THE LARVAE OF AMERICAN ANOPHELES MOSQUITOES,
IN RELATION TO CLASSIFICATION AND
IDENTIFICATION.*

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Plates XIV and XV.

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INTRODUCTION.

The characteristics of *Anopheles* larvae are of interest from two points of view. The field worker, on the one hand, wishes to be able to identify the different Anophelines from larval characters alone, without being forced to resort to the tedious procedure of breeding out adults. He is particularly interested in the distinctions between good malaria carriers and poor ones. The systematic entomologist, on the other hand, desires also to know whether the variations in larval structure may not shed light on the classification of this group of closely related species.

The larval characteristics of the Old World Anophelines are now fairly well known. The publications of Christophers, Stanton, Strickland, Swellengrebel, and Edwards, to mention only a few of the workers in this field, have given to science careful descriptions and figures of the majority of the *Anopheles* larvae of Europe, Africa, and the Orient.

In America, conditions are not quite so satisfactory. The monograph of Howard, Dyar, and Knab describes the larvae of many North and Central American species, and descriptions of *Anopheles* larvae have also been published by Peryassu in Brazil and by Lardé Arthes in Salvador. Unfortunately, none of these authors have based their tabulations of species on the variations of the clypeal hairs, which, according to the Old World authors, furnish the most significant and reliable characters. For this reason, it has been difficult to compare the descriptions of American species with those of Old World forms.

Recently, through the great kindness of Dr. Harrison G. Dyar, I have been permitted to study the collection of larval skins of Anophe-

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line mosquitoes in the United States National Museum, including the specimens on which the larval descriptions in the Monograph were based. In this paper I propose to describe the larval characters which are useful in distinguishing between different species of *Anopheles*, indicate the groups into which the species fall, and give descriptions of these characters for the species which I have been able to examine. For the convenience of field workers, I also include a key or synopsis to the American *Anopheles* larvae, so far as they are known. Besides the material in the National Museum collection, I have also studied considerable numbers of larvae collected by myself in various parts of the eastern United States and in Porto Rico, and have utilized the previous publications of Howard, Dyar, and Knab and of Peryassu wherever it was possible.

LARVAL CHARACTERS IN ANOPHELES.

The characters which are of use in discriminating between different *Anopheles* larvae are almost entirely the variations in form and position of certain hairs or modifications of hairs. Since the form of these hairs, or rather their degree of development, varies in the different larval stages of the same individual, everything which is said hereafter about the characteristics of the different species must be taken as applying only to the last larval stage, the mature larva. The characters can usually be clearly seen in the living larva. They show up still better in larvae killed and mounted whole in balsam. Many of them can be made out with ease in the cast larval skins, studied in glycerine or balsam mounts. By breeding out adult *Anopheles* in individual vials the larval skin can be preserved for study in connection with the adult which came from it, thus giving an undoubted identification.

The various hairs and similar structures which must be considered in the study of *Anopheles* larvae may be tabulated as follows, using mainly the terminology of Stanton (1915):

Dorsal Head Hairs.....	clypeal hairs.....	{ anterior.. { inner
		{ posterior { outer
	frontal hairs	
	occipital hairs....	{ inner
		{ outer
	antennal hair	
	sub-antennal hair	
Dorsal Thoracic Hairs....	{ anterior sub-median group	
	{ palmate hairs	

Abdominal Hairs..... { palmate hairs
 { lateral hairs of segments 4 to 6
 { lateral comb of segment 8

TEXT-FIGURE 1. Dorsal view of head and anterior edge of thorax of a mature larva of *A. punctipennis*. i.a.c., inner anterior clypeal hair. o.a.c., outer anterior clypeal hair. p.o., posterior clypeal hair. f., frontal hair. i.o., inner occipital hair. o.o., outer occipital hair. a., antennal hair. s.a., sub-antennal hair. a.s.m., anterior sub-median thoracic hairs.

