

## A SURVEY OF THE MOSQUITOES OF THE SOUTHERN RYUKYUS

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Requests for information on the mosquitoes of the Ryukyuan area, and recent activity among Japanese workers, have prompted the assembling and publication of the data presented below. These notes are based mainly on an unpublished mimeographed report submitted to Ryukyuan authorities in 1951. Since that time the identifications have been verified with the help of Dr. Alan Stone of the U.S. National Museum, and Dr. K. L. Knight of the U.S. Navy. Assistance during the period of collection was rendered by Dr. Shinken Ohama and Mr. Koubo Miyara.

Mosquito larvae and adults were collected during a three-month period, October to December, 1951 on the islands of Ishigaki and Iriomote, the two largest islands of the southern Ryukyus, known in the aggregate as Yaeyama. Several undescribed species and many new records resulted.

The study was made under the auspices of the SIRI Program, Pacific Science Board, National Research Council, while working with the Public Health and Welfare Department, United States Civil Administration of the Ryukyu Islands.

The collection period of October to December was probably not so favorable from the standpoint of quantity of material as midsummer would have been. Weather conditions were often poor—cloudy, windy and rainy—making field work difficult if not impossible. Temperatures fell abruptly toward the end of November, with a generally depressing effect on insect populations. Nevertheless, the 38 species of mosquitoes collected are considered representative, especially since a survey by Teller and Gentry (1955) made during January, 1954 revealed no additional species and a total of only 18. However, it must be said that January is an unusually poor month for field investigations. Ishigaki Island is extensively mountain-

ous but the highest elevation is reached by Mt. Omoto at 1,750 feet. Along the coast and in the southern half of the island there is considerable flat and sloping land suitable for agriculture. The important crops are sweet potato and rice with much smaller acreages devoted to soybeans, peanuts and sugarcane. The only large river is the Miyara, which nearly bisects the island. However, there are about 35 other small rivers, some of which may be of considerable importance with respect to malaria. The mountains are heavily forested, but mostly with small, second growth timber. Tree holes, which harbor several types of mosquito larvae in addition to *Culicoides*, are common only where species of *Ficus* occur. Large numbers of these are present in two collecting sites, along the Tori River and on the Yarabu Peninsula.

Iriomote Island is the largest of the Ryukyus south of Okinawa. It is almost completely covered with low but rugged mountains and is traversed by six large rivers as well as many smaller ones. Agriculture is confined to the relatively flat areas along the coast and adjacent to the larger rivers. Here, also, the culture is one of sweet potato and rice.

The climate of Yaeyama is similar to that of Okinawa with warm weather from April to November and winter temperatures in the low forties. The rainfall averages 86.4 inches on Ishigaki and 109.3 inches on Iriomote. September is the rainiest month but there is enough rainfall distributed over the year to maintain a large population of insects.

An effort was made to collect in all types of environments such as rice paddies, road puddles, drying creek bottoms, stream eddies, rock holes, tree holes, leaf axils, artificial containers, crab holes, polluted pools, fresh and brackish water. No water was found in epiphytes, and no pitcher-plants were located. Furthermore, no mos-

quito larvae were observed in temporary rain puddles nor in brackish water. This does not eliminate any of the above as possible breeding sites, however. Collections were made in forest, jungle, grassland, swamp, cultivated and domestic areas. In addition to the many larvae taken, several hundred adults were netted in underbrush and near damp rocks. Species collected only as biting females were *Mansonia uniformis* (Theobald), *Mansonia crassipes* (v. d. Wulp), *Aedes (Aedes)* sp., and *Aedes albocinctus* Barraud.

The total collection consisted of 1,234 pinned adults, about 500 slide-mounted larvae, and over 1,000 larvae in alcohol.

Of the 38 species of mosquitoes located, 33 were found on Ishigaki and 31 during a 3-week November stay on northern Iriomote. This compares with 37 species in the much more intensively collected island of Okinawa. The total for the three islands is 49. The species are obviously a part of the Oriental fauna and many of them are widespread in that region. However, 7 of the 37 Yaeyama species are unknown outside the Ryukyus. Most of the others were new records for the southern Ryukyus.

Useful publications bearing on mosquitoes of the area are Barraud (1934), Bohart and Ingram (1946), LaCasse and Yamaguti (1950), Teller and Gentry (1955), and Bohart (1956).

The following list of species includes notes on distribution, ecology, abundance, and evidence of man-biting habits.

