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*ANOPHELES* (DIPTERA: CULICIDAE)

A SUMMARY OF THE "TARSIMACULATUS" COMPLEX OF  
*ANOPHELES* (DIPTERA: CULICIDAE)

By

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Among the American anopheline mosquitoes of the subgenus *Nyssorhynchus*, one of the most confusing groups to deal with is that composed of several closely related species, most of which were considered to be *Anopheles tarsimaculatus* by older entomologists. According to Edwards' (1932) classification, these species belong to the *Tarsimaculatus* series and the *Nyssorhynchus* group of the subgenus *Nyssorhynchus*. In this series, Edwards lists the following species: *A. albimanus*, *bachmanni*, *perezi*, *strodei*, and *tarsimaculatus*. It has become evident that "*tarsimaculatus*" represents a group of closely related forms, and it is the object of this paper to present the comparative morphology of certain characters of the male terminalia and of the eggs that may be used to differentiate between them, and to describe a new species belonging to this group. The mosquitoes dealt with in this paper are: *A. oswaldoi* Peryassu, 1922; *A. aquasalis* Curry, 1932 (= *tarsimaculatus* of Darling, 1910, and Rozeboom, 1938); *A. anomalophyllus* Komp, 1936; *A. núnñez-tovari* Gabaldon, 1940; *A. rangeli* Gabaldon, Cova-Garcia, and Lopez, 1940; and a species collected by C. H. T. Townsend along the Rio Tapajos, Boa Vista, Brazil, which we are describing as new; and "*A. tarsimaculatus* Goeldi" of Galvao and Lane (1937, 1938).

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MATERIAL AND METHODS

The majority of the specimens studied belong to Root's collection, and were taken in Brazil, Colombia, Venezuela, Trinidad, and Grenada. These were supplemented by specimens collected by the authors in Panama and Venezuela, and by material deposited in the U. S. National Museum by Townsend, Komp, and others. We are indebted to Dr. Alan Stone, of the U. S. National Museum, for the use of museum equipment and specimens.

The ordinary technic in preparing the male terminalia of anopheline mosquitoes for study is to macerate them in potassium hydroxide solution, wash them in water, dehydrate them in two or more concentrations of alcohol, clear them in clove oil or similar fluid, and mount them in balsam or some less satisfactory medium. Much of the confusion in mosquito taxonomy is due to the improper technic of mounting the male terminalia by earlier entomologists. Many details of the structure can be brought out by staining the specimens in acid fuchsin after washing them in acidulated water, and it is often desirable to dissect out the parts in addition to staining. Curry (1932) recognized the value of removing the anal lobe, which in anophelines is a hood-like structure obscuring the view of the mesosome and the claspette lobes. The technic followed by the authors is one that was taught to them by Komp, who rightly insists that it is essential especially for the study of *Culex* terminalia. After

the specimen is washed in acidulated water, it is stained for several hours in acid fuchsin, and dehydrated in 70 and 95 per cent alcohols, to which a drop of acetic acid has been added. It is then transferred to clove oil, and is dissected in a drop of the oil in a hollow-ground slide. The parts are then transferred to a slide containing a very thin sheet of balsam. The balsam, with the parts of the terminalia, is allowed to dry for a day or more before a coverslip, with a drop of thin balsam on its lower side, is placed over the specimen. By this method it is possible to see certain structures more clearly than in unstained specimens, especially the shape of the mesosome, the leaflets on the tip of the mesosome, the size and arrangement of the hairs and bristles on the claspette lobes, and Gabaldon's "preapical plate." Nevertheless, staining and dissecting destroys other characters that we consider to be of importance in the study of *Nyssorhynchus* males. The general shape of the fused dorsal lobes is lost in dissected specimens, as the membrane is unfolded and mounted flat. Gabaldon's "refringent structure" is also lost. The appearance of the preapical plate is often changed by staining, as the membrane surrounding the plate also takes up the stain; the stain may also obscure the degree of natural pigmentation of the plate. Thus it is necessary to study both stained and dissected terminalia, and unstained and undissected material. Some of the unstained, undissected specimens should be mounted with the fused dorsal lobes uppermost, as the refringent structure and the hairs at the base of the lobes may be obscured by the mesosome and, if it has not been removed, by the anal lobe.

*Anopheles (Nyssorhynchus) goeldii*  
n. sp.

The following description is based on six males and nine females, loaned to us by the U. S. National Museum. Holotype male, and paratype males and females, have been returned to the U. S. National Museum. The type locality is Rio Tapajos, Boa Vista (Fordlandia), Brazil. Recently one of us (Gabaldon) has identified this species from material collected at La Ceiba, Trujillo, Venezuela, a town on the southern shore of Lake Maracaibo.

*Female.* Vertex with some long, pale bristles and long, slender, erect white scales, which are shorter, triangular, and truncate posteriorly; a line of narrow, recumbent, white scales along the upper, inner margin of eyes down to base of antennae; occiput with erect, triangular, black, truncated scales. Proboscis long, slender, black. Vestigial first, and second segments of palp dark, a few white scales at tip of second segment; the third segment mainly dark-scaled, but with some white scales mixed with the dark ones on the apical three-fourths, and with a narrow ring of white scales at the apex; fourth segment with a narrow black ring at the base, the rest white; fifth segment with a narrow, basal black ring, the rest white.

Mesonotum and scutellum sparsely clothed with narrow, recumbent, yellow scales; some long, narrow, white scales before and above the wing base. Prothoracic lobes with a small patch of dark scales anteriorly and with long, slender bristles. Sternopleura with several long, dark hairs and a small patch of narrow, white scales on the upper portion, and with several white scales level with the lower border of the mesepimeron. Knobs of halteres with small, pale scales.

