A Survey of the Mosquito Fauna in Palawan, Mindanao and North Luzon, Republic of the Philippines[1]

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ABSTRACT. Among the approximately 300 mosquito species known from the Philippines, 132 species belonging to 15 genera were identified from about 5,000 larval and adult specimens collected from the Philippines in 1981-82. Five species are reported from the Philippines for the first time: *Armigeres pectinatus* (Edwards), *Culex perplexus* Leicester, *Topomyia auriceps* Brug, *Toxorhynchites kempi* (Edwards) and *Tx. leicesteri* Theobald. In addition, 2 unknown species belonging to *Cx. (Culex)* sp. in *mimeticus* Subgroup and *Cx. (Culiciomyia)* sp. were collected. The bionomics and taxonomy of certain species are also discussed.

INTRODUCTION

In a recent study on the Culicidae for a project initiated in 1981, "the phylogenic studies on mosquito fauna of Southeast Asia," we have made extensive mosquito surveys in Palawan, Mindanao and North Luzon, Republic of the Philippines, as the first research area. Some parts of the results were published as new species by Miyagi, Toma and Rivera (19); Miyagi, Toma and

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Tsukamoto (20); Miyagi, Toma and Cabrera (21); and Toma, Miyagi and Cabrera (32); and as biological notes by Mogi, Okazawa, Miyagi and de las Llagas (22); Mogi, Miyagi and Cabrera (23); Tsukamoto (33); Tsukamoto and Horio (34); Tsukamoto, Miyagi and Toma (35).

The following 132 taxa of mosquitoes, except 2 unknown species, were identified from approximately 5,000 adult and immature specimens collected by us during the present survey. The species are listed alphabetically according to subgeneric classification, and for some species, information is provided for habitat, association of mosquito species and distribution. All scientific names used herein follow Knight and Stone (13).

MATERIALS AND METHODS

The major areas of mosquito collections were Palawan, North Luzon and Mindanao as shown in Fig. 1.

Palawan Island: The collections were made mainly in coastal mangrove forest, cultivated plain and mountainous forest of the Montible Subcolony, Iwahig Penal Colony, and Puerto Princesa, from 24 October to 7 December 1981, 7 to 10 August 1982, and 16 to 24 October 1982. According to meteorological records, the rainy season of this area is from June to September.

North Luzon (Cagayan): Collection areas were confined to paddy fields of Tuguegarao, hilly area of Amulung and mountain area of Carao from 16 to 18 October 1981 and from 21 to 28 November 1981.

Mindanao: Collections were made mainly at the base of mountains in Ilomavis (about 500-1,000 m) and in the primary forest of Mt. Apo (1,000-2,500 m) from 16 December 1981 to 16 January 1982.

Larval and pupal collections were made at approximately 400 different habitats, such as artificial containers (water tank, tin can, bottle, etc.), rock pools, tree holes, bamboo stumps, bamboo internodes, pitcher plants, leaf axils of taros, bananas and wild bananas, fallen leaves, barrow pits, ditches, paddy fields, crab holes, and so on. In addition, about 300 oviposition traps (small plastic containers, ca. 15 cm in diameter, and wooden boxes, 20 x 20 x 15 cm) were distributed in mountainous zones of the collection areas. All immatures breeding in the traps were collected 2 weeks to one month later. The immatures collected were equally divided on return to the field laboratory. One group was preserved in MacGregor solution and later mounted in balsam. The other group was kept alive and reared to the adult stage. Specimens were pinned shortly after emergence in the case of reared adults.

