

THE SPECIES OF NYSSORHYNCHUS CONFUSED UNDER
TARSIMACULATUS GOELDI, AND A NEW NAME,
A. EMILIANUS, FOR ONE SPECIES FOUND
IN PARA, BRAZIL (DIPTERA, CULICIDAE)¹

W. H. W. KOMP,
Senior Medical Entomologist,
U. S. Public Health Service

There exists in the American tropics a complex of *Anopheles* mosquitoes of the group *Nyssorhynchus*, placed by Edwards in his series *tarsimaculatus*. Many members of this group may be readily separated from one another by definite characters of the male terminalia and larvae, but there remains a number of other closely related species which have hitherto been lumped under the name *tarsimaculatus* Goeldi, and which cannot be so easily separated. The purpose of this paper is to trace the growth of our knowledge of this complex, and to show that at least two, probably more, species have been confused under the name "*tarsimaculatus*."

HISTORICAL

In 1901 Theobald (1) described a supposed variety of *Anopheles argyritarsis* R.-D., which had a narrow black band on the fifth hind tarsal segment, as *argyritarsis*, var. *albipes*. In 1903 he raised his variety to specific rank. The species *A. albipes* has been shown to be the same as *A. albimanus* Wiedemann, and hence the name *albipes* Theobald falls to the synonymy of *albimanus*.

In 1905 Goeldi (2) mentioned the species *argyritarsis* var. *albipes* as occurring in Bélem, Pará, Brazil. He proposed to emend Theobald's varietal name *albipes* to "*tarsi-maculata*."

Howard, Dyar and Knab in 1917 (3) recognized that mosquitoes allied to but differing from *A. albimanus* Wied. occurred in Central and South America, for which they used the name *tarsimaculatus* Goeldi, stating "Goeldi's name *Anopheles tarsimaculatus* 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

¹From the Gorgas Memorial Laboratory, Panama, Republica de Panama.

recognizing Goeldi's name as the first valid name for the species before us."

Peryassú (4) separated the first of the valid species composing the "*tarsimaculatus*" complex when he distinguished *oswaldoi* from "*tarsimaculatus*," basing the distinction on the smaller amount of black on the second hind tarsal segment of his species. Costa Lima (5) also separated *oswaldoi* from "*tarsimaculatus*," using the same character, as well as the length of the spine on the eighth segment of the pupa.

Root (6) in 1926 showed that *albimanus* could with certainty be distinguished from the "*tarsimaculatus*" complex by characters of the male terminalia, thus disposing of the former idea that "*tarsimaculatus*" was a variety of *albimanus*. But Root was apparently dealing with the species now known as *oswaldoi*, a species which he did not recognize.

In 1932 Curry (7) showed that two distinct varieties of the *tarsimaculatus* complex occurred in Panama, one, which he calls var. *aguacaelestis*, breeding in fresh water, and the other, called var. *aguasalis*, breeding in brackish or slightly saline water. Curry mentioned the possibility that his var. *aguacaelestis* might be Peryassú's *oswaldoi*, a probable contingency, but one which has not yet been definitely proved. Curry showed that the two forms occurring in Panama could be separated by means of characters of the male terminalia. Rozeboom (8) showed that Curry's two forms could be differentiated on egg-characters. (Observations reported in the present paper show that the Panama form called "variety *aguasalis*" by Curry (7) and "*tarsimaculatus*" by Rozeboom (8) is a distinct species of the *tarsimaculatus* complex, not a variety, and should be called *aguasalis* Curry.)

Townsend (9, 10, 11) pointed out that many races and varieties probably existed in the supposed valid species of the Nyssorhynchus group, as noted in the course of his work in Boa Vista (Fordlandia), on the Rio Tapajos, Brazil. Apparently he was not equipped to deal with the taxonomy of the Culcidae, as he states definitely that *albimanus* occurred in his region, in which no other worker has ever found it. He remarks that his "mounts of the male terminalis appeared to show the lobules of the fused dorsal lobes" of *albimanus*. These mounts, now in the U. S. National Museum, labeled *albimanus* by Townsend, have been examined by the writer, who found them to be *triannulatus* Neiva and Pinto (= *bachmanni* Petrocchi).

Townsend also remarks that his *albimanus* is "apparently a race of *albimanus* and the same form called *tarsimaculatus* by Goeldi and figured by him on Plate O of his "Os Mosquitos no Pará'." (The form found in Pará is a good species of the *tarsimaculatus* complex, and not at all related to *albimanus*, which has never been found in any part of Brazil.)