Dorsal Head Hairs.—The location of the head hairs can best be described by reference to text-figure 1, which shows the appearance of the hairs on the dorsal surface of the head and anterior part of the thorax in the common North American species, *A. punctipennis*. For the purposes of our terminology, we imagine the head as divided into three regions—

Clypeus—the narrow portion projecting forward in front of the bases of the antennae.

Frons—the region just between and behind the bases of the antennae.

Occiput—the posterior dorsal region of the head.

1. Inner anterior clypeal hairs. In Fig. 1 (*i.a.c.*) these hairs are long, slender, and simple (*i.e.*, unbranched), arising close together from the anterior edge of the clypeus near the median line and projecting almost straight forward. In other species these hairs may arise much farther apart and may show various other forms. In species which normally have these hairs simple, a forked condition may appear as a rare abnormality. I have seen this in both *A. punctipennis* and *A. quadrimaculatus*.

2. Outer anterior clypeal hairs—a pair of hairs projecting anterolaterally from the edge of the clypeus just above the mouth-brushes. They are often hard to see clearly on this account. In *punctipennis* and many other related species these hairs are thickly dichotomously branched (Fig. 1, *o.a.c.*), forming a flat, fan-shaped tuft. In some species where there are not so many branches, the dichotomous character of the branching can be seen more clearly (*A. strigimacula*). This pair of hairs shows the greatest variety of forms of any of the head hairs and is correspondingly valuable in identification.

3. Posterior clypeal hairs—a pair of hairs on the clypeus but well behind the margin. In *A. punctipennis* (Fig. 1, *p.c.*) they are very short and split into several branches. Their location with respect to the other clypeal hairs may be characteristic even in species where they are otherwise similar (compare *A. pseudopunctipennis* with *A. neivai*).

4. Frontal hairs—these hairs, six in number, are inserted in a more or less irregular line between the bases of the antennae. They extend forward over the clypeal region. In the great majority of *Anopheles* larvae these hairs are long and laterally branched, as they are in *A. punctipennis* (Fig. 1, *f.*). The shortening and reduction of branching which are found in a few species seem to be in some way a response to unusual habitats, for they occur only in species which breed in tree-holes, bamboo joints, or the leaf-bases of epiphytic Bromeliaceae. These species include the members of the Coelodiazesis group (*A. barberi*, *plumbeus*, *barianensis* and *culiciformis*), in which the frontal hairs are very short with few or no branches, the *Dendropaedium* group (*A. cruzi*, *A. neivai*), and *A. asiatica*. In the last three species, the frontal hairs are of normal length but some or all of them lack the usual lateral branches. In *A. fajardo*i the outermost pair of frontal hairs seems to be absent.

5. Occipital hairs—the two pairs of occipital hairs are usually similar and may be considered together. The inner and outer pairs

(Fig. 1, *i.o.* and *o.o.*) are separated by the converging lines which mark the line along which the head-capsule splits at ecdysis. These hairs do not appear to furnish any important characters for the identification of American *Anopheles*, but this may be because they have not been studied extensively.

6. Antennal hair—a hair on the shaft of the antenna (Fig. 1, *a.*) usually located on the inner or dorsal surfaces, from one fourth to one half of the distance from base to apex. Christophers (1913) called attention to the fact that in all the primitive forms (his *Proto-anopheles*) this hair was branched, while in the more specialized forms (his *Deutero-anopheles* and *Neo-anopheles*) it was simple. This relation is certainly the rule, but it is not of universal application. Even in the Orient, the species of the *Coelodiazesis* group have this hair simple, in keeping with the general reduction of the head hairs incident to their tree-hole habitat. The common and widespread South American species usually placed in the "Cellia" group have branched antennal hairs. And finally, in *A. pseudo-punctipennis*, I found larval skins from Central America in the National Museum collection which showed a distinctly branched antennal hair, while larval skins from California (originally described as *A. franciscanus*) had the antennal hair simple. In species which have this hair branched, there is considerable variation in the number of branches in different species, as may be seen by comparing the figures of the antennal hairs of *A. albimanus*, *A. grabhamii*, and *A. strigimacula* (Plate XIV, Fig. 1-3).

