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74. MORPHOLOGICAL OBSERVATIONS ON A POPULATION OF THE *PUNCTULATUS* COMPLEX OF *ANOPHELES* (DIPTERA, CULICIDAE) FROM RENNELL ISLAND (SOLOMON GROUP)

75. THE MOSQUITOES (DIPTERA, CULICIDAE) OF RENNELL AND BELLONA

BY

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74. MORPHOLOGICAL OBSERVATIONS ON A POPULATION OF THE *PUNCTULATUS* COMPLEX OF *ANOPHELES* (DIPTERA, CULICIDAE) FROM RENNELL ISLAND (SOLOMON GROUP)

BY

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INTRODUCTION

Up to 1969, *Anopheles (Cellia) farauti* had been the only anopheline mosquito reported from Rennell Island. The first finding by BLACK (1952), at Niupani on Lake Tegano, on the eastern half of the island, was confirmed by the subsequent findings in the same locality or nearby of adults and/or aquatic stages of *A. farauti* by LAIRD and LAIRD in 1953, BROWN in 1955, the Noona Dan Expedition in 1962, and RAGOSO in 1966.

During the same period the species was also reported from the western half of the island, the forested "bush" area. Immature stages were collected in three different localities: at Matangi by BROWN in 1955 (1 larva), by DE BEAUX in 1956 (2 larvae), and by RAGOSO in 1966 (aquatic stages in unspecified number[1]); at Teabamagu by RAGOSO in 1966 (11 larvae[1]); at Songoa[2] by DE BEAUX in 1956 (5 larvae). The specimens collected by BROWN and DE BEAUX have been identified by BELKIN, and are at present in BELKIN's collection (University of California, Los Angeles) while RAGOSO's specimens are untraceable.

In the course of my trips to Rennell, in 1969 and 1970 (MAFFI, 1973), I paid only two visits to Lake Tegano and Niupani, and one of them was very short (26-29 July 1969 and 25 Jan. 1970). In spite of a careful and prolonged search for

1. In 1966 no anopheline except *A. farauti* was considered to exist on Rennell. Therefore it seems probable that the identifications made by RAGOSO, a malaria technician (Entomology) of the Medical Services, B.S.I.P., were only macroscopical, and that anopheline larvae were not kept.
2. No locality with such a name exists at present on Rennell, but it must have been somewhere between Labagu and Matangi. A locality "Nanggau", reported in STANLEY's map of 1928 and in GROVER's map of 1957 (CHRISTIANSEN, 1968, figs. 3 and 4), still exists in this position.

aquatic stages of mosquitoes, no anophelines were found. No attempt was made to capture adults.

More time was spent in the bush, on the forested western part of the island: in 1969 from 23 to 25 July; in 1970 from 21 to 24 Jan., from 6 to 13 Feb., and from 10 to 13 Sept. Here anophelines were found at two localities: Gongona and Matangi.

The first finding was at Gongona (24 July 1969): a single larva, associated with *Culex (Lophoceraomyia)* sp., Rennell form, in a natural, open water collection, with dense vegetation along the border. A second visit, six months later, yielded negative results.

More rewarding was the breeding place at Matangi: also a natural, open, shallow water collection, sunlit and edged by vegetation. Anopheline larvae were collected on 25 July 1969; larvae and pupae on 23-24 Jan. and on 9-10 Feb. 1970. The associated species were *Culex (Culex) annulirostris* and/or *Culex (Loph.)* sp., Rennell form. Some individual rearing was carried out on the spot. During the visit to Matangi in Jan. 1970, a few adult females were captured, man-biting indoors at midnight.

However, when Matangi was visited for the last time in Sept. 1970, only a few larvae of *C. annulirostris* were found. Since between Feb. and Sept. 1970 Rennell had been subjected to two cycles of intradomiciliary spraying with residual insecticides (DDT), the disappearance of the anophelines was not unexpected. Whether this is temporary or definitive, only future investigations will show.

Due to the prevailing working conditions, simple techniques were used for the collections on Rennell. The adults were pinned and stored; the immature stages and the associated skins were preserved in MacGregor solution, except for a few kept in alcohol. Later the latter material was mainly mounted in polyvinyl lactophenol (Gurr); only in a few cases were chloral gum or Aquamount (Gurr) used. The results were uneven, and not always satisfactory.

The material consists of 15 adult females, 66 larvae, 23 larval skins, 22 pupae, and 7 pupal skins. Also the proboscis, palpi, wings and buccopharyngeal armature[3] of 2 adult females have been mounted.

The 15 adult females are deposited in the British Museum (Nat. Hist.), London; all the remaining material is in the Bernice P. Bishop Museum, Honolulu.

THE ANOPHELINE POPULATION FROM MATANGI[4]

When checked by means of the pertinent keys (BELKIN, 1962, pp. 90-91, 118, 120, 121, 126-127), all available stages (adult female, pupa, larva) of the anopheline population collected at Matangi[4] present morphological characters leading to the *punctulatus* complex.

3. Cibarial armature (KNIGHT & LAFFOON, 1970, p. 70).
4. The larva collected at Gongona is considered as part of the material from Matangi.

At the specific level, however, it is difficult to reach a conclusion. A major negative factor is that male genitalia are not available (BELKIN, 1962, p. 80); but to this must be added the incontrovertible fact that at none of the available stages do the morphological characters considered useful for a diagnosis of species within the complex lead to unequivocal results.

Therefore, and because I consider this paper as a preliminary report, I have not attempted to give a complete morphological description of the population found on Rennell, but have limited my contribution to examining the material under study for the diagnostic characters of species which are reported for the *punctulatus* complex species in the most recent literature (OWEN, 1945; BELKIN *et al.*, 1945; ROZEBOOM & KNIGHT, 1946; BELKIN, 1962), to the listing of the peculiarities I have noticed, and to some comments.

Adult female. Both in the keys and in the descriptions of the species of the *punctulatus* complex all the authors concur that a very important differential morphological character on which to base the separation of the adults, male or female, is the colour pattern of the labium (OWEN, p. 236, pl. I, pp. 239, 240; BELKIN *et al.*, pp. 241-242, 253, 256, 258, 261; ROZEBOOM & KNIGHT, pp. 95-101, table 1, 112-113, 117-120, 122, figs. 20-27; BELKIN, pp. 126, 139, 142, 144, fig. 43). On this character have centered most of the controversies on the identification of the species within the complex (ROZEBOOM & KNIGHT, pp. 95-98), and the doubts expressed by OWEN (p. 239) and by BELKIN *et al.* (p. 256) on the exact relationship between *A. moluccensis, A. farauti* and *A. koliensis,* and ROZEBOOM & KNIGHT's (pp. 100-101, 120, 122) subsequent conclusion, apparently correct, that *A. koliensis* of Guadalcanal and the "intermediate form" of New Guinea are the same.

According to the classification suggested by ROZEBOOM & KNIGHT, which is based on the differences in the colour pattern of the labium, all the adult females from Rennell fall into type C (Figs. 1, 2). Except for three cases, reminiscent of ROZEBOOM & KNIGHT's figs. 24, 25 and 26, all the other Rennell specimens present the labium shown in their fig. 23 (with some minor variations in the size of the ventral subapical patch).

The sample collected is too small to allow any deductions of statistical significance. However, it is worth noting that in the pertinent literature a labium of the C type has never been reported in *A. punctulatus* or *A. farauti,* whereas it is the rule in *A. koliensis.* For the latter species it has been constantly found in several hundreds of wild specimens from Guadalcanal (OWEN, p. 240) and in 69 wild specimens[5] from Hollandia (ROZEBOOM & KNIGHT, p. 101, table 1); and in the series,[6] a labium of the C type has been noted in all OWEN's 500 specimens from Guadalcanal and in 96.4 % of 584 imagos, half from Guadalcanal and half from Hollandia (ROZEBOOM & KNIGHT).

All the Rennell specimens lack the small sectoral dark spot on the wing (Figs.

5. I.e., the "intermediate form" of LEE and WOODHILL (ROZEBOOM & KNIGHT, pp. 97, 101).

6. "Series" has the meaning of "progeny reared from individual females", as by ROZEBOOM & KNIGHT (p. 99).

2, 3), a character known to be constant in *koliensis,* both from Guadalcanal and from New Guinea, whereas it has never been found in *punctulatus* or *farauti,* with a single exception. The character is therefore used for the differential diagnosis of species within the *punctulatus* complex (OWEN, pp. 236, pl. I,[7] 239, 240; BELKIN *et al.,* pp. 242, 261; ROZEBOOM & KNIGHT, pp. 102, 103, table 3; BELKIN, pp. 139, 142, 144, fig. 43[7]). The stated exception is the *koliensis*-like wing in 41.5 % of 183 *farauti* from Hollandia (ROZEBOOM & KNIGHT, p. 103, table 3).

By the above differential characters the adult females from Rennell should be classified as *koliensis.* This, however, is contradicted by the characteristics of the buccopharyngeal armature (Fig. 4), which are more reminiscent of, though not identical to those of *farauti* (BELKIN, fig. 43).

Pupa. This stage is not described in OWEN's paper. On the basis of the diagnostic differential characters in the relevant key, the pupae from Rennell fall into the *punctulatus* complex (BELKIN *et al.,* p. 242; BELKIN, pp. 91, 120, 127), and at the specific level they are strongly suggestive of *koliensis.* Indeed (Figs. 5, 6), they are differentiated from *punctulatus* by the characters of hair 1-II, which has less than ten branches, and from *farauti* by those of hair 9-IV, which is of the same order of magnitude as 9-V, VI, and at least two or three times as long as 9-III (BELKIN *et al.,* p. 243, table 1; ROZEBOOM & KNIGHT, pp. 107-112, tables 16-18, 121; BELKIN, pp. 127, 144-145, figs. 44, 46, 49).[8]

The pigmentation of the trumpet (Fig. 6), though evident, does not fully comply with the characteristics which are normally seen in *farauti* and *koliensis,* species with a trumpet strongly pigmented, in sharp contrast with the integument of the cephalothorax (ROZEBOOM & KNIGHT, pp. 109-110; BELKIN, pp. 127, 139, 142, 144).[9]

By the characteristics of the paddle, which has a fringe of slender spicules only, the pupae (and pupal skins) fall into the *punctulatus* complex (BELKIN, p. 127).

At the specific level, however, their position is unclear.

The paddle is lightly pigmented, as in *punctulatus* (BELKIN, p. 142).

The accessory paddle hair (2-P) is consistently forked, 2-3 branched (Fig. 7). This character has no correspondent within the complex, as far as I can see; and even at the tribe level hair 2-P is always represented as simple except for *B. hollandi* and *A. lungae,* as can be seen in the relative figures (BELKIN *et al.,* figs. figs. 19,[10] 20; ROZEBOOM & KNIGHT, fig. 14; BELKIN, figs. 40,[10] 44, 46, 49, 52, 54, 56). There are only two descriptions of hair 2-P, and both refer to *B. hollandi* (BELKIN *et al.,* p. 245; BELKIN, p. 131).

7. When compared with that in OWEN's paper (pl. I) the drawing of the wing of *koliensis* in BELKIN (fig. 43) appears incomplete in the markings of part of vein R.
8. Due to the limited number of specimens and/or skins available no attempt has been made to utilize measurements to assess differential characters, as done by BELKIN *et al.* (p. 254) and particularly by ROZEBOOM & KNIGHT (pp. 108-111).
9. As done by BELKIN (p. 82), colours and colour pattern have been described from pupal and larval skins.
10. In BELKIN *et al.* (fig. 19) hair 2-P of *B. hollandi* is represented as simple, whereas it is forked, with 3 branches, in BELKIN (fig. 40).