Over 5,000 specimens were preserved for taxonomic studies, about equally divided between immature stages and adults, including 260 individual rearings from larvae or pupae. Identifications were made mainly with the use of keys and descriptions given by Baisas (1, 2), Baisas and Ubaldo-Pagayon (3), Barraud (4), Basio (5), Belkin (6), Bram (7), Brug (8), Delfinado (9, 10), Harrison and Scanlon (11), Knight (12), Knight and Laffoon (15), Knight and

Hull (16), Knight and Marks (14), Macdonald (17), Mattingly (18), Peyton (24), Reid (25), Reinert (26), Sirivanakarn (27-30) and Tanaka et al. (31). The specimens used for this study were deposited in the collection of University of the Ryukyus and some of them will be deposited in the U. S. National Museum, Washington, D. C., USA, after our research project is accomplished.

NOTES ON CERTAIN SPECIES - TAXONOMY AND BIONOMICS

Armigeres (Leicesteria) pectinatus (Edwards) 1914. Bull. Entomol. Res. 4:263.

This species has not previously been recorded from the Philippines. Two males and 10 females with larval and pupal skins agree well in all respects with the description of *pectinatus* by Macdonald (1960). The larvae were collected from bamboo internodes and live bamboo stumps in mountain forest Iwahig, Palawan. They were often associated with *Tripteroides nitidoventer*, *Tp. powelli* and *To. apsarae*.

Culex (Culex) sp. in *mimeticus* Subgroup.

Culex (Culex) sp. is one of the members of the *mimeticus* complex. In pattern of wing spots, the adult of *Cx.* sp. is very similar to *Cx. diengensis* Brug, but in the male genitalia, it is quite different from *diengensis* by the long, slender and distal portion of the narrow clasper. Five males and 5 females were reared from larvae collected from a ground pool in Mt. Apo (1500 m elevation), Mindanao. They were associated with *Anopheles lindesayi benguetensis*.

Culex (Culex) perplexus Leicester 1908. Stud. Inst. Med. Res. F. M. S. 3:150.

The presence of *Cx. perplexus*, here reported for the first time in Palawan, Philippines, is not surprising since this species is widespread in Malaya (Peninsular and Sabah). A single larva was collected from a slow-moving stream pool of Iwahig, Palawan, associated with *An. franciscoi*, *An. vanus* and *Cx. pseudovishnui*.

Culex (Culiciomyia) azurini Miyagi and Toma 1984. Mosq. Syst. 16:172.

This species was originally described from Palawan, Philippines. The larvae of *azurini* were found in only brackish water crab holes from mangrove forests in Palawan. They were often associated with *Aedes baisasi*, *Ae. wardi* and *Cx. spathifurca*.

Culex (Culiciomyia) sp.

Two larvae and 1 male were reared from larval collections from artificial containers located in the forest (1,500-2,000 m elevation) of Mt. Apo, Mindanao. They were usually associated with *Zeugnomyia aguilari*, *Uranotaenia modesta* and *Mimomyia deguzmanae*. In respect to the male genitalia, *Culex (Culiciomyia)* sp. agree with the description of *Cx. bailyi* Barraud by

Bram (1967) but the larva differs from the latter in that seta 5-C is 3, 4 branched instead of 4-6 branched, that setae 7, 8-P are all bifid instead of 2-3 branched, and setae 1-V, VII were all single instead of 1-V 3-4 branched and 1-VII 2-3 branched.

Topomyia (Suaymyia) apsarae Klein 1977. Entomol. Med. Parasitol. Cah. 15:123.

In Palawan, several larvae were collected only in bamboo internodes bearing a tiny hole bored by a beetle. They prey upon small insect larvae in fluid accumulating in the bamboo internode. *Topomyia rausai* Miyagi has recently been synonymized with *To. apsarae* by Miyagi, Toma and Cabrera (1983).

Topomyia (Suaymyia) auriceps Brug 1939. Tijdschr. Entomol. 82:96.

This species was originally described from Celebes and is a newly recorded mosquito in Palawan, Philippines. In Palawan, the immatures of this species were found in leaf axils of wild banana in forest. They were rarely associated with *To. pseudobarbus* in leaf axils of wild banana. One male specimen with larval and pupal skins was examined. The male genitalia agree in all respects with the description of *auriceps* by Brug 1929.