7. Sub-antennal hair—this is the hair which James and Liston call the "basal hair." In most species it is a long feathered hair inserted laterally just behind the base of the antenna and curving forward and downward to lie below the antennal shaft (Fig. 1, *s.a.*). In *A. culiciformis*, of India, this hair has a characteristic clubbed form.

Dorsal Thoracic Hairs.—Of the many hairs on the thorax, only two groups have been carefully studied for purposes of specific discrimination.

1. Anterior sub-median thoracic hairs—two groups of three hairs each, situated near the mid-dorsal line and the anterior edge of the thorax (Fig. 1, *a.s.m.*). The outer hair of each group is always short and simple. In the primitive *Anopheles* the median hair is long and laterally branched, while the inner one is short and only very slightly branched if at all. See figures of these hairs in *A.*

punctipennis (Fig. 1) and in *A. barberi* and *A. grabhamii* (Plate XIV, Figs. 4 and 5). In the more specialized forms, both of the South American and Oriental-African faunas, both the median and inner hairs are long and profusely branched (*A. albimanus*, Plate XIV, Fig. 7). *A. neivai* shows the slightest development of the inner hair which I have found in a member of the specialized South American group (Plate XIV, Fig. 6). *A. fajardoi* shows, as usual, an entirely unique condition, having the inner hair profusely branched on one side only and the median hair very long, forked close to the base, and sparsely branched (Plate XIV, Fig. 8).

2. Palmate hairs—the posterior corners of the thorax bear a palmate hair in many of the Oriental *Anopheles*. Small palmate hairs on the thorax have been reported only in *A. albimanus* and *argyritarsis* among American species. The distribution of the palmate hairs and their use in identification will be discussed in more detail when considering the palmate hairs of the abdominal segments.

TEXT-FIGURE 2. Individual leaflets of the palmate hairs of the larvae of—

1. *A. grabhamii*.
2. *A. pseudopunctipennis*.
3. *A. schuffneri* (after Swellengrebel).
4. *A. albimanus*.
5. *A. neivai*.
6. *A. fajardoi*.

Abdominal Hairs.—1. Palmate hairs—these peculiarly modified hairs occur in pairs and may be present on the thorax and on abdominal segments 1 to 7. Their location has been extensively used as a diagnostic character, but it is evident that much more variation in this respect occurs than had previously been taken into account. Darling (1910) first pointed out that the larva of *A. albimanus* some-

times possessed palmate hairs on its thorax, in Panama. Recently, Miss Evans has reported the same occurrence in larvae of *A. argyritarsis* from Venezuela. In a large collection of the larvae of *A. albimanus* which I recently made in Porto Rico, this condition is almost universal. Evidently, then, the larval distinction between *argyritarsis* and *albimanus* given in Howard, Dyar, and Knab's monograph will not hold in all cases. Several field men have recently expressed to me their doubt whether the distinction between *A. crucians* and *A. quadrimaculatus*, based on the number of their palmate hairs, will hold good. At any rate, it is clear that the location and number of the palmate hairs must be used with caution as a diagnostic character and only in default of something better. The form of the individual leaflets of these hairs, however, seems to be a character of great value for classification. In the majority of the "Proto-anopheles" the leaflets are lanceolate with a number of irregular notches along the sides near the tip (Fig. 2, 1). In the specialized Old World group, the leaflets have a lanceolate base and a long or short terminal filament, usually separated off by notches (Fig. 2, 3). This condition is not approached by any of the American species, with the exception of *A. pseudopunctipennis* (Fig. 2, 2). In the specialized group, typical of tropical America, the leaflets are slender and smooth, entirely without notches, and either sharply pointed (*A. albimanus*, Fig. 2, 4) or with truncate tip (*A. neivai*, Fig. 2, 5). *A. fajardoii* lives up to its reputation for uniqueness by the leaflet shown in Fig. 2, 6, shaped something like a tennis racket and equipped with a long terminal hair.

