

On the seasonal distributions of the larvae of *Anopheles* (*A.*) *omorii* and nine other mosquito species found in a tree hole.*

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Introduction

Since the discovery of the larvae of an unornamented anopheline mosquito, *Anopheles* (*Anopheles*) *omorii* Sakakibara 1959, on July 21, 1956 in a tree hole, larval survey had been continued till September 5, 1959. The survey was intended to make clear the number of mosquito species breeding in the tree hole and the seasonal distribution of the larvae of each species.

From the results of the survey made 17 times during the period, ten species of mosquitoes were found utilizing the hole as their breeding place, and the seasonal distribution of the larvae of *Anopheles omorii* and several other species became roughly clear. This report deals with the brief account of these results of the survey.

The author wishes to express his sincere appreciation to prof. N. Omori for many helpful suggestions and for reading manuscript and to prof. M. Miyagawa for his invaluable encouragement to continue the work. He also wishes to acknowledge his indebtedness for the assistance received during the course of this work from the Director of Kune Mine, the staffs of Kune Mine Hospital and to the officers of Misakubo Forestry Office.

Place and method of observation

A tree hole was found in jungle at the slope, about 550 meters above the sea, of Mt. Tochu (900 meters above the sea) in Misakubo town, Iwata-gun, Sizuoka Prefecture, Japan. The hole was formed as follows: an aged zelkova tree, *Zelkova serrata*, was cut down upside down on the slope but it was left without being used because of having a large hollow in trunk. The hole is about 50cm in diameter and 250cm in depth. The water was nearly always reddish brown in color and was about 7.0 in PH.

The larvae of mosquitoes were collected by a dipper of 18cm in diameter and 3cm in depth and the numbers of each species were recorded in total by ten dips, on each visit. The larvae collected by the method as above were brought to the laboratory in the Hospital and identified but those of *Anopheles omorii* collected from October to April were returned to the hole on counting the number in order to examine the states of hibernation of this anopheline mosquito.

The place in which the tree hole was found was about 460 meters apart from a hut where one or two officers were staying only in summer and 1300 meters from the Branch Office of Misakubo Forestry Office which is located near a mountain village and at about 40km from our Kune Mine Hospital. The hole was usually under the snow during from mid December

* Contributions from the Research Institute of Endemics, Nagasaki University No. 352

to late February and was often frozen during from November to March.

Results of observation

The list of mosquito species collected in the tree hole in question is given in Table 1. The numbers of the larvae of each species collected by ten dips on each visit are tabulated

Table 1 List of mosquito species collected in the tree hole

| |
|---|
| <i>Anopheles (Anopheles) omorii</i> Sakakibara, 1959 |
| <i>Culex (Culiciomyia) kyotoensis</i> Yamaguti et LaCasse, 1952 |
| <i>Tripteroides (Tripteroides) bambusa</i> Yamada, 1917 |
| <i>Armigeres (Armigeres) subalbatus</i> (Coguillet, 1898) |
| <i>Megarhinus towadensis</i> Matsumura, 1916 |
| <i>Aedes (Finlaya) kobayashii</i> Nakata, 1956 |
| <i>Aedes (Finlaya) bunanoki</i> Sasa et Ishimura, 1951 |
| <i>Aedes (Finlaya) japonicus</i> (Theobald, 1901) |
| <i>Aedes (Stegomyia) galloisi</i> Yamada, 1921 |
| <i>Aedes (Stegomyia) albopictus</i> (Skuse, 1895) |

in Table 2. From the data shown in Table 2 the brief accounts on the seasonal distributions of the larvae of each species are given as follows.

1) *Anopheles omorii*

The earliest visit to the place throughout the survey period was made on March 20, 1958 when 2nd instar larvae were only found. While, in late April 3rd instar larvae were also collected. In October there found a good number of 1st instar larvae and also in the latest visit of early December. From the above facts, it is clear that a large number of 1st instar larvae appeared by about the end of October will enter into hibernation in 1st and 2nd instar larvae remaining as they are until April.