Topomyia (Topomyia) cabrerai Miyagi, Toma and Rivera 1983. Mosq. Syst. 15:1.

This species was originally described from Ilomavis (1,500 m elevation). It is an uncommon species; a few immatures were collected from leaf axils of Calocasia growing on tree trunks 5 to 10 m above the ground at an elevation about 1,000 m (Miyagi, Toma and Rivera 1983).

Topomyia pseudobarbus Baisas 1946. Mon. Bull. Bur. Hlth. Philipp. Manila 22(4):46.

With some hesitation, Brug (1939) reported 7 males, 9 females and 8 larvae from Kabaenae and Boae-baoe, Celebes as *To. dubitans* Leicester 1908. He did not have access to any Leicester's material which had long been lost, and described and illustrated *"dubitans"* on the basis of a 1908 description which lacks description and illustration of male. Judging from literatures, the male terminalia of *To. pseudobarbus* Baisas 1946 from Palawan, Philippines, are identical with that of *To. dubitans* of Brug (1939). As type specimen of *To. dubitans* no longer exists, we could not make *To. pseudobarbus* a synonym of *To. dubitans* Leicester and have strong feelings that the specimens of Brug should be identified as *To. pseudobarbus* Baisas. Several larvae were collected from leaf axils of wild banana at Ilomavis, Mindanao, and of taro plants at Taguiliat forest, Iwahig, Palawan. They were associated with *Ae. ananae, Ae. medleri* and *Malaya genurostris* in Ilomavis and with *Ar. baisasi* and *Ae. flavipennis* in Palawan. Two males from Palawan and Mindanao agree in genital structure with the descriptions of *psudobarbus* by Baisas (1946), respectively. This species is known to occur in Celebes and Philippines (Palawan, Mindanao).

Tripteroides (Tripteroides) riverai Miyagi and Toma 1983. Mosq. Syst. 15:6.

The immature stages of *Tp. riverai* have been collected in water accumulating in erect bamboo internodes bored by certain beetles and were also found in newly cut bamboo stumps on Palawan (Miyagi and Toma 1983).

Toxorhynchites (Toxorhynchites) kempi (Edwards) 1921. Bull. Entomol. Res. 12:72.

This species was originally described from India and is known to occur in Indochina and Java. It has not previously been reported from the Philippines. Several larvae of *Tx. kempi* were collected from Ilomavis, Mindanao. They were associated with *Ae. alcasidi*, *Ae. albopictus* and *Tp. nitidoventer*.

Toxorhynchites (Toxorhynchites) leicesteri Theobald 1904. Entomologist 37:36.

This is a new record from the Philippines. The immatures of this species were commonly found in old bamboo stumps in shaded forests of Palawan. They were associated with *Tp. nitidoventer*, *Ae. albolineatus* and *Ae. mediopunctatus*. This species is known to occur in Malaya, Singapore, Thailand and Philippines (Palawan).

Table 1. List of mosquito species collected from Luzon (L), Palawan (P) and Mindanao (M).

Species Collected	L	P	M	Habitat
Anopheles (Anopheles)				
baezai Gater		o		Brackish water pool
franciscoi Reid	o	o	o	Shoreline pool
lesteri Baisas and Hu		o		Paddy field
lindesayi benguetensis King			o	Ground pool
manalangi Mendoza		o		Slow-moving stream
peditaeniatus (Leicester)	o	o		Paddy field
pilinotum Harrison and Scanlon		o		Shaded ground pool
pseudobarbirostris Ludlow			o	Paddy field
vanus Walker		o		Shoreline pool
Anopheles (Cellia)				
balabacensis Baisas		o		Footprint
flavirostris (Ludlow)	o	o	o	Slow-moving stream
indefinitus (Ludlow)	o	o		Paddy field
kochi Doenitz		o	o	Paddy field, ditch
limosus King			o	Ditch, footprint
litoralis King		o	o	Brackish water pool
ludlowae (Theobald)		o	o	Ditch, footprint

Table 1 cont.