He plunged the subject into confusion by making several unwarrantable assumptions regarding Goeldi's "*tarsimaculatus*," such that the mosquito population of Pará had changed in the last thirty years (since 1905), so that "*tarsimaculatus*" and *darlingi* now replace *albimanus* and *albitarsis* respectively. Neither of these two latter species has ever been found in Bélam, Pará, the scene of Goeldi's labors.

But Townsend pointed out that a strict adherence to the rules of nomenclature necessitated the abandonment of Goeldi's new name "*tarsimaculatus*" for any member of the complex, a statement with which the writer reluctantly agrees, and which will be discussed later in this paper.

The *tarsimaculatus* complex has been studied by Gabaldon et al. in Venezuela, who showed that two additional species could be separated out, which he called *A. nunez-tovari* and *A. rangeli* (12, 13). Ayroza Galvão (14) carefully went over the evidence presented by most of the authors who had worked with the complex, and came to the conclusion that six varieties of the complex occurred in Brazil, which he called *tarsimaculatus* Goeldi, *tarsimaculatus oswaldoi* Peryassú, *tarsimaculatus* of Root, and *oswaldoi oswaldoi*, *oswaldoi metcalfi*, and *oswaldoi noroestensis*.

Some of Ayroza Galvão's varieties seem founded on good evidence, but others are based on assumptions that cannot be proved. For instance, *oswaldoi metcalfi* is stated to be the form described by Root (6), with the second hind tarsal segment not less than 25 per cent black, and with eggs which do not show the oval elevations of the exochorion on the lateral and inferior faces, but instead have little stars formed by eight or ten lines radiating from an imaginary center, as described by Root. The oval elevations found on the eggs of all the known members of the *tarsimaculatus* complex may appear as Root had described, depending on various factors such as the intensity of illumination, degree of magnification, and the age and condition of the egg. Galvão states that he is not sure that *metcalfi* is a valid variety of *oswaldoi*.

Ayroza Galvão (14) obtained male and female specimens of a species of the *tarsimaculatus* complex from the Rio Parauari, Rio Maués, and Rio Maracaparú, tributaries of the Amazon in the interior of Brazil. No ecological data accompanied this material, but it was believed to be the same species with which Goeldi worked in Belém, although the localities from which the material came were some 800 to 1000 miles inland from Belém, which is at the mouth of the Amazon. (This material is probably of a new species, to be described by Rozeboom and Gabaldon). He later obtained material from Belém, but apparently believed that it was the same as Curry's species *aquasalis* from Panama (15). (This material is *emilianus*, described later in this paper.)

None of the workers cited above took into consideration the possibility that the species from Belém, Pará, might be different from anything hitherto described. In order to clarify this point, a visit was made during April, 1941, to Belém, for the purpose of obtaining material of Goeldi's species from the type locality. The life-history and ecology of Goeldi's species were worked out, and it was found to be distinct from *oswaldoi*, *nunez-tovari*, *rangeli*, or the so-called "*tarsimaculatus*" of Curry and Rozeboom (= *aquasalis* Curry). In order to obviate further difficulties in the nomenclature of the species of this difficult group, the species found in Pará, with which Goeldi worked in 1905, is here described and renamed. The necessity for such a renaming of the species is considered later in this paper.

Anopheles (*Nyssorhynchus*) *emilianus*, new species

Egg.—Of the usual *Nyssorhynchus* type, with lateral floats covering most of the dorsal surface, except in an elliptical area at the anterior (larger) end, a very narrow central area between the floats, and a U-shaped posterior area, the base of which almost reaches the posterior tip of the egg. A frill is present bordering the anterior and posterior areas of exposed endochorion. The ventral surface of the egg is convex, but the dorsal surface is almost flat, without the extreme convexity seen in the egg of *A. aquasalis* Curry.

The measurements of the egg are: Length, 0.485 mm.; Width, 0.1125 mm.

Length of exposure of endochorion between frill at anterior end, 0.0625 mm.

Number of float chambers, 25 to 30.

The eggs here described were obtained from females collected biting cattle, at a dairy on the northern outskirts of the city of Belém, a few hundred feet from a grassy pool in which larvae which gave apparently

identical adults were obtained. Four lots of eggs were obtained from as many females. All these lots agreed in their characters, and were distinct from the eggs of another species of the Nyssorhynchus group, probably *A. oswaldoi*, obtained at the same time from females which had a very small black ring at the base of the second hind tarsal segment.