As to the life history of this mosquito during from late April to the end of October, the records of collection given in Table 2 suggest that: The larvae begin to develop from mid April pupating in late May and emerging as adults by the beginning of June. The egg laying may occur in mid to late June, July, August and September. Accordingly, the life cycles may be repeated three times during warmer months and four times throughout a year. The period which may be required for one life cycle was based on the rearing data obtained in the laboratory as shown in Table 3.

2) *Culex kyotoensis*

The larvae seem to appear from mid July reaching maximum in number in early October. Although the larvae of 2nd, 3rd and 4th instar were collected on as late as December 9, 1956, they were supposed to emerge by the end of the year, otherwise to die during the winter.

This mosquito has been reported to breed in a wide variety of situation excepting tree hole. Accordingly, this finding is the first record of breeding in the hole.

3) *Tripteroides bambusa*

The larvae of this mosquito were found breeding in a very small number in every season. Eggs were collected in September and October. It appears, therefore, that the mosquito may hibernate in egg and larval stages.

Table 2 The numbers of individuals of immature stages of ten

| Species No. individuals Water temp. °C Date | | | <i>An. omorii</i> | | | | | | | <i>C. kyotoensis</i> | | | | | | |
|--|------|--|-----------------------|------------|-----|-----|----|-----------|--------------|----------------------|------------|----|-----|----|-----------|--------------|
| | | | No. eggs | No. larvae | | | | No. pupae | Total of L+P | No. rafts | No. larvae | | | | No. pupae | Total of L+P |
| | | | | I | II | III | IV | | | | I | II | III | IV | | |
| Jul. 20, '56 | 21.0 | | | 4 | 12 | 4 | 0 | 0 | 20 | | 0 | 0 | 2 | 0 | 0 | 2 |
| Aug. 11, '56 | 26.0 | | | 5 | 7 | 20 | 33 | 0 | 65 | 3 | 6 | 8 | 0 | 0 | 0 | 14 |
| Aug. 27, '56 | 19.0 | | 20 | 0 | 7 | 18 | 22 | 5 | 52 | | | | | | | 0 |
| Oct. 7, '56 | 18.0 | | 1 | 260 | 0 | 0 | 0 | 0 | 260 | | 90 | 10 | 0 | 0 | 0 | 100 |
| Dec. 9, '56 | 1.0 | | | 110 | 0 | 0 | 0 | 0 | 110 | | 0 | 6 | 1 | 3 | 0 | 10 |
| Apr. 16, '57 | 8.8 | | | 0 | *5 | 0 | 0 | 0 | 5 | | | | | | | 0 |