Coxae and trochanters with patches of

light and dark scales. Femora and tibiae light below and dark outwardly; yellowish scales scattered among the dark ones on the outer surface; femora with narrow pale, apical rings; fore and hind tibiae swollen apically; all tibiae with narrow, apical, pale rings. Fore tarsi with broad, conspicuous white rings at the apices of the first, second, and third segments; the fourth segment dark; the fifth with some white scales at the apex. Mid tarsi with indistinct, narrow, yellowish rings at the joints. First segment of hind tarsus dark, with a very narrow ring of white scales at the apex; second hind tarsal with slightly less than the basal third black, the rest white; third and fourth segments entirely white; fifth with a black basal ring.

Wing (plate I, figure 1) with costa white at base for about one half the distance to the humeral cross vein (spot  $B_1$ ); then black to humeral cross vein; spot  $B_2$  may be larger or smaller than the black spot just basal to it; spot  $B_3$  sometimes does not reach the costa; spot  $M_1$  involves the subcosta and the first vein, but sometimes does not reach the costa; spot  $M_2$  always present, involving the costa, subcosta, first vein, and base of the second vein; spot  $Sc$  large, involving costa, tip of subcosta, and first and second veins; spot  $Ap$  also large, involving costa, first vein, and upper branch of second vein. Second vein with a few white scales at base (spot  $M_2$ ), a small white spot before the fork (spot  $Sc$ ); the fork white; the upper branch white before the tip (spot  $Ap$ ) and black at the tip; lower branch with a small dark spot beyond the fork, then white to the tip, which is black-scaled. Third vein white, with a small dark spot near each end. Fourth vein with the stem mostly light-scaled, or dark-scaled

with a number of white scales mixed with the dark ones, a small white spot before the fork; the fork white scaled; the upper branch with a small dark spot beyond the fork, followed by a longer white spot, a dark spot, and a small white spot at the tip; lower branch with a long dark spot in the middle, the tip white. Fifth vein mostly white, a small black spot before the fork; the upper branch with two small dark spots before the middle, and a third larger dark spot near the apex, a few white scales at the tip; lower branch with a small black spot near the apex, a few white scales at the tip. Sixth vein mostly white, with a dark spot near each end.

Abdominal tergites with central patches of narrow, yellowish scales; the postero-lateral tufts composed of broad, dark scales. Cerci densely clothed with yellowish and dark scales. First sternite bare; the other sternites with some broad, white scales centrally and broad black ones apically.

*Male.* Male with coloration of the female.

Terminalia: sidepiece with a short, stout parbasal spine; on the inner surface, at the middle, are two long, heavy, accessory spines with hooked tips; internal spine long, slender, situated just above the accessory spines. Clasper almost as long as the sidepiece, with a short, stout, apical spine.

Membranous tip of mesosome broader than long, blunt, and with a pair of short, pointed leaflets (plate III, figures 3 and 5).

Apex of the fused dorsal lobes (plate I, figure 3) slightly broader than the membranous tip of the mesosome; the outer corners slightly rounded; apical border slightly and broadly excavated; lateral slopes steep and somewhat concave. Refrigent structure absent or

very indistinct. Preapical plate (plate I, figure 3; plate IV, figures 5 and 6) circular, very slightly pigmented. Basal lobules small; the long hairs scattered over their surfaces, and about as long as the width of the membranous tip of the mesosome.

*Larva.* Anterior clypeal hairs single and unbranched, but with minute lateral branchlets along the apical half; the inner hairs as far apart as the distance between the inner and outer hairs. Inner hair of anterior submedian thoracic group resembling a palmate hair, with approximately 12 short, broad leaflets arising at the same level on a short stem. First three abdominal segments with long plumose lateral hairs; on segments 4, 5, and 6 these hairs are long and single. Palmate hairs on first abdominal segment small and somewhat indistinct; those on segments 2 to 7 large; the leaflets pointed, and with smooth edges. Pecten with irregular alternation of long and short teeth. Posterior flap of spiracular apparatus with a pair of broad, triangular, lateral projections near the anterior point (plate I, figure 2).

*Egg.* The structure of the egg cannot be made out clearly in the specimens, mounted on slides, which were deposited in the Museum. The frill is present on both ends of the egg as a horseshoe-shaped ribbon of exochorion; the floats are separated from one another on the dorsal surface, so that there is an exposed area of dorsal endochorion between the floats and in the area bordered by the frill. Float with approximately 25 ridges. (Townsend states that the "gorgasi" eggs he collected had from 25-30 float ridges.)

Characters for separating *A. goeldii* from the other members of this complex are described below; they are found in

the mesosome and the fused dorsal lobes of the male terminalia.

*Characters for separating species of the "Tarsimaculatus" complex*

A. *The mesosome.* The characters of the mesosome that are of specific value are the shape of the membranous tip, the presence or absence of lateral leaflets, and the structure of the leaflets. In this discussion, the width of the mesosomal tip refers to the width of the base of the membranous tip, while the length signifies the distance from the base, or the point at which the leaflets arise, to the apex.

*A. anomalophyllus* can be distinguished from all the other members of this group by the serrated outer border and by the unusual length of the leaflets, which, according to Komp's photomicrograph, are almost twice as long as the width of the membranous tip. In *anomalophyllus* the membranous tip is about as long as broad.

