The Immature Stages of *Aedes (F.) samoanus* and the Status of *Toxorhynchites* in American Samoa

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Aedes (Finlaya) samoanus (Gruenberg, 1913) was described from four females collected at Apia, Western Samoa. It was the only known species of the Kochi Group from Samoa until Belkin (1962:377-379) described *Aedes (Finlaya) oceanicus.* A third species from Samoa, *Aedes (Finlaya) tutuilae* Ramalingam and Belkin, 1965 was subsequently added to this group. *Aedes samoanus* was shown to be a nocturnal vector of *Wuchereria bancrofti* in American and Western Samoa (Ramalingam and Belkin, 1964; Ramalingam, 1968). The descriptions of the larval and pupal stages of this species, however, still remain unpublished. The larval description attributed in the past to *samoanus* (Stone and Bohart, 1944; Marks, 1947) is actually that of *oceanicus.* During studies carried out on the mosquito fauna of Samoa and Tonga in the mid 1960's a large number of whole larvae and pupae and about 60 individual rearings of this species were obtained. Descriptions of these stages were included in a Ph.D. dissertation (Ramalingam, 1965).

The terminology used in describing the larval and pupal stages is that of Belkin (1962). The following system is used for setal branching: if only one numeral is given in parentheses following the seta number it represents the only number of branches encountered in the sample; if two sets of figures are given, the first represents the modal number of branches and the second, the range encountered in the sample. The chaetotaxy of the larva and pupa was determined from a sample of ten individuals.

Aedes (Finlaya) samoanus

PUPA (fig. 1). Abdomen: 2.93 mm. Trumpet: 0.4 mm. Paddle: 0.69 mm. Relative position, length, degree of development and branching of setae as figured. The pupa briefly described by Belkin (1962:380) does not belong to this species. *Cephalothorax:* Pigmentation light to dark brown; dorsal area between the trumpets with slightly darker pigmentation. Mesonotum with one pair of large submedian, clear, unpigmented spots; in the living pupa these spots are iridescent. Trumpet uniformly pigmented and with the same amount of pigmentation as the rest of the cephalothorax. Metanotum without clear unpigmented spots. Setae: 1(2), 2(1;1,2), 3(1;1,2), 4(5;2-8), 5(4;2-7), 6(2;2-4), 7(3;2-5), 8(2;2-4), 9(2;1,2), 10(3;2-8), 11(1), 12(5;4-7). *Abdomen:* Tergites I-IV with slightly darker pigmentation in the median area than the other tergites which are uniformly and lightly pigmented. Setae 0 and 14 single on all segments. Segment I: seta 1 (11-15 primary branches, each primary branch with several secondary branches; slightly shorter than the length of the segment), 2(1;1-3), 3(1), 4(5;4-7), 5(3;2-5), 6(1;1,2), 7(3;2-4), 9(1;1,2), 10(10;7-12). Segment II: Seta 1(4;2-12), 2(1), 3(1), 4(4;1-6), 5(2;1-3), 6(1;1-3),7(4;2-5), 8(2;2,3), 9(1;1,2), 11(1;1,2). Segment III: seta 1(3;2-4), 2(1), 3(1), 4(2;1-3), 5(2;1-3), 6(1;1,2),

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7(3;2-4), 8(2;1-4), 9(1), 10(2;1-3), 11(1). Segment IV: seta 1(2;2-5), 2(1), 3(4;3-6), 4(2;1-4), 5(2), 6(1;1,2), 7(3;2-4), 8(2;1-4), 9(1), 10(2;1-3), 11(1). Segment V: seta 1(2;1-3), 2(1), 3(2;1,2), 4(5;4-7), 5(2), 6(1;1,2), 7(4;3-6), 8(3;1-4), 9(1), 10(1), 11(1). Segment VI: seta 1(2), 2(1), 3(1;1-3), 4(3;2-6), 5(2;2-4), 6(1;1-2), 7(2;1-4), 8(2;1-3), 9(1), 10(2;1-4), 11(1). Segment VII: seta 1(2;1-3), 2(1), 3(2;1-3), 4(2;1,2), 5(2;1-3), 6(3;2-4), 7(1;1,2), 8(2;2-4), 9(5;3-7), 10(2;1-4), 11(2;1,2). Segment VIII: seta 4(2;1-3), 9(12;10-14). *Paddle* as figured; midrib darkened and strongly sclerotized; apex distinctly emarginate; external margin with short dorsal spicules; seta 1 slender. The male genital lobe extending to 0.58 of paddle; female genital lobe to 0.36.