Species Collected	L	P	M	Habitat
maculatus Theobald			o	Paddy field
mangyanus (Banks)		o		Slow-moving stream
philippinensis Ludlow	o	o		Paddy field
riparis King and Baisas		o		Wooden box
subpictus Grassi		o		Brackish water pool
tessellatus Theobald	o	o		Paddy field
vagus Doenitz	o	o		Paddy field
Aedeomyia (Aedeomyia)				
catasticta Knab		o		Paddy field
Aedes (Aedimorphus)				
pampangensis (Ludlow)	o			Paddy fieldfallow
vexans (Meigen)	o	o	o	Paddy field
Aedes (Finlaya)				
ananae Knight and Laffoon			o	Leaf axil of banana
banksi Edwards			o	Rock pool in forest
flavipennis (Giles)		o		Leaf axil of banana
jugraensis (Leicester)		o		Wooden box in forest
leucopleurus Rozeboom		o		Tree hole
medleri Knight and Laffoon			o	Leaf axil of wild banana
melanopterus (Giles)	o	o	o	Tree and rock hole
niveus (Ludlow)		o		Coconut shell
paradissimilis Rozeboom		o		Tree hole
poicilius (Theobald)			o	Leaf axil of banana
rizali (Banks)			o	Rock pool in forest
saperoi Knight	o	o		Old bamboo stump
saxicola Edwards		o		Rock pool of river
Aedes (Geoskusea)				
baisasi Knight and Hull		o		Brackish water in crab hole
Aedes (Neomelaniconion)				
lineatopennis (Ludlow)	o			Paddy field, footprint
Aedes (Rhinoskusea)				
wardi Reinert		o		Brackish water in crab hole
Aedes (Stegomyia)				
aegypti (Linnaeus)	o	o	o	Artificial container
albolineatus (Theobald)		o		Tree holes, bamboo
albopictus (Skuse)	o	o	o	Artificial container
alcasidi Huang	o	o	o	Bamboo, coconut shell

Table 1 cont.

Species Collected	L	P	M	Habitat
boharti Knight and Rozeboom	o	o	o	Bamboo, tree hole
desmotes (Giles)	o		o	Bamboo
gardnerii (Ludlow)		o		Bamboo
laffooni Knight and Rozeboom		o		Tree hole, wooden box
mediopunctatus (Theobald)		o	o	Bamboo
paullusi Stone and Farner		o	o	Bamboo, tree hole
Aedes (Verrallina)				
campylostylus Laffoon		o		Footprint, mud hole
hamistylus Laffoon		o		Fresh water swamp
johnsoni Laffoon			o	Mud hole, footprint
macrodixoa Dyar and Shannon			o	Semi-permanent ground pool
panayensis Ludlow		o		Brackish water pool
uncus (Theobald)		o		Male, biting collection
Armigeres (Armigeres)				
aureolineatus (Leicester)		o		Wooden box in forest
baisasi Stone and Thurman		o		Tree hole, coconut shell
ejercitoi Baisas			o	Tree hole
malayi (Theobald)		o	o	Coconut shell
manalangi Baisas		o		Old bamboo stump
subalbatus (Coquillett)		o		Coconut shell
Armigeres (Leicesteria)				
digitatus (Edwards)		o	o	Internode of bamboo
magnus (Theobald)			o	Old bamboo
pectinatus (Edwards)		o		Internode of bamboo
Zeugnomyia				
aguilari Baisas and Felciano			o	Tree hole, fallen leaf
lawtoni Baisas			o	Tree hole, fallen leaf
Culex (Culex)				
bitaeniorhynchus Giles	o	o	o	Paddy field, ditch
sp. near *diengensis* Brug			o	Ground pool
fuscocephala Theobald	o	o	o	Paddy field
gelidus Theobald	o	o		Paddy field
incognitus Baisas	o		o	Paddy, footprint
mimulus Edwards		o		Tree hole
perplexus Leicester		o		Slow-moving stream
pseudovishnui Colless	o	o		Paddy field

Table 1 cont.