Mesosomal leaflets are also present in *núñez-tovari*, *rangeli*, and *goeldii*. In *núñez-tovari* they are short, spine-like, about half as long as the base of the membranous tip, and clearly visible in undissected and unstained material. The edges are not serrated. The membranous tip of the *núñez-tovari* mesosome is broader than long. *A. rangeli* was described as having a mesosome without leaflets. It is true that in unstained and undissected material the leaflets are not visible. Apparently the leaflets are easily broken off, or fold into a position that obscures them, for even in unstained but dissected specimens they are often invisible. Komp (1936) quotes a statement from a letter written to him by Root, in which Root said that he carefully dissected and examined the hypopygia of "*tarsimaculatus*" from

Brazil and Venezuela, and that he never observed "anything approaching the conditions" in Komp's slides of *anomaloptyllus*. We know that Root's Venezuelan material was all *rangeli*, so that even a keen observer such as Root failed to detect these leaflets. In stained, dissected specimens the leaflets are easily seen (plate III, figure 6). They are similar in shape and size to those of *núñez-tovari*. Because the leaflets are invisible in unstained, undissected terminalia, the key given by Gabaldon, Covagarcía, and Lopez (1940) is useful in separating *rangeli* from the related species, although actually it is morphologically incorrect. The membranous mesosomal tip of *rangeli* is at least as long as broad. In *A. goeldii* the membranous tip of the mesosome is broader than long; leaflets are present, and are similar to those of *núñez-tovari* and *rangeli* (plate III, figures 3 and 5). They can be seen in unstained, undissected specimens, but not as easily as those of *núñez-tovari*. Galvao and Lane (1937), in their key to the male terminalia of the *Nyssorhynchi*, include "*tarsimaculatus* Goeldi, 1905" with those species that do not have leaflets. Galvao and Lane (1938) state that Townsend's specimens are the same as Goeldi's original species. After having examined the eggs, adults, and terminalia of the specimens that Townsend collected at Boa Vista, which are now in the U. S. National Museum, and having compared them with Goeldi's (1905) figures, we believe it is possible that this material is the same as that of Goeldi. But Galvao and Lane (1938) state that they received the same species from Snr. Cesar Worontzow Dashkow, who collected the mosquito in the Parauai and Maues Rivers, on the right bank of the Amazon River, and in the Maracapuru River, about 200 kilometers from the

left bank of the Solimoes River. If Dashkow's species is the same as that of Townsend, it should have leaflets on the mesosome, but if these leaflets are absent, it may be another undescribed member of the "*tarsimaculatus*" complex. At present it is impossible for us to be certain that Dashkow's mosquito is the same as either Goeldi's *albipes* or *A. goeldii*. It is possible that they all represent one species.

*A. oswaldoi* and *aquasalis* do not have mesosomal leaflets. In both species the membranous tip is as long as broad (plate III, figure 4).

B. *The fused dorsal lobes.* The fused dorsal lobes in these mosquitoes have the appearance of a truncated cone. They are formed by the fusion of the inner claspette lobes, and so the entire structure is composed of a single membrane, its shape resulting from the folding of the membrane upon itself. This fusion takes place along the mid-line of the morphologically ventral slope of the lobes; basally this ventral membrane flares out on each side into a lobule which we are calling the "basal lobule." Between the lobules there is a deep cleft. Just above the apex of the cleft, along the line of fusion, the membrane becomes sclerotized, forming a more or less distinct plate, which Gabaldon (1940) has named the "preapical plate." This plate is quite heavily pigmented in some species, but in others it is almost refractile. Curry (1932) called attention to this structure as an aid in the differentiation of *A. oswaldoi* from *aquasalis*. Gabaldon's "refrangent structure" (1940) is the thickened and refractile edge of the membrane bordering the apical part of the cleft. In some species the refrangent structure has lateral arms; they seem to be the thickened, refractile edge of a fold or border of the membrane on the morphologically dorsal

side. The refringent structure can best be seen in unstained specimens that have not been cleared too much and that have been mounted with the membranous lobes next to the coverslip. Apically the two halves of the membrane are also separated by a cleft. The lateral sides of the lobes slope downwardly and outwardly like the steep roof of a house. The morphologically dorsal edge of the membrane sweeps downwards from the apex to fuse with the sclerotized ventral lobes. Extending upwards from the inner, basal corners of the sidepieces there is a short, finger-like process, which fits into the cavity of the cone formed by the folding of the membrane; it seems to be a supporting structure, and has no systematic value. The entire membrane is striated and the ridges at the apex are thicker and more deeply pigmented than they are basally.

In *A. núñez-tovari* the refringent structure is distinct, and racquet-shaped, with lateral arms (plate II, figure 1; plate III, figure 1). It is also present in *oswaldoi* (plate II, figure 2) but is less distinct, and is rather pointed apically, so that it has the shape of an inverted V. Indistinct lateral arms are present. In *rangeli* (plate II, figure 3) it has the shape of an inverted U, the sides being sub-parallel; lateral arms are not present. An indistinct, V-shaped refringent structure can be seen in *aquasalis* (plate I, figure 5), but there are no lateral arms. In *goeldii* no refringent structure is visible.

*A. oswaldoi* has the largest preapical plate in relation to the size of the fused dorsal lobes, of any species of this series (plate III, figure 2). As Curry pointed out, it forms a crescent-shaped bridge between the halves of the lobe. It is heavily pigmented, and the degree of pigmentation can be used to separate *oswaldoi* from the other species, in un-

stained material. The borders of the plate are indistinct, merging gradually into the striations of the membrane laterally, while basally the edge of the plate can be made out clearly, especially in stained specimens, but the edge is very irregular. The size and pigmentation of the unstained plate are so distinctive that even with the low power of a compound microscope *oswaldoi* can be recognized immediately by these characters.

In stained specimens, the preapical plate of *aquasalis* is almost identical with that of *oswaldoi*, as the membrane at the edges of the plate also become deeply stained, so that there seems to be a crescent-shaped bridge in this species also (plate IV, figure 4). However, the unstained plate has much less pigment than does that of *oswaldoi*, and the center of the plate is more heavily pigmented than the edges, so that it appears to be a roughly circular structure. Curry stated that the lobes "exhibit at the junction a tiny diffuse or ring-like area of sclerosis." An indefinite area of sclerotization is shown in plate IV, figure 3; although this specimen was stained, for some reason the membrane surrounding the plate did not become heavily stained.