2. Lateral hairs of abdominal segments 4 to 6—in all Anopheline larvae, so far as I am aware, the first two abdominal segments bear two very long and strong feathered hairs on each side, while the third segment bears a single hair of the same kind. It has long been known, also, that members of the *Coelodiazesis* and *Dendropaedium* groups bear smaller but still distinctly feathered hairs on segments four to six. Not much attention has been paid to these hairs in other species, perhaps because they are difficult to make out in larval skins which have been mounted in balsam. There are distinct differences in these hairs, in some species at least, which will probably repay study. Figure 3 shows their form in some of the species which I have studied. The examination of a long series of larvae of *albimanus* and *grahamii* has shown no variations from the condition shown. In *A. punctipennis* and *A. quadrimaculatus* these hairs may be split up into three,

four, or even five branches. The five-branched condition was most common in the comparatively small number of larvae of *A. crucians* which I have examined.

TEXT-FIGURE 3. Lateral hairs from the fourth abdominal segments of the larvae of several species of *Anopheles*.

3. Lateral comb of the eighth segment—the lateral chitinous comb of the eighth segment in *Anopheles* larvae corresponds to the more or less triangular patch of scales found in about the same position in many other mosquito larvae. In nearly all species the comb consists of long and short teeth, irregularly alternated. In species of the *Coelodiazesis* and *Dendropaedium* groups there seems to be a tendency for all the teeth to be long and about of equal length. In *A. neivai* and, according to Christophers, in the Oriental *A. culiciformis* the teeth of the comb have numerous lateral branches.

LARVAL CHARACTERS AND CLASSIFICATION.

The subdivision of the genus *Anopheles* has been carried to an extreme by Theobald, who recognized a large number of genera, distinguished mainly by the form and distribution of scales in the adult. This system took on a new lease of life when Christophers (1913) revised it as the result of splendid detailed studies of adult coloration

and larval characters. Even as thus revised, Theobald's classification seems far more detailed than the group warrants and it will undoubtedly be superseded by the simple and natural division suggested by Christophers in 1915 as a result of his studies on the male hypopygium. In this paper I propose to accept Christophers' subdivisions as subgenera, retaining also some of the Theobaldian generic names as convenient handles for referring to particular groups of closely related species. Most of the American species which I have been able to examine fit into this classification very naturally. Some few of the aberrant South American species will require further treatment. *A. fajardoi*, for instance, differs so markedly from all the other species of *Anopheles*, that I am obliged to place it in a special subgenus. A study of the hypopygium of this species may necessitate placing it in a separate genus. The following synopsis shows the grouping indicated for the American species on the basis of larval characters:

GENUS ANOPHELES Meigen.

Sub-genus *Anopheles* Meigen. Type, *A. maculipennis* Meigen.

Leaflets of palmate hairs usually lanceolate, notched near tip.

Antennal hair usually branched.

Inner hair of anterior sub-median thoracic group simple or only very slightly branched.

Coelodiazesis group—characterized by extreme reduction of all head hairs and by the presence of feathered lateral hairs on abdominal segments four to six.

Species known to be included—*A. barberi*.

Anopheles group—characterized by thick dichotomous branching of outer anterior clypeal hairs.

Species known to be included—*A. quadrimaculatus*, *occidentalis*, *punctipennis*, *crucians*, *grabhamii*.

Species probably included—*A. walkeri*, *atropos*.

?Patagiamyia? group—characterized by unbranched condition of all clypeal hairs.

Species known to be included—*A. pseudopunctipennis*, *eiseni*.

Arribalzagia group—characterized by thin dichotomous branching of outer anterior clypeal hairs.

Species known to be included—*A. strigimacula*, *punctimacula*.

Species probably included—*A. maculipes*, *apici-macula*, *mediopunctatus*, *vestitipennis*, *pseudomaculipes*, *intermedius*.

Sub-genus *Nyssorhynchus* Blanchard. Type, *A. argyritarsis* Rob-Desv.

Leaflets of palmate hairs narrow, without notches, usually ending in a smooth, sharp point.

Antennal hair slightly branched or simple.

Inner hair of anterior sub-median thoracic group profusely branched.

