MOSQUITOES OF THE BOGOR BOTANICAL GARDENS

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INTRODUCTION

Various types of plant communities in botanical gardens provide surroundings for animal life. In addition to their main role in botany, the botanical gardens provide aspects for zoological investigations as well (Adisoemarto 1974) . The Bogor Botanical Gardens provide most of all possible types of environments for the development and construction of mosquito population. To develop the study of some ecological aspects of the mosquitoes, the availability of qualitative data is very much desired. For this purpose, observations on mosquito fauna have been carried out in the Bogor Botanical Gardens and the results are presented in this paper.

MATERIALS AND METHODS

The Bogor Botanical Gardens, which are 200 acres, are divided into roughly 20 sections, each of which is assigned for certain plant communities, such as the bamboo groves, the palms, the pandans, the legumes and the dipterocarps. Scattered in these gardens are complexes of housing and office buildings, inhabited by 150 permanent residents and about 200 people in the office buildings during the working days between 7 a.m. and 2 p.m. Approximately, 300 more people work outdoors from 7 a.m. to noon. Thousands of visitors wander around the gardens on Sundays and holidays. These gardens are traversed by a natural river (Ciliwung) and two small creeks. There are also six artificial ponds and other types of water bodies scattered in these gardens. Almost all major groups of animals are represented in these gardens.

Mosquitoes for this study were collected from July to December 1973 by the conventional sweeping method and by trapping. Sweeping was done in all available habitats by using ordinary insect nets and aspirators. This activity was carried out from time to time, so that each habitat was visited at various times from 7 a.m. to 4 p.m. Trapping was done by using bamboo poles which collected rain water for the mosquitoes to breed. Four bamboo poles were erected in each of the 14 habitats (Table I) to provide the breeding sites for the mosquitoes. In so doing, the methods applied were not designed for quantitative analyses.

Table I. Habitats in the Bogor Botanical Gardens selected to trap mosquitoes from their surroundings.

Plot no.	Habitat	Condition
1	Rattan and other palm species	Secluded, dark
2	Bamboo grove	Secluded, dark
3	Tree legumes with no undergrowths	Almost bright
4	Pandans	Bright
5	Rubiaceae	Half-opened, somewhat dark
6	Guttiferae	Half-secluded, dark
7	Climbers with undergrowths	Half-opened, partially dark
8	Shrubs, near dwellings	Open, bright
9	Bananas and shrubs	Open, bright
10	Dipterocarpaceae	Half-opened, partially dark
11	Mixed forest	Secluded, dark
12	Clear shaded area	Half-opened, partially dark
13	Extension of Dipterocarpaceae	Half-opened, dark
14	Palmae	Open, bright

The selection of these habitats was done in such a way that the surroundings represented as many as possible sections of the gardens, ranging

from an open bright site without undergrowths to a miniature forest.

Examination of poles was done daily to check the appearance of the larvae in the poles. If the pole water was positive with larvae, it was then transfered into jars and kept in a laboratory under room conditions to rear the larvae until their emergence. Larvae population from each different plot was reared separately. However, mixing pole water from different poles of the same plot collected on the same day, was occasionally practiced. The time of emergence of the adult mosquitoes was noted.

RESULTS AND DISCUSSIONS

A total of 12 species of mosquitoes have been collected from the Bogor Botanical Gardens during the observation period (Table II). These were *Aedes (Stegomyia) aegypti* L., *A. (S.j albopictus* Skuse, *A. (S.) annandalei* Theobald, *Armigeres (Armigeresj malayi* Theobald, *A. (A.) subalbatus* Coquillett, *A. (LeicesteriaJ digitatus* Edwards, *Culex (Culex) bitaeniorhynchus* Giles, *C. (C.) quin - quefasciatus* Say, *Culex (Culiciomyia) fragilis* Ludlow, *Tripteroides aranoides* Theobald *T. coeruleocephala* Leicester and *Anopheles (Anopheles) roperi* Reid. In addition, *Toxorhynchites splendens* Wiedemann, a larvivorous species of Culicidae, was also collected.

Aedes aegypti appeared in two localities, with one specimen in each of the localities, namely in the partially dark dipterocarp section and a somewhat dark half-opened plot of Rubiaceae. The larvae of this species were found together with those of *Aedes albopictus* and *Armigeres subalbatus*. However, *A. aegypti* was apparently the loser in the competition. This situation explain why this species was not encountered in the sweeping method. The occurrence of this species in bamboo stumps is unusual, since the common habitats for this species are artificial collections of water near human habitations (Barraud 1934, Mattingly 1965). This species has been known to bite man and is also reputed to be the principal vector of dengue haemorrhagic fever in many parts of Southeast Asia.