*A. rangeli* has a preapical plate that is clearly defined, but rather small and narrow (plate IV, figure 2). The apical margin is convex, and the basal margin is concave, but in the center it may have a small convexity which, in some specimens, is lengthened into a uvula-like process. It does not have as granular an appearance as do the preapical plates of *oswaldoi* and *aquasalis*.

In *A. núñez-tovari* the preapical plate is small and circular, in unstained specimens. There is very little pigment, and the plate has an almost refractile appearance. The preapical plate of *goeldii* has even less pigment; it is also circular in

outline, but seems to be slightly larger than the plate of *núñez-tovari*.

In Komp's paratype slide of *A. anomalophyllus* the preapical plate is somewhat rectangular, being longer than broad. The basal border is very irregular, and seems to be produced in a number of very fine spines. It is quite heavily sclerotized and pigmented (the specimen is not stained), and the surface of the plate is rather smooth. The lateral borders are quite distinct (plate I, figure 4).

According to the photomicrograph published by Galvao and Lane (1938), the preapical plate of their "*A. tarsimaculatus*" is a small, crescent-shaped, scar-like structure, with the ends pointing apically. By examination of Galvao's and Lane's figure we cannot be certain that this scar is not simply the basal edge of a slightly tilted circular plate, or whether the plate actually has this shape.

The apical portion of the membranous lobes is also of value in identification. In *oswaldoi* the tip is only slightly wider than the base of the membranous tip of the mesosome. The apex of each half is rounded, and the apices are separated from one another by a deep fissure. The slope of the lateral membranes is steep. In *aquasalis* the apical portion of the membranous lobes is very similar to that of *oswaldoi*. In *rangeli* the tip is distinctly wider than the membranous tip of the mesosome, and the slope of the lateral membranes is almost vertical. The outer corners of the tip are rounded, and the apical border has a very shallow indentation. The hairs on the upper part of the lobes appear to be longer in *rangeli* than in the other species, and usually are arranged to form lateral, pointed tufts. The apical portion of the lobes in *núñez-tovari* is also distinctly wider than the membranous tip of the mesosome, and the slopes are almost ver-

tical. The outer corners are pointed, and the apical border has a broad, shallow, V-shaped excavation. The apex of the lobes of *goeldii* is only slightly broader than the tip of the mesosome; the outer corners are sharply rounded, the apical border is slightly and broadly excavated, and the lateral slopes, in our specimens, are steep and somewhat concave. In Galvao's and Lane's (1938) figures of the dorsal lobes of their "*tarsimaculatus*," the apex of the lobes is much broader than the membranous tip of the mesosome, the outer corners are pointed, the apical border is excavated in a broad, shallow V, and the lateral slopes are not as steep as in the other species under consideration.

The basal lobules of *A. oswaldoi* and *rangeli* are much larger than those of the other species; the hairs are larger and tend to be distributed on the basal border of the lobules, forming a comb-like row. These basal hairs are distinctly longer than the width of the mesosomal tip. In *rangeli* there is a clump of long hairs on the inner angle of each basal lobule, pointing to the apex; this tuft is characteristic for this species (plate IV, figure 1). In the other species, the basal lobules are smaller, and the hairs are shorter and scattered over the surface of the lobules. In *núñez-tovari* the basal lobules are indistinct and have very short hairs; they are small in *goeldii* and have hairs that are about as long as the width of the membranous tip of the mesosome. Curry described these hairs as being arranged radially in *aquasalis*; he seems to have been the first to use the basal hairs as an aid in recognizing species in this group of mosquitoes. In Komp's paratype slide of *anomalophyllus* the membranous lobes have been dissected away from the side-pieces. Unfortunately they are rather badly torn, but

the basal lobules seem to be quite large, with a row of long hairs along the basal border; these hairs are distinctly longer than the width of the tip of the mesosome.

C. *The egg.* Egg structure is proving to be a valuable character in the identification of *Nyssorhynchus* mosquitoes. Root's original drawing of a *tarsimaculatus* egg is really a figure of the egg of *oswaldoi*. In *oswaldoi* the floats are large, covering almost all of the dorsal surface of the egg. There is a small, spindle-shaped area of exposed dorsal endochorion between the floats, but often the floats meet along the mid-dorsal line and eliminate this exposed area. The frill is present only on the anterior end of the egg as a small circular structure. The egg of *rangeli* is very similar to that of *oswaldoi*, but the floats have not been observed to fuse along the mid-dorsal line, so that the central, spindle-shaped area of exposed endochorion is always present. The frill is collar-like, similar to the frill in Root's figure of Brazilian *albitarsis* eggs, and to the figure of *A. darlingi* var. *paulistensis* of Galvao, Lane, and Correia (1937).

Only two other eggs are known of the species discussed in this paper. In the egg of *aquasalis* the frill is present on both ends and the floats are widely separated dorsally, thus exposing a broad area of endochorion. As nearly as we can determine from the slide mounts of eggs in the U. S. National Museum, the egg of *goeldii* is similar to that of Goeldi's original *Cellia argyrotarsis* var. *albipes*; this is also Townsend's view. The difference in the number of float ridges in Townsend's and Goeldi's material may be of no importance, as Galvao and Lane (1938) have pointed out. A possible difference between the eggs of *goeldii* and of *aquasalis* is that in the former the frill

is broad and may flare outwardly from the ends of the egg, as Goeldi showed in drawings of his species; in *aquasalis* the frill is a narrow ribbon lying entirely on the dorsal surface of the eggs, and not protruding from the ends of the egg.