Nyssorhynchus group—characterized by slightly branched antennal hair and branched clypeal hairs. Frontal hairs normal.

Species known to be included—*A. albinus*, *tarsimaculata*, *argyritarsis*.

Species probably included—*A. braziliensis*, *pictipennis*.

Myzorhynchella group—characterized by simple antennal and clypeal hairs (according to Peryassu). Frontal hairs normal.

Species known to be included—*A. lutzii*, *parva*.

Species probably included—*A. nigratarsis*, *gilesi*.

Dendropaedium group—characterized by feathered lateral hairs on abdominal segments four to six and by presence of some unbranched frontal hairs. Antennal and clypeal hairs simple.

Species known to be included—*A. cruzi*, *neivai*.

Species probably included—*A. bellator*, *hylephilus*, also possibly *A. (Kerteszia) boliviensis*.

Sub-genus *Chagasia* Cruz. Type, *A. fajardoi* Lutz.

Leaflets of palmate hairs racket-shaped with a terminal hair.

Antennal hair simple.

Median hair of anterior sub-median thoracic group split into two branches from base.

Only four frontal hairs present.

Species known to be included—*A. fajardoi*.

LARVAL CHARACTERS AND IDENTIFICATION.

For the convenience of field workers, I include here a key to the identification of the mature larvæ of American *Anopheles* as far as they are known. As can be readily seen, much remains to be done in completing such a key. The characters at present known only serve to designate whole groups of species in many instances. I have included statements as to the position of the palmate hairs, though in the light of what I have already stated in regard to their use, they should not be relied upon absolutely. The form of these statements can be readily understood, I think. For example, the statement "Palmate hairs on Th, 1-7" means that they are present on the thorax and the first to seventh abdominal segments.

KEY TO THE KNOWN LARVAE OF AMERICAN ANOPHELES MOSQUITOES.

1. Outer anterior clypeal hair unbranched 2.
 Outer anterior clypeal hair dichotomously branched 5.
 Outer anterior clypeal hair split up like a fan at tip—
 A. fajardoi—Palmate hairs on 3-5.
 Outer anterior clypeal hairs with fine lateral branches—
 A. aldimanus—Palmate hairs on Th, 1-7 or on 1-7.
 A. tarsimaculatus—Palmate hairs on 1-7.
 A. argyritarsis—Palmate hairs on Th, 1-7 or on 2-7.
2. Lateral hairs of abdominal segments 4 to 6 feathered 3.
 Lateral hairs of abdominal segments 4 to 6 not feathered 4.
3. Frontal hairs very short and unbranched—
 A. barberi—Palmate hairs on 3-6.
 Frontal hairs of normal length, some of them unbranched—
 A. cruxi—Palmate hairs on 1-7, leaflets sharp pointed.
 A. neivai—Palmate hairs on 2-7, leaflets truncate at tip.
4. Leaflets of palmate hairs slender, smooth, not notched—
 A. lutsi—Palmate hairs on 1-7.
 A. parvus—Palmate hairs on 1-7.
 Leaflets of palmate hairs lanceolate, notched near tip—
 A. eiseni—Palmate hairs on 2-7.
 Leaflets of palmate hairs approaching terminal filament type—
 A. pseudopunctipennis—Palmate hairs on 3-7.
5. Outer anterior clypeal hair with more than twenty ultimate branchlets..... 6.
 Outer anterior clypeal hair with less than ten ultimate branchlets—
 A. punctimacula—Palmate hairs on 3-7.
 A. strigimacula—Palmate hairs on 3-7.
 A. apicimacula—Palmate hairs on 3-7.
6. Inner anterior clypeal hair with fine lateral branches—
 A. grabhami—Palmate hairs on 3-7.
 Inner anterior clypeal hairs unbranched—

- A. punctipennis*—Palmate hairs on 2-7.
A. quadrimaculatus—Palmate hairs on 2-7.
A. crucians—Palmate hairs on 3-7, first and last pairs small.
A. occidentalis—Palmate hairs on 3-7, all about same size.

APPENDIX.

Descriptions of Larvae of American Anopheles.