| Jun. 29, '57 | 19.0 | | | 80 | 0 | 0 | 0 | 0 | 80 | | | | | | | 0 |
| Jul. 31, '57 | 23.1 | | | 26 | 26 | 1 | 1 | 0 | 54 | | | | | | | 0 |
| Oct. 22, '57 | 10.0 | | | 80 | 0 | 0 | 0 | 0 | 80 | | | | | | | 0 |
| Mar. 20, '58 | 5.5 | | | 0 | 30 | 0 | 0 | 0 | 30 | | | | | | | 0 |
| Apr. 29, '58 | 12.0 | | | 0 | 12 | 21 | 0 | 0 | 33 | | | | | | | 0 |
| May 24, '58 | 12.5 | | | 0 | 0 | 1 | 22 | 5 | 28 | | | | | | | 0 |
| Jul. 20, '58 | 20.0 | | | 115 | 13 | 2 | 0 | 0 | 130 | | 0 | 6 | 0 | 0 | 0 | 6 |
| Sept. 12, '58 | 21.5 | | | 8 | 0 | 0 | 0 | 0 | 8 | | 12 | 0 | 0 | 0 | 0 | 12 |
| Sept. 21, '58 | 18.0 | | | 2 | 0 | 0 | 0 | 0 | 2 | | 12 | 0 | 1 | 0 | 0 | 13 |
| May 4, '59 | 14.0 | | | 0 | 0 | 1 | 17 | 0 | 18 | | | | | | | 0 |
| Sept. 5, '59 | 20.0 | | | 19 | 0 | 0 | 2 | 0 | 21 | | 44 | 0 | 0 | 0 | 0 | 44 |
| Total | | | 21 | 709 | 112 | 68 | 97 | 10 | 996 | 3 | 164 | 30 | 4 | 3 | 0 | 201 |
| | | | <i>Ae. kobayashii</i> | | | | | | | <i>Ae. bunanoki</i> | | | | | | |
| Jul. 20, '56 | 21.0 | | | 0 | 3 | 4 | 6 | 4 | 17 | | | | | | | 0 |
| Aug. 11, '56 | 26.0 | | | 1 | 1 | 3 | 1 | 4 | 10 | | | | | | | 0 |
| Aug. 27, '56 | 19.0 | | | 1 | 0 | 0 | 0 | 0 | 1 | | | | | | | 0 |
| Oct. 7, '56 | 18.0 | | | | | | | | 0 | | | | | | | 0 |
| Dec. 9, '56 | 1.0 | | | 0 | 0 | 0 | 1 | 0 | 1 | | | | | | | 0 |
| Apr. 16, '57 | 8.8 | | | 63 | 0 | 0 | 0 | 0 | 63 | | 55 | 43 | 0 | 0 | 0 | 98 |
| Jun. 29, '57 | 19.0 | | | 32 | 3 | 2 | 1 | 0 | 38 | | 8 | 9 | 0 | 0 | 0 | 17 |
| Jul. 31, '57 | 23.1 | | | 26 | 3 | 1 | 1 | 2 | 33 | | | | | | | 0 |
| Oct. 22, '57 | 10.0 | | | 0 | 0 | 0 | 0 | 1 | 1 | | | | | | | 0 |
| Mar. 20, '58 | 5.5 | | | 48 | 0 | 0 | 0 | 0 | 48 | | 5 | 0 | 0 | 0 | 0 | 5 |
| Apr. 29, '58 | 12.0 | | | 20 | 20 | 34 | 4 | 0 | 78 | | 0 | 6 | 4 | 0 | 0 | 10 |
| May 24, '58 | 12.5 | | | 44 | 74 | 69 | 30 | 41 | 258 | | 0 | 2 | 0 | 10 | 0 | 12 |
| Jul. 20, '58 | 20.0 | | | 52 | 6 | 1 | 1 | 4 | 64 | | 5 | 0 | 0 | 0 | 0 | 5 |
| Sept. 12, '58 | 21.5 | | | 7 | 0 | 0 | 1 | 0 | 8 | | | | | | | 0 |
| Sept. 21, '58 | 18.0 | | | | | | | | 0 | | | | | | | 0 |
| May 4, '59 | 14.0 | | | 5 | 6 | 6 | 0 | 0 | 17 | | 1 | 2 | 0 | 1 | 0 | 4 |
| Sept. 5, '59 | 20.0 | | | 0 | 0 | 0 | 18 | 2 | 20 | | | | | | | 0 |
| Total | | | | 299 | 116 | 120 | 64 | 58 | 657 | | 74 | 62 | 4 | 11 | 0 | 151 |