The most commonly found and ubiquitous mosquitoes in the Bogor Botanical Gardens were *Aedes albopictus*. This species has been found living together with *Aedes aegypti, 'A. annandalei. Armigeres subalbatus, Culex quinquefasciatus* and *Tripteroides aranoides*, although the coexistence of these six species at the same time was never encountered. The sweeping method has also proven that this species was the most commonly found and ubiquitous in the gardens. *Aedes albopictus* has also been known to be responsible for the transmission of dengue haemorrhagic fever in other parts of Southeast Asia. The larvae are usually found in tree-holes, bamboo and leaf axils, while the adults prefer a dark, cool and humid environment.

The adults of *Aedes annandalei* were collected by tearing the larvae from water trapped in a

Table II. List of mosquito species recorded from the Bogor Botanical Gardens

Species	Methods of collecting Trapping	Sweeping	Man biting females
Culicinae			
Aedes (Stegomyia) aegypti	+		+
Aedes (Stegomyia) albopictus	+	+	+
Aedes (Stegomyia) annandalei	+	+	
Armigeres (Armigeres) malayi		+	
Armigeres (Armigeres) subalbatus	+	+	+
Armigeres (Leicesteria) digitatus		+	
Culex (Culex) bitaeniorhynchus		+	+
Culex (Culex) quinquefasciatus	+	+	+
Culex (Culiciomyia) fragilis		+	
Tripteroides aranoides	+		
Tripteroides coeruleocephala	+		
Anophelinae			
Anopheles (Anopheles) roperi		+	

+ present + biting

secluded bamboo grove and in another floristic community of the gardens with dark and damp surroundings. The larvae could live in coexistence with *Aedes albopictus* and *Armigeres subalbatus*. Random sweeping infrequently collected this mosquito, which was caught in partially dark or shaded areas of the gardens. In one locality the adults of this species were collected together with *Aedes albopictus, Armigeres subalbatus, A. digitatus, Culex bitaeniorhynchus* and *C. fragilis*. This species was never encountered to bite man during the observation, but it was formerly stated that *A. annandalei* was commonly taken biting under trees outside, shortly after sunset (Bonne-Wpster & Brug 1932), or bite man readily in the shade (Mattingly 1965).

Armigeres subalbatus was trapped from all localities, but it was not as common as *Aedes albopictus*. These two species can live in coexistence. The larvae have been found in bamboo stumps and coconut shells. On a separate occasion, this species has been observed breeding in a septic tank within the housing complex of the gardens. The adults were caught together with *Aedes albopictus, A. annandalei* and *Anopheles roperi* in a rather densely vegetated environment. *Armigeres subalbatus* has been encountered indoors and is known to bite man.

During this study, *Armigeres malayi* was collected only by sweeping. Although the larvae have been reported to occupy the same breeding sites as those of *A. subalbatus*, no adult mosquitoes were ever collected by the trapping method during the study. There is no available explanation for its absence from the bamboo pole traps. However, on a separate occasion, larvae of *Armigeres malayi* were collected from coconut shells found in the Bogor Botanical Gardens and reared to adult stage. Nothing is known of the female biting habits (Delfinado 1966), but this species has been encountered indoors in the Bogor Botanical Gardens.

Armigeres (Leicesteriaj digitatus was collected only by sweeping, although the larvae have been known to breed in bamboo and tree-holes. The adults have not been known to bite man, and in the Bogor Botanical Gardens they were found together with *Aedes albopictus, A. annandalei, Armigeres subalbatus* and *Culex bitaeniorhynchus*.

Culex bitaeniorhynchus was also frequently found in the Bogor Botanical Gardens, constituting **the** second most common outdoor species. However, unlike *Aedes albopictus*, the pattern of distribution of this species coincided with the location of ponds, creeks, river and other bodies of water in the gardens. This is due to the fact that these water bodies are the breeding sites of the larvae. They live amongst green algae in open weedy pools. However, this species has been known to be highly variable and have diversified feeding habits (Sirivanakarn 1973). The adult females have been known to bite man.

The adults of *Culex quinquefasciatus* were relatively rare in the Bogor Botanic Gardens. A small number of the adult mosquitoes reared from larvae was found together with *Aedes albopictus, A. annandalei, Armigeres subalbatus, Tripteroides aranoides* and *T. coeruleocepkala* in a secluded dark and humid environment. Sweeping in a somewhat dark environment near an artificial pond also collected a small number of the adults together with *Aedes albopictus* and *Culex bitaeniorhynchus*. The larvae have been known to breed in domestic collections of water, in overflow waters from houses, kitchens, etc., in foul ground pool, ditches, cesspools and large artificial containers, but rarely in tree-holes or bamboos. The lack of these preferred breeding sites, combined with a tendency of the gradual replacement of *C. quinquefasciatus* by *Aedes albopictus*, may explain the rareness of this species in the Bogor Botanical Gardens. *C. quinquefasciatus* is a potential vector of *Wuchereria bancrofti*, the causal agent of filariasis.