- A. barberi* Coquillett. Antennal hair simple. Clypeal hairs all short and simple. Frontal hairs all very short and simple or forked. Occipital hairs short and simple.
 Inner hair of anterior sub-median thoracic group simple. Palmate hairs on abdominal segments 3 to 6. Leaflets lanceolate, notched toward tip. Lateral hairs of segments 4 to 6 feathered. Comb of eighth segment with long teeth.
- A. punctipennis* Say. Antennal hair branched. Inner anterior clypeal hairs long, simple, close together. Outer anterior clypeal hairs thickly dichotomously branched. Posterior clypeal hairs very short, three branched. Frontal hairs normal. Occipital hairs branched.
 Inner hair of anterior sub-median thoracic group slightly branched at tip. Palmate hairs on abdominal segments 2 to 7, slightly smaller on 2. Leaflets lanceolate, notched toward tip. Lateral hairs of segments 4 to 6 split into 3 to 5 branches. Comb of eighth segment with long and short teeth.
- A. quadrimaculatus* Say. Larva indistinguishable from *punctipennis*.
- A. occidentalis* Dyar and Knab. Similar to *A. punctipennis*, but palmate hairs only on segments 3 to 7, all being of equal size.
- A. crucians* Wied. Similar to *A. punctipennis*, but palmate hairs on segments 3 to 7, those on 3 and 7 slightly smaller. Lateral hairs of segments 4 to 6 split into from 4 to 6 branches.
- A. grabhamii* Theobald. Similar to *A. punctipennis*, but inner anterior clypeal hairs have fine lateral branches outwardly, palmate hairs occur on segments 3 to 7 only and the lateral hairs of segments 4 to 6 are split into two branches.
- A. pseudopunctipennis* Theobald. Antennal hair simple or slightly branched. Inner anterior clypeal hairs long, simple, set well apart. Outer anterior clypeal hairs long, simple. Posterior cly-

peal hairs long, simple, not much farther apart than inner pair of anterior clypeal hairs. Frontal hairs normal. Occipital hairs long and feathered.

Inner hair of anterior sub-median thoracic group slightly branched at tip. Palmate hairs on abdominal segments 3 to 7. Leaflets lanceolate, with a long slender tip. Comb of eighth segment with long and short teeth.

- A. eiseni* Coquillett. Antennal hair branched. Clypeal hairs as in *pseudopunctipennis*. Frontal hairs normal. Occipital hairs simple, forked, or slightly branched.

Palmate hairs on abdominal segments 2 to 7. Leaflets lanceolate, with notches toward the tip. Comb of eighth segment with long and short teeth.

- A. punctimacula* Dyar and Knab. (*A. malefactor* Dyar and Knab.) Antennal hair much branched. Inner anterior clypeal hairs long, close together, with fine side branches outwardly. Outer anterior clypeal hair dichotomously branched, ordinarily with only eight ultimate branchlets. Posterior clypeal hairs short and simple. Frontal hairs normal. Occipital hairs branched.

Palmate hairs on abdominal segments 3 to 7. Leaflets lanceolate, notched toward tip. Comb of eighth segment with long and short teeth.

- A. strigimacula* Dyar and Knab. Indistinguishable from *A. punctimacula*.

- A. neivai* Dyar and Knab. Antennal hair simple. Clypeal hairs all long and simple, inner anterior pair well apart, posterior pair farther apart than outer anterior pair. Frontal hairs of normal length, two inner pairs simple, outer pair feathered toward tip, bare near base. Occipital hairs simple or forked.

Inner hair of anterior sub-median thoracic group long, with numerous lateral branches. Palmate hairs on abdominal segments 2 to 7. Leaflets ligulate with truncate tip. Lateral hairs of segments 4 to 6 feathered. Comb of eighth segment with long teeth feathered on both sides.

- A. cruzi* Dyar and Knab. (*Myzomyia lutzi* Theobald.) According to the description and figure of Peryassu (1921), this species differs from *A. neivai* as follows: All six frontal hairs are shown as long and simple. Palmate hairs on abdominal segments 1 to 7. Leaflets slender, smooth, sharply pointed.