FIG. 1.
Egg of *A. emilianus*,
upper surface.

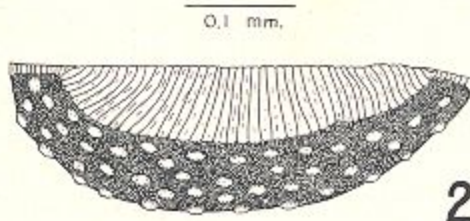


FIG. 2.
Egg of *A. emilianus*,
side view.

The number of elevations of the exochorion is greater than shown in this figure.

FIG. 3.
Egg of *A. aquasalis*,
upper surface.
(From Rozeboom, 1938.)

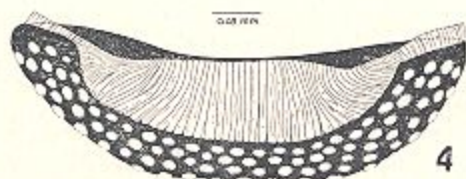
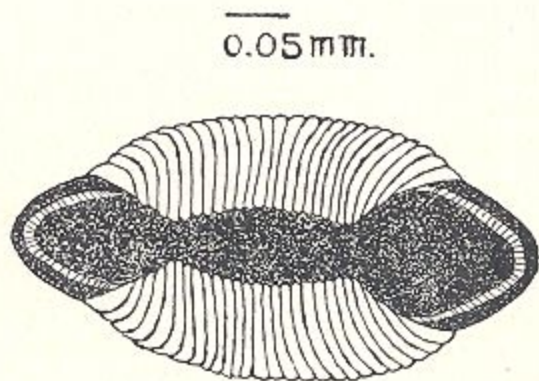


FIG. 4.
Egg of *A. aquasalis*,
side view.

Adult Female.

Head: Proboscis long, slender, black. Palpi with terminal segment white, sometimes a few black scales basally; penultimate segment narrowly black at base and apex, middle with pure white scales; antepenultimate segment black, sometimes with scattered white scales on dorsal surface, the extreme apex white. Second segment with outstanding black scales, a few white scales at extreme tip.

Antenna with torus dark, with a few white scales. Flagellar segments with gray tomentum, the basal segments with a few white scales.

Vertex with a tuft of long white setae, mixed with shorter curved white scales, overhanging the clypeus.

Occiput with many broad white truncate scales centrally, the sides with similar dark brown scales. A few small white scales on anterior eye-margins.

Thorax: Mesonotum dark gray, with a central darker line extending from anterior promontory to antescutellar space. Three dark spots on disk, two on each side posterior to lateral fossae, the third on antescutellar space, extending onto scutellum. Anterior promontory with a small tuft of white setae and elongated white scales. Disk of mesonotum covered with curved white scales, mixed with long dark setae; a patch of long white setae and elongated white scales before wing-root. Scutellum crescent-shaped, with short white scales and very long dark setae. Halteres with stem pale, knob black, with black scales below, the upper surface outlined with white scales.

Abdomen: Dark brown, clothed with long brown hairs; the tergites dorsally with triangular patches of yellow scales with a brassy luster. Lateral scale-tufts of broad brown scales on second to seventh segments. Sternites with a tuft of brown scales on each side of median line on segments 2 to 7, these brown scales preceded by a few white scales on segments 5 to 7. Eighth segment and cerci with cream-colored and brown scales.

Legs: Fore femur black, with an incomplete white basal ring, broadly yellowish on apical third beneath, a few light scales at extreme tip. Fore tibia black above, yellowish beneath, a few light scales at extreme tip. First fore tarsal segment yellowish below, black above, a narrow white apical ring. Second and third segments black with narrow white apical rings, that on third segment broadest. Fourth segment all black; fifth segment basally black, apically white.

Mid femur black above, yellowish below; laterally a light streak; two broad white spots before apex. Mid tibia black above, yellow below, a narrow white apical ring. First, second, and third mid tarsal segments black, with a narrow white apical ring. Fourth and fifth segments all black.

Hind femur black above, broadly yellowish below nearly to tip. Outer aspect with a long white streak ending in a broad white spot near apex; a few light scales at extreme tip. Hind tibia black above, broadly yellowish below, a few light scales at extreme tip. First hind tarsal segment black above, narrowly yellow below, a very small white spot at extreme tip. Second segment very slightly less than half black basally, the apex white. Third and fourth segments all white. Fifth segment white, with a narrow black basal ring.

