culiciomyia*)			
229. *bailyi* Barraud, 1934	Bram67	Sumps, open puddles, rock pools, elephant hoofprints, tree holes	M
230. *barrinus* Bram, 1967*	Bram67	Puddles, elephant tracks	
231. *dispectus* Bram, 1966* (as subgenus *Thaiomyia*)	Bram66 Harrison87	Bamboo stumps, bamboo internodes	
232. *fragilis* Ludlow, 1903	Causey37a, Iyengar53, Bram67	Elephant tracks, bamboo stumps, pools, ditches	M, P
233. *harrisoni* Sirivanakarn, 1977*	Sirivanakarn77a	300–400 m inside a cave: rock pools	
234. *lampangensis* Sirivanakarn, 1973*	Sirivanakarn73	High elevation: stream bed pools, stream margins	
235. *nigropunctatus* Edwards, 1926	Causey37a, Iyengar53, Bram67	Small shady pools, rock pools, puddles, rice fields, ditches, hoofprints	M, P, J

236. *pallidothorax* Theobald, 1905	Causey37a, S&E65, Bram67	Tree holes, bamboo stumps, stream pools, puddles, rock pools, swampy ground pools, elephant footprints	M, P, J
237. *papuensis* (Taylor, 1914)	Bram67	Stream pools, rock pools, elephant hoofprints, artificial containers	M, P
238. *sasai* Kano, Nitahara & Awaya, 1954	Miyagi *et al.* 86	High elevation: tree holes, artificial containers	J
239. *scanloni* Bram, 1967	Bram67	Rock pools, stream pools, puddles, elephant hoofprints, artificial containers	M, P
240. *spathifurca* (Edwards, 1915)	Causey37a, Bram67	Artificial containers, elephant tracks, temporary pools, canals, rice fields, ditches, crab holes	M, P
241. *spiculothorax* Bram, 1967	Bram67	Bamboo stumps	M
242. *termi* Thurman, 1955*	Thurman55, Bram67	Elephant hoofprints	
243. *thurmanorum* Bram, 1967* (as *Cx. viridiventer*)	Bram67 (Thurman59)	Elephant hoofprints	
Culex (*Eumelanomyia*)			
244. *brevipalpis* (Giles, 1902)	Causey37a, Bram67, Sirivanakarn72	Bamboo stumps, tree holes, artificial containers	M, P, J
245. *foliatus* Brug, 1932 (as *Cx. castrensis*)	Bram67, Sirivanakarn72 (Causey37a)	Under heavy shades: stream margin pools, stream bed pools, rock pools, puddles, footprints	M, P
246. *hinglungensis* Chu, 1957	Bram67, Sirivanakarn72	Mountainous areas: ——	P
247. *kiriensis* Klein & Sirvanakarn, 1969	K&S69, Sirivanakarn72	Mountainous areas: a stream bed pool, a stream margin pool (pupae)	
248. *macrostylus* Sirivanakarn & Ramalingam, 1976	Miyagi *et al.* 86	High elevation: forest ponds	M
249. *malayi* (Leicester, 1908)	Causey37a, Bram67, Sirivanakarn72	Ponds, ditches, rock pools, stream pools	M
250. *otachati* Klein & Sirivanakarn, 1969	K&S69, Sirivanakarn72	Mountainous areas: ——	
251. *phangngae* Sirivanakarn, 1972*	Sirivanakarn72	Bamboo stumps, tree holes	
252. *tenuipalpis* Barraud, 1924	Thurman59, Bram67, Sirivanakarn72	High elevation: road side pools, elephant footprints	M
Culex (*Lophoceraomyia*)			
253. *aculeatus* Colless, 1965	Bram67, Sirivanakarn77b	Mountainous heavy shades: stream edge pools, swamps, marshy depressions, rock pools	M

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Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
254. *alphus* Colless, 1965	Bram67, Sirivanakarn77b	Shaded wells, pools, ponds, coastal forest swamps	M
255. *bengalensis* Barraud, 1934	Bram67, Sirivanakarn77b	Elephant hoofprints, puddles, wheel tracks, stream pools, tree holes	M
256. *bicornutus* Theobald, 1910	Bram67, Sirivanakarn77b	Rock pools, clay pots, coconut shells, puddles, footprints, containers	M, J
257. *cinctellus* Edwards, 1922	Bram67, Sirivanakarn77b	Marshy depressions, swamps, ditches, ponds, shaded stream margins	M, P, J
258. *curtipalpis* (Edwards, 1914)	Bram67, Sirivanakarn77b	Pitcher plants	M
259. *demissus* Colless, 1965 (=*Cx. fuscosiphonis* Bram & Rattanarithikul, 1967)	Sirvivanakarn77b (B&R67, Bram67)	Tree holes, root holes	M
260. *eukrines* Bram & Rattanarithikul, 1967*	B&R67, Sirivanakarn77b	Rock holes, flood pools, bamboo internodes, coconut shells, tree holes, Pandanus axils, crab holes	
261. *ganapathi* Colless, 1965	Bram67, Sirivanakarn77b	Tree holes, bamboo stumps, stream margins, rock ploos, coconut shells, artificial containers	M
262. *gracicornis* Sirivanakarn, 1977	Sirivanakarn77b	Unshaded flooded ground pools	M
263. *hirtipalpis* Sirivanakarn, 1977*	Sirivanakarn77b	High elevation: ——	
264. *incomptus* Bram & Rattanarithikul, 1967*	B&R67, Sirivanakarn77b	High elevation: tree holes	
265. *infantulus* Edwards, 1922	Causey37a, Bram67, Sirivanakarn77b	Small ground pools, ditches, ponds, wells, artificial containers, footprints, palm bracts, axils	M, P, J
266. *lucalis* Colless, 1965	Bram67, Sirivanakarn77b	Pitcher plants	M
267. *macdonaldi* Colles, 1965	Bram67, Sirivanakarn77b	Shaded fresh water ground pools, swamps along coast, rock pools	M, P
268. *mammilifer* (Leicester, 1908)	Thurman59, Bram67, Sirivanakarn77b	Small ground pools, puddles, footprints, bamboos (stump, internode), Nipa leaf axils	M, P
269. *minor* (Leicester, 1908)	Causey37a, Bram67, Sirivanakarn77b	Bamboos, tree holes, rock pools	M, P
270. *minutissimus* (Theobald, 1907)	Thurman59, Sirivanakarn77b	Flooded ground pools, rock springs, shallow wells, stagnant water, coconut shells	M