- A. albimanus* Wiedemann. Antennal hair slightly branched. Both

pairs of anterior clypeal hairs long, with numerous fine lateral branches. Posterior clypeal hairs fairly long, simple. Frontal hairs normal. Occipital hairs short, slightly branched.

Inner hair of anterior sub-median thoracic group stout and profusely branched. Palmate hairs on thorax and abdominal segments 1 to 7 or on 1 to 7 alone. Leaflets slender, smooth, sharply pointed. Lateral hairs of segments 4 to 6 single. Comb of eighth segment with long and short teeth.

- A. tarsimaculatus* Goeldi. Similar to *A. albimanus*, but palmate hairs have not yet been reported on the thorax.
- A. argyritarsis* Robineau-Desvoidy. Similar to *A. albimanus*, but palmate hairs are reported either on thorax and abdominal segments 1 to 7 or on 2 to 7 only.
- A. lutzi* Cruz. According to the description and figure of Peryassu (1921), the antennal hair is simple. All clypeal hairs simple. Frontal hairs normal. Occipital hairs branched.

Palmate hairs on abdominal segments 1 to 7. Leaflets slender, smooth, sharply pointed.

- A. parvus* Chagas. Indistinguishable from *A. lutzi*, as far as I can tell from the data given by Peryassu.
- A. fajardoi* Lutz. Antennal hair simple. Clypeal hairs very long and stout, split up like the sticks of a fan near tip. Frontal hairs four in number, all long and feathered. Occipital hairs branched.

Inner hair of anterior sub-median thoracic group long, with many branches on one side only. Middle hair of same group split into two long branches, each with sparse lateral branches. Palmate hairs on abdominal segments 3 to 5 only. Leaflets racket-shaped, notched outwardly, with a long terminal hair.

EXPLANATION OF PLATES.

PLATE XIV.

1. Antenna of larva of *A. grabhamii*.
2. Antennal hair of larva of *A. strigimacula*.
3. Antenna of larva of *A. albimanus*.
- 4 to 8. Anterior sub-median thoracic hairs of larvae of—
 4. *A. barberi* (right side).
 5. *A. grabhamii* (right side).
 6. *A. neivai* (left side).
 7. *A. albimanus* (right side).
 8. *A. fajardoi* (right side).

PLATE XIV.

PLATE XV.

PLATE XV. Clypeal hairs of the larvae of—

1. *A. barberi*.
2. *A. grabhamii*.
3. *A. strigimacula*.
4. *A. punctimacula*.
5. *A. neivai*.
6. *A. pseudopunctipennis*.
7. *A. albimanus*.
8. *A. fajardoi*.

BIBLIOGRAPHY.

CHRISTOPHERS, S. R.

1913. Contributions to the study of colour marking and other variable characters of Anophelinae with special reference to the systematic and phylogenetic grouping of species. *Annals of Trop. Med. and Par.*, VII, p. 45.

CHRISTOPHERS, S. R.

1915. The male genitalia of Anopheles. *Indian Jour. of Med. Research*, III, 2.

DARLING, S. T.

1910. Factors in the transmission and prevention of malaria in the canal zone. *Annals of Trop. Med. and Par.*, IV, pt. 2.

EVANS, A. M.

1921. Notes on Culicidae collected in Venezuela. *Annals of Trop. Med. and Par.*, XV, 4.

HOWARD, DYAR, AND KNAB.

1917. The Mosquitoes of North and Central America and the West Indies. IV. Carnegie Inst. of Washington, Pub. 159.

JAMES AND LISTON.

1911. The Anopheline Mosquitoes of India. Thacker, Spink and Co., Calcutta, 2d Ed.

LARDE ARTHES, C. R.

1921. Anofeles de El Salvador, y Profilaxia Paludica. Univ. del Salvador.

PERTASSU, A. G.

1921. Os Anophelíneos do Brazil. *Arch. Mus. Nac.*, Rio de Janeiro, XXIII, pp. 9-104.