D. *The larva.* The lateral projections of the posterior spiracular plate, the taxonomic value of which was found by Gabaldon, Cova-Garcia, and Lopez (1940), are longer in *rangeli* than in *aquasalis*, but shorter than in *oswaldoi*. Additional studies of this structure in the other larvae are necessary. The larva of *núñez-tovari* is still unknown.

E. *Breeding water.* A further differentiation between *aquasalis* and the other members of this series is that it breeds in brackish water, while the rest are found only in fresh water.

#### DISCUSSION

Wiedemann described *A. albimanus* in 1821. In 1901 Theobald described *A. argyrotarsis* var. *albipes*, which he thought was nothing more than a color variety of *A. argyrotarsis* Robineau Desvoidy, 1827. By 1903 Theobald had decided that *albipes* should have specific rank, and placed it in his newly-created genus *Cellia*, but in 1907 he listed *albipes* as a synonym of *albimanus*. It should be noted that at this time he listed *tarsimaculatus* as a synonym of *albimanus*, but did so because he considered Goeldi's species to be the same as his original *albipes*, for in 1910 he stated that although Dyar and Knab believed *tarsimaculatus* was distinct from both *argyritarsis* and *albimanus*, ". . . all the long series sent me by Professor Goeldi from Para are the same as those received from many other places, and are undoubtedly *albimana*." Theobald made this statement in reply to the conclusion of Dyar and Knab (1906), who

said, "The specimens from Para are, however, not properly referable to *albimanus*, Wied., nor to *argyrotarsis*, Rob. Des. Goeldi's name may therefore be used for this form." Goeldi proposed the name "*tarsimaculata*" in 1905. Goeldi identified his specimens as *Cellia argyrotarsis* var. *albipes*, thinking they were the same as Theobald's species, and figured the egg and the last hind tarsus of the adult. Goeldi's mosquito was not *albipes*, but a new species, as Dyar and Knab concluded. These authors (1906), and Howard, Dyar, and Knab (1917) decided that as Goeldi figured his species, the name *tarsimaculata* should be applied to it. In the Monograph they state (p. 978): "Goeldi's name *Anopheles tarsimaculata* was not proposed for a new species, but suggested as a desirable emendation of *albipes*. There is therefore no original description, but the species is figured and with the discussion the new name is published. We have therefore felt justified in recognizing Goeldi's name as the first valid name for the species before us." Most of the subsequent workers have followed the decision of these authors, including Root (1926), Edwards (1932), and more recently, Galvao and Lane (1938), who support their conclusion by citing Article 21 of the International Rules of Zoölogical Nomenclature, which states, "The author of a scientific name is that person who first publishes the name in connection with an indication, a definition, or a description, unless it is clear from the contents of the publication that some other person is responsible for said name and its indication, definition, or description." But we do not see how Article 21 applies to this case. Goeldi did not realize that he was dealing with a new species, as he proposed "*tarsimaculata*" simply because *albipes* has the same meaning that *albitarsis* has,

and might lead to confusion. Therefore, Goeldi proposed his name illegally, for Article 32 of the International Rules states, "A generic or specific name, once published, cannot be rejected, even by its author, because of inappropriateness." If this ruling is followed, *tarsimaculatus* has no standing. Thus *tarsimaculatus* becomes a synonym of *albipes*, and as *albipes* is a synonym of *albimanus*, *tarsimaculatus* is also a synonym of *albimanus*, while Goeldi's original mosquito is still unnamed.

Townsend (1933) also argued that *tarsimaculatus* was unavailable for Goeldi's species, and, provisionally accepting *gorgasi* Dyar and Knab (1907) as being a synonym of *tarsimaculatus*, called his mosquito "*gorgasi*." Because the egg of this form was similar to the drawing of Goeldi's *albipes*, Townsend felt that his mosquito might be the same as Goeldi's species. Townsend said, "It seems strange that the name *tarsimaculatus* was ever adopted from Goeldi by Howard, Dyar and Knab. It could scarcely have been due to a misunderstanding of Goeldi's text, for Knab was proficient in the Portuguese language. Goeldi stated clearly that he proposed the name purely and simply to replace *albipes* Theobald, on the mistaken assumption that the latter name could be dropped under the rules because it means the same as *albitarsis*. Since *albipes* Th. equals *albimanus* Wied., there was not even that excuse for Goeldi's proposal. . . ."

We are as reluctant to drop the old, familiar name "*tarsimaculatus*" as other workers may be, but for the reasons given above, and after discussions with Komp,<sup>2</sup> and with Stone, Hall, and Muesebeck of the Bureau of Entomology

<sup>2</sup> We are especially indebted to Mr. Komp for his careful examination of our manuscript, and for his helpful suggestions and criticisms.

and Plant Quarantine, we can see no other alternative.

As matters now stand, the male and larva of Goeldi's species from Para are unknown. We cannot be certain that Goeldi's species from Para is the same as Townsend's material from Boa Vista, Rio Tapajos, Brazil, for in spite of the apparent similarity in the eggs, our knowledge of the eggs of the "*tarsimaculatus*" complex is still too meagre for us to assume that such similarity could not occur in the eggs of two species. Certainly not all *Nyssorhynchus* species can be separated on egg structure; the egg of *albitarsis* in Panama is identical with that of *argyritarsis*. Furthermore, considerable variation may occur in the eggs of one species, as is true of *A. strodei*. We believe, however, that Townsend's material from Boa Vista (Fordlandia) represents a hitherto undescribed species. If it is later shown that Goeldi's species is the same as Townsend's, the name *goeldii* is available for Goeldi's material. If it proves to be an undescribed species, a new name will be required for it.