The non-human-biting *Culex fragilis* was rarely found in shaded areas of the Bogor Botanical Gardens, together with *Aedes albopictus, A. annandalei* and *Culex bitaeniorhynchus*. The larvae of this species have been known to breed in artificial containers, coconut shells, ground pools and tree-holes, but trapping by bamboo poles did not collect the adults. On a separate occasion, adults of this species were obtained by rearing larvae collected from brackish water contained in a well on Pulau Dua, West Jawa.

Two more non-biting mosquito species, *Tripteroides aranoides* and *T. coeruleocephala*, were collected from the Bogor Botanical Gardens. An adult specimen of *T. coeruleocephala* was obtained from a bamboo pole set in a secluded dark and humid environment. It is associated with *Aedes albopictus, A. annandalei, Armigeres subalbatus, Culex quinquefasciatus* and *Tripteroides aranoides*. This species has been known to breed in bamboos,

tree-holes and pitcher plants.

Unlike *T, coeruleocephala, T. aranoides* is more widely distributed, although it has been known to occupy the same types of breeding sites. However, none were collected by the sweeping method.

The only anopheline species found in the Bogor Botanical Gardens was *Anopheles roperi,* which has been known to breed in pools on the margins of streams or in the beds of drying streams in the forest (Scanlon *et al.* 1968, Hodgkin 1950). This might be the reason why the bamboo pole trapping did not collect this species. Although Hodgkin mentioned the possibility of this species being a vector of human malaria, Wharton *et al.* (1963) proved that this species was definitely a vector of mouse deer malaria caused by *Plasmodium traguli.*

In addition to these 12 species of mosquitoes, a predaceous species of Culicidae, *Toxorhynchites splendens,* was occasionally found, by sweeping as well as by trapping method. A single larva was found among a larvae population of the other mosquitoes. In laboratory rearing, a single larva could eat up the whole mosquito larvae population of about 60 individuals collected from a bamboo pole. This species has also been known to breed in tree-holes, water butts and jars.

CONCLUSIONS AND SUGGESTIONS

Out of the 12 species of culicine and anopheline mosquitoes recorded from the Bogor Botanical Gardens, *Aedes albopictus, Armigeres subalbatus, Culex bitaeniorhynchus* and *C. quinquefasciatus,* are worthy of further study. This consideration is based mainly on the feeding habits of the adult females which bite man and the fact that they are encountered indoors. *Aedes albopictus* and *Culex quinquefasciatus* deserve more attention since these species have been known to transmit human diseases.

During the present situation, *Aedes segypti* in the Bogor Botanical Gardens can be ignored; however, attention must be paid to the changes that may be in favour of this species.