271. *pairoji* Sirivanakarn, 1977	Sirivanakarn77b	Shaded jungle swamps, marshes, stream edge pools	M
272. *peytoni* Bram & Rattanarithikul, 1967	B&R67, Sirivanakarn77b	Tree holes, root holes, bamboos (stump, internode), coconut shells, rock pools	M
273. *pholeter* Bram & Rattanarithikul, 1967*	B&R67	Mountainous forest: crab holes, stream pools, tree holes, footprints	
274. *pilifemoralis* Wang & Feng, 1964	Sirivanakarn77b	High elevation: stream pools, puddles, animal footprints	
275. *quadripalpis* (Edwards, 1914)	Bram67, Sirivanakarn77b	Stream pools, stream margins, pits, swamps, seepages, rock pools, elephant hoofprints	M, P
276. *reidi* Colless, 1965	Bram67	Coastal areas: fresh water ground pools in Nipa swamps, tidal pools, Nipa axils, coastal crab holes	M, P
277. *rubithoracis* (Leicester, 1908)	Causey37a, Bram67, Sirivanakarn77b	Open ground pools, rice fields, marshes, swamps, puddles, crab holes	M, P, J
278. *spiculosus* Bram & Rattanarithikul, 1967	B&R67, Sirivanakarn77b	High elevation: bamboos (stump, internode), tree holes, artificial containers	M
279. *traubi* Colless, 1965	Bram67, Sirivanakarn77b	Tree holes, bamboo stumps	M
280. *tuberis* Bohart, 1946	Sirivanakarn77b	Crab holes, deep rock holes	J
281. *variatus* (Leicester, 1908)	Bram67, Sirivanakarn77b	Marshy depressions, large ground pools, puddles, ditches, ponds, swamps	M
282. *whartoni* Colless, 1965	Sirivanakarn77b	Ground pools, ditches, coastal swamps	M
283. *wilfredi* Colless, 1965	Bram67, Sirivanakarn77b	High elevation: ground pools, ponds, elephant footprints, seepages, stream pools, tree holes	M
Culex (*Lutzia*)			
284. *fuscanus* Wiedemann, 1820	Causey37a, Iyengar53, Bram67	Ground pools, rock pools, ditches, artificial containers	M, P, J
285. *halifaxii* Theobald, 1903 (=*Cx. raptor* Eewards, 1922)	Causey37a, Bram67 (Thurman59)	Ground pools, rock pools, ditches, artificial containers	M, P, J
Ficalbia (*Ficalbia*)			
286. *minima* (Theobald, 1901)	Causey37a, Iyengar53	Blind ditches, ponds	M
Mimomyia (*Etorleptiomyia*)			
287. *elegans* (Taylor, 1914)	Iyengar53, Thurman59	Swampy areas: animal hoofprints, fresh water holes	M, P, J
288. *luzonensis* (Ludlow, 1905)	Causey37a	Rice fields, ground pools, ditches, artificial containers	M, P, J

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Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
Mimomyia (*Mimomyia*)			
289. *aurea* (Leicester, 1908)	Iyengar53, Thurman59	——	M
290. *chamberlaini* Ludlow, 1904	Thurman59	With *Pistia*: ponds, fish ponds, ground pools, irrigation ditches, water tanks	M, P
291. *c. metallica* (Leicester, 1908)	Thurman59	With *Pistia*: pools, marshes	M, P
292. *hybrida* (Leicester, 1908)	Thurman59	With *Pistia*: ground pools, ponds	M, P
Hodgesia			
293. *lampangensis* Thurman, 1959*	Thurman59	Elephant tracks in grassy marshes	
294. *malayi* Leicester, 1908	Thurman59	Jungle pools, grassy ponds	M, P
Coquillettidia (*Coquillettidia*)			
295. *crassipes* (Van der Wulp, 1881)	Causey37a, Iyengar53, S&E65	With reed: sunny marshes, swamps, rice fields	M, P, J
296. *novochracea* (Edwards, 1927)	Thurman59	——	
297. *ochracea* (Theobald, 1903)	Causey37a, Iyengar53	Marshes, swamps	M, P, J
298. sp. (near *giblini*) (as *Mansonia giblini*) (as *Taeniorhynchus giblini*)	Macdonald57 (Iyengar53, Thurman59) (I&M56)	——	M, P
Mansonia (*Masonioides*)			
299. *annulifera* (Theobald, 1901)	Causey37a, Iyengar53, S&E65	With *Pistia*: ponds	M, P
300. *bonneae* Edwards, 1930	Causey37a, Thurman59	Tree roots in swamp forests	M, P
301. *dives* (Schiner, 1868) (=*Ma. longipalpis* van der Wulp, 1881)	Thurman59, S&E65 (Causey37a, Iyengar53)	Swamp forests	M, P
302. *indiana* Edwards, 1930	Causey37a, Iyengar53, S&E65	With water hyacinth: ponds, pools	M
303. *uniformis* (Theobald, 1901)	Causey37a, Iyengar53, S&E65	With water hyacinth: ponds	M, P, J
Orthopodomyia			
304. *albipes* Leicester, 1904	Gould *et al.* 68, Zavortink71	Bamboo stumps, tree holes	M, P
305. *andamanensis* Barraud, 1934	Thurman59, Zavortink71	Bamboo stumps, tree holes	M, P, J