LARVA (fig. 2). Head: 0.71 mm. Siphon: 0.72 mm. Anal Saddle: 0.2 mm. Body a pale yellow color, head and siphon light brown. Thorax and abdomen covered with conspicuous stellate setae. *Head:* Width 1.14 of length; ocular bulge distinct; pigmentation light brown, dark brown ventrally around the area of the mouthparts. Mental plate as figured, a strong brown median tooth and 9(9-11) distinct teeth on each side, often a smaller tooth at the base. Setae lightly to moderately pigmented. Seta 1(7;4-8; branches short and stubby), 4(18;14-22; branches in one plane), 5(1), 6(10;9-12; branches in one plane), 7(7;6-9; stellate), 8(2), 9(2;2,3), 10(1), 11(11;10-13; stellate), 12(2;1-2), 13(1), 14(19;16-24; stellate), 15(4;3,4; minute). Antenna 0.24 of head length; shaft nearly the same width throughout, width about 0.2 of length; shaft uniformly and lightly pigmented, without spicules. Relative position, degree of development of antennal setae as figured; all setae single; seta 1 placed at 0.69 from base of shaft. *Thorax:* All setae and tubercles lightly to moderately pigmented; apices of long setae attenuated; barbs present on some setae. Prothorax: seta 0(22;18-25), 1(18;17-21), 2(1), 3(21;17-27), 4(1), 5(10;9-13), 6(1), 7(2), 8(19;16-22), 9(17;15-17), 10(9;8-10), 11(3;2-4), 12(1), 14(2). Mesothorax: seta 1(35;26-39), 2(4;3-5), 3(1), 4(1), 5(1), 6(7;6-9), 7(1), 8(2;1-3), 9(9;7-11), 10(1), 11(7;6-8), 12(1), 13(18;16-21), 14(29;25-34). Metathorax: seta 1(35;27-38), 2(1), 3(20;17-25), 4(4;2-5), 5(19;16-23), 6(1), 7(8;7-9), 8(18;16-22), 9(8;6-10), 10(1), 11(7;6-8), 12(1), 13(31;29-34). *Abdomen:* All setae and tubercles lightly to moderately pigmented; stellate setae with branches of equal length. Seta 14 single on all segments. Segment I: seta 1(35;27-38), 2(1), 3(20;17-25), 4(4;2-5), 5(19;16-23), 6(1), 7(8;7-9), 8(18;16-22), 9(8;6-10), 10(1), 11(7;6-8), 12(1), 13(31;26-34). Segment II: seta 0(1), 1(32;26-37), 2(26;21-31), 3(1), 4(4;3-6), 5(14;12-18), 6(5;5,6), 7(2;1,2), 8(1), 9(10;9-11), 10(9;8-12), 11(3;2-4), 12(1), 13(28;23-32). Segment III: seta 0(1), 1(31;27-35), 2(26;25-30), 3(1), 4(4;3,4), 5(16;13-19), 6(2;2,3), 7(13;11-16), 8(1), 9(10;9-12), 10(1), 11(4;3,4), 12(1), 13(29;21-31). Segment IV: seta 0(1), 1(32;27-38), 2(25;23-32), 3(1), 4(4;3-5), 5(16;13-18), 6(2;2,3), 7(16;11-19), 8(1), 9(11;9-12), 10(1), 11(4;4,5), 12(1), 13(30;22-33). Segment V: seta 0(1), 1(30;25-35), 2(26;22-34), 3(1), 4(2;2-5), 5(17;14-20), 6(2;2,3), 7(18;13-21), 8(1), 9(13;11-17), 10(1), 11(4;3,4), 12(1), 13(31;24-37). Segment VI: seta 0(1), 1(32;27-36), 2(27;23-32), 3(2;1,2), 4(1;1,2), 5(18;16-20), 6(3;3,4), 7(19;15-22), 8(4;2-5), 9(13;12-16), 10(25;17-30), 11(4;3,4), 12(1), 13(31;23-37). Segment VII: seta 0(1), 1(25;22-30), 2(24;19-28), 3(1), 4(1), 5(18:15-22), 6(18;14-22), 7(1), 8(24;19-31), 9(16;13-18), 10(21;16-27), 11(4;3,4), 12(1), 13(25;20-30). Segment VIII: Comb lightly pigmented and difficult to see; consisting of approximately 93(77-112) scales, arranged in 5,6 overlapping rows. Comb scales in middle of posterior row with base of free part elongate and with a single pair of lateral denticles; the distal part flattened and expanded, the apex with a few spicules. Seta 0(1), 1(25;20-29), 2(1), 3(1;1,2), 4(1), 5(22;18-25), 14(1). *Siphon:* Index about 3.9 (3.5-4.4); pigmented light brown; strongly pilose, spicules with 2-4 branches, very numerous and uniformly covering the whole siphon. Pecten extending over basal 0.37 of siphon, composed of 8(7-11) evenly spaced teeth; teeth as figured. Seta 1(4;3-5; barbed), 2(1), 3 to 5 not visible, 6(1), 7 not