Species Collected	L	P	M	Habitat
quinquefasciatus Say	o	o	o	Artificial container
sinensis Theobald	o			Paddy fieldfallow
sitiens Wiedemann		o	o	Brackish water pool
tritaeniorhynchus Giles	o	o	o	Paddy field
vishnui Theobald		o	o	Paddy field
whitmorei (Giles)	o		o	Paddy field
Culex (Culiciomyia)				
azurini Miyagi and Toma		o		Brackish water in crab hole
sp. near *bailyi* Barraud			o	Wooden box in forest
fragilis Ludlow		o		Wooden box in forest
nigropunctatus Edwards	o	o	o	Paddy field
papuensis (Taylor)		o	o	Tree hole
scanloni Bram		o		Wooden box
spathifurca (Edwards)		o		Brackish water in crab hole
Culex (Eumelanomyia)				
brevipalpis (Giles)	o			Tree hole
hinglungensis Chu		o		Stream pool
yeageri Baisas		o		Slow-moving stream
Culex (Lophoceraomyia)				
kuhnsi King and Hoogstraal	o	o	o	Tree hole, bamboo
lavatae Stone and Bohart	o	o	o	Tree hole
minor (Leicester)		o	o	Wooden box
Culex (lutzia)				
fuscanus Wiedemann	o	o	o	Paddy field, ditch
halifaxii Theobald		o		Artificial container
Mimomyia (Etorleptiomyia)				
luzonensis (Ludlow)	o	o	o	Paddy fieldfallow
Mimomyia (Ingramia)				
deguzmanae (Mattingly)			o	Tree hole, rock pool
Mimomyia (Mimomyia)				
chamberlaini Ludlow	o			Paddy fieldfallow
Coquillettidia				
crassipes (Van der Wulp)		o		Swamp with panac grass
Mansonia (Mansonioides)				
uniformis (Theobald)		o	o	Swamp with Pista

Table 1 cont.

Species Collected	L	P	M	Habitat
Orthopodomyia				
anopheloides (Giles)	o	o		Tree hole
Malaya				
genurostris Leicester	o	o	o	Leaf axil of taro and banana
Topomyia (Suaymyia)				
apsarae Klein		o		Internode of bamboo
auriceps Brug		o		Leaf axil of wild banana
Topomyia (Topomyia)				
barbus Baisas			o	Leaf axil of wild banana
cabrerai Miyagi, Toma and Rivera			o	Leaf axil of wild banana
dejesusi Baisas and Feliciano			o	Leaf axil of taro
hernandoi Baisas and Feliciano			o	Leaf axil of wild banana
pseudobarbus Baisas		o	o	Leaf axil of wild banana
Tripteroides (Tricholeptomyia)				
apoensis Baisas and Ubaldo-Pagayon			o	Arboreal pitcher plant
delpilari Baisas and Ubaldo-Pagayon			o	Arboreal pitcher plant
roxasi Baisas and Ubaldo-Pagayon			o	Arboreal pitcher plant
werneri Baisas and Ubaldo-Pagayon			o	Arboreal pitcher plant
Tripteroides (Tripteroides)				
dyari Bohart and Farner			o	Pitcher plant
monetifer (Dyar)	o		o	Bamboo
nitidoventer (Giles)	o	o	o	Bamboo, tree hole
powelli (Ludlow)	o	o	o	Bamboo
riverai Miyagi, Toma and Tsukamoto		o		Internode of bamboo
toffaletii Baisas and Ubaldo-Pagayon		o	o	Bamboo, tree hole
Uranotaenia (Pseudoficalbia)				
abstrusa Peyton			o	Footprint
bicolor Leicester			o	Rock pool in forest
demeilloni Peyton and Rattanarithikul			o	Bamboo
modesta Leicester		o	o	Tree hole, wooden box

Table 1 cont.