306. *anopheloides* (Giles, 1903) (=*Or. lemmonae* Thurman, 1959) (=*Or. maculata* Theobald, 1910) (=*Or. maculipes* Theobald, 1910)	Thurman59, Zavortink71 (Thurman59) (Thurman59) (Thurman59)	Bamboo stumps, tree holes, artificial containers	M, P
307. *siamensis* Zavortink, 1968*	Zavortink71	Rot holes in trees, stumps, roots, bamboo stumps	
308. *wilsoni* Macdonald, 1958	Zavortink71	Bamboos (cracked, split, internode)	M
Malaya			
309. *genurostris* Leicester, 1908 (as *Harpagomyia genurostris*)	Thurman59, Gould *et al.* 68 (Iyengar53)	Taro leaf axils	M, P, J
310. *jacobsoni* (Edwards, 1930)	Thurman58	Banana leaf axil	M, P, J
Topomyia (*Suaymyia*)			
311. *apsarae* Klein, 1977	Miyagi *et al.* 86	Bamboo internodes	M, P
312. *cristata* Thurman, 1959*	Thurman59	High elevation: ——	
313. *houghtoni* Feng, 1941	Miyagi *et al.* 86	Ginger flower bracts	M
314. *leucotarsis* Thurman, 1959* (=*To. pseudoleucotarsis* Thurman, 1959)	Thurman59 (Ramalingam, personal communication)	High elevation: ——	
315. *yanbarensis* Miyagi, 1976	Miyagi *et al.* 86	Bamboo internodes	J
316. sp. 1 (near *decorabilis*)	Miyagi *et al.* 86	Bamboo internodes	
Topomyia (*Topomyia*)			
317. *aenea* Thurman, 1959*	Thurman59	——	
318. *angkoris* Klein, 1977	Miyagi *et al.* 86	Taro leaf axils	
319. *inclinata* Thurman, 1959*	Thurman59	——	
320. *lindsayi* Thurman, 1959*	Thurman59	High elevation: ——	
321. *svastii* Thurman, 1959* (=*To. unispinosa* Thurman, 1959)	Thurman59 (Ramalingam, personal communication)	High elevation: ——	
322. sp. 2 (near *aenea*)	Miyagi *et al.* 86	Banana leaf axils	
323. sp. 3 (near *svastii*)	Miyagi *et al.* 86	Banana leaf axils	
324. (*Top.*?) sp. 4	Miyagi *et al.* 86	Ginger flower bracts	
Tripteroides (*Rachionotomyia*)			
325. *affinis* (Edwards, 1913)	Thurman59, Mattingly81	Bamboo stumps, artificial containers	

Continued

Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
326. *aranoides* (Theobald, 1901)	Causey37a, Thurman59, Gould *et al.* 68, Mattingly81	Bamboo stumps, pitcher plants	M
327. *serratus* (Barraud, 1929)	Thurman59, Mattingly81	——	
328. *tenax* (De Meijere, 1910)	Mattingly81	Pitcher plants	M
Tripteroides (*Tripteroides*)			
329. *aeneus* (Edwards, 1921)	Thurman59	——	M
330. *caeruleocephalus* (Leicester, 1908)	Thurman59	Bamboo stumps, tree holes, artificial containers	M
331. *denticulatus* Delfinado & Hodges, 1968	D&H68	Tree holes	M
332. *hybridus* (Leicester, 1908)	Thurman59	——	M
333. *indicus* (Barraud, 1929)	Thurman59	Tree holes	
334. *powelli* (Ludlow, 1909)	Thurman59, Gould *et al.* 68	Tree holes	P
335. *proximus* (Edwards, 1915)	Buei *et al.* 83	Bamboo stumps, tree holes	M
336. *similis* (Leicester, 1908)	Thurman59	Bamboo stumps	M
337. *tarsalis* Delfinado & Hodges, 1968	D&H68	Tree holes	M
Uranotaenia (*Pseudoficalbia*)			
338. *abdita* Peyton, 1977	Peyton77	Fresh water crab holes, rock holes	
339. *albipes* Peyton, 1977*	Peyton77	Tree holes	
340. *approximata* Peyton, 1977*	Peyton77	Bamboos (pot, cup)	
341. *bicolor* Leicester, 1908	Gould *et al.* 68, Peyton77	Rock pools, stream pools, stream edges, elephant hoof-prints, log holes, tree holes, bamboo stumps, swamps	M, P
342. *bimaculata* Leicester, 1908	Peyton77	Bamboos (internode, stump, split), tree holes	M
343. *demeilloni* Peyton & Rattanarithikul, 1970	P&R70, Peyton77	Bamboos (internode, stump, split, pot)	M, P
344. *enigmatica* Peyton, 1977*	Peyton77	Fresh-water crab holes	
345. *gouldi* Peyton & Klein, 1970	P&K70, Peyton77	Seepages, swamps, stream pools	
346. *hirsutifemora* Peters, 1964	Harbach *et al.* 86	Swamp pools, seepage holes	M
347. *koli* Peyton & Klein, 1970	P&K70, Peyton77	Forested hills or mountains: crab holes, elephant foot-prints	