* The failure in collecting much larvae would be due to the sinking of them by

mosquito species collected in a tree hole during from 1956 to 1959

| <i>T. bambusa</i> | | | | | | | | <i>Ar. subalbatus</i> | | | | | | <i>M. towadensis</i> | | | | | | | | | |
|----------------------|------------|----|-----|----|-----------|---------------------|------------|-----------------------|-----|----|-----------|-----------------------|----------|----------------------|----|-----|----|----------------|---------------|----|------|--|--|
| No. eggs | No. larvae | | | | No. pupae | Total of L+P | No. larvae | | | | No. pupae | Total of L+P | No. eggs | No. larvae | | | | No. pupae | Total of L+P | | | | |
| | I | II | III | IV | | | I | II | III | IV | | | | I | II | III | IV | | | | | | |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 3 | 1 | 0 | 7 | | | | |
| | | | | | | 0 | | | | | | 0 | | 1 | 2 | 6 | 1 | 0 | 10 | | | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | | | | |
| | 0 | 1 | 2 | 0 | 0 | 3 | | | | | | 0 | | | | | | | 0 | | | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | | | | |
| | 2 | 0 | 0 | 0 | 0 | 2 | | | | | | 0 | | 0 | 0 | 0 | 0 | 9 | 9 | | | | |
| | 1 | 2 | 0 | 0 | 0 | 3 | | | | | | 0 | | 1 | 1 | 2 | 4 | 0 | 8 | | | | |
| | 2 | 0 | 0 | 0 | 0 | 2 | | | | | | 0 | | | | | | | 0 | | | | |
| | 1 | 0 | 0 | 0 | 0 | 1 | | | | | | 0 | | 0 | 0 | 0 | 0 | 1 | 1 | | | | |
| | 1 | 1 | 0 | 0 | 0 | 2 | | | | | | 0 | | 4 | 20 | 0 | 0 | 0 | 24 | | | | |
| | 1 | 0 | 0 | 0 | 0 | 1 | | | | | | 0 | | 2 | 1 | 1 | 2 | 0 | 6 | | | | |
| | | | | | | 0 | | | | | | 0 | | 0 | 0 | 1 | 0 | 0 | 1 | | | | |
| | 1 | 0 | 0 | 0 | 0 | 1 | | | | | | 0 | | 0 | 0 | 1 | 0 | 0 | 1 | | | | |
| | | | | | | 0 | | | | | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | | | | |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | | | | |
| | | | | | | 0 | | | | | | 0 | 10 | 5 | 0 | 0 | 0 | 0 | 5 | | | | |
| 9 | 9 | 4 | 2 | 0 | 0 | 15 | 1 | 2 | 0 | 0 | 0 | 3 | 46 | 16 | 24 | 14 | 8 | 10 | 72 | | | | |
| <i>Ae. japonicus</i> | | | | | | <i>Ae. galloisi</i> | | | | | | <i>Ae. albopictus</i> | | | | | | No. of species | Total No. L+P | | | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 4 | 46 | | |
| | | | | | | 0 | | | | | | 0 | | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 100 | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 2 | 53 | | |
| | 1 | 0 | 0 | 0 | 0 | 1 | | | | | | 0 | | | | | | | 0 | 5 | 364 | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 3 | 121 | | |
| | | | | | | 0 | 1 | 0 | 0 | 0 | 0 | 1 | | 4 | 3 | 0 | 0 | 0 | 7 | 6 | 177 | | |
| | 2 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 0 | 0 | 0 | 8 | | 4 | 5 | 0 | 0 | 0 | 9 | 7 | 163 | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 4 | 97 | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 3 | 84 | | |
| | | | | | | 0 | 1 | 0 | 0 | 0 | 0 | 1 | | | | | | | 0 | 5 | 86 | | |
| | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | | | | | | | 0 | 7 | 125 | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 5 | 324 | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 6 | 212 | | |
| | | | | | | 0 | | | | | | 0 | | 1 | 0 | 0 | 0 | 0 | 1 | 5 | 30 | | |
| | | | | | | 0 | | | | | | 0 | | 1 | 0 | 0 | 0 | 0 | 1 | 5 | 18 | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 4 | 39 | | |
| | | | | | | 0 | | | | | | 0 | | | | | | | 0 | 5 | 90 | | |
| 4 | 0 | 0 | 0 | 0 | 0 | 4 | 6 | 5 | 0 | 0 | 0 | 11 | | 10 | 8 | 0 | 0 | 1 | 19 | 10 | 2129 | | |

the accidental disturbance of the water surface at the first dipping.

Table 3 Developmental period of *Anopheles omorii* in Autumn, 1956, in the laboratory