visible, 8(1), 9(1). *Anal Segment:* Saddle with light brown pigmentation; covered with small uniform spicules, except at the caudolateral border (between setae 1 and 3), where the spicules are much longer; gills as figured, narrow and long, ventral pair about 0.79 of dorsal pair. Seta 1(3;3,4), 2(7;6,7), 3(1), 4a(5;4,5), 4b(5;5,6), 4c(6;5-8), 4d(7;6-9), 4e(5;5,6).

DISCUSSION. The pupa of *samoanus* can be readily recognized from those of *oceanicus* and *tutuilae* by the absence of clear unpigmented spots on the metanotum. At least one pair of such spots is present in the other two species. The trumpet in *tutuilae* is dark and contrasting with the rest of the cephalothorax, whereas in *samoanus* it is about the same color as the cephalothorax.

In the larval stage, *samoanus* can be differentiated from *oceanicus* by the distinctly and uniformly spiculose (pilose) siphon, in contrast to the comparatively smooth siphon with sparse spicules in *oceanicus*. The branching of head setae 4, 6-C is distinct in the three species. Head seta 4-C is 2-4 branched in *oceanicus*, 7-11 branched in *tutuilae* and 14-22 branched in *samoanus*. Head seta 6-C is 2,3 branched in *oceanicus*, 4-6 branched in *tutuilae* and 9-12 branched in *samoanus*. The spicules on the siphon of *samoanus* are denser and the individual spicules are 2-4 branched, whereas in *tutuilae* they are less dense and are simple.

Toxorhynchites in American Samoa

During the 1950's two species of *Toxorhynchites* were introduced into American Samoa from colonies maintained in Hawaii, in the hope of controlling *Aedes (Stegomyia) polynesiensis* Marks, 1951, the main vector of Bancroftian filariasis. The first introduction in 1952 by D. H. Butchard was that of *Toxorhynchites (T.) brevipalpis* Theobald, 1901. In 1955 C. P. Hoyt introduced two species: *T. brevipalpis* and presumably *Toxorhynchites (T.) splendens* (Wiedemann, 1819). These two species were reintroduced by Peterson (1956) in July 1955. Peterson did not have the opportunity of observing the long-term effects of *Toxorhynchites* on populations of *polynesiensis* in Samoa and this aspect has so far not been reported. The surveys carried out in 1963 offered this opportunity.

Extensive collections in 1963 revealed that neither *T. brevipalpis* nor *T. splendens* occurred in American Samoa. Instead a third species, *Toxorhynchites (T.) amboiensis* (Doleschall, 1857) was found to occur quite commonly there. It appears that *T. brevipalpis* was unable to establish itself or else it disappeared as a result of competitive displacement by *T. amboinensis*, a situation analogous to that reported on Oahu, Hawaii by Steffan (1970). As for the introduction of *splendens*, apparently there was a misidentification, so that the species originally introduced was *amboinensis* and not *splendens*, as supposed. This was confirmed by Belkin who examined material from the stock colonies in Hawaii in 1964. The misidentification of *Toxorhynchites* in Hawaii has been reported by Steffan (1968, 1975).