348. *lutescens* Leicester, 1908	Peyton77	Bamboos (split, internode, stump, pot), tree stumps, artificial containers	M
349. *maxima* Leicester, 1908	Thurman59, Peyton77	High elevation: rock pools, drum cans, tree holes, split bamboos, stream pools, elephant footprints	M
350. *modesta* Leicester, 1908	Peyton77	Tree holes, bamboos (stump, split), Pandanus leaf axils, pitcher plants	M, P
351. *nivipleura* Leicester, 1908	Peyton77	Tree stumps, tree holes, old tires, bamboo stumps	M, J
352. *nocticola* Peyton, 1977*	Peyton77	Cave: pools	
353. *novobscura* Barraud, 1934	Thurman59, Peyton77	Bamboo stumps, tree holes, tree stumps	M, J
354. *obscura* Edwards, 1915	Peyton77	Fallen leaves, bamboos, tin cans, coconut shells, rock holes	M, P
355. *patriciae* Peyton, 1977	Peyton77	Bamboos (internode, split, stump), tree holes	M
356. *pseudomaculipleura* Peyton & Rattanarithikul, 1970	P&R70, Peyton77	Bamboos (split, cut, internode, stump), tree holes, tree stumps, banana leaf axils	M
357. *recondita* Edwards, 1922	Iyengar53, Thurman59	Tree holes	
358. *spiculosa* Peyton & Rattanarithikul, 1970	P&R70, Peyton77	Fresh-water crab holes	
359. *stricklandi* Barraud, 1926	Thurman59, Peyton77	Small rock pools, stream pools	
360. *sumethi* Peyton & Rattanarithikul, 1970*	P&R70, Peyton77	A cave: clear shallow pools	
Uranotaenia (*Uranotaenia*)			
361. *annandalei* Barraud, 1926	Causey37a, Miyagi *et al.* 86	Ground pools, back water of streams	P, J
362. *bimaculiala* Leicester, 1908 (as *Ur. micans*?)	I&M56, Thurman59 (Iyengar53)	Swamp pools	M
363. *campestris* Leicester, 1908	Iyengar53, Thurman59, Gould *et al.* 68	Swampy grounds	M
364. *diraphati* Peyton & Klein, 1970	P&K70	Heavily shaded swamps	
365. *edwardsi* Barraud, 1926	Thurman59	——	M
366. *lateralis* Ludlow, 1905	Thurman59, Gould *et al.* 68	Ground pools, crab holes, coconut shells, artificial containers	M, P
367. *longirostris* Leicester, 1908	Iyengar53, I&M56, Thurman59	Fresh water marshes, ponds, ditches, Nipa axils	M
368. *macfarlanei zelena* Barraud, 1934	Thurman59	Seepages	M, J
369. *metatarsata* Edwards, 1914	Thurman59	——	M, P

Continued

Genus (Subgenus) species	Record reference	Larval breeding place	Distribution in common
370. *prajimi* Peyton & Rattanarithikul, 1970*	P&R70	Shaded forest areas: stream pools, rock pools, footprints	
371. *rampae* Peyton & Klein, 1970	P&K70	Swamps, shaded springs	
372. *somboon*i Peyton & Klein, 1970	P&K70	Mountain areas: seepages	
373. *testacea* Theobald, 1905	Causey37a, Thurman59, Miyagi *et al.* 86	Large stream pools, rock pools, tin cans, ground pools, valley streams	M, P
374. *trilineata* Leicester, 1908	Thurman59, Gould *et al.* 68	Jungle pools	M
375. sp. 1 (near *micans*)	Miyagi *et al.* 86	Rice fields, ground pools	
376. sp. 2	Miyagi *et al.* 86	Rice fields, ground pools	
	Subfamily Toxorhynchitinae		
Toxorhynchites (*Toxorhynchites*)			
377. *albipes* (Edwards, 1922)	Miyagi *et al.* 86	High elevation: tree holes	
378. *bickleyi* Thurman, 1959*	Thurman59	High elevation: tree holes	
379. *gravelyi* (Edwards, 1921)	Thurman59	High elevation: bamboo stumps	
380. *leicesteri* Theobald, 1904	Thurman59	Bamboo stumps	M, P
381. *magnificus* (Leicester, 1908)	Causey37a, Thurman59	Bamboos (internode, new stump)	M, P
382. *manopi* Thurman, 1959*	Thurman59	High elevation: ——	
383. *splendens* (Wiedemann, 1819)	Causey37a, Iyengar53, Thurman59, Gould *et al.* 68	Tree holes, artificial containers	M, P
384. *sunthorni* Thurman, 1959*	Thurman59	High elevation: artificial containers	

*: Recorded only from Thailand, M: Malaysia, P: Philippines, J: Japan
B&R: Bram and Rattanarithikul, D&H: Delfinado and Hodges, H&S: Harrison and Scanlon,
I&M: Iyengar and Menon, K&S: Klein and Sirivanakarn, P&K: Peyton and Klein,
P&R: Peyton and Rattanarithikul, R&G: Rattanarithikul and Green, R&H: Rattanarithikul and Harrison,
S&E: Scanlon and Esah, T&T: Thurman and Thurman,
——: Larval breeding place unknown or undescribed.

Thaiomyia of *Culex* has been synonimized under *Culiciomyia* by Harrison (1987).

Resurrection of Records

Annotations for some of the mosquito species may need to be added to the list of the Thai fauna because most of them did not appear in the catalog of mosquitoes of the world by Knight and Stone (1977).

Anopheles (*Ano.*) *gigas* Giles: Based on Reid (1968), this taxon has been recorded from northern Thailand as *sumatrana* and *formosus*, but the distribution of these varieties in Thailand is doubtful because they are known only from Sumatra and the Philippines, respectively. The records in Thailand should be probably considered as a taxon (*sensu lato*): *An. gigas*. Harrison and Scanlon (1975) listed this species as "not known from Thailand". However, Thailand is surrounded by many countries having the species such as Malaysia, Burma, China and Vietnam. As a matter of fact, specimens collected by us from Doi Inthanon, Chiang Mai Province, in October–November 1983 were indentified as *An. gigas* (unpublished data), confirming the earlier distribution records in Thailand.

An. (*Cellia*) *indefinitus* (Ludlow): Rattanarithikul and Harrison (1973) and Harrison and Scanlon (1975) included this species as a Thai mosquito in their list or key although no detailed locality data are available in their papers.

An. (*Cel.*) *maculatus* species group: Rattanarithikul and Green (1986) splitted *An. maculatus* Theobald (*sensu lato*) into 6 distinct species: one original, one restored, two resurrected, and two new species. Since we have, at present, no published evidence to refuse this proposal, all the taxa are included in the checklist.

An. (*Cel.*) *pseudojamesi* Strickland and Chowdhury: This species was earlier known as *An. ramsayi* Covell, but recently Huda and Harrison (1985) concluded that the name *pseudojamesi* has priority over *ramsayi*.

An. (*Cel.*) *varuna* Iyengar: Scanlon *et al.* (1968) and Rattanarithikul and Harrison (1973) once treated this species as a doubtful record in Thailand. Its distribution was later confirmed there, however, by Harrison (1980).