The strongest similarity of hair 2-P as in the material from Rennell is with that of *B. hollandi* as in BELKIN; however, the former is never marginal, as stated and depicted for the latter.

A few additional minor characters of the pupae from Rennell have been compared with those depicted for *farauti* and *koliensis* in ROZEBOOM & KNIGHT (figs. 11, 12) and in BELKIN (figs. 44, 49). Apart from an occasional peculiarity (e.g., hair 1-VII often appears to be 2-branched), the similarities (in hairs 10-C, 3-V, 3-VI) are closer to *farauti* than to *koliensis*, and in particular to the pupa of *farauti* as represented by ROZEBOOM & KNIGHT. However, considering the geographical variations that *farauti* can exhibit in the immature stages (BELKIN, p. 138), no conclusions can be drawn.

Summing up it can be said that the pupa from Rennell shows the morphological characters which, by key, lead to *koliensis*, but presents, in addition, some peculiar features.

Larva. As evident from Figs. 8 and 9, the larvae collected on Rennell (most of them fourth-instar specimens) present a characteristic "strong pigmentation of the head capsule and antenna" (BELKIN, pers. commun., 1969), with constant and marked pattern of dark and light coloured areas.

In the relevant literature there is some disagreement about the diagnostic value to be attached to the different degree of pigmentation of the head and antenna of the larva: ROZEBOOM & KNIGHT (p. 103) consider this character as not fully reliable, whereas BELKIN *et al.* (p. 260) refer that *farauti* collected in the field usually has pigmented antennae and BELKIN (pp. 139, 142, 144) describes the pigmentation of the head (and antenna) as strong in *farauti*, light and uniform in *koliensis* and light in *punctulatus*.

If the value of the character is accepted, in accordance with BELKIN's criteria, the larvae from Rennell should be classified as *farauti*.

A few additional characteristics presented by the head of the larva are worth reporting.

The inner clypeal hair (2-C) is nearly always extensively barbed. The outer clypeal hair (3-C) is without exception forked, and in general it appears strongly barbed. As far as I have been able to assess, the length of the outer is half or slightly more than that of the inner clypeal hair. The difficulties presented by such an assessment are pointed out by ROZEBOOM & KNIGHT (p. 104).

The fine characters of the inner and outer clypeal hairs are reported to change according to the locality of origin. The characters noted in the larvae from Rennell differ sharply from those in OWEN's larvae of *koliensis* from Guadalcanal, in which they are unbranched (pp. 236, pl. II, 239),[11] whereas they are similar to those reported by ROZEBOOM & KNIGHT (pp. 103-105, tables 4, 5) in *koliensis*, wild or

11. This character seems, however, quite variable. In *koliensis* from Guadalcanal BELKIN *et al.* (p. 261) give the anterior clypeal hairs as "either simple or slightly frayed". BELKIN (p. 144, fig. 50), on a wide sample (801 larvae) describes 2-C as "frequently lightly barbed" and 3-C as "frequently barbed", but represents them simple.

reared, from Hollandia (New Guinea), and in wild *farauti* from all over the area (Espiritu Santo, Guadalcanal, Hollandia, and Morotai in the Moluccas). That the outer clypeal hairs [and the outer occipitals, i.e., vertical hair (9-C)] had heavier branching in the wild specimens of *farauti* than in the laboratory reared ones had already been noted by BELKIN *et al.* (p. 259).

The posterior clypeal hair (4-C) – not easy to be seen in my specimens – is delicate, 2-4 branched or frayed, and does not reach the tubercles of the inner clypeals. This last character has been noted by ROZEBOOM & KNIGHT (p. 105, table 6, p. 113) in 97.5 % of 834 *koliensis* from Guadalcanal and Hollandia, in 80 % of 131 *farauti* from Hollandia, and in 58 % of 45 *farauti* from Morotai.

The sutural hair (8-C) (Fig. 9) is rather short, always forked, and has usually 2-3 branches and rarely 4. The vertical hair (9-C) is possibly slightly shorter, 4-6 branched.

Similar features have been reported by ROZEBOOM & KNIGHT (p. 105, tables 7, 8, p. 113) in *koliensis* from Guadalcanal and Hollandia, and in *farauti* from Hollandia and Morotai: the branching of hairs 8-C and 9-C is almost constant in both species. It should be noted that already OWEN (p. 236, pl. II, p. 239) had considered the multiple branching of the occipitals noted in *koliensis* from Guadalcanal as a character separating it from *punctulatus.*

In the larvae from Rennell the characteristics of the mental plate (Fig. 10) are suggestive of that of *punctulatus,* or – outside the complex but still within the genus – of that of *A. lungae* (BELKIN, figs. 47, 53). The aulaeum, for what I have been able to see, is narrow apically, with a pair of median teeth, and is uniformly and moderately pigmented; it is therefore similar to that of *koliensis* (BELKIN, pp. 127, 144, fig. 50).

Apart from the mental plate and the aulaeum, the head of the larva from Rennell is more reminiscent of *farauti,* particularly as this species appears at the western end of its range, than of *koliensis.*

On the thorax the shoulder hairs (1-3-P) are well developed (Fig. 11). The presence of a stout, swollen stem of 1-P leads, by key, to the elimination of *punctulatus* (OWEN, p. 239; BELKIN *et al.,* p. 106, fig. 7; ROZEBOOM & KNIGHT, p. 121; BELKIN, pp. 127, 142, fig. 47).

The tubercles of 1-3-P (Fig. 11) are strong, nearly always fused, and lightly pigmented. Fused tubercles have been consistently reported for *farauti* all over its range, and for *koliensis* from Hollandia, whereas separate tubercles are common in *koliensis* from Guadalcanal[12] (OWEN, pp. 236, 239; BELKIN *et al.,* pp. 243, 256,

12. In his original description of *A. koliensis,* based on specimens captured on Guadalcanal, OWEN (p. 239) lists "the basal tubercles of prothoracic hairs 1 and 2 separated" as one of the three characters used to separate the species from *A. farauti.* However, as later shown by ROZEBOOM & KNIGHT (p. 106, table 9, pp. 112-113), this character is valid for the Guadalcanal specimens of *koliensis* (on 221 larvae examined, 74 % had separate tubercles and 26 % fused) but not for those from Hollandia (on 587 larvae, 6 % had separate and 94 % fused tubercles). The latter percentage reported for *koliensis* from Hollandia is actually higher than the highest one (93) of fused tubercles found in *farauti* on Guadalcanal.

259, 261; Rozeboom & Knight, p. 106, table 9, pp. 112-113, figs. 2, 5-7; Belkin, pp. 127, 139, 144, figs. 45, 50). As for the degree of pigmentation, the shoulder hairs of the relevant species[13] are described in *farauti* as pigmented by Belkin *et al.* (p. 259) and as heavily pigmented by Belkin (p. 139), who describes them (p. 144) as lightly pigmented in *koliensis*.

Thus the shoulder hairs of the larvae from Rennell appear to be similar, though not identical, to those of *koliensis* from Hollandia.

There is agreement among the authors[14] that to define the species of a member of the *punctulatus* complex at the larval stage the most reliable and significant characters are those shown by the abdominal hair 1 (palmate hair), as it appears on the different abdominal segments, and in particular on segments I-III (Belkin *et al.*, pp. 243, 256, 259, 261; Rozeboom & Knight, pp. 106-107, table 10, pp. 112, 113, 118, 121, figs. 3, 8-10; Belkin, pp. 127, 137, 140, 142, 144, figs. 45, 47, 50).

By key, *farauti* can be separated from *koliensis* and *punctulatus* by the characteristics of hair 1-I, which is "usually a small true palmate tuft with broad flattened leaflets, sometimes notched" (Belkin, pp. 127, 139, fig. 45). When this is not the case, and hair 1-I appears to be "not palmate, usually with slender or narrow hair-like branches, never notched", the alternative between the other two species is settled by the features of hair 1-II. This is always distinctly smaller than hair 1-III; however, whereas in *punctulatus* hair 1-II has "more slender, not pigmented" leaflets, these are "distinctly serrate and pigmented" in *koliensis* (Belkin, pp. 127, 142, 144, figs. 47, 50). There is full agreement on this subject among all the authors.

By the characters of the abdominal palmate hairs (Figs. 12, 13) the larvae from Rennell key out to *koliensis*. However, as pointed out by the extensive investigations by Rozeboom & Knight, the characters of hair 1-I vary from one locality to another. For instance, all the *farauti* larvae (81 wild and 257 reared) from Guadalcanal and from Espiritu Santo present a typical hair 1-I (i.e., a true palmate hair), whereas this is so only for 97.5 % of the wild *farauti* from Morotai, and for a small fraction (9 %) of the wild *farauti* from Hollandia. All the remnant wild *farauti* from the last two localities show a hair 1-I with slender or hairlike branches: the latter type is more frequent at Hollandia (59 % of 138), the slender at Morotai (25 % of 40). On Guadalcanal, *koliensis* has always hair 1-I with hairlike branches; this was noted by Owen (p. 237, pl. II) and by Belkin *et al.* (p. 261), and assessed by Rozeboom & Knight in 97 % of the reared larvae (table 10). The same authors found that at Hollandia the character was present in all the reared *koliensis* (491) and in 98 % of the wild specimens (91).

As represented in Belkin (fig. 50), the larvae from Rennell consistently show a smaller tergal plate on segment II than on I and III (Figs. 12, 13).

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13. *A.punctulatus* – eliminated by key – has shoulder hairs lightly pigmented (Rozeboom & Knight, p. 106) or unpigmented (Belkin, p. 142).
14. Owen reports that *koliensis* from Guadalcanal has a poorly developed 1-I, and notes the well developed 1-II as a character separating it from *punctulatus*. This author, however, does not list the characters of 1-I in *koliensis* as of differential value from those in *farauti* (pp. 237, pl. II, 239).

On the whole, the larvae from Rennell show morphological characters which in part have been reported for *koliensis* and in part for *farauti*.[15] The greatest morphological analogies seem to be with those populations of *farauti* and *koliensis* which occupy the western part of their areas of distribution.

COMMENTS AND CONCLUSIONS

Up to 1969 the only anopheline species recorded on Rennell was *A. farauti*. Most of the specimens had been found around Niupani, on the eastern half of the island. Only a few larvae had been collected on the western, forested half, around Matangi.

The findings of July 1969-February 1970 reverse the situation. The search for anophelines around Niupani yielded negative results, whereas a considerable number of anopheline specimens, at various stages, were found at Matangi – and a single larva at Gongona, farther west. The comments are therefore centered on Matangi.

E. S. Brown collected a single anopheline larva at Matangi (Nov. 1955); J. de Beaux, 2 larvae at Matangi and 5 at Songoa (Oct. 1956). All were typical *farauti* (Belkin, pers. commun., 1969).

In April 1966 Ragoso collected aquatic stages of anophelines at Matangi and the nearby Teabamagu. That they were anophelines is undoubted, even though the specific identification as *farauti* may be debatable (see footnote (1) on p. 29).

The numerous specimens I collected in 1969 and 1970 at Matangi, as well as the single larva from Gongona, show that at present there exists in the area a well defined and uniform anopheline population which by differential morphological characters is easy to assign to the *punctulatus* complex, but at the specific level cannot be identified unequivocally with any of the three important members of the complex *(farauti, punctulatus, koliensis)*.