Species Collected	L	P	M	Habitat
obscura Edwards		o	o	Fallen leaf
rossi Delfinado		o		Crab hole in forest
Uranotaenia (Uranotaenia)				
clara Dyar and Shannon			o	Stream pool
testacea Theobald		o	o	Footprint
Toxorhynchites (Toxorhynchites)				
kempi (Edwards)			o	Bamboo
leicesteri Theobald		o		Old bamboo stump
minimus (Theobald)	o			Internode of bamboo
splendens (Wiedemann)	o	o	o	Tree hole, leaf axil of banana

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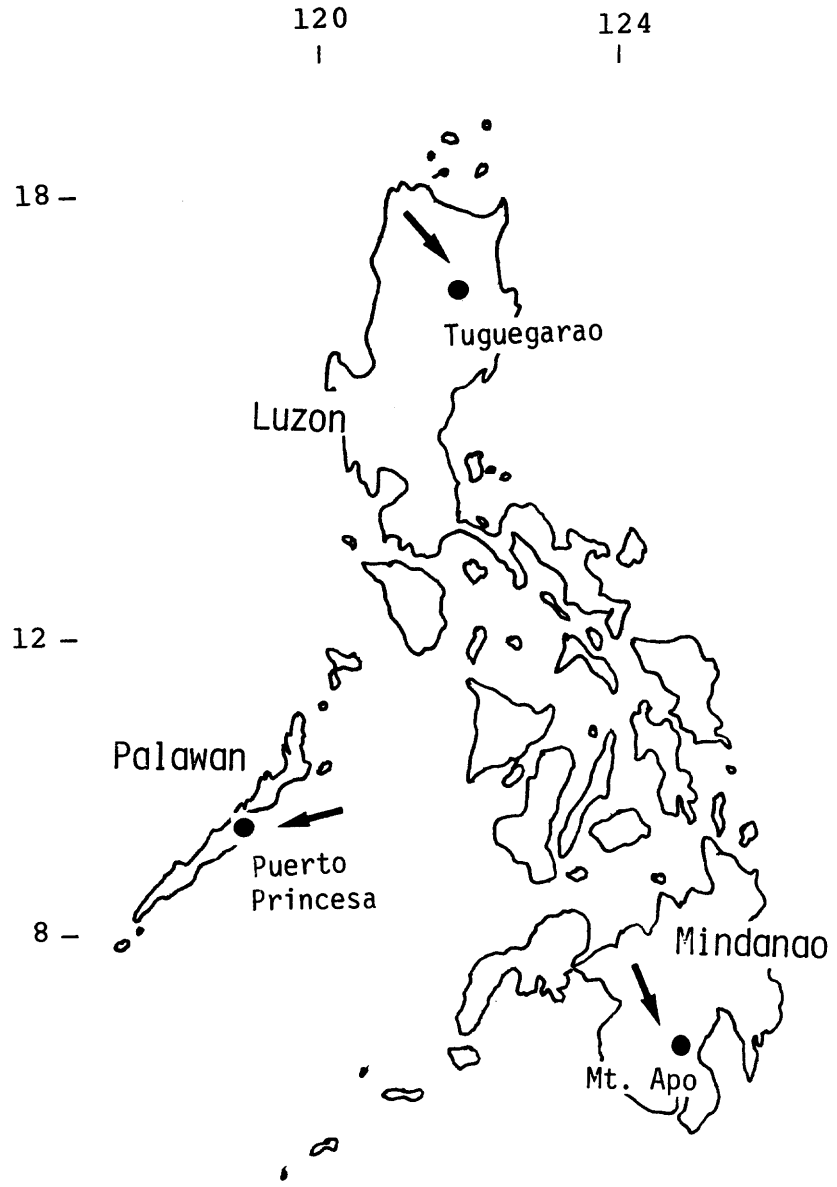

Fig. 1. A map of the Philippines, showing areas of mosquito collections.