We do not believe that the name *gorgasi* Dyar and Knab can be correctly applied to the Panamanian form of the complex (= *aquasalis* Curry). *A. gorgasi* was described from a single battered female collected at La Boca, Canal Zone, on the Pacific side of the Isthmus of Panama. At present, *aquasalis* is rare in Panama, and is found only on the Atlantic side of the Isthmus. Curry (1932) said, "*A. tarsimaculatus* has not to my knowledge been taken in larval or adult form in the interior or on the Pacific side of the Isthmus; the few records of its having been taken there probably result from confusion with other similar species. . . ." Next to the specimen of *gorgasi* in the U. S. National Museum is a male *albimanus*, col-

lected and identified by Komp which, in addition to the black ring on the fifth hind tarsal segment, has a small black ring on the base of the third and fourth segments. Recently one of us (Rozeboom) found in Root's collection a vial containing a male *albimanus*, collected in Panama in July, 1930, by Dr. D. P. Curry; this male has a small black ring at the base of the third hind tarsal joint. The terminalia were stained and dissected, and showed the characteristic structure of the fused dorsal lobes, with the rounded, cleft apex and the bladders on the dorsal aspect. Hoffman (1938) has also observed extra black rings on the hind tarsal segments of *albimanus* in Mexico. We know, therefore, that anomalies do occur in *albimanus*. Because *aquasalis* is not found on the Pacific side of the Isthmus of Panama, and because variations are known to occur in *albimanus*, it is probable that *gorgasi* is a synonym of *albimanus*, rather than of "*tarsimaculatus*." The next available name for the Panamanian species is *aquasalis* Curry.

It is interesting to note that we found a number of these species in Root's collection, all labelled "*A. tarsimaculatus*." Material from Brazil (P. de Caixas and Bangu) is *oswaldoi*; that from Venezuela and Trinidad is *rangeli*; that from the Island of Grenada is *aquasalis*; and a single slide-mount of *núñez-tovari* was found, labelled "*Anopheles tarsimaculatus*, Andagoya, Colombia, Aug. 11, 1930, Dr. White. Hertig."

Many problems concerning this group of mosquitoes still remain to be solved at the time of sending this paper to press (May, 1940). Only a few of the eggs are known. The limits of variability of egg characters are unknown. Undescribed forms may exist; Senevet and Abonnenc (1938) described *A. ininii* from French Guiana, which belongs to

this group. The fused dorsal lobes have peculiar bulbous basal lobules, over which are scattered extremely long hairs, directed apically. The description is inadequate, as nothing is said concerning the presence or absence of mesosomal leaflets, or of details of the structure of the fused dorsal lobes. Galvao and Lane recognize three varieties of *oswaldoi*, and we do not yet know the identity of Goeldi's species from Para.

Much could be learned through an exchange of material between workers in various countries; we can offer Venezuelan specimens in return for specimens from other parts of South America.

#### SUMMARY AND CONCLUSIONS

1. A new *Anopheles*, *A. goeldii*, is described from material collected by Townsend at Boa Vista, Rio Tapajos, Brazil.

2. The comparative morphology of the mesosome, fused dorsal lobes, and eggs of *A. oswaldoi*, *aquasalis*, *rangeli*, *núñeztovari*, *anomaloptyllus*, and *goeldii* n. sp., and of "*tarsimaculatus*" of Galvao and Lane (1937, 1938) is discussed.

3. The authors conclude that Goeldi's name "*tarsimaculatus*" is a synonym of *albimanus* Wiedemann.

4. The identity of Goeldi's material from Para is still uncertain, as abundant material from this locality is required for comparison with other similar species, to determine whether it is new, or one of the species already described.

5. The "*A. tarsimaculatus*" of Panama is a distinct species. The authors conclude that *A. gorgasi* Dyar and Knab 1907 is a synonym of *A. albimanus* Wiedemann; therefore the Panamanian form should be called *A. aquasalis* Curry, 1932.

#### REFERENCES

- Curry, D. P.  
1932 Amer. Jour. Hyg., 15: 2, 566-572.
- Darling, S. T.  
1910 Studies in relation to malaria. I. C. C. Rept., U. S. Govt. Printer, Washington, D. C.
- Dyar, H. G., and Knab, F.  
1906 Jour. N. Y. Ent. Soc., 14: 176.
- Idem.  
1907 *Ibid.*, 15: 198.
- Edwards, F. W.  
1932 Diptera Fam. Culicidae. Genera Insectorum, 194<sup>me</sup> Fasc. L. Desmet-Verteneuil, Imprimeur-Editeur, 60-62, rue T'Kint, Bruxelles.
- Gabaldon, A.  
1940 Publicaciones de la Division de Malariologia, Caracas, Venezuela (No. 5: 3-7).
- Gabaldon, A., Cova-Garcia, P., and Lopez, J. A.  
1940 Publicaciones de la Division de Malariologia, Caracas, Venezuela (No. 5: 9-23).
- Galvao, A. L., and Lane, J.  
1937 Ann. Fac. Med. Univ. S. Paulo, 13: 211-238.
- Idem.  
1938 In Livro Jubiler Prof. Travassos, Rio de Janeiro, Brazil, 3: 169-178.
- Galvao, A., Lane, J., and Correa, R.  
1937 Rev. Biol. e Hyg., 3: 37-45.
- Goeldi, E. A.  
1905 Os Mosquitos No Para. Mem. Mus. Goeldi, 154 pp.