Aedes (*Finlaya*) *albolateralis* (Theobald), *Ae.* (*Fin.*) *alboniveus* Barraud, *Ae.* (*Fin.*) *albotaeniatus* (Leicester), *Ae.* (*Fin.*) *aureostriatus* (Doleschall), *Ae.* (*Fin.*) *feegradei* Barraud, *Ae.* (*Fin.*) *flavipennis* (Geiles), *Ae.* (*Fin.*) *pseudotaeniatus* (Giles), *Ae.* (*Fin.*) *shortti* (Barraud), *Ae.* (*Scutomyia*) *albolineatus* (Theobald), and *Ae.* (*Stegomyis*) *edwardsi* (Barraud): It is quite likely that some Malayan mosquitoes may extend their distribution to adjacent provinces in peninsular Thailand. These aedine mosquitoes were recorded by Scanlon and Esah (1965) from Doi Pui, North Thailand, and by Gould *et al.* (1968) from Koh Samui Island, South Thailand. We also collected many larvae of *Ae. pseudotaeniatus* on November 1983 from Doi Suthep, northern Thailand, and on December 1983 from Khao Soi Dao, southeast Thailand and *Ae. shortti* on December 1983 from Trok Nong, southeast Thailand (unpublished date).

Heizmannia (*Hez.*) *propinqua* Mattingly: This species has been added to the present checklist although Mattingly (1970) noted as follows: "A whole larva from Ban Pha Man, Thailand, in the U.S. National Museum, agrees with the above description and may belong to the present species but the record requires confirmation."

Cx. (*Cux.*) *mimeticus* Noe: This species was once recorded by Causey (1937a) but Bram (1967) considered it doubtful. Sirivanakarn (1976) and Knight and Stone (1977) also did not print the name "Thailand" as a distribution country. The species was, however, collected in 1983 from both northern and southeastern provinces of Thailand (Miyagi *et al.*, 1986). Apiwathnasorn (1986) also considered this species as one of the Thai mosquitoes without any reference from which we can track its evidence.

Coquillettidea (*Coq.*) sp. (near *giblini*): This species was recorded as *Mansonia* (*Coquillettidia*) *giblini* (Taylor) by Iyengar (1953) and soon thereafter as *Taeniorhynchus* (*Coquillettidia*) *giblini* by Iyengar and Menon (1956). Knight and Stone (1977) listed New Guinea, Indonesia, and the Bismark Archipelago as distribution sites of *Cq.* (*Coq.*) *giblini*. According to Macdonald (1957), the species "near *giblini*" occurs widely in Thailand, the Malay Archipelago, Philippines, etc., and "In 1940 F. E. Edwards examined specimens from Malaya and decided they were different from Australian species *giblini*. His conclusions, however, were never published, and appparently no one pursued the subject. The literature records of *giblini* have been included in the distribution list, but the probability of two species being involved should be borne in mind." It seems that this species, or at least one of these taxa, still remains undescribed or uncertain as to whether it is a distinct species or whether specimens from Thailand should be considered within a range of intraspecific variation. In any case, this species has been included as "sp. near *giblini*" in the present checklist.

Tripteroides (*Trp.*) *denticulatus* Delfinado and Hodges and *Tp.* (*Trp.*) *tarsalis* Delfinado and Hodges: Both Thailand and Malaya were recorded as distribution countries by Delfinado and Hodges (1968), although the world catalog omitted the name of "Thailand" by Knight and Stone (1977). Apiwathnasorn (1986) also followed the catalog.

Uranotaenia (*Ura.*) *annandalei* Barraud and *Ur.* (*Ura.*) *testacea* Theobald: These species were recorded by Causey (1937) from Thailand but Knight and Stone (1977) ignored these records. Recently, we also confirmed the distribution of these species both in Chanthaburi and Chiang Mai Provinces in 1983 (Miyagi *et al.*, 1986). (In the latter paper, we considered both species as new records because at that time our information was based primarily on the catalog by Knight and Stone, 1977).

Uncertain Distribution, Doubtful Records, and Misidentifications

Distribution of many mosquito taxa once reported from Thailand has not been confirmed by further research or recent collections. The records from this country of the following taxa are considered uncertain or doubtful mainly due to misidentifications in earlier studies. It is, therefore, considered reasonable not to included them in the present checklist until their distribution is verified by new materials:

Anopheles (*Ano.*) *aitkenii* James: This species was listed by Thurman (1959) as one of the mosquitoes of Thailand. Harrison and Scanlon (1975), however, recognized that its distribution should be confined to India. The earlier record species might be considered as one of 12 species of the "aitkenii group".

An. (*Ano.*) *albotaeniatus* (Theobald): This species was recorded by Iyengar (1953) from south Thailand and also was listed by Thurman (1959). However, Scanlon *et al.* (1968), Rattanarithikul and Harrison (1973) and Harrison and Scanlon (1975) considered this record doubtful. Although Knight and Stone (1977) also treated this as "?Thailand" in its distribution, Apiwathnasorn (1986) gave a plus (+) mark at the column "Thailand" in the Southeast Asian mosquito list.

An. (*Ano.*) *brevipalpis* Roper: Known from Borneo, Malaya, and the Bangka Island (Indonesia). Reid (1968) noted that "it is said to occur in Thailand though not reported by Scanlon *et al.* (1968)." To confirm this distribution, further surveys will be necessary.

An. (*Cellia*) *filipinae* Manalang and *An.* (*Cel.*) *majidi* Young and Majid: Although these were listed by Thurman (1959) as recorded species in Thailand. Scanlon *et al.* (1968), Rattanarithikul and Harrison (1973) and Harrison (1980) treated them as doubtful records due to a misidentification.

An. (*Cel.*) *fluviatilis* James: The name was recorded in the list "prior to 1950" by Thurman (1959). Knight and Stone (1977) and Apiwathnasorn (1986) also adopted "Thailand" as its distribution in their catalogs. However, Scanlon *et al.* (1968), Rattanarithikul and Harrison (1973) and Harrison (1980) thought it a doubtful record.