Toxorhynchites amboinensis apparently has little effect on the density of *Aedes polynesiensis* as this species was fairly abundant on the island of Tutuila during the period of the survey and was responsible for a high transmission index of *W. bancrofti* in American Samoa (Ramalingam, 1968). In fact, the breeding habitat of *polynesiensis* does not exactly coincide with that of *amboinensis*. While *polynesiensis* breeds mainly in treeholes, rockholes, coconut shells, artificial containers and cocoa pods, the major breeding place of *amboinensis* is the leaf axils of *Colocasia* and *Alocasia* (taro), a site in which *polynesiensis* does not choose to breed. *Toxorhynchites amboinensis* was occasionally collected in treeholes and on a single occasion each in a bamboo stump and a rockhole. The obvious species that *amboinensis* could be expected to control in Samoa is *Aedes*

(Finlaya) oceanicus Belkin, as this species is confined in its breeding to the leaf axils of taro and pandanus and is constantly exposed to predation by *amboinensis*. Despite this, the population of *oceanicus* in taro is always very high. There appears to be some regulatory mechanism in *amboinensis* that prevents it from excessively high populations. Thus, although *Toxorhynchites amboinensis* has been able to establish itself in American Samoa, it has not been successful as a biological control agent in suppressing the population density of even a single species of mosquito.

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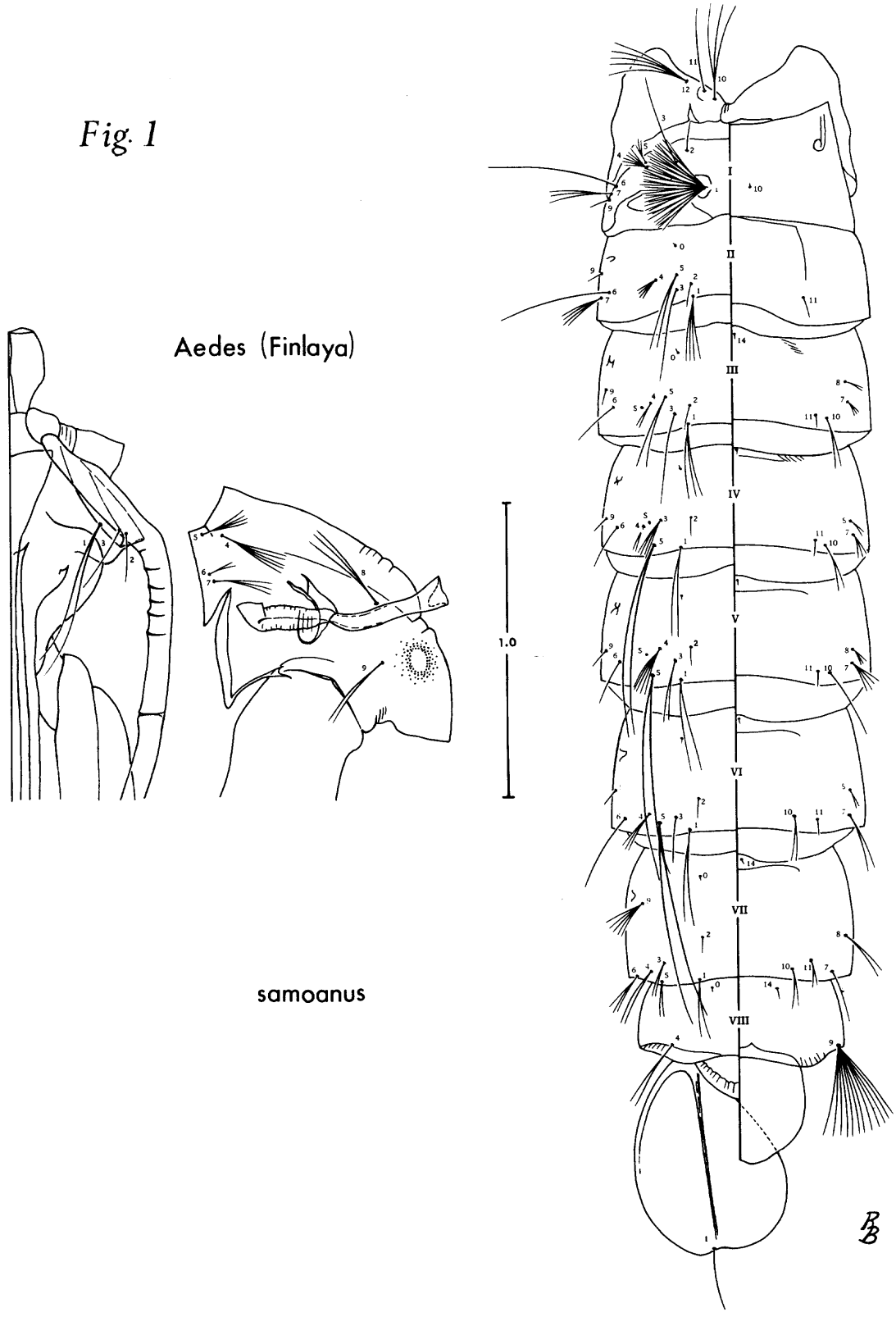
FIGURES