- Hoffman, C. C.  
1938 *Anales del Inst. Biol. (Mexico)*, 9: 1 and 2, 167-180.
- Howard, L. O., Dyar, H. G., and Knab, F.  
1917 *The mosquitoes of North and Central America and the West Indies*, 4: 975-979.  
Carnegie Inst., Washington.
- Komp, W. H. W.  
1936 *Proc. Ent. Soc. Wash.*, 38: (7), 160-164.
- Peryassu, A. G.  
1922 *A Folha Medica*, 3: 179.
- Root, F. M.  
1926 *Amer. Jour. Hyg.*, 6: 684-717.
- Rozeboom, L. E.  
1938 *Amer. Jour. Hyg.*, 27: 95-107.
- Senevet, G., and Abonnene, E.  
1938 *Arch. Inst. Past. Alg.*, 16: 486-611.
- Theobald, F. V.  
1901-1910 *A Monograph of the Culicidae or mosquitoes*, 1: 125-128; 3: 110-113;  
4: 106-109; 5: 69.
- Townsend, C. H. T.  
1933 *Rev. Ent.*, 3: 1, 7-12.
- Wiedemann, C. R. W.  
1821 *Dipt. Exot.*, 10.

## EXPLANATION OF PLATES

## PLATE I

1. Wing of *A. goeldii*.
2. Anterior portion of posterior flap of spiracular apparatus of *A. goeldii*, showing lateral projections.
3. Fused dorsal lobes of *A. goeldii*.
4. Preapical plate of *A. anomalophyllus*.
5. Fused dorsal lobes of *A. aquasalis*.

## PLATE II

1. Fused dorsal lobes of *A. núñez-tovari*.
2. Fused dorsal lobes of *A. oswaldoi*.
3. Fused dorsal lobes of *A. rangeli*.

## PLATE III

1. Fused dorsal lobes of *A. núñez-tovari* (Colombia). The lateral arms of the refringent structure are not in focus.
2. Preapical plate of *A. oswaldoi* (Panama).
3. Mesosome of *A. goeldii* showing shape of membranous tip. The leaflets are folded and are not visible.
4. Mesosome of *A. aquasalis* (Grenada).
5. Mesosome of *A. goeldii*, showing leaflets.
6. Mesosome of *A. rangeli* (Trinidad).

## PLATE IV

1. Fused dorsal lobes of *A. rangeli* (Venezuela), showing clumps of long hairs on the inner angles of the basal lobules.
2. Fused dorsal lobes of *A. rangeli* (Trinidad), showing shape of the preapical plate.
3. Fused dorsal lobes of *A. aquasalis* (Grenada), showing indistinct area of sclerotization (preapical plate).
4. Fused dorsal lobes of *A. aquasalis* (Panama), with the preapical plate resembling that of *oswaldoi*, due to staining of the membrane at the sides of the plate.
- 5 and 6. Fused dorsal lobes of *A. goeldii*, showing circular preapical plate.

The apices of the fused dorsal lobes in the photomicrographs (plate IV, and figure 2, plate III) are distorted, as the membrane was unfolded during dissection.