| Egg No. | Collection | | Date of | | Days: egg to adult | Sex |
|---------|------------|-------|----------|-----------|--------------------|-----|
| | Date | Stage | Pupation | Emergence | | |
| 1 | Sept. 27 | egg | Oct. 20 | Oct. 23 | 28 | ♂ |
| 2 | " | " | " | 24 | 29 | " |
| 3 | " | " | 21 | " | " | ♀ |
| 4 | " | " | 22 | 25 | 30 | ♂ |
| 5 | " | " | " | 26 | 31 | " |
| 6 | " | " | " | " | " | " |
| 7 | " | " | 23 | " | " | " |
| 8 | " | " | " | " | " | " |
| 9 | " | " | 24 | 27 | 32 | ♀ |
| 10 | " | " | " | " | " | " |
| 11 | " | " | " | 28 | 33 | ♂ |
| 12 | " | " | " | " | " | ♀ |
| 13 | " | " | " | " | " | " |
| 14 | " | " | 25 | " | " | " |
| 15 | " | " | 26 | 29 | 34 | " |
| 16 | " | " | " | 30 | 35 | " |
| 17 | " | " | 27 | Nov. 1 | 36 | " |
| 18 | " | " | 28 | 3 | 38 | " |
| 19 | " | " | Nov. 1 | 5 | 40 | " |

Remarks : Mean air temperatures at a meteorological observatory near the laboratory during from Sept. 27 to Oct. 23 and Sept. 27 to Nov. 5 were 17.7 and 17.5°C respectively.

4) *Armigeres subalbatus*

The larvae of this mosquito were collected only once throughout the survey. This may be due to the fact that the water of this tree hole is not so polluted as in its favorable breeding place.

5) *Megarhinus towadensis*

It appears that the adults emerge from pupae developed from hibernated 4th instar larvae by the beginning of May. This was presumed from a pupa being captured on late April and eggs being collected on early May. The facts that eggs and younger larvae were collected on late July and early September appear to show that two life cycles may perhaps be repeated during warmer months. In laboratory, the larvae hatched from the eggs collected in the hole on early September developed to the 4th instar in about a month which hibernated till the beginning of May of the next year. The older larvae easily sink and not readily rise to the surface, especially in cold months. Thus, it appears that the full grown larvae hibernate in the mud in the bottom of the hole.

6) *Aedes kobayashii*

This species appears to hibernate in egg stage. The younger larvae are collected already from mid April which may emerge as adults by the beginning of June. The youngest ones are found in late June, in late July and in some cases in August and even in mid September, decreasing in number rather in August. The younger larvae found during from late August to mid September may develop to adults by the end of the year. The eggs deposited by these adults seem to enter into overwintering. Thus, this species seems

to perform its life cycles at least four times a year. Here, however, we can say nothing about the fate of a 4th instar larva which was collected as late as on December 9, 1956.

7) *Aedes bunanoki*

The larvae of this species were collected over many months, though in a very small numbers and in only younger stages. It is supposed that the mosquito may hibernate in egg and also in larval stages.

8) *Aedes japonicus* and 10) *Aedes albopictus*

These are very common in Japan but appear to be temporal breeder in this hole. They seem to hibernate in egg stage.

9) *Aedes galloisi*

The record of collecting the larvae of this rare species is very scanty and therefore it was very interesting and fortunate for us that we found the species breeding in this hole though very small in number.

This species seems to hibernate in egg stage considering that the youngest instar larvae are being collected in March and April.

Summary

1) In a large hole formed in zelkova tree, *Zelkova serrate*, immature stages of ten mosquito species were collected during from July 21, 1956 to September 5, 1959. From the data obtained by the survey, the life cycles and the hibernating stage of *Anopheles omorii*—it was the chief object of this survey—and those of most species were surmised.

2) It was found that the proper breeders in the hole are *An. omorii*, *Ae. kobayashii* and *M. towadensis*; sub-proper breeders are *T. bambusa*, *Ae. bunanoki*; while, the other five species may be temporal breeders.

3) It is of interest that the very rare species in Japan, *An. omorii*, *Ae. kobayashii*, *Ae. bunanoki* and *Ae. galloisi* were collected in this same hole.

4) The months in which relatively many species were found simultaneously were April and June, and next, March and September. While, the number of species rather decrease in July and August and especially so after October.

5) *An. omorii* seems to hibernate in younger stage larvae which may develop to adults by the beginning of May and to perform its life cycles four times a year.

6) It seems that *M. towadensis* hibernates in 4th instar larvae; *C. kyotoensis* does in adult stage; *T. bambusa* in egg and larval stages; and that *Ar. subalbatus* and five aedine mosquitoes in egg stage.

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