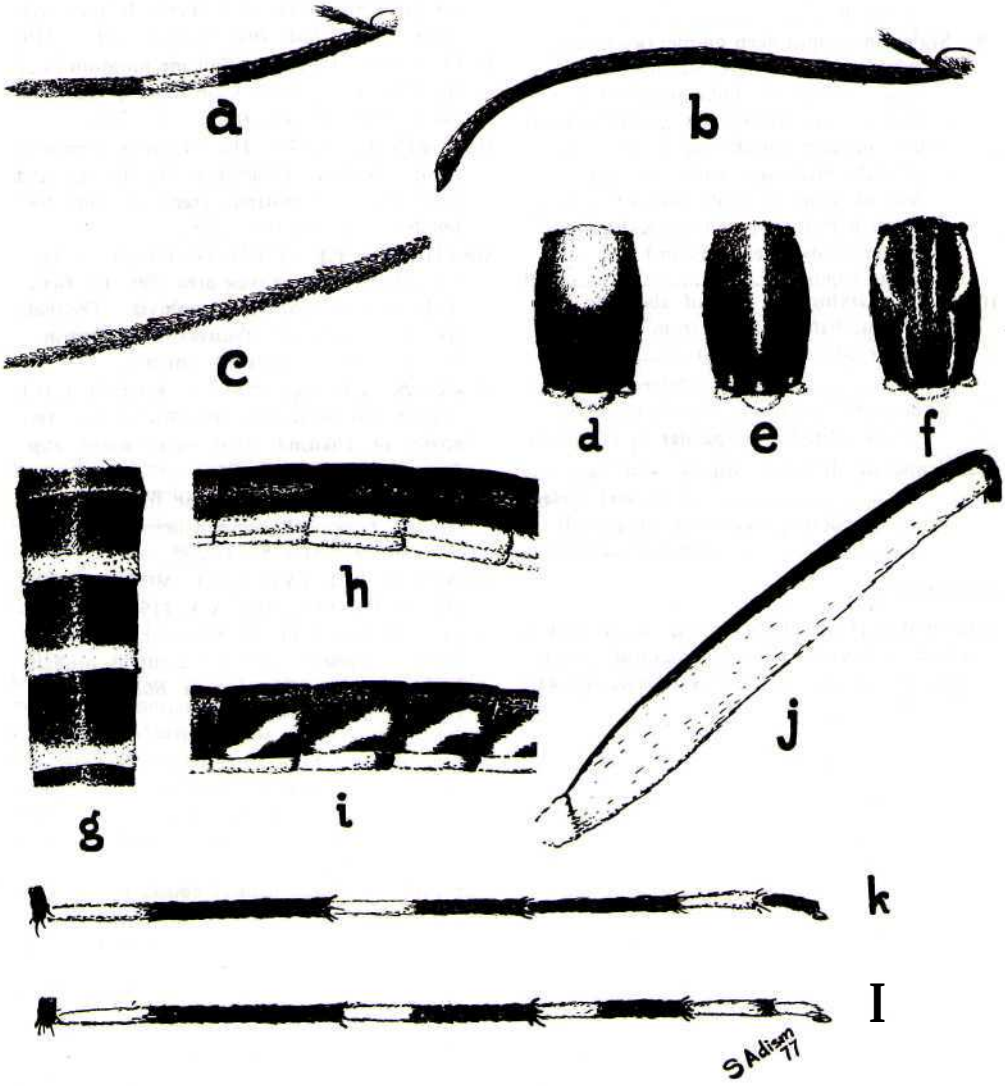
The presence of the rest of the species may be to the benefit to the human population in the gardens, in regard to the pressure they exert to lower the population of the harmful species.

A means should be created to facilitate the breeding of *Toxorhynchites splendens* in the breeding sites of harmful species.

Further studies on the population dynamics of the harmful species may be conducted in these gardens, which indeed provide perfect outdoor laboratories.

KEY TO THE SPECIES OF MOSQUITOES OF THE BOGOR BOTANICAL GARDENS

1. Body-covering scales black; snow white markings always present, especially on legs, as definite bands, stripes or lines 2
   Body-covering scales dark brown or otherwise paler; pale body markings if present not snow white, but rather yellowish; shapes of pale markings not definite 4
2. Mesonotum with large anterior white spot (Fig. Id); hind tarsus with three white bands (Fig, Ik) ..... *Aedes annandalei*
   Mesonotum with one median or two submedian white lines (Figs, le and If); hind tarsus with five white bands (Fig. 1 1) 3
3. Mesonotum with a nearly complete median white line (Fig. le) ..... *Aedes albopictus*
   Mesonotum with two narrow submedian white lines and a pair of submarginal curved white markings (Fig. 10 ..... *Aedes aegypti*
4. Abdomen with uninterrupted (continuous) dorsal pale bands (Fig. lg) 5
   Abdomen without continuous dorsal bands; abdominal markings if present only on lateral margin (Figs, lh and li) 6
5. Proboscis with white band (Fig. la); side of thorax with obvious black markings ..... *Culex bitaeniorhynchus*
   Proboscis without white band; side of thorax without black markings ..... *Culex quinquefasciatus*
6. Scales on palpus bushy (Fig. lc) ..... *Anopheles roperi*
   Scales on palpus appressed (not bushy) 7
7. Abdomen without white markings; proboscis straight ..... *Culex fragilis*
   Abdomen with white markings; proboscis curved downward (Fig. lb) 8
8. White markings on side of abdomen forming a single lateral line (Fig. lh) .....


a
b
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.....*Tripteroides aranoides*

White markings on side of abdomen forming lateral bands or spots (Fig. li). if continuous, white markings on venter as bands.....9

9. Scales on occiput deep purple; two silvery white spots on outer surface of hind femur; venter of abdomen golden yellow.....*Tripteroides coeruleocephala*

Scales on occiput dark brown with white or pale markings; white marking on side of femur as continuous stripe on lower half, from base to apex (Fig. lj); venter of abdomen white or black with white bands.....10

10. White markings on side of abdomen as oblique bands starting from lower anterior corners (Fig. li).....
.....*Armigeres digitatus*

White markings on side of abdomen more or less rounded or paralel to margin 11

11. Venter of abdomen entirely white.....
.....*Armigeres malayi*

Venter of abdomen black with white bands
.....*Armigeres subalbatus*

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