Wings: Of the usual *Nyssorhynchus* type, and quite variable. Spot B 2 (second white spot from base of wing) usually broader than preceding black spot, sometimes the same size, and rarely somewhat smaller. In 11 specimens examined, spots M 1 and M 2 (the fourth and fifth spots beyond the base of the wing, respectively) were present. Third vein white with two small black spots near each end. Sixth vein white with two black spots, one near base, the other before tip.

Larva (4th Stage).

Head: Anterior internal clypeal hairs long, finely feathered, usually well separated at base, but space between insertion of hairs variable, sometimes very small. Anterior external clypeal hairs not as long as internals, with central shaft with many coarse branches beyond middle; more widely separated from internal clypeals than these are separated from each other.

Posterior clypeal hairs well behind and in line with external clypeals, usually simple, sometimes 2- or 3-branched.

Frontal hairs normal, much branched from central shaft; the four inner hairs equidistant, the outer pair well separated from these, inserted somewhat anterior to the others.

Inner occipital hair small, 3- or 4-branched, set well behind outer occipital hairs, well inside suture.

Outer occipital hairs set close to suture, larger, longer, 3- or 4-branched.

Antenna with shaft thickly spined; tuft small, 6- or 7-branched from central shaft; inserted on dorsal surface, about one-third distance from base to tip. Sabres long, serrate on one margin, pointed; cone moderate, finger long; terminal hair exceeding sabres, 2- or 3-branched.

Thorax: Anterior submedian prothoracic hair-group arising from common chitinized plate; inner hair like a palmate hair, with about 12 to 15 long, lanceolate leaflets; middle hair long, with central shaft strongly laterally branched; outer hair short, simple.

Large mesothoracic hair thickened at base, strongly feathered along shaft.

Small dorso-lateral hair short, simple.

Metathoracic palmate hair present, inconspicuous, with about 12 unpigmented lanceolate leaflets.

Prothoracic pleural hair-group of 4 hairs, anterior pair and posterior ventral hair long, simple; anterior ventral hair short, split near base into 2 to 5 (or more) terminal branches. Spur moderate, stout, pointed.

Mesothoracic pleural hair-group of 3 hairs; anterior pair long, simple; posterior ventral hair much shorter, very slender, simple. Spur long, stout, curved, pointed.

Metathoracic pleural hair-group of 3 hairs, anterior pair long, the anterior dorsal hair sometimes split at tip (noted in 5 of 10 larvae examined); anterior ventral hair simple; posterior hair short, the tip usually split into two branches. Spur long, stout, pointed.

Abdomen: Seven pairs of dorsal palmate hairs present on first seven segments; those on first segment very small, unpigmented, with about 12 lanceolate leaflets, each about half as long as those of palmate hair on 4th abdominal segment.

About 20 to 25 elements in each tuft beyond first segment, each element very narrow, lanceolate, pointed.

Antepalmate hair on 4th segment strong, simple.

Antepalmate hair on 5th segment strong, usually bifid.

Respiratory apparatus normal; the lateral anterior wings of the median plate variable but are usually short, wide, and extend to the rim of the spiracular openings.

Pecten with about 16 teeth, irregularly long and short, spined at base.

The anal segment is normal, with no characters of value in classification.

Pupa: Of the usual *Nyssorhynchus* type, the posterior lateral spine of the 8th abdominal segment long, slender, pointed.

Male Terminalia.

Side-piece (coxite) of the usual *Nyssorhynchus* type. Parabasal spine relatively short, thick, the tip somewhat recurved and pointed, inserted in a long pedunculated tubercle. The two parabasal spines longer, with flattened tips, inserted in two tubercles, at about the basal third of the side-piece. Internal spine very long, slender, cylindrical, the tip curved towards base of terminalia, inserted in a slightly protruding tubercle on the dorso-internal aspect of the side-piece.

Clasper (style) of the usual *Nyssorhynchus* type, with a few setae on the outer aspect before the tip. Terminal spine long, about 0.03 mm., pointed.

Mesosome without leaflets. The membranous tip is somewhat longer than wide, deeply excavate within; length of tip, from the two incurving triangular parts at base, to apex = 0.045 mm., width of tip at widest point 0.04 mm. (In *Anopheles aquasalis* Curry the corresponding measurements are: Length, 0.038 mm.; width, 0.04 mm.). The proportion of length to width in *emilianus* is 1.09 to 1, while in *aquasalis* the length is to the width as 0.91 is to 1.