It should also be noted that a thorough search of all the known and possible breeding places – and the capture of adults – at Matangi and nearby has failed to show the presence of any typical *farauti*. Indeed, in spite of extensive investigations, particularly on the western half, *farauti* has not been found anywhere on Rennell.

The simplest mechanism which could explain the above events at Matangi is that of a replacement of the existing typical *farauti* with a new anopheline population. The mechanics of such a replacement are impossible to assess at this stage.

The systematic position of the Matangi anopheline population, and its origin, are the two leading questions, and presumably they are interrelated.

As already stated, morphological characters place the nearest affinities of the Matangi population with the populations of *farauti* and *koliensis* from New Guinea.

15. Belkin says (pers. commun., 1969): "Although this seems to be *koliensis* on the basis of the condition of larval hair 1-I, I would not be surprised to encounter this condition in some isolated populations of *farauti*. The larvae you sent differ from most *koliensis* I have seen in the strong pigmentation of the head capsule and antenna."

This is not surprising when one considers the existence of the Rennell submarine bridge.

The results obtained by BRYAN (1970, 1973) and by BRYAN & COLUZZI (1971) in their studies of *farauti* from different localities have shown the importance of a genetic definition. Such an approach would be commendable; however, it can be done only if and when the population reappears at Matangi. At present it cannot be found, having faded away under the pressure of the residual insecticides.

In the unfortunate hypothesis of a definitive disappearance of the Matangi anopheline population it will be only by an exhaustive morphological study of the existing material, and of a thorough analysis of the pertinent literature – a work at a level far beyond the scope of this paper – that the systematic position of the population may be defined.

In many instances in the South Pacific, mosquitoes are found to have been introduced on islands, including Rennell (BELKIN, p. 45). Therefore this possibility cannot be dismissed, even if the relative isolation of Rennell and its limited contacts with other islands seem to give little support to it, at least for anophelines.

This leads to two alternative hypotheses.

When introduced into Rennell, the population already presented those characteristics (or most of them) which morphologically define the Matangi population. If so, its origin would at present be untraceable: indeed no record exists that a member of the *punctulatus* complex with such morphological characteristics has ever been found anywhere. In addition, from the existing evidence it would appear that the Matangi population kept its morphological identity while sympatric – and on a very small area – with typical *farauti*.

The second hypothesis is based on the assumption that within the *punctulatus* complex hybridization is a possibility, a fact which up to now is not supported by the available evidence (BRYAN, 1973). On this assumption the Matangi anopheline population could be considered as the result of the hybridization of the originally existing species (possibly the typical *farauti*) with another member of the *punctulatus* complex. Research of the last decade has shown that *punctulatus* and *koliensis* (particularly the latter) have an area of distribution over the Solomons and New Guinea considerably wider than it has been supposed to be in the past; therefore the opportunities for the two species seem quite even. However, on morphological grounds, *koliensis* seems a more probable potential parent of the Matangi population.

The concept of hybridization within the complex – if and when supported by evidence – would lead to much revision of the current systematics of the *punctulatus* complex.

The anopheline population at Matangi thus raises challenging questions which can only be solved by more extensive and detailed investigations on the *punctulatus* complex.

ACKNOWLEDGEMENTS

I am grateful to Dr. BRIAN TAYLOR, Government Entomologist, British Solomon Islands Protectorate, for his help in defining the imagos of the population.

I am greatly indebted to Professor JOHN N. BELKIN, Department of Entomology, University of California at Los Angeles, for checking most of the material, generously providing unpublished data, and giving valuable suggestions on the text.

SUMMARY

The only anopheline mosquito reported in the past from Rennell Island has been *Anopheles farauti* Laveran, a species of the *punctulatus* complex.

During visits to Rennell in 1969-70 anophelines were found at Matangi, in the forested central part of the island. The specimens, at all stages, show morphological affinities with the *punctulatus* complex; they are not, however, fully identifiable with any of the species of the complex, though specific characters place them closest to *koliensis* and/or *farauti.*

The findings, and a subsequent perusal and analysis of the most recent literature related to the subject, point to the need for further and more detailed investigations on the *punctulatus* complex.

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PLATE 3

Fig. 1. Adult female. Proboscis and palpi.
Fig. 2. Adult female.
Fig. 3. Adult female. Wing. No separate sectoral dark spot on vein C between the basal and median dark spots.
Fig. 4. Adult female. Buccopharyngeal armature.
Fig. 5. Pupa. Abdominal segments and paddle. Hair 9–IV–VII.

PLATE 4

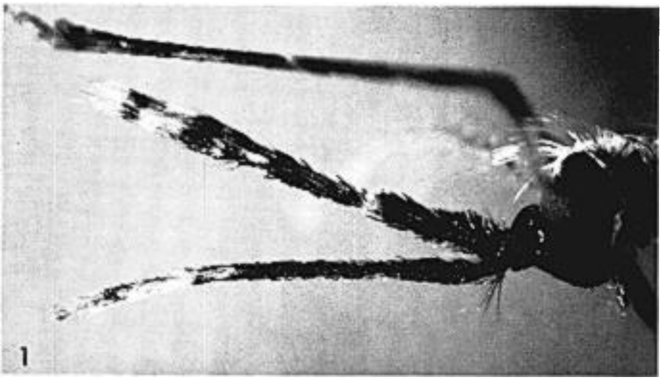
Fig. 6. Pupa. Part of cephalothorax and of abdominal segment I-III. Hair 9-III indicated by arrow. Trumpets.
Fig. 7. Pupa. Paddle hair (1-P) and accessory paddle hair (2-P).
Fig. 8. Larva. Head capsule and antennae. Pigmentation.

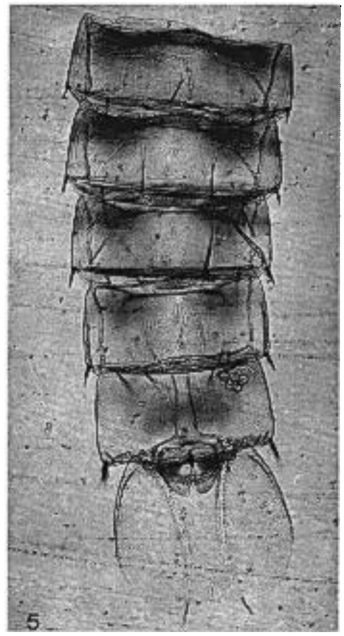
PLATE 5

Fig. 9. Larva. Head. Sutural hair (8-C), indicated by arrow, and vertical hair (9-C).
Fig. 10. Larva. Head. Mental plate.
Fig. 11. Larva. Thorax. Shoulder hairs (1-3-P).

PLATE 6

Fig. 12. Larva. Abdomen. Main tergal plates I-VIII, with accessory plates (which appear displaced). Abdominal palmate hairs (hair 1).
Fig. 13. Larva. Abdomen. Tergal plates II-III. Abdominal palmate hairs: hair 1-I, indicated by arrow, hair 1-II and hair 1-III.





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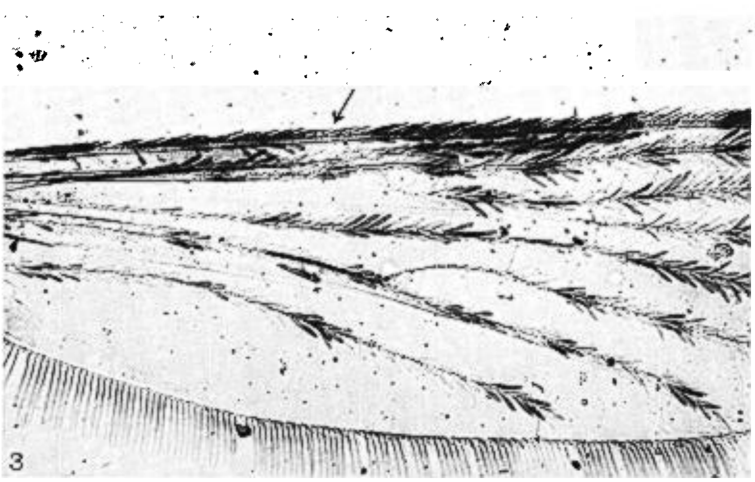