1. Pupa of *Aedes (Finlaya) samoanus*
2. Larva of *Aedes (Finlaya) samoanus*

Fig. 1



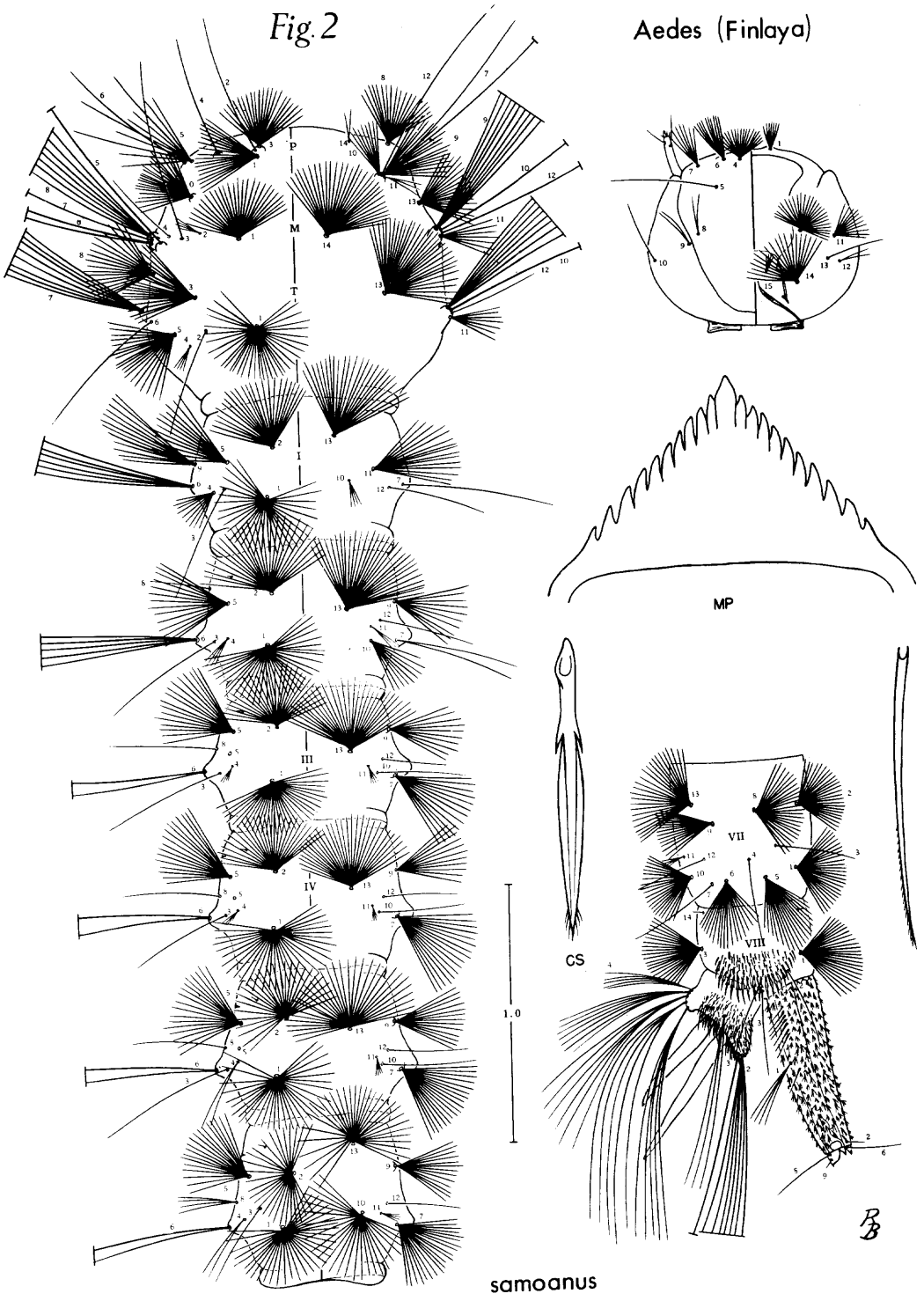


Fig. 2
Aedes (Finlaya)
P
M
T
I
III
IV
MP
CS
VII
VIII
1.0
samoanus