An. (*Cel.*) *leucosphyrus* Doenitz: Reported taxon from Thailand by Causey (1937) and many earlier workers is now considered to be *An. balabacensis* (*s. l.*), or *An. dirus* Peyton and Harrison.

An. (*Cel.*) *ludlowae* (Theobald): Recorded by Barnes (1923), and listed by Causey (1937) and Thurman (1959) as "*ludlowi*". Its known distribution is the Philippines, Hainan, Taiwan, Moluccas, and ?Borneo (Knight and Stone, 1977). Therefore, the earlier record from Thailand may need further confirmation.

An. (*Cel.*) *maculipalpis* Giles: This was recorded by Barnes (1923), but its distribution is confined to Africa (Knight and Stone, 1977). This may be due to misidentification.

An. (*Cel.*) *pallidus* Theobald: Recorded by Causey (1937) and listed by Thurman (1959) and Scanlon *et al.* (1968). Rattanarithikul and Harrison (1973), however, considered this species doubtful, and Knight and Stone (1977) also listed its distribution as "?Thailand". Although Table 1 of the present paper does not include this species among the Thai mosquito fauna, more extensive surveys may be necessary because Thailand is surrounded by many neighboring countries where this species occurs such as Burma, Malaysia, Cambodia, Laos and Indonesia.

An. (*Cel.*) *punctulatus*: Recorded by Barnes (1923) as *An. punctulatus* Theobald (=*tessalata*), but the authou's name should be "Doenitz", and its distribution is confined to islands such as New Guinea, Bismark, Solomons, and Moluccas (Knight and Stone, 1977).

Aedes (*Aedimorphus*) *stenoetrus* (Theobald): Knight and Stone (1977) included the name "Thailand" as a country of distribution and Apiwathnasorn (1986) followed their treatment. The specimens collected by Thurman (1959) from Chiang Mai and kept in the U. S. National Museum, however, were not this species but were "actually *Ae. vexans vexans*" (Meigen) (based on Reinert, 1973a). In the present paper, therefore, this species is excluded from the list of Thai mosquitoes.

Ae. (*Adm.*) *taeniorhynchoides* (Christophers): Listed by Iyengar (1953) and Thurman (1959). This is now also considered by Reinert (1973a) to be *Ae. v. vexans*.

Ae. (*Cancraedes*) *curtipes* Edwards: Knight and Stone (1977) and Apiwathnasorn (1986) listed its distribution as "?Thailand."

Ae. (*Finlaya*) *christophersi* Edwards, *Ae. dissimilis* (Leicester), *Ae. gubernatoris* (Giles), *Ae. lacteus* Knight, *Ae. laoagensis* Knight, *Ae. leucopleurus* Rozeboom, *Ae. macdougalli* Edwards, *Ae. niveoides* Barraud, and *Ae. paradissimilis* Rozeboom: All these species belonging to subgenus *Finlaya* were listed by Thurman (1959) as mosquitoes recorded from Thailand. However, Knight and Stone (1977) did not accept these earlier distribution records from Thailand.

Ae. (*Mucidus*) *ferinus* Knight: This species was listed by Thurman (1959) as recorded "during 1957", and Scanlon and Esah (1965) also recorded it from Doi Pui, northern Thailand, although its taxonomic status was not conclusive. According to Tyson (1970), distribution of the species was restricted to the Philippines and adults of *Ae. ferinus* and *Ae. quasiferinus* are very similar in morphology. Therefore, misidentification of the latter is probable.

Ae. (*Verrallina*) *cautus* Barraud: Reported by Delfinado (1967), but Reinert (1974) found that the deposited Thailand specimens were a mixture of *Ae. atrius* Barraud, *Ae. vallistris* Barraud and *Ae. varietas* (Leicester), and that no *Ae. cautus* material was present in the collection from Thailand.

Ae. (*Ver.*) *indicus* (Theobald): Delfinado (1967) reported Thailand as a new record for *indicus*. After examining the Thailand specimens, however, Reinert (1974) concluded that this record was incorrect.

Heizmannia (*Hez.*) *greeni* (Theobald): Reported by Causey (1937), but it seems to consist of several species such as *chengi* Lien, *propinqua* Mattingly, *proxima* Mattingly and *scanloni* Mattingly (Mattingly, 1970).

Hz. (*Hez.*) *indica* (Theobald): The catalog by Knight and Stone (1977) included "Thailand" for this species. Apiwathnasorn (1986) also adopted such treatment. However, since "the record by Causey (1937) from Thailand may refer to *reidi*" (Mattingly, 1970), this species is deleted from the present checklist.

Hz. (*Hez.*) *viridis* Barraud: Thurman (1959) listed this species as one of the Thai mosquitoes reported in 1957. However, *Hz. viridis* was know only from India, and Mattingly (1970) did not include this species among Southeast Asian mosquitoes.

Culex (*Cux.*) *cornutus* Edwards: Reported by Thurman (1959), but eliminated later by Bram (1967).

Cx. (*Cux.*) *theileri* Theobald: The specimen collected and listed by Thurman (1959) was later identified as *Cx. annulus* Theobald by Bram (1967). But the latter species was further synonymized with *Cx. vishnui* Theobald by Sirivanakarn (1976).

Cx. (*Cux.*) *univittatus* Theobald: Thurman (1959) listed this species under the item "during 1957". However, its distribution is restricted from India to Mediterranean region (Sirivanakarn, 1976; Knight and Stone, 1977). Although once synonymized name *Cx. perexiguus* has been resurrected from *univittatus* (according to Knight, 1978), the name *perexiguus* has never been recorded from Thailand.

Cx. (*Culiciomyia*) *viridiventer* Giles: Collected and listed by Thurman (1959), this was not true *viridiventer*, and Bram (1967) described it as a new species *Cx. thurmanorum* Bram.

Cx. (*Mochthogenes*) *castrensis* Edwards: Reported by Causey (1937), but is now considered to be *Cx.* (*Eumelanomyia*) *foliatus* Brug (based on Bram, 1967).