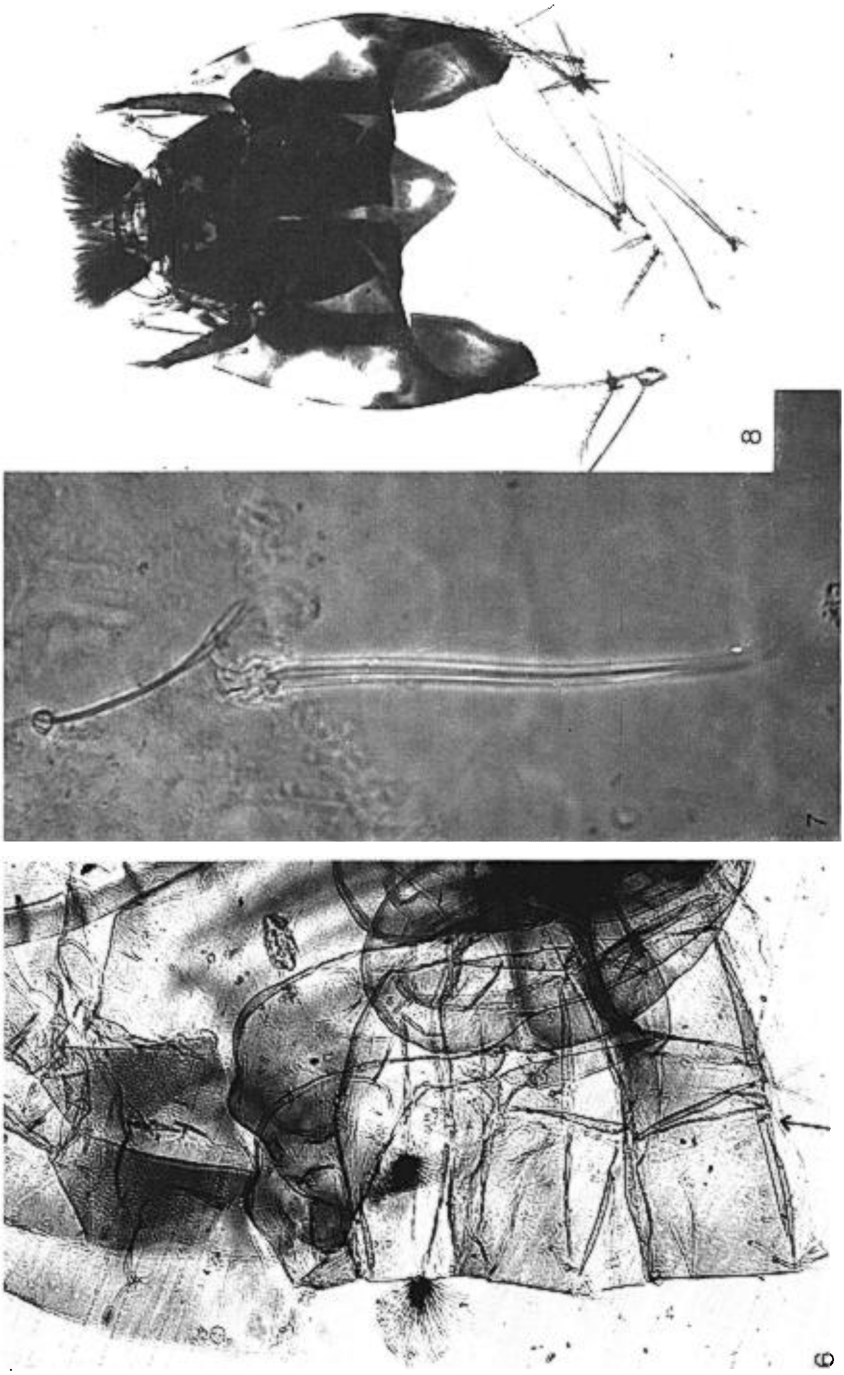
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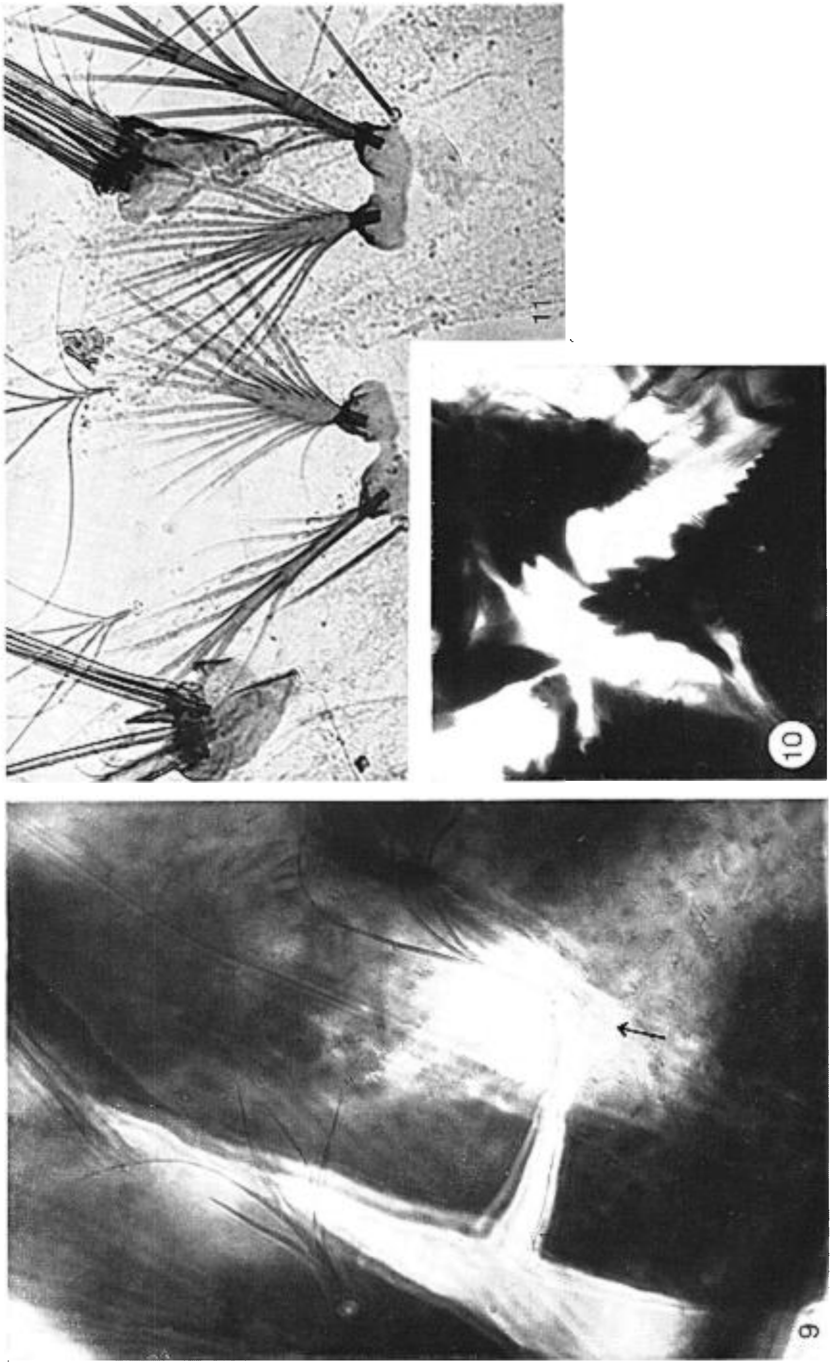
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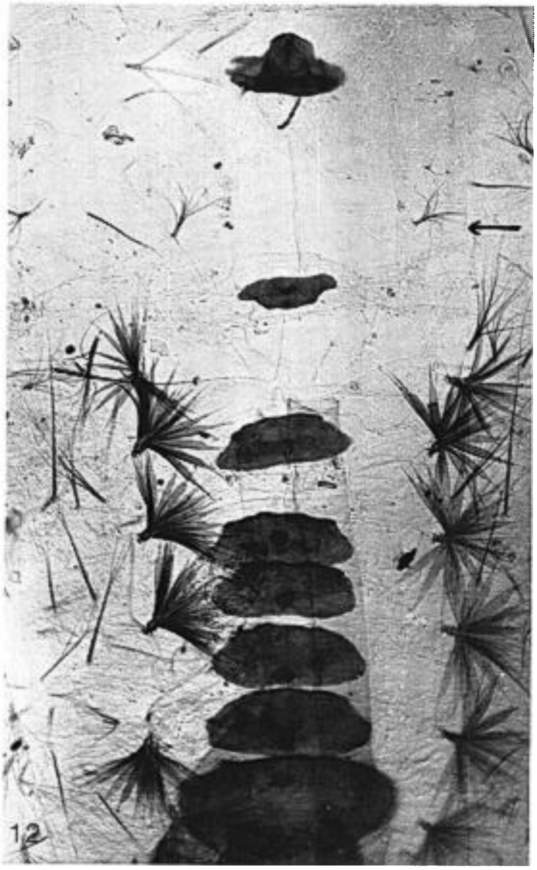
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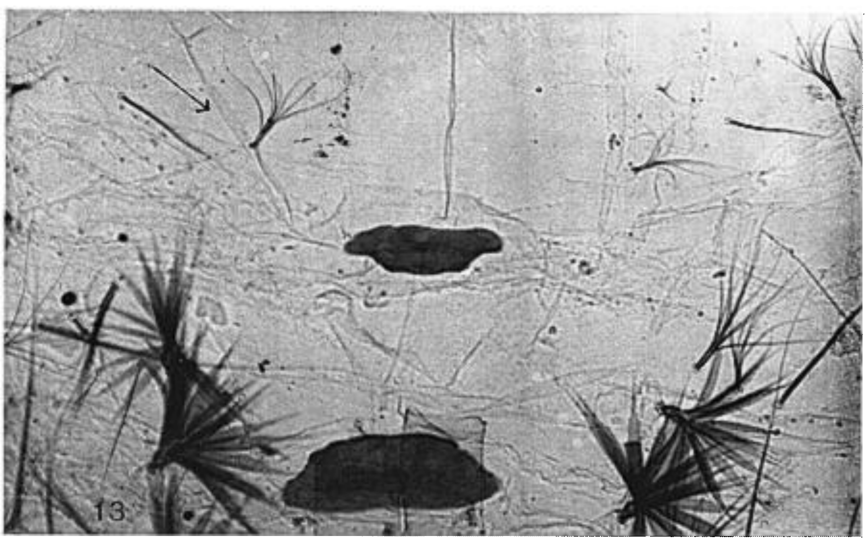
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75. THE MOSQUITOES (DIPTERA, CULICIDAE) OF RENNELL AND BELLONA

BY

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INTRODUCTION

The characteristics of the islands of Rennell and Bellona, in the British Solomon Islands, have been extensively described in previous papers of this series. Additional and pertinent information is contained in BELKIN (1962, pp. 40, 44).

During the last years no ecological changes relevant for the mosquito fauna have occurred in Bellona. In Rennell, however, a prospection for bauxite, which covers the western half of the island, was started in 1969. By the end of 1970 it had resulted in the building of an airstrip and quarters for personnel near Hatagua, and of a four-wheel vehicle track from Labagu to Kaagua (with a branching to Lughugi), and in a considerable increase in the network of paths in the forest. All these activities created conditions favouring the expansion of some species, as the most recent collections – September 1970 – show.

An additional factor liable to interfere with natural conditions in Rennell is the malaria campaign, which was started in February 1970. Based on domiciliary spraying with DDT at six-month intervals, and covering the whole island, the campaign will show its impact particularly on those species which usually visit the houses.

In consideration of the above recent changes in part of Rennell – which could well take a dramatic turn if bauxite mining is started – and of the additional material collected during 1969-1970 on the islands, the present paper appears justified. It is mainly a factual report, covering the situation up to December 1970. Though Bellona can be considered ecologically static it has been included because of its similarities with Rennell.

MOSQUITO COLLECTIONS ON RENNELL AND BELLONA

The first collections of mosquitoes on the two islands were carried out in the course of sociological and health investigations. S.M. LAMBERT was the first to visit both islands in May-June 1930 and again in June 1933 (LAMBERT, 1931, 1933, 1934); his entomological material was identified by F.M. ROOT. R.H. BLACK followed in June 1952 (BLACK, 1952). M. LAIRD and E. LAIRD were on the islands in August 1953; their specific interests were mosquito larval ecology and malaria (LAIRD & LAIRD, 1956). The detailed results of their visit were published a few years later (LAIRD & LAIRD, 1959) and include data on the previous surveys by LAMBERT & BLACK. In the meantime the islands had been visited twice: by E. S. BROWN in November 1955 and by J. DE BEAUX in October-November 1956. BELKIN (1962) reported on their collections.

The next collections, limited to Rennell, were made by the Danish expeditions: the first by the Noona Dan Expedition in August 1962, the second by T. WOLFF from March to August 1965 (WOLFF, 1968). Their material was identified by TAYLOR who himself also collected on Rennell and Bellona in 1971 (TAYLOR, 1973).

B. RAGOSO, malaria technician of the Malaria Service, B.S.I.P., visited the islands in April 1966 and made a series of catches and collections, with a particular emphasis on anophelines.

I visited Bellona on only two occasions, and for short periods: four days in April 1969 and half a day in January 1970. Rennell, however, was covered quite extensively during four visits: 23-29 July 1969; 21-27 January, 6-14 February and 10-13 September 1970. The difference of time spent on Bellona and on Rennell is related to the purpose of the visits, which was to assess the malaria problem on the two islands. Since no evidence of indigenous malaria was found on Bellona, limited time was spent there. On Rennell, however, the pertinent problem became more challenging with the finding there of a second vector, *Anopheles ?koliensis,* and additional systematic investigations were considered important for a satisfactory epidemiological assessment. These activities led, *inter alia,* to incidental collections of mosquitoes.

The field activities on Rennell were basically focused on malariometric survey and/or checking of spraying operations, and the number of localities visited, though not complete, is fairly representative.

MATERIAL AND METHODS

Since most of the collections have been incidental, the stages most frequently collected were the aquatic ones. Only anopheline adults were captured, except in nine cases.

Specimens of aquatic stages were preserved in MacGregor solution, and later mounted in polyvinyl lactophenol (Gurr). They were identified by me. Imagos were pinned on the spot and preserved; they were identified by Dr. BRIAN TAYLOR, Government Entomologist, B.S.I.P., in Honiara. Specimens posing special problems were sent to Prof. J.N. BELKIN, University of California, Los Angeles.

Past collections from Rennell and Bellona are deposited in various museums and institutions (BELKIN, 1962). The material collected by the Noona Dan Expedition (1962) and WOLFF (1965) is in the Zoological Museum, Copenhagen. The anopheline imagos I collected are deposited in the British Museum (Natural History), London; the other specimens in the Bernice P. Bishop Museum, Honolulu, Hawaii.