*Anopheles minimus* Theobald. Widely distributed in the Oriental Region. Larvae are usually found in the eddies or grassy edges of clear, fast-flowing, sunlit streams. It is a prime malaria vector but fortunately is much less common than *sinensis*. On Ishigaki it is most abundant along the north coast, the northern peninsula, and Fanan River where I collected many specimens. On Iriomote it is reported from the more swiftly flowing parts of most of the rivers as they approach the coast.

*Anopheles ohamai* Ohama (1947). This species breeds with *minimus* and could be

a malaria vector if it were more common. It is known on both islands. I collected it in the Fanan River of northeastern Ishigaki. It is closely related to *saperoi* Bohart and Ingram from Okinawa but *ohamai* has the pale costal spot beyond the wing middle about as large as the subcostal spot, instead of smaller. In the larva the postclypeal hair is shorter.

*Anopheles sinensis* Wiedemann. A common rice-paddy species throughout the Orient. It also frequents grassy spring pools and other semi-stagnant places. It bites at night but is somewhat zoophilic. It is probably responsible for some malaria each year but is far outranked as a vector by *minimus* during periods of population movement as in war-time.

*Toxorhynchites yaeyamae* Bohart. A rare tree-hole species. Four larvae were captured, one to a hole. Three of these came from Shirahama, Iriomote and one from the Yarabu Peninsula, Ishigaki. A similar but unnamed species occurs on Okinawa and still another, *yamadae* Ouchi, inhabits the northern Ryukyus. The larval, pupal and adult descriptions of *yaeyamae* were given by Bohart (1956).

*Tripteroides bambusa* Yamada. The common "fuzzy" larva of *Ficus* tree holes on both islands. The species is well known in Japan but does not seem to occur on Okinawa.

*Ficalbia luzonensis* (Ludlow). One adult of this widespread Oriental species was taken in shrubbery near Hoshitate, Iriomote.

*Harpagomyia genurostris* (Leicester). A widespread Oriental species breeding in leaf axils of large taro plants. It was common on both islands.

*Uranotaenia annandalei* Barraud. Known from India and China, it is rare on Okinawa, but abundant on Ishigaki and Iriomote. The larval antenna is unusual in having 3 leaf-like appendages. The favored habitat is a drying creek pool. Ishigaki localities were Kawara, Mt. Banna, Mt. Maeshi, Kabira, and Fanan River. Iriomote collections were made near Sonai, the Nakara River, and Shirahama.

*Uranotaenia bimaculata* Leicester. A tree-hole species widespread in the Orient. I found it uncommonly in tree holes on Mt. Omoto and Mt. Maeshi, Ishigaki, and swept it from shrubbery along the Nakara River, Iriomote.

*Uranotaenia macfarlanei* Edwards. Another widely distributed Oriental species which was fairly common in Yaeyama. On Ishigaki it was taken on Mt. Kawara, Mt. Banna, and Kabira. On Iriomote it was collected near Sonai and along the Nakara River. The larvae inhabit small ground pools.

*Uranotaenia stonei* Bohart. An endemic Ryukyuan species found originally in northern Okinawa. It is common on Ishigaki where larvae breed in cave springs, rock holes and crab holes. Larvae are of the sinuous "*Aedes*" type, contrasting with the *Anopheles*-like other Yaeyama species. Adults were disturbed from shrubbery on Mt. Banna, Mt. Kawara, Mt. Maeshi, and the Yarabu Peninsula of Ishigaki.

*Armigeres subulbatus* (Coquillett). A well-known Oriental species, widely scattered in Yaeyama but uncommon. Adults bite readily by day. Larvae were bred from tree holes along the Tori River and from taro axils along the Fanan River, Ishigaki.

*Orthopodomyia anopheloides* (Giles). Not previously recorded from the Ryukyus, this Oriental species is common in tree holes on Ishigaki and Iriomote.

*Mansonia crassipes* (v. d. Wulp). This reddish species was taken in shrubbery rather frequently on Iriomote from Shirahama to Hoshitate.

*Mansonia uniformis* (Theobald). Adults of this ubiquitous Oriental species were collected several times day-biting and occasionally sweeping. Localities were Yarabu Peninsula on Ishigaki, and Sonai, Hoshitate and Shirahama on Iriomote.

*Aedes (Aedes) ishigakiensis* Bohart. A long series of adults were reared from a foxhole in a pine grove on Mt. Banna, Ishigaki. Larval, pupal and adult characters were given by Bohart (1956).

*Aedes (Aedes)* sp. Two females of an

unidentified species near *atrius* Barraud were taken day-biting in the forest east of Hoshitate, Iriomote.

*Aedes (Finlaya) albocinctus* Barraud. Three females of this Oriental species were taken day-biting on Iriomote, two on the mountain back of Shirahama, and one above the east fork of the Nakara River.