Cx. (*Eum.*) *khazani* Edwards: Thurman (1959) listed this species under the item "reported during 1957" but this was known only from India. Bram (1967) eliminated the species from Thai fauna because no locality data was available and no specimen was found from any Thailand collection deposited in a museum.

Cx. (*Lophoceraomyia*) *flavicornis* Barraud: Listed by Thurman (1959), this was pointed out to be a misidentification and was described as a new species, *Cx. incomptus*, by Bram and Rattanarithikul (1967).

Cx. (*Lop.*) *fraudatrix* (Theobald): Thai specimens reported by Causey (1937) were also pointed out by Bram (1967) to be a mixture of *Cx. macdonaldi* Colless and *Cx. variatus* (Leicester).

Cx. (*Lop.*) *minutissimus* (Theobald): Reported by Thurman (1959), but was eliminated by Bram (1967).

Cx. (*Lop.*) *uniformis* (Theobald): Thurman (1959) listed this as one of the species recorded from Thailand. Specimens determined as "*uniformis*" in the Thurman collection belonged to either *minor* or *spiculosus* (based on Bram, 1967).

Mimomyia (*Ravenalites*) *fusca* (Leicester): Although Thurman (1959) listed this species as genus "*Ficalbia*" under the item "between 1950 and 1956", Knight and Stone (1977) did not include "Thailand" in its distribution.

Uranotaenia (*Pseudoficalbia*) *atra* Theobald: Known distribution of this species is New Guinea, the Bismark Archipelago, and Australia (Knight and Stone, 1977). Causey (1937) reported that "this species is widely distributed in Siam." Since then, however, no one has recorded it in Thailand. We can thus assume that it must have been a misidentification of some other common species.

Ur. (*Pfc.*) *maculipleura* Leicester: Thurman (1959) listed this species as recorded "during 1957". According to Peyton (1977), there are many similar but distinct species in Thailand, such as *pseudomaculipleura, stricklandi,* etc. Therefore, the earlier record from Thailand may be due to a misidentification.

Ur. (*Ura.*) *alboannulata* (Theobald): This was listed as a Thai mosquito species by Thurman (1959), but this species is known only from India (Knight and Stone, 1977).

Ur. (*Ura.*) *micans* Leicester: First recorded by Iyengar (1953) as *micans*(?), it was soon identified as *Ur. bimaculiala* Leicester by Iyengar and Menon (1956). Although Thurman (1959) and Knight and Stone (1977) listed *micans* as a Thai mosquito species, in the present paper this species is treated as an uncertain record until specimens of true "*micans*" are collected from Thailand in the future.

Ur. (*Ura.*) *orientalis* Barraud: Causey (1937) collected and reared larvae of this species, then obtained adults. However, its known distribution is only India according to Knight and Stone (1977). Identification of the species, therefore, should be reconfirmed by new material.

Toxorhynchites (*Tox.*) *amboinensis* (Doleschall): Iyengar (1953) reported this species from South Thailand without any comment or locality data. Except for this report, no one has recorded it in Thailand. All the known distribution areas of *Tx. amboinensis* are restricted to islands in Southeast Asia and the Southwest Pacific Ocean and do not included the Asian mainland. In spite of extensive surveys of *Toxorhynchites* spp. in 1986 on the Malay Peninsula, no specimen of *Tx. amboinensis* has been collected (unpublished data), making the record of this species in South Thailand doubtful.

Probable Distribution

Thailand is immediately surrounded by four countries, Malaysia, Burma, Laos, and Cambodia, and indirectly by their adjacent countries, China and Vietnam. It is, therefore, highly probable that some mosquito species which occur in these countries may also occur in Thailand, because many species have been recorded from a combination of at least two of these countries or areas, for example, the Malay Peninsula–China or Burma–Cambodia combinations. As a matter of fact, we have collected *Topomyia* (*Suaymyia*) *houghtoni* Feng (previously known only from Malaya and China), and *Tx.* (*Tox.*) *albipes* (Edwards) (betore it was known only from India and Indochina) from north Thailand (Miyagi *et al.*, 1986).

The possibility of occurrence near a border is also likely even if the distribution of a mosquito species is known from a single adjacent country. Again, we can quote several examples of such new records to Thailand from our collections (Miyagi *et al.*, 1986): *To.* (*Sua.*) *apsarae* Klein and *To.* (*Top.*) *angkoris* Klein, the type localities of both species are in Cambodia only 200 km. from the border of Thailand. (It should be point out that the species name *angkoris* is misspelled as *ankoris* by Ward, 1984; Gaffigan and Ward, 1985; and Apiwathnasorn, 1986). *Culex* (*Eum.*) *macrostylus* Sirivanakarn and Ramalingam was also collected from Doi Inthanon, northern Thailand, though it was known before only from Malaya (Sirivanakarn and Ramalingam, 1976). Therefore, more extensive surveys for mosquito fauna in Thailand may give rise to many "new records" in the near future.

Although we can mention a number of mosquito species possibly or probably distributed in Thailand, we would like to refer here to only two examples in the genus *Toxorhynchites*.

Tx. (*Tox.*) *angustiplatus* Evenhuis and Steffan: Based on its description as a new species, Evenhuis and Steffan (1986) noted that "it probably occurs throughout the northern states on Peninsular Malaysia and possibly also in southern Thailand at low elevations in association with *Nepenthes* pitchers."

Tx. (*Tox.*) *klossi* (Edwards): This species can be collected from several kinds of mountainous pitcher plants in Malaya from Genting Highland, Pahang State, to Gunung Jerai, Kedah State, near the Thai-Malaysian border. Pitcher plants are also found in peninsular Thailand, where ecological conditions of natural environments are quite similar to those in Kedah State (type-locality of this mosquito) of Malaya. Therefore, it is suspected that larvae of this mosquito may inhabit pitcher plants in some peninsular provinces of Thailand adjacent to the border.