PRESENTATION

In the two lists – one for each island – the species of mosquitoes are entered in sequence, following BELKIN's systematic treatment (1962). Under each species are given, in alphabetical order, the localities of findings. Each of these has a serial number, which also appears on the map and in Table 1. Under each locality are given, chronologically, the finding(s) with date, collector (by code), stages and number of specimens, and bionomics.

On a map of Rennell (Fig. 1, pp. 48-49) are reported the relevant localities with serial numbers. Bellona is shown in Fig. 2, p. 58. In Table 1 the localities of findings on Rennell are entered for each species.

COMMENTS ON FINDINGS

Anopheles (Cellia) farauti Laveran, 1902

On Bellona the species has been reported only once, by BROWN in 1955. Previous visits failed to detect anophelines, and later visits were not more successful. Though some of the investigations on Bellona were too short to enable valid conclusions to be drawn, during at least two of them, by BLACK and by RAGOSO,[1] particular attention was devoted to anophelines. A possible explanation for the find may be that of a temporary presence of the vector, possibly wiped out by adverse ecological conditions.

On Rennell, LAMBERT failed to find anophelines in 1930 and in 1933, in spite of spending considerable time at the lake in 1930. It is here, at Niupani, that BLACK found larvae of *A. farauti* in 1952, a finding confirmed by several collectors. However, it is worth noting that larvae were always difficult to find: BLACK got them "after a prolonged search", the LAIRDS found "a single breeding place [apparently the self-same one found by Black] in upwards of three hours' collecting", and BROWN collected 3 larvae, 2 males, and 56 females. RAGOSO and the Noona Dan captured

1. E.g., RAGOSO's activities were: indoor resting daytime collections, for a total of 10½ hrs., in 42 houses at 7 different localities; man-biting night collections, for a total of 20 hrs., in 3 localities. Night collections were carried out between 6.30 and 11.30 p.m. Larval collections yielded only culicines.

adults but never found larvae; and in spite of a prolonged search for suitable breeding places along the lake, both WOLFF and I got negative results.

At Niupani BLACK was unable to find larvae of *A. farauti* outside the lake; taro gardens and the village well yielded negative results. Similar were the results of BLACK's search along the coast, at the base of the cliffs at Tuhugago and at Labagu, and of the LAIRDS' search at Labagu, in spite of a long search for imagos and aquatic stages. On the road from Labagu to Teabamagu BLACK found only culicines, in holes filled with rain water. However, this should not be far from the finding places Songoa,[2] Matangi or Teabamagu. The latter finding is here listed as *A. farauti,* though some doubts exist about the accuracy of the identification of species.

Due to incomplete data the exact breeding places are sometimes difficult to locate.

Anopheles (Cellia) cf. ***koliensis*** Owen, 1945

On Rennell larvae were collected by MAFFI in 1969 near Gongona and at Matangi. Collections during two successive visits to Matangi in 1970 yielded many additional larvae as well as pupae and females, man-biting indoors at midnight. A last visit to Matangi, in September 1970, after two DDT spraying cycles, gave negative results. Successive visits to Ahanga pool also gave negative results.

The specimens collected, at the various stages, are in basic agreement with the description of *A. koliensis* given by OWEN (1945). However, when compared with this species using the most recent and comprehensive literature on the subject (BELKIN *et al.,* 1945; ROZEBOOM & KNIGHT, 1946; BELKIN, 1962), the specimens appear to present morphological diagnostic characters which are in part suggestive of *koliensis,* in part of *A. farauti* and in part peculiar. Therefore, I consider that the specimens should be identified as *A. koliensis* on a purely tentative basis, valid only until a definitive decision is reached (MAFFI, 1973).

It is unfortunate that the species may have disappeared under the impact of DDT domiciliary spraying operations, as has been the case with *A. koliensis* in other parts of the Solomons, thus limiting the available material for a proper study.

Uranotaenia quadrimaculata Edwards, 1929

An isolated record from Bellona. Not reported from Rennell.

Uranotaenia barnesi Belkin, 1962

On Rennell the species is fairly widespread over the western half, having been reported from Matangi to Kaagua. Never reported from Bellona.

2. From the schedule of the activities of J. DE BEAUX this locality, today untraceable, must have been somewhere along the Labagu-Matangi road.

Culex (Culex) annulirostris Skuse, 1889

On Rennell the species is spread along Lake Tegano and has been found at Matangi. The species has never been reported from Bellona proper, though LAIRD captured two fed females at sunrise, in August 1953, on the ship which had brought the visitors from Point Cruz, Guadalcanal, to Bellona (LAIRD & LAIRD, 1956).

Culex (Culex) squamosus (Taylor, 1905)

An isolated record, from Niupani, Lake Tegano. Never reported from Bellona.

Culex (Lutzia) halifaxii Theobald, 1903

An isolated record from Bellona. Never reported from Rennell.

Culex (Culiciomyia) fragilis Ludlow, 1903

A single record from Rennell. Never reported from Bellona.

Culex (Culiciomyia) pullus Theobald, 1905

On Rennell aquatic stages of the species have been collected from coconut shells in 1956 and imagos in 1965. It has been found again recently (in 1970) as aquatic stages, extensively breeding in wheel tracks and in coconut shells. Never reported from Bellona.

Culex (Lophoceraomyia) sp., Rennell form

On Rennell the species is widespread. It has been collected on the coast, on the lake, and extensively near villages of the forested interior. In September 1970 it was found breeding heavily in wheel tracks between Matangi and Hatagua.

The larvae of my 21 collections show in general the morphological characteristics of the *buxtoni* complex, as described by BELKIN (1962, p. 272). However, in a few instances (Bellona: 690430/2; Rennell: 700207/1-3), all from fully shaded forest, the specimens are suggestive of the *solomonis* complex and particularly of *walukasi.* In two additional instances only (Rennell: 700126/2, 700213/3), both collections of treehole-breeders on *Thespesia populnea* along the seashore, intermediate characteristics are noticeable. As noted by BELKIN (1962, pp. 249-251), the subgenus is in need of investigation.

Some specimens of collection 700126/2, near Kagaba (26.1.70), are infected with *Coelomomyces* sp. (MAFFI & GENGA, 1970).

For Bellona there are four findings from 1953 and one from 1969.

Aedes (Finlaya) notoscriptus (Skuse, 1889)

This species was collected by LAMBERT in 1930 on Rennell and Bellona, and again on both islands by LAIRD and LAIRD in 1953. All these specimens were identified as *Aedes (Finlaya) albilabris.*

The species was reported as *albilabris* by BELKIN (1962) on the basis of a fragmentary female and two larvae from Rennell (Niupani and Labagu). Nine females from Ongomelage, Rennell, were examined by B. TAYLOR, who came to the conclusion that they were *A. (F.) notoscriptus;* consequently Prof. BELKIN confirmed the identification.

Though widely scattered – from the lake to the coastal parts and as far as the western tip of Rennell – the findings of this species are not many. The characteristics of the larva leave some questions open, and it will only be after sufficient material is available that a final statement on the species, or possibly the group, on the islands will be justified.

The revised identification results in an interesting territorial change in the pertinent distribution map in BELKIN (1962, fig. 221).

Aedes (Stegomyia) albolineatus (Theobald, 1904)

The species, widespread on Bellona (reported from 8 different localities) has been found on Rennell only at Labagu.

Aedes (Stegomyia) gurneyi Stone & Bohart, 1944

This species has been captured a few times on Rennell and Bellona.

Aedes (Stegomyia) hebrideus Edwards, 1926

The species was first reported from Rennell and Bellona by LAMBERT and has since been found by any visitor whose activities were not limited to anophelines. It is the most widespread mosquito on both islands and has been reported from 11 different localities on Bellona and from 15 on Rennell.

The larvae show variations, as pointed out by BELKIN (1962, p. 459).

Aedes (Stegomyia) hoguei Belkin, 1962

The species has only been reported from Rennell and Bellona. The capture in 1970 of 18 females attacking in daytime (in the forest at Ongomelage) has enabled completion of the study of the imaginal stage and assessment of its behaviour (TAYLOR & MAFFI, 1971).

Larvae were collected near Matahenua on Bellona.

Tripteroides (Rachionotomyia) solomonis **(Edwards, 1924)**

On Rennell the species has been collected only as larvae and pupae, in coconut shells or husks. Never reported from Bellona.

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I am particularly indebted to Prof. J. N. BELKIN, University of California, Los Angeles, who has identified doubtful specimens, generously provided unpublished data and given invaluable guidance which has made possible the completion of this paper.

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Finally, I want to thank Dr. WOLFF, the Editor of this series, for his valuable assistance in preparing the present paper for publication.

SUMMARY

The findings of Culicidae on the islands of Rennell and Bellona up to 1970 are reported. A total of 16 species are discussed.

The previous information has been gathered, and the personal contributions added. Comments are given, particularly on some recent findings.

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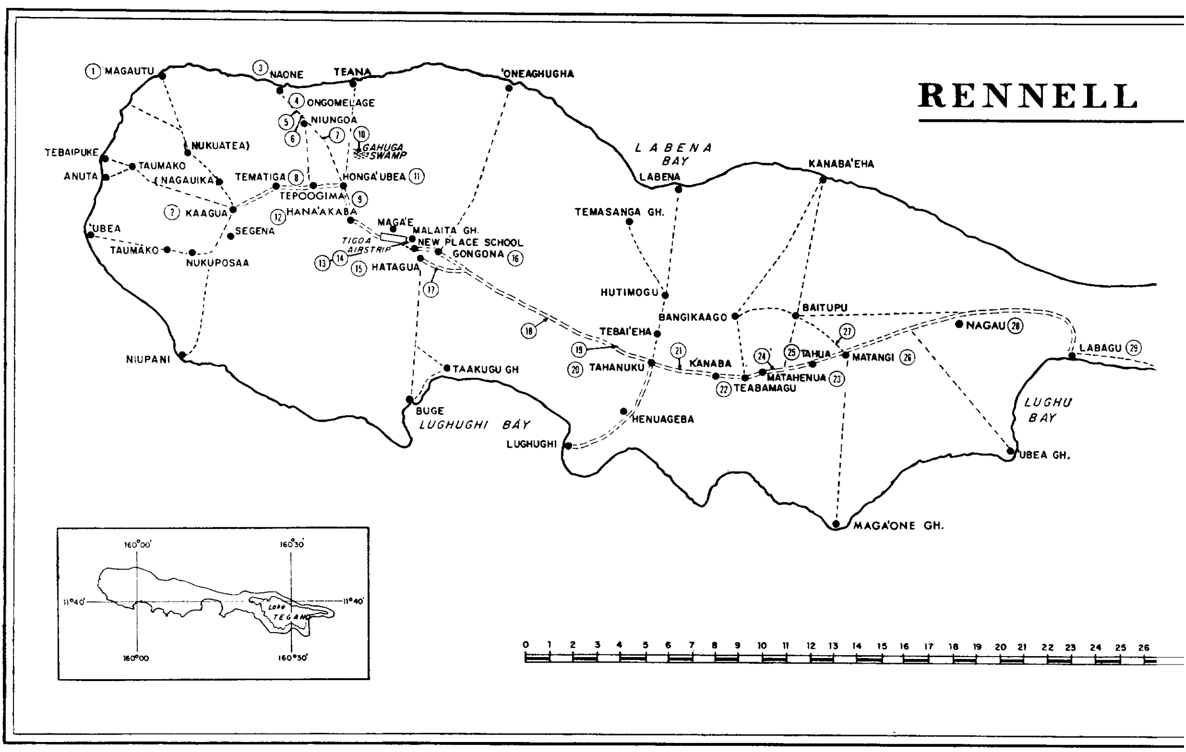