*Aedes (Finlaya) feegradei* Barraud. This Burmese species was reported previously on Okinawa by Bohart (1953). Adults were reared from larvae taken in deep and narrow *Ficus* tree holes near the Yarabu River, Ishigaki.

*Aedes (Finlaya) japonicus* (Theobald). This Japanese species is common in rock holes along streams on both islands.

*Aedes (Finlaya) okinawanus* Bohart. Previously known only from Okinawa, this species occurs sparingly in Yaeyama. Adults sometimes day-bite in deep shade. It breeds in tree holes and was taken on Mt. Omoto and Yarabu Peninsula, Ishigaki, as well as Sonai, Shirahama and Nakara River, Iriomote.

*Aedes (Stegomyia) aegypti* (Linnaeus). Found practically around the world, this species was common in artificial containers of villages along the south coast of Ishigaki. It is a well-known vector of dengue in the Pacific area along with the following species.

*Aedes (Stegomyia) albopictus* (Skuse). A widespread Oriental species which was found breeding in small tree holes on Mt. Maeshi and in a metal drum at Shiraho, Ishigaki. Adults were day-biters but not numerous enough to be pestiferous.

*Aedes (Stegomyia) flavopictus downsi* Bohart. This mosquito is a dominant day-biting pest in wooded areas. It breeds frequently in taro axils and sometimes in tree holes. It is known only from Okinawa and Yaeyama, where it is common on both Ishigaki and Iriomote.

*Aedes (Stegomyia) riversi* Bohart. Second only to *downsi* as a woodland day-biter. It is abundant on both islands where the larvae breed primarily in tree holes. As the larvae were not found in rock holes, this may be a subspecies of the Okinawan form.

*Culex (Lutzia) vorax* Edwards. The larva is predaceous in ground pools and artificial containers. Adults bite man. It is widespread on both islands, but not common.

*Culex (Lophoceraomyia) cinctellus* Edwards. An Oriental species often swept from shrubbery in Yaeyama. Larvae breed in open grassy ground pools.

*Culex (Lophoceraomyia) infantulus* Edwards. A well-known Oriental species which is widespread but uncommon in Yaeyama. The larvae breed in ground pools.

*Culex (Lophoceraomyia) minor* Leicester. This Oriental species is a common tree-hole and rock-hole breeder everywhere in Yaeyama.

*Culex (Neoculex) hayashii* Yamada. Not uncommonly breeding in springs and cutoff stream pools on Ishigaki but not found on Iriomote. Elsewhere it is known from Japan, China, and Okinawa.

*Culex (Culiciomyia) nigropunctatus* Edwards. Not previously reported from the Ryukyus but occurring over much of the Orient. The larva has a peculiar false joint on the siphon. It was found in grassy ground pools on Mt. Banna, Ishigaki, and along the Nakara River, Iriomote.

*Culex (Culiciomyia) ryukyensis* Bohart. Collected once in a ground pool on Mt. Banna, Ishigaki, and once in a cutoff stream pool near Shirahama, Iriomote. This species is common in northern Okinawa.

*Culex (Culex) bitaeniorhynchus* Giles. Generally found in rice paddies and algal ground pools on both islands as well as elsewhere in the Orient. It is a night-biter but not abundant enough to be much of a pest.

*Culex (Culex) quinquefasciatus* Say. This worldwide species breeds in almost any form of stagnant water, especially if polluted with sewage or food. In Yaeyama, larvae are common in laundry sumps, clogged sewer drains, and artificial con-

tainers. Its role in transmission of filariasis is well known.

*Culex (Culex) sinensis* Theobald. A rice-paddy breeder throughout the Orient and probably well distributed in Yaeyama. However, I took only one adult from shrubbery on Mt. Maeshi, Ishigaki.

*Culex (Culex) tritaeniorhynchus* Giles. This prolific Oriental mosquito was infrequently found in Yaeyama, but is common on Okinawa. It is a ground pool breeder and incriminated in transmission of Japanese "B" encephalitis in Japan and Okinawa.

*Culex (Culex) vishnui* Theobald. A widespread Oriental species but scarce in Yaeyama. I collected larvae once in a swamp above a rice paddy near Kabira, Ishigaki, and once in a grassy pool along the Nakara River, Iriomote. The adult bites man.

*Culex (Culex) whitmorei* (Giles). Essentially a rice-paddy breeder throughout the Orient, but not previously recorded from the Ryukyus. Larvae were found near Sonai, Iriomote. Adults are known to bite man.

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