Fused ventral lobes of claspette (which are dorsal in position) composed of a tent-like structure, with median apical sulcus, and two long basal lobules fringed with sparse long hairs from free margin. The length of these hairs is about 0.05 mm., while in *aquasalis* they are fewer and about 0.038 mm. long. The hairs on both sides of the median cleft between the two basal lobules are finer and extend nearer the free edge of the basal lobules than they do in *aquasalis*. The pre-apical plate, which is situated at the apex of the cleft between the two basal lobules, is apparently slightly elliptical, with the long axis oriented in a median line. The median flattened chitinized strip, which supports the tent-like structure of the fused lobes, and which is attached basally to the side-pieces, and apically just below the pre-apical plate, is finely sculptured along its entire length.

Dorsal lobes of the usual *Nyssorhynchus* type, consisting of a pedicel bearing at its apex three long, curved, pointed, striate filaments, widened basally, with median vein.

Anal lobes as usual in *Nyssorhynchus*, the membrane rugose, without pilosity, supported by paired chitinized paraprocts on inner aspect.

Ninth tergite membranous centrally, fine-pilose on most of surface, the pilosity longest at angles nearest anal lobes. Ninth sternite narrow, with basally-projecting rounded projection.

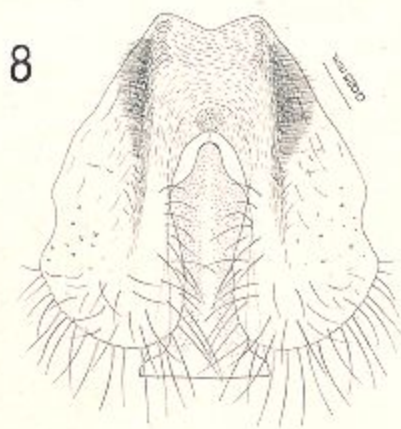
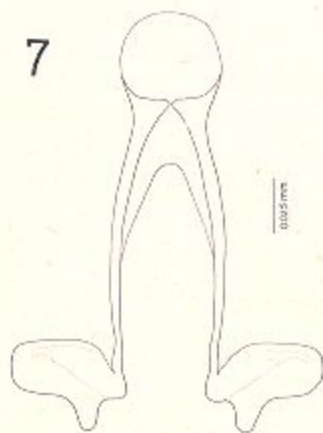
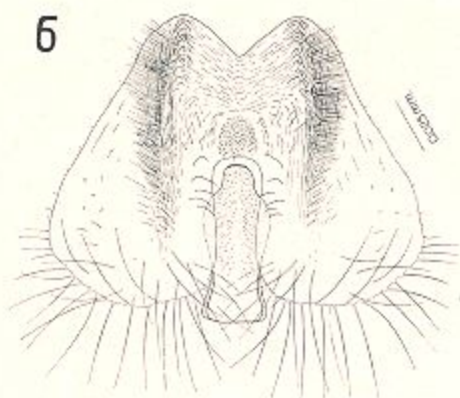
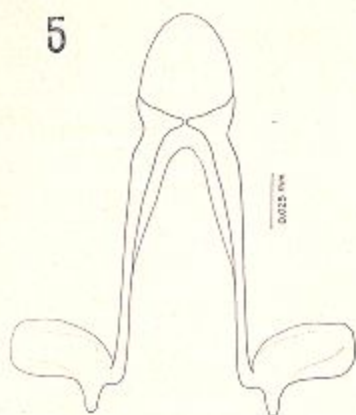


FIG. 5. Mesosome of *A. emilianus*.
 FIG. 6. Fused claspette lobes of *A. emilianus*.
 FIG. 7. Mesosome of *A. aquasalis*.
 FIG. 8. Fused claspette lobes of *A. aquasalis*.

Type locality: Belém, Pará, Brazil.

Type material: Holotype male, reared from larvae collected in a grassy pool on the northern outskirts of Belém, Pará, Brazil; allotype female, from same locality; a series of three males and three females, also reared, are paratypes. Collector, W. H. W. Komp. Date of collection: April 14, 1941. Types

deposited in the U. S. National Museum, together with mounted larvae from the same pool from which the type series was obtained.