Fig. 1. Map of Rennell Island. Localities wi

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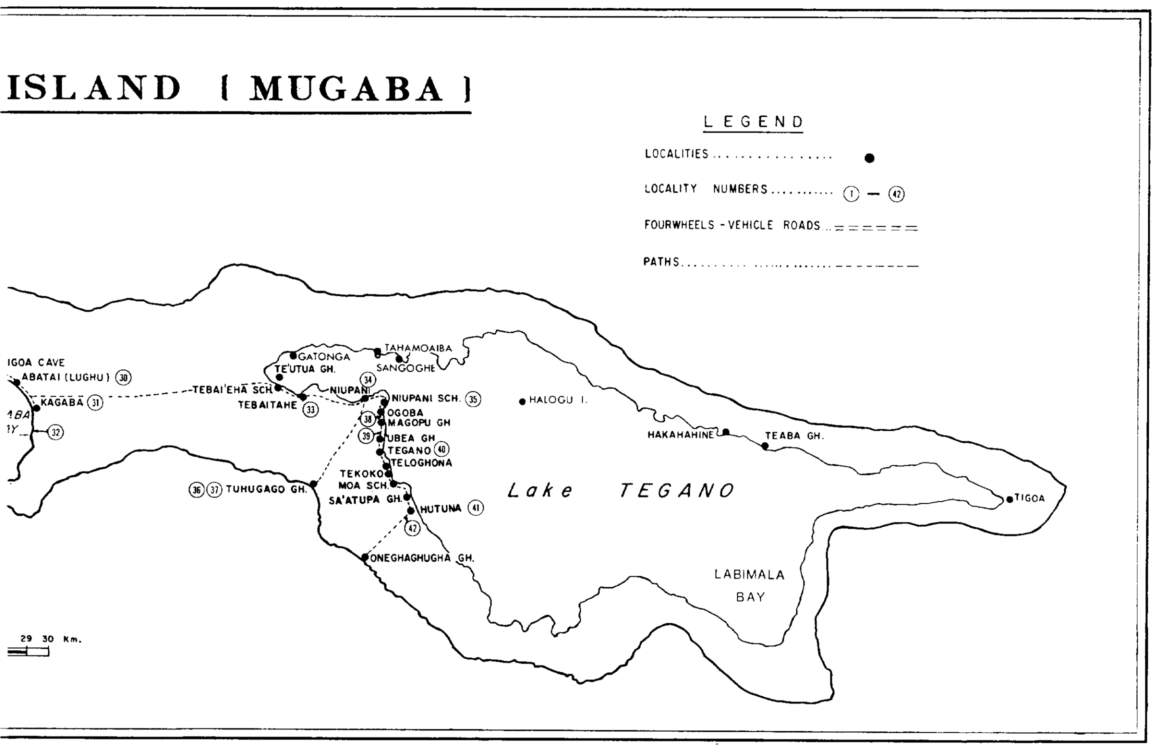

mosquitoes have been obtained are numbered.

LIST OF MOSQUITOES ON RENNELL AND BELLONA

(Additional list in TAYLOR, 1973)

Collectors: ESB = E.S.BROWN; JdB = J. DE BEAUX; LAM = S.M.LAMBERT; MAM = MARIO MAFFI; MEL = M. and E.LAIRD; NDE = Noona Dan Expedition; RAG = B.RAGOSO; RHB = R.H.BLACK; WOL = TORBEN WOLFF.

(°) indicates where and when the first finding of the species occurred.
Data on the bionomics by LAIRD and LAIRD can be found in their paper in this series (1959, table 1, pp. 214-215).

RENNELL ISLAND

Date	Serial no. and locality	Coll. code	Stages & Nos. ♂	♀	L	P	Bionomics
Anopheles (Cellia) farauti							
24.11.55	26. Matangi	ESB, 4209	.	.	1	.	
23.10.56	Matangi	JdB, R7	.	.	2	.	Drinking rock pool, clear, shady.
22. 4.66	Matangi	RAG	.	.	?	.	"Some anopheles and culicine" (larvae).[1]
June 52	34. Niupani°	RHB	2[2]	1[2]	(3)	.	Larvae taken at the edge of Lake Tegano, amongst growing grass.
19. 8.53	Niupani	MEL, 250	.	.	?	.	
25.-29.11.55	Niupani	ESB, 4215, /23, /25, /35, /43, /50, /51, /56	2	56	3	.	4243: Coconut shell.
25. 8.62	Niupani	NDE	.	1	.	.	Caught by lantern light.
20. 4.66	Niupani	RAG	.	7	.	.	Night catches from 6.30 to 11.30 p.m.[3]
22.10.56	? Songoa	JdB, R3, R4	.	.	5	.	Taro garden. Clear water in swamp in the shade of tall grass.
22. 4.66	22. Teabamagu	RAG	.	.	11	.	"Best breeding place for anopheline larvae".[4]

1. As no specific identification was made the larvae are given only tentatively as *A.farauti*. An indoor resting daytime collection of anophelines (midday, 2 houses, total ½ hr.) was negative.
2. "My 1952 collection contains three anophelines bred out from larvae – nothing else" (BLACK, pers. commun., April 1971).
3. A 2 hr. daytime collection of anophelines resting indoor (8 houses) yielded negative results.
4. A 1 hr. resting indoor daytime collection (4 houses) was negative.

Date	Serial no. and locality	Coll. code	Stages & Nos. ♂	♀	L	P	Bionomics
Anopheles (Cellia) cf. *koliensis*							
24. 7.69	16. Gongona°	MAM, /1	.	.	1	.	Ample (10 m diam.) natural open pond, with muddy water and vertical vegetation at the edge. Larva, taken in thick grass.
25. 7.69	26. Matangi	MAM, /1	.	.	7	.	Ample (6 m diam.) natural open pond with clay and rocky bottom. Clear water. Grass at the edge, with sun-shade. Larvae in the sun and at the edge.
23. 1.70	Matangi	MAM, /1, /1 bis	.	16	42	14	As above. Water less clear.
24. 1.70	Matangi	MAM, /1	.	.	6	.	As above.
9. 2.70	Matangi	MAM, /1, /2	.	.	9	3	As above. Water less clear.
10. 2.70	Matangi	MAM, /6	.	.	24	12	As above.
Uranotaenia barnesi							
6. 2.70	15. Hatagua	MAM, /3	.	.	1	.	Small rocky pool for bathing. Clear water.
12. 9.70	Hatagua	MAM, /1	.	.	38	.	As above.
11. 9.70	10. Gahuga Swamp	MAM, /2	.	.	7	.	Ample (100 m diam.) open pond with swampy edge covered with vertical vegetation and tall bush. Larvae in shade.
23. 7.69	2. Kaagua	MAM, /2	.	.	8	.	Small rocky pool for bathing. Clear water, a few green algae.
24. 1.70	23. Matahenua	MAM, /1 bis	.	.	8	.	Small rocky well. Clear water.
10. 2.70	Matahenua	MAM, /1	.	.	4	.	As above.
22.10.56	26. Matangi°	JdB, R5, R6	.	.	4	.	Water hole in village. Clear, light shade.
24.10.56	22. Teabamagu	JdB, R8	.	.	2	.	Clear, shady rock pool.
Culex (Culex) annulirostris							
28. 7.69	41. Hutuna	MAM, /1	.	.	2	.	Large swampy area with wild taro and ferns. Sun and shade.
28. 7.69	Hutuna	MAM, /3	.	.	1	.	As above, but smaller and more shaded.
23. 1.70	26. Matangi	MAM, /1, /1 bis	.	.	3	1	Natural open shallow pond (5 m diam.) with clear water. Edges shaded, with vegetation.

Date	Serial no. and locality	Coll. code	Stages & Nos. ♂	♀	L	P	Bionomics
9. 2.70	Matangi	MAM, /1, /2	.	.	2	.	As above, but water slightly polluted.
10. 2.70	Matangi	MAM, /2	.	.	2	.	As above.
10. 9.70	Matangi	MAM, /9	.	.	3	.	As above, but water considerably less and highly polluted.
19. 8.53	34. Niupani°	MEL, 250	.	.	.	.	
25.-29.11.55	Niupani	ESB, 4215, /23, /25, /35, /50, /52, /55	2	21	5	1	
2.11.56	Niupani	JdB, R18-21	.	.	68	2	At stagnant edge of lake. Light shade.
26. 8.62	Niupani	NDE	.	1	.	.	Malaise trap.
30. 8.62	Niupani	NDE	.	1	.	.	Malaise trap.
26. 7.69	Niupani	MAM, /1	.	.	4	5	Flooded edge of lake. Vertical vegetation and decomposing plant material.
25. 1.70	Niupani	MAM, /2	.	1	.	.	Attacking at sunset in the open.
27. 7.69	40. Tegano	MAM, /2	.	.	7	.	Ample swampy area with taro and ferns. Sun and shade.
25. 1.70	33. Tebaitahe	MAM, /1	.	.	1	.	Small, foul water collection at the edge of lake.

Culex (Culex) squamosus

19. 8.53	34. Niupani°	MEL, 250	.	.	.	.	

Culex (Culiciomyia) fragilis

24.10.56	22. Teabamagu°	JdB, R10-11	.	.	13	.	Coconut shell in coconut grove.

Culex (Culiciomyia) pullus

13. 9.70	15. Hatagua	MAM, /2	.	.	1	4	Coconut shell.
10. 9.70	17. Near Hatagua	MAM, /2	.	.	2	.	Long wheel track, fairly clear. In shade.
10. 9.70	18. Hatagua-Tahanuku	MAM, /3	.	.	2	.	Short wheel track, muddy decomposing leaves. In shade.
1.11.56	41. Hutuna	JdB, R16	.	.	3	.	Coconut shell.
2. 4.65	Hutuna	WOL	.	1	.	.	Malaise trap V.
3. 4.65	Hutuna	WOL	.	1	.	.	Malaise trap VI.
10. 9.70	21. Near Tahanuku	MAM, /6	.	.	6	.	Muddy and polluted wheel track.
24.10.56	22. Teabamagu°	JdB, R11	.	.	14	.	Coconut shell.