PLATE I

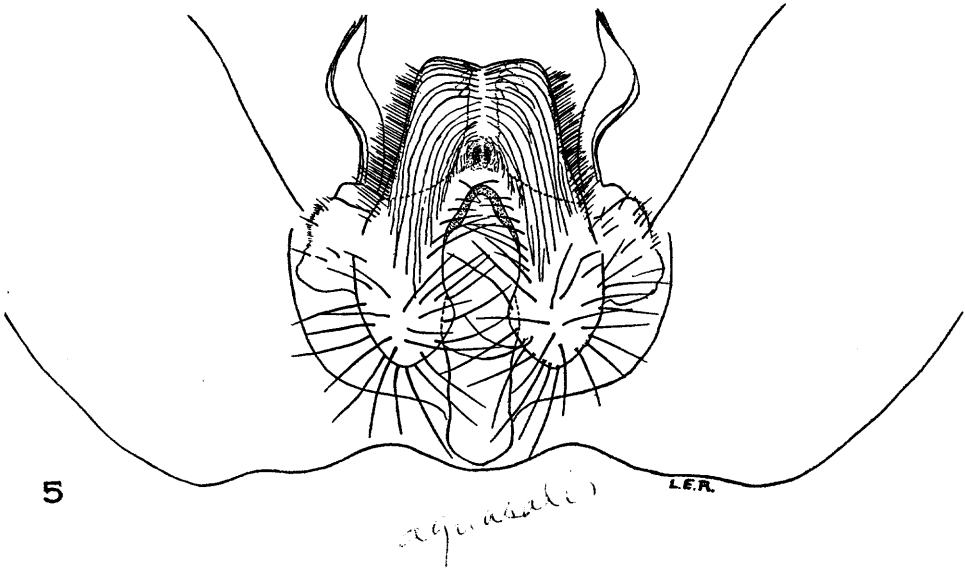
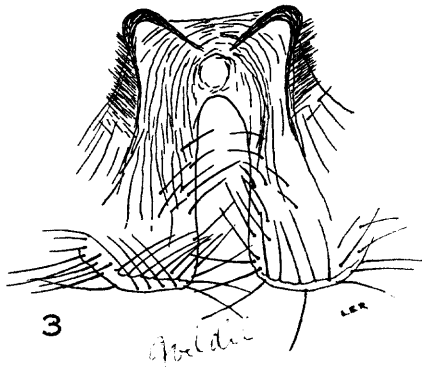
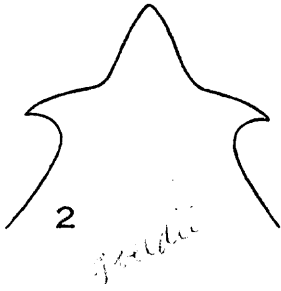
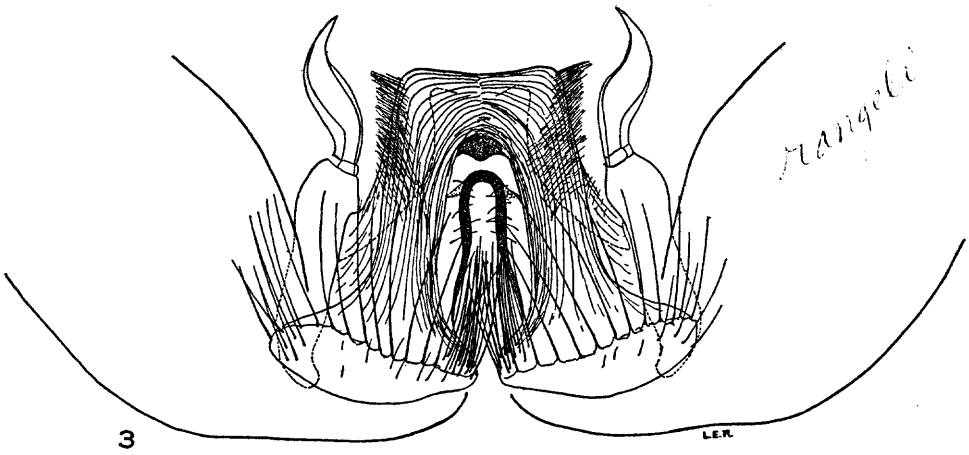
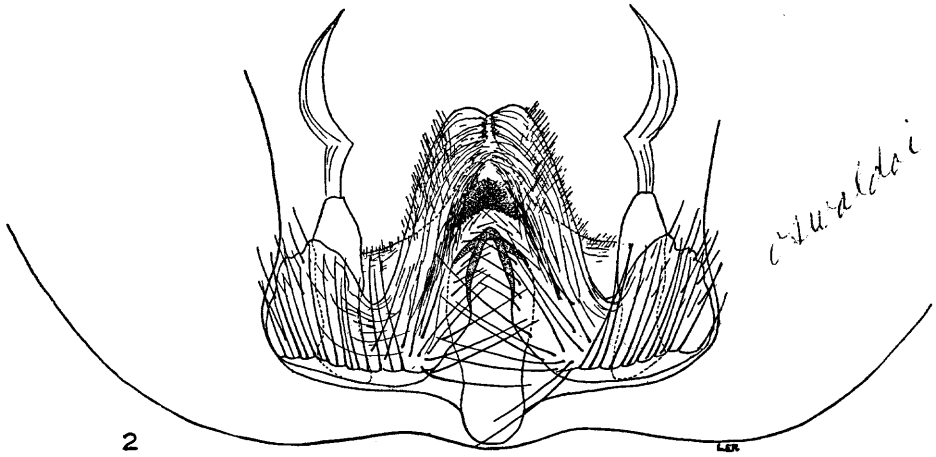
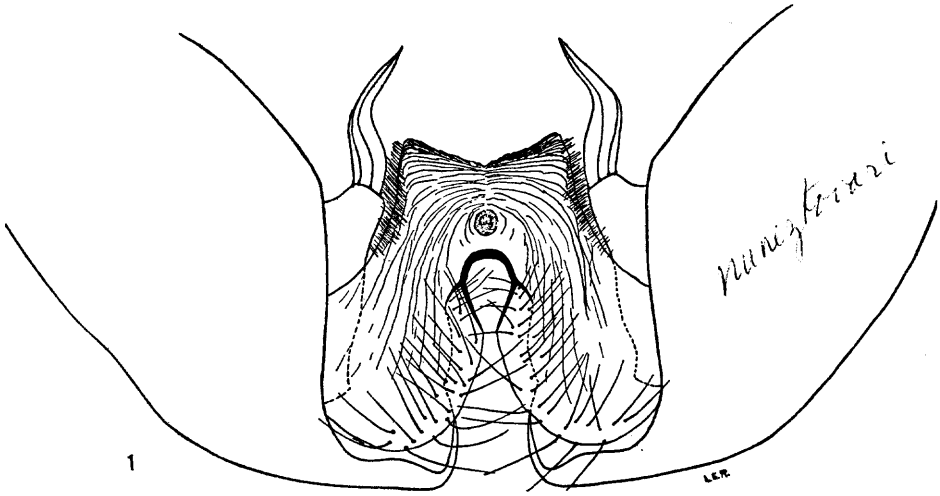
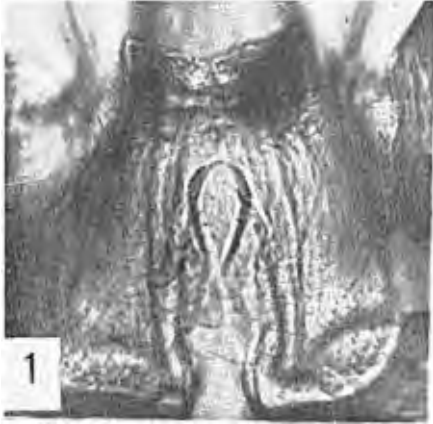


PLATE II



*noveboracensis*

PLATE III



*oswaldi*



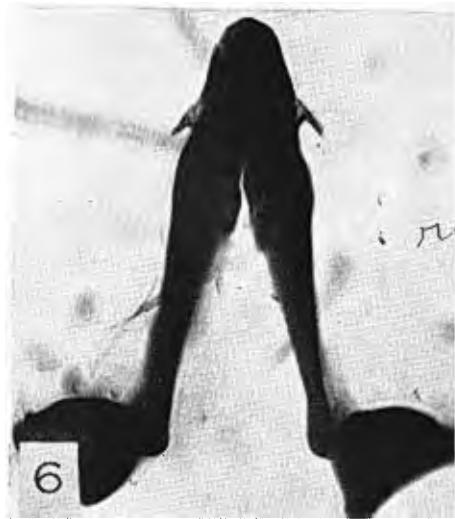
*gouldii*



*aquasalis*



*gouldii*



*longi*

PLATE IV