Comparison of Mosquito Fauna

For convenience in the analysis of data, Table 2 shows a "quick-look" comparison of mosquito fauna in major taxonomic levels such as genus (and subgenus) among Thailand, Malaysia, Philippines, and Japan. Out of 384 taxa of the mosquito fauna in Thailand, 54 taxa (14.1%) have been recorded only from Thailand (i.e., are endemic), whereas nearly 40% of the Philippine mosquito fauna are endemic. As shown in this table, general patterns of the genera which appear in Thailand are quite similar to those of Malaysia. For example, at least 249 among the Thai mosquito taxa (64.8%) are distributed in common with Malaysia (mosquito fauna of the latter consists of at least 408 recorded taxa, based on a preliminary checklist prepared by Tsukamoto, unpublished). On the contrary, 113 taxa (29.4%) are common with the Philippine fauna (which consists of more than 300 taxa listed by Tsukamoto *et al.*, 1985), and only 44 taxa (11.5%) are common with the Japanese fauna which consists of 109 taxa (based on Tanaka *et al.* 1979).

Significant differences can also be observed in quality within genus or subgenus level between Thailand and the Philippines in special taxonomic groups. For example, the Philippine fauna involves only a single species of *Heizmannia* while the Thai fauna lacks any species of *Zeugnomyia*. In addition, none of the species of *Tripteroides* is endemic in Thailand whereas nearly all species of this genus are known only from the Philippines. A similar situation is also observed in the subgenus *Finlaya* of the genus *Aedes*: only 2 out of 23 species (8.7%) are endemic in Thailand whereas 18 out of 23 species (78.3%) are recorded only from the

Table 2 Endemic and common geographic distribution of Thai mosquitoes among some related countries in Asia

Genus (Subgenus)	No. of mosquito species		Common distribution with		
	Thailand	Endemic	Malaysia	Philippines	Japan
	Subfamily ANOPHELINAE				
Anopheles	65	4	52	15	4
(*Anopheles*)	(34)	(2)	(31)	(5)	(2)
(*Cellia*)	(31)	(2)	(21)	(10)	(2)
	Subfamily CULICINAE				
Aedes	100	16	51	24	6
(*Aedimorphus*)	(10)	(0)	(7)	(3)	(1)
(*Finlaya*)	(23)	(2)	(12)	(4)	(1)
(*Stegomyia*)	(16)	(1)	(9)	(3)	(2)
(*Verrallina*)	(23)	(4)	(11)	(4)	(0)
others	(28)	(9)	(12)	(10)	(2)
Armigeres	22	2	18	8	1
Heizmannia	16	3	9	1	0
Culex	80	12	60	34	21
(*Culex*)	(23)	(1)	(20)	(15)	(10)
(*Culiciomyia*)	(14)	(5)	(8)	(6)	(3)
(*Eumelanomyia*)	(9)	(1)	(5)	(3)	(1)
(*Lophoceraomyia*)	(31)	(4)	(25)	(8)	(5)
Others	(3)	(1)	(2)	(2)	(2)
Mimomyia	6	0	6	5	2
Orthopodomyia	5	1	4	3	1
Topomyia	14	6	2	1	1
Tripteroides	13	0	9	1	0
Uranotaenia	39	6	22	8	4
Other genera	16	1	13	10	4
	Subfamily TOXORHYNCHITINAE				
Toxorhynchites	8	3	3	3	0
Total (17 genera)	384	54 (14.1%)	249 (64.8%)	113 (29.4%)	44 (11.5%)

Philippines. Such phenomena well reflect examples of increased acceleration in speciation during the mosquito evolution in an archipelago isolated from a large continent.

ACKNOWLEDGMENTS

We are grateful to Dr. Masahiro Horio (University of Occupational and Environmental Health), Drs. Motoyoshi Mogi, Takao Okazawa (Saga Medical College), and Mr. Thongchai Deesin (Faculty of Tropical Medicine, Mahidol University), for their cooperation as joint team members in field collections of mosquitoes; to Ms. Rampa Rattanarithikul (U.S. Army Medical Component, AFRIMS, Bangkok) for her useful advice and help in obtaining literature.

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タイ国の蚊相：チェックリスト

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タイ国の蚊については今迄世界の蚊のカタログや東南アジアの蚊のリストの中に散在していたり，個々の種の採集記録，新種の記載，特定のグループについてのモノグラフなどが断片的に多数存在していただけで，その全体像を把握することは困難であった。われわれは1983－1984年の現地調査による採集結果に加えてこれらの文献を整理し，タイ国としては最初の総合的なチェックリストを作成した。すなわち，以前にタイ国から報告されていた種類の中から誤同定によるものやシノニムまたは産地不確実なものを除き，疑問視されていたものを復活させるなど分類学的な考察の結果，ハマダラカ属65種，ヤブカ属100種，クロヤブカ属22種，ムナゲカ属16種，イエカ属80種，ギンモンカ属14種，ナガスネカ属13種，チビカ属39種，オオカ属 8 種，その他27種など総計384種が一応確実に分布しているものと考えられた。その他に，囲まれて隣接する 2 つ以上の国に分布していながらまだタイ国からは発見されていないものが数十種あるので，将来もっと多くの種がタイ国の蚊として追加されるであろう。

タイ国の蚊はその生物地理学的立場からも予想されるように，総数の約65％がマレーシアの蚊相と共通であり，約30％がフィリピンのそれと共通である。これに対し，日本にも共通に分布しているものは僅かに11％であり，またタイ国固有の特産種は54種（14％）に過ぎない。

さらに，各種についてシノニムや誤同定当時の種名を掲げ，単に分類学的配列に従ってリストしたのみでなく，実際の採集地がたどれるように主要な分布記録文献を示し，幼虫の発生場所についても述べてフィールドでの実用の便宜をはかった。

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JAPANESE JOURNAL OF TROPICAL MEDICINE AND HYGIENE

Vol. 15 No. 4 December, 1987

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Published by

JAPANESE SOCIETY OF TROPICAL MEDICINE

c/o Institute of Tropical Medicine, Nagasaki University
12–4 Sakamoto-machi, Nagasaki 852, Japan