Date	Serial no. and locality	Coll. code	Stages & Nos. ♂	♀	L	P	Bionomics
Culex (Lophoceraomyia) sp., Rennell form							
24. 7.69	16. Gongona	MAM, /1	.	.	7	.	Natural open pond (10 m diam.) with muddy water. Vertical vegetation at the edges.
8. 2.70	12. Hana'akaba	MAM, /1	.	.	4	.	Fairly clear rain pool in taro swamp, shaded by brush and trees.
25.10.56	15. Hatagua	JdB, R12	.	.	9	.	Drinking rock pool, shady.
6. 2.70	Hatagua	MAM, /2	.	.	6	.	Bathing rock pool.
6. 2.70	Hatagua	MAM, /3	.	.	3	.	Shaded shallow collection, rocky and muddy bottom. Decomposing plant material.
10. 9.70	18. Hatagua-Tahanuku	MAM, /4	.	.	9	9	Large wheel track, muddy, green algae. In shade.
11. 9.70	Hatagua-Tahanuku	MAM, /1	.	.	.	2	As above.
10. 9.70	Hatagua-Tahanuku	MAM, /5	.	.	6	1	As above, but smaller.
18. 3.65	41. Hutuna	WOL	.	1	.	.	Malaise trap II.
28. 7.69	Hutuna	MAM, /1	.	.	4	.	Large swampy area, with wild taro and ferns. Sun and shade.
23. 7.69	2. Kaagua	MAM, /3	.	.	16	8	Rocky and clay depression, shallow, covered with vegetation, full of rainwater.
May 1930	31. Kagaba?	LAM	3	2	.	.	
26. 1.70	32. Kagaba	MAM, /2	.	.	6	.	Water with decomposing leaves in tree hole of *Thespesia populnea* (L.) Soland.
13. 2.70	29. Labagu	MAM, /3	.	.	22	.	As above.
18. 8.53	Labagu	MEL 247-249	.	.	.	.	
24. 1.70	23. Matahenua	MAM, /1 bis	.	.	2	.	Small drinking rock well.
10. 2.70	Matahenua	MAM, /1	.	.	3	.	As above.
10. 9.70	24. Near Matahenua	MAM, /8	.	.	5	2	Small muddy, sunny, wheel track.
24.11.55	26. Matangi	ESB, 4210	.	.	1	.	
22.-23.10.56	Matangi	JdB, R5, R6	.	.	7	.	Bathing rock pool, exposed and clear.
25. 7.69	Matangi	MAM, /1	.	.	5	.	Natural open clear shallow pond (5 m diam.). Edges shaded, with vegetation.
10. 2.70	Matangi	MAM, /5	.	.	8	1	Shaded water pond in a tunnelled mound.
10. 2.70	27. Near Matangi	MAM, /4	.	.	14	.	Shaded pond on rocky soil.
26. 8.62	34. Niupani	NDE	1	.	.	.	Malaise trap.

Date	Serial no. and locality	Coll. code	Stages & Nos. ♂	♀	L	P	Bionomics
27. 7.69	35. Niupani Sch.	MAM, /2	.	.	10	2	Small freshwater pond with decomposing leaves on rocky and clay bottom.
7. 2.70	6. Near Ongomelage	MAM, /1	.	.	9	.	Rainwater in tree hole in forest.
7. 2.70	Near Ongomelage	MAM, /2	.	.	24	.	Rainwater in hollow on coral boulder, forest.
7. 2.70	7. Ongomelage-Honga'ubea	MAM, /3	.	.	3	.	Rainwater in tree hole in forest.
22.10.56	? Songoa	JdB, R3	.	.	1	.	Taro garden swamp. Clear water, shaded by grass.
10. 9.70	21. Near Tahanuku	MAM, /7	.	.	7	14	Small wheel track and footprints. Decomposing leaves, shade.
24.10.56	22. Teabamagu	JdB, R8, R11	.	.	7	.	Clear shady rock pool and coconut shell.
24. 7.69	8. Tematiga	MAM, /3	.	.	3	.	Extensive wild taro swamp. Arboreal vegetation, shade.
13. 9.70	14. Tigoa	MAM, /1	.	.	2	1	Water in hole on swampy ground, sunny. Vertical vegetation and green algae.

Aedes (Finlaya) notoscriptus

Date	Serial no. and locality	Coll. code	♂	♀	L	P	Bionomics
24. 1.70	30. Abatai	MAM, /3	.	.	2	.	Clear rainwater in a 5-gallon metal container.
24. 3.65	41. Hutuna	WOL	.	1	.	.	Malaise trap IV.
May 1930	31. Kagaba°	LAM	.	1	.	.	Biting in daytime.
10. 6.33	Kagaba	LAM	.	19	.	.	As above.
5. 4.65	Kagaba	WOL	.	7	.	.	Malaise trap VII.
26. 1.70	32. Kagaba	MAM, /2	.	.	2	.	Water with decomposing leaves in tree hole of *Thespesia populnea* (L.) Soland.
13. 2.70	29. Labagu	MAM, /3	.	.	10	.	As above.
18. 8.53	Labagu	MEL, 241, 249	.	.	.	.	
21.10.56	Labagu	JdB, R1	.	.	2	.	Coconut shell.
25.11.55	34. Niupani	ESB, 4215	.	1	.	.	
21. 1.70	4. Ongomelage	MAM, /2	.	2	.	.	Attacking at 7 a.m.
7. 2.70	Ongomelage	MAM, /0	.	8	.	.	Attacking at 9 a.m.
7. 2.70	7. Ongomelage-Honga'ubea	MAM, /2	.	.	1	.	Rainwater in hollow on coral boulder, in forest.
20. 8.53	37. Tuhugago	MEL, 252	.	.	.	.	
26. 7.69	Tuhugago	MAM, /3	.	.	6	4	Coconut shell, clear water.
29. 7.69	Tuhugago	MAM, /2	.	.	1	.	Coconut husk with foul liquid.

Aedes (Stegomyia) albolineatus

Date	Serial no. and locality	Coll. code	♂	♀	L	P	Bionomics
18. 8.53	29. Labagu°	MEL, 242, 244					

Date	Serial no. and locality	Coll. code	♂	♀	L	P	Bionomics
Aedes (Stegomyia) gurneyi							
26. 3.65	41. Hutuna°	WOL	.	3	.	.	Malaise trap IV.
2. 4.65	Hutuna	WOL	.	1	.	.	Malaise trap V.
29. 3.65	42. Soaika Hill near Hutuna	WOL	.	8	.	.	Malaise trap V.
Aedes (Stegomyia) hebrideus							
24. 1.70	30. Abatai	MAM, /2	.	.	4	3	10-gallon metal container, clear water.
25.10.56	15. Hatagua	JdB, R12	.	5	.	.	Drinking rock pool, shade.
21. 1.70	Hatagua	MAM, /3	.	3	.	.	Attacking in house at sunset.
6. 2.70	Hatagua	MAM, /4	.	.	3	.	Coconut husk with foul liquid.
28.11.55	41. Hutuna	ESB, 4236, /42, /43	14	14	3	11	4243: Coconut shell.
1.11.56	Hutuna	JdB, R16, R17	.	.	13	1	Coconut shell.
28. 3.65	Hutuna	WOL	.	1	.	.	In lantern light.
28. 7.69	Hutuna	MAM, /2	.	.	3	2	Half coconut husk.
28. 7.69	Hutuna	MAM, /4	.	.	3	1	Coconut shell.
May 1930	31. Kagaba°	LAM	3	17	"many"		Adults biting in daytime. Larvae and pupae in a canoe.
May 1930	?Kagaba	LAM	.	10	.	.	Biting in the bush at midday.
10. 6.33	Kagaba	LAM	.	.	76	47	Treetrunk.
10. 6.33	Kagaba	LAM	.	.	254	38	Coconut shell.
5. 4.65	Kagaba	WOL	.	1	.	.	Malaise trap VII.
25. 7.69	Kagaba	MAM, /2	.	.	2	.	Coconut husk with foul liquid.
24.& 26.1.70	Kagaba	MAM, /4, /1	.	10	.	.	Attacking outside and indoors, in daytime and at sunset.
18. 8.53	29. Labagu	MEL, 239, 240, 241, 243, 245, 246, 248, 249	.	.	.	.	
30.11.55	Labagu	ESB, 4281	.	1	.	.	
21.10.56	Labagu	JdB, R1, R2	.	8	16	10	Coconut shell. Adults biting in house at 10 a.m.
13. 2.70	Labagu	MAM, /1, /2	.	.	17	20	Coconut husk.
23. 7.69	1. Magautu	MAM, /1	.	.	6	4	Coconut shell.
26.10.56	? Mangina	JdB, R14, R15	.	.	21	3	Coconut shell, light shade.
21. 1.70	3. Naone	MAM, /1	.	7	.	.	Attacking at sunrise.
19. 8.53	34. Niupani	MEL, 251	.	.	.	.	
25.11.55	Niupani	ESB, 4215	.	2	.	.	
2.-3.11.56	Niupani	JdB, R22	.	.	23	8	Coconut shell.
26. 7.69	Niupani	MAM, /2	.	.	6	1	Coconut shell.
25. 1.70	Niupani	MAM, /2	.	5	.	.	Attacking at sunset in the open.
29. 3.65	42. Soaika Hill near Hutuna	WOL	.	1	.	.	Malaise trap V.

Date	Serial no. and locality	Coll. code	Stages & Nos. ♂	♀	L	P	Bionomics
22. 1.70	20. Tahanuku	MAM, /1	.	3	.	.	In water cave. Attacking at 8 a.m.
24.10.56	22. Teabamagu	JdB, R11	.	.	6	.	Coconut shell in coconut grove.
3.11.56	33. Tebaitahe	JdB, R23	.	8	3	.	Adults at 11 a.m. Coconut shell.
27.11.55	Lake Tegano	ESB, 4229	.	1	.	.	
24. 7.69	8. Tematiga	MAM, /2	.	.	1	2	Coconut husk.
20. 8.53	37. Tuhugago	MEL, 252	.	.	.	.	
26. 7.69	Tuhugago	MAM, /4	.	.	11	.	Small pool with decomposing leaves, on a beach boulder.
29. 7.69	Tuhugago	MAM, /2	.	.	3	.	Coconut husk with foul liquid.
29. 7.69	Tuhugago	MAM, /3	.	.	13	3	Small pool of almost fresh water on a boulder on the beach, decomposing leaves.
29. 7.69	Tuhugago	MAM, /4	.	.	7	3	Very small pool on a beach boulder. Brackish, many decomposing leaves.

Aedes (Stegomyia) hoguei

10. 6.33	31. Kagaba°	LAM	1	.	.	.	Recorded as *A. variegatus* (n.sp.); probably this species.
28.11.55	41. Hutuna	ESB, 4242	3	1	1	.	
30.11.55	29. Labagu	ESB, 4281	.	1	.	.	
21.10.56	Labagu	JdB, R1	.	.	3	.	Coconut shell.
26.10.56	?Mangina	JdB, R14, R15	.	.	11	5	Coconut shell, light shade.
7. 2.70	4. Ongomelage	MAM, /0	.	18	.	.	Attacking at 9 a.m.

Tripteroides (Rachionotomyia) solomonis

10. 9.70	15. Hatagua	MAM, /1	.	.	.	1	Coconut with very foul liquid.
13. 9.70	Hatagua	MAM, /2	.	.	14	1	Old coconut with muddy water.
24.10.56	22. Teabamagu°	JdB, R11	.	.	1	.	Coconut shell.
26. 7.69	37. Tuhugago	MAM, /3	.	.	16	.	Coconut shell, clear water.
29. 7.69	Tuhugago	MAM, /2	.	.	2	.	Coconut husk with foul liquid.

Date	Locality	Coll. code	Stages & Nos. ♂	♀	L	P	Bionomics
Anopheles (Cellia) farauti							
22.11.55	Ngotokanaba°	ESB, 4147	.	1	.	.	40-gallon drum.
Uranotaenia quadrimaculata							
29. 4.69	Ngotokanaba°	MAM, /5	.	.	2	.	Coconut spathe.
Culex (Lutzia) halifaxii							
15. 8.53	Matahenua°	MEL, 231	.	.	.	.	
Culex (Lophoceraomyia) sp.							
17. 8.53	Ahanga	MEL, 238	.	.	.	.	
16. 8.53	Hangemangama	MEL, 237	.	.	.	.	
15. 8.53	Matahenua°	MEL, 231, 232	.	.	.	.	
30. 4.69	Matahenua	MAM, /2	.	.	1	.	Small pool on the rim.
Aedes (Finlaya) notoscriptus							
June 1930	?Western end°	LAM	.	2	.	.	In daytime.
21. 6.33	N.W. end	LAM	.	1	.	.	As above.
21. 6.33	Bellona	LAM	.	.	96	5	Treetrunk.
17. 8.53	Ahanga	MEL, 238	.	.	.	.	
29. 4.69	Ahanga	MAM, /6	.	.	3	.	Polluted rainwater in a canoe.
16. 8.53	Hangemangama	MEL, 237	.	.	.	.	
15. 8.53	Matahenua	MEL, 233	.	.	.	.	
30. 4.69	Matahenua	MAM, /2	.	.	2	.	Small pool on the rim.
29. 4.69	Ngongona	MAM, /4	.	.	1	.	Small rainwater collection in buttresses of *Poinciana*.
20. 1.70	Ngotokanaba	MAM, /2	.	.	2	2	Rainwater in 55-gallon drum.
Aedes (Stegomyia) albolineatus							
21. 6.33	Bellona°	LAM	.	.	18	1	Treetrunk.
17. 8.53	Ahanga	MEL, 238	.	.	.	.	
29. 4.69	Ahanga	MAM, /7	.	.	1	.	Very small rainwater pool on a rock on the beach.
29. 4.69	Mid-island	MAM, /1	.	.	1	.	Coconut shell.
19.10.56	Ghongau	JdB, B1	.	.	2	.	Wooden bowl with clean rainwater, light shade.
22.11.55	Kapata	ESB, 4154	.	1	1	.	
30. 4.69	Matahenua	MAM, /1	.	.	3	.	Very small pool on coral boulder in forest.
30. 4.69	Matahenua	MAM, /2	.	.	6	.	Small pool on a rock.

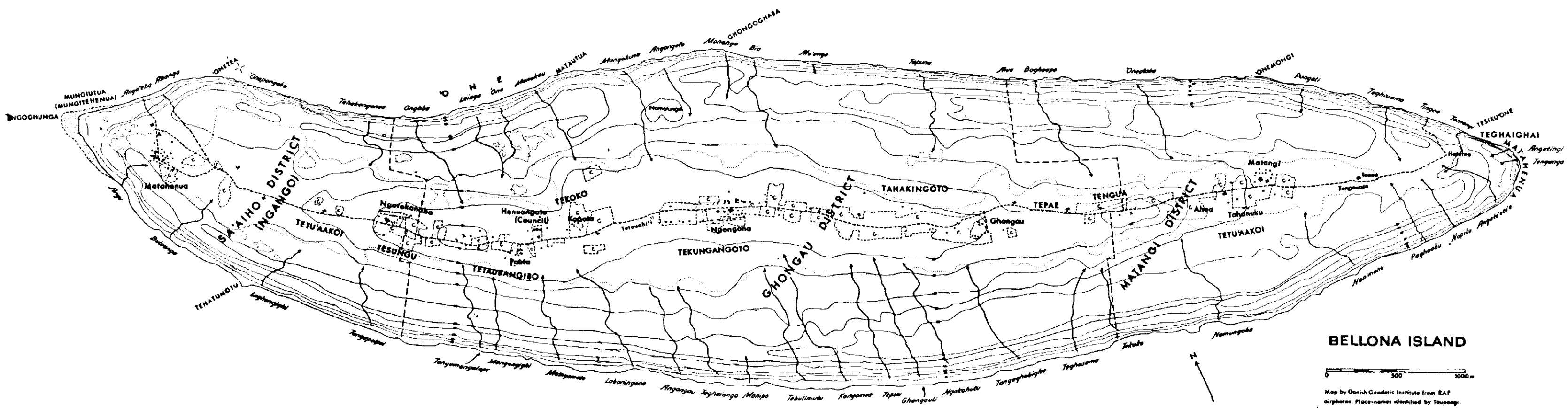

Fig. 2. Map of Bellona Island. After CHRISTIANSEN (1968).

Date	Locality	Coll. code	Stages & Nos. ♂	♀	L	P	Bionomics
29. 4.69	Near Ngakea	MAM, /3	.	.	3	1	Coconut shell.
29. 4.69	Ngongona	MAM, /4	.	.	5	.	Buttresses of *Poinciana.*
20.-29.11.55	Ngotokanaba	ESB, 4123, /47, /48	1	2	2	1	4147: 40-gallon drum.
20. 1.70	Ngotokanaba	MAM, /2	.	.	3	2	55-gallon drum.
Aedes (Stegomyia) gurneyi							
19.10.56	Ghongau	JdB, B2	.	.	1	.	Large wooden dish, clean, light shade.
21.11.55	Tahanuku°	ESB, 4147	1	.	1	.	40-gallon drum.
Aedes (Stegomyia) hebrideus							
June 1930	?Western end°	LAM	.	2	.	.	In daytime.
21. 6.33	N.W. end	LAM	5	6	.	.	As above.
23. 6.33	Bellona	LAM	.	1	.	.	At night.
15. 8.53	Ahanga	MEL, 229, 230	.	.	.	.	
29. 4.69	Ahanga	MAM, /6	.	.	10	7	In canoe, polluted.
29. 4.69	Ahanga	MAM, /7	.	.	2	4	Very small pool on a rock at seashore.
29. 4.69	Ahanga	MAM, /8	.	.	6	7	In canoe, polluted.
29. 4.69	Ahanga	MAM, /9	.	.	7	4	Small pool on a tree stump, rich in decomposed leaves.
20. 1.70	Ahanga	MAM, /3	.	.	13	2	Coconut with foul liquid.
15. 8.53	Ahanga	MEL, 232	.	.	.	.	
29. 4.69	Mid-island	MAM, /2	.	.	7	.	Dug-out canoe log.
19.10.56	Ghongau	JdB, B1-B7	1	4	5	3	Wooden bowl and large wooden dish with clean water, light shade. Adults attacking at 2 p.m.
20.-21.11.55	Ngotokanaba	ESB, 4123 /44, /46	1	13	5	4	4144: Coconut shell; 4146: Coconut spathe.
29. 4.69	Ngotokanaba	MAM, /5	.	.	8	.	Coconut spathe.
20. 1.70	Ngotokanaba	MAM, /2	.	.	4	29	55-gallon drum.
16. 8.53	Longona[1]	MEL, 235, 236	.	.	.	.	
15. 8.53	Matahenua	MEL, 234	.	.	.	.	
20. 1.70	Matahenua	MAM, /1	.	.	6	.	55-gallon drum, clear water.
30. 4.69	Matahenua	MAM, /1	.	.	1	.	Very small pool on coral boulder.
29. 4.69	Near Ngakea	MAM, /3	.	.	1	.	Coconut shell.
21.-22.11.55	Tahanuku	ESB, 4147	2	3	15	12	40-gallon drum.
Aedes (Stegomyia) hoguei							
30. 4.69	Matahenua°	MAM, /2	.	.	5	.	Small pool on a rock on the rim.

1. Probably BRADLEY's "Longau" (LAIRD & LAIRD, 1956) and the present "Ghongau".

Table 1. Rennell localities where mosquitoes have been collected.

×: Included in the list of localities, etc., in the present paper. ○: Included in TAYLOR's list (Nat. Hist. Rennell Isl. vol. 7, 1973). ⊗: Included in both lists.

LOCALITY \ SPECIES	*Anopheles (C.) farauti*	*Anopheles (C.)* cf. *koliensis*	*Uranotaenia barnesi*	*Culex (C.) annulirostris*	*Culex (C.) squamosus*	*Culex (C.) fragilis*	*Culex (C.) pullus*	*Culex (C.) buxtoni*	*Culex (L.) lairdi* (?)	*Culex (L.)* sp., Rennell Form	*Aedes (F.) notoscriptus*	*Aedes (F.)* sp.	*Aedes (S.) albolineatus*	*Aedes (S.) gurneyi*	*Aedes (S.) hebrideus*	*Aedes (S.) hoguei*	*Tripteroides (R.) solomonis*	*Tripteroides (R.) coheni*
1 Magautu	.	.	.	.	.	.	.	.	.	.	.	.	.	.	×	.	.	.
2 Kaagua	.	.	×	.	.	.	.	.	.	×	.	.	.	.	.	.	○	.
3 Naone	.	.	.	.	.	.	.	.	.	.	.	.	.	.	×	.	.	.
4 Ongomelage	.	.	.	.	.	.	.	.	.	.	×	.	.	.	.	×	.	.
5, 6, 7 Ongomelage to Honga'ubea	.	.	.	.	.	.	.	.	.	×	×	.	.	.	.	.	.	.
8 Tematiga	.	.	.	.	.	.	.	.	○	×	.	.	.	.	×	.	.	.
9 Tepoogima	.	.	.	.	.	.	.	.	.	.	.	○	.	.	.	.	.	.
10, 11 Gahuga Swamp Honga'ubea	.	.	×	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12 Hana'akaba	.	.	.	.	.	.	.	.	.	⊗	.	.	.	.	.	.	.	.
13, 14 Tigoa airstrip	.	.	.	○	.	.	.	.	.	⊗	.	.	.	.	○	.	○	.
15 Hatagua	.	.	×	.	.	.	×	.	.	×	.	.	.	.	×	.	×	.
16 Gongona	.	×	.	.	.	.	.	.	.	×	.	.	.	.	.	.	.	.
17, 18, 19 Hatag. to Tahanuku	.	.	.	.	.	.	×	.	.	⊗	.	.	.	.	.	.	.	.
20, 21 Tahanuku	.	.	.	.	.	○	⊗	.	.	×	.	○	.	.	⊗	.	.	.
22 Teabamagu	×	.	×	.	.	×	×	.	.	×	.	.	.	.	×	.	×	.
23, 24 Matahenua	.	.	×	.	.	.	.	.	.	×	.	.	.	.	.	.	.	.
25 Tahua	.	.	.	○	.	.	○	.	.	.	.	.	.	.	.	.	.	.
26, 27 Matangi	×	×	⊗	×	.	.	.	.	.	⊗	.	○	.	.	.	.	.	.
28 Nagau	.	.	.	.	.	.	.	.	.	.	.	.	.	○	.	.	○	.
? Songoa	×	.	.	.	.	.	.	.	.	×	.	.	.	.	.	.	.	.
29 Labagu	.	.	.	.	.	.	.	.	.	×	×	.	×	.	⊗	×	.	.
30 Abatai	.	.	.	.	.	.	.	.	.	.	×	.	.	.	×	.	.	.
31, 32 Kagaba	.	.	.	.	.	.	.	.	.	×	×	.	.	.	⊗	.	.	.
33 Tevaitahe	.	.	.	×	.	.	.	.	.	.	.	.	.	.	×	.	.	.
34, 35 Niupani	×	.	.	⊗	×	.	.	.	○	×	⊗	.	.	○	⊗	○	○	○
? Mangina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	×	×	.	.
36, 37 Tuhugago	.	.	.	.	.	.	.	.	.	.	⊗	.	.	.	⊗	○	×	.
38, 39 Niupani to Tegano	.	.	.	.	.	.	.	○	.	×	○	.	.	○	.	.	○	.
40 Tegano	.	.	.	⊗	.	.	.	.	○	.	.	○	.	.	.	.	.	.
41 Hutuna	.	.	.	×	.	.	⊗	.	○	×	×	.	.	×	⊗	×	.	.
42 Soaika Hill	.	.	.	.	.	.	.	.	.	.	○	.	.	⊗	×	.	.	.

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