NECESSITY FOR RENAMING THE SPECIES HITHERTO CALLED
TARSIMACULATUS

The reason that a new name for Goeldi's material is required is that Goeldi violated one of the rules of nomenclature by proposing an emendation of a valid specific name. Article 32 of the International Rules of Zoological Nomenclature states: "A generic or specific name, once published, cannot be rejected, even by its author, because of inappropriateness." In the present case, the name in question is *argyrotarsis*, var. *albipes*. Goeldi proposed to change the name *albipes* to "*tarsi-maculata*," because *albipes* was too similar to the name of a related species, *albitarsis*. This is proved by Goeldi's statement on page 133 of "Os Mosquitos no Pará," which reads "Nesta ocasião não posso esquivar-me de formular uma queixa contra o tal termo 'albipes,' que em vez de ajudar o discernimento de certa forma e a retenção do nome, contribue antes para confundir, tanto mais que tem de navegar ao lado do termo 'albitarsis' pela especie typica. Não são afinal das contas ambas tanto 'albipes' como 'albitarsis'? Porque não recorrer a uma designação que elimine, de uma feita, a confusão, escolhendo por exemplo 'tarsi-maculata'?" Which being translated reads "At this juncture I cannot avoid voicing complaint against such a term as 'albipes.' Instead of helping in the differentiation of a certain type and in the retention of the name, it rather increases confusion. This is especially so since it must accompany the term 'albitarsis' for the typical species. In the last analysis, are not both species 'albipes' as well as 'albitarsis'? Why not resort to some designation which shall remove at once the confusion, selecting, for instance, 'tarsi-maculata'?" There is no possibility that Goeldi believed that he was describing a new species, and nothing can be found in his paper which can lead us to believe that he thought his material was new. Thus the contention of Galvão and Lane (14) that Goeldi's name is valid is incorrect, as they quote an inapplicable portion of the International Code: "Article 21. The author of a scientific name is that person who first publishes the name in connection with an indication, a definition, or a description . . ." They omit any reference to Article 32, which has already been quoted, and

which applies in this instance, as Goeldi had no intention of describing a new species. As *tarsimaculatus* is *albipes*, and *albipes* is a synonym of *albimanus*, therefore *tarsimaculatus* is also a synonym of *albimanus*.

Two other possible names for Goeldi's species remain to be considered. One is that of the species named *evansi* by Juan Brèthes (16). This was described from males sent to Brèthes from Tucuman, Argentina, by N. C. Davis. Brèthes' description does not mention the appearance of the adult specimen, so that we have only Davis' word for it that the material was *tarsimaculatus*. Davis has well described the errors into which Brèthes fell in trying to describe the male terminalis of his *evansi*. Davis (17) states "In fig. 2 of Brèthes' paper is shown (A) 'side-piece and half of the aedoeagus'. In this drawing the 'half of the aedoeagus' is obviously one of the hairy protuberances found applied or attached to the fused dorsal lobes of the claspette (Root's nomenclature). Fig. 2 C. is labeled 'inner side of the aedoeagus'; this is not the aedoeagus, but the fused dorsal lobes of the claspette (Root) or the median lobe (of Evans). The drawings in Fig. 2, A. B. C., are evidently from dissected genitalia; the true mesosome is not shown, unless it appears in D., faintly discernible through the anal lobe. That the mislabeling is no accident is proved by the corroborative text.

"If the label 'aedoeagus' of Brèthes is changed to 'the fused dorsal lobes' of Root, it then becomes necessary to decide the species identification. It is barely possible that Brèthes was working with both forms, and that A and C (fig. 2) were taken from different specimens. But whatever may be concluded about the hairy lobes in A, it is certain that C does not represent any part of what Root called '*strodei*'. In the latter most of the terminal striations of the dorsal lobes flare outward, not inward, and the extremity is not hairy, as figured by Brèthes. Fig. 2, C, would be an unusual, but perhaps not impossible, view of the inner surface of the fused dorsal lobes of *tarsimaculatus*. Perhaps Brèthes can furnish other more convincing drawings, but, from the present evidence, '*evansi*' should refer to the common type of *tarsimaculatus* found in Argentina."

Now from the work of Ayroza Galvão and his co-workers in southern Brazil, it is believed that the so-called *tarsimaculatus* of this region is composed of a number of races or varieties of *oswaldoi*. The present writer does not see how it is possible to refer Brèthes' material to any one species of the complex, as

none of his figures bear the slightest resemblance to any known species, and are insufficient in themselves to enable one to place the species with which he was dealing. The lack of a description of the adult also renders this impossible. In the circumstances, the only possible course is to consider Brèthes' species unrecognizable from his description, and to eliminate it from further consideration. Or on the basis of Galvão's findings, it may be referred to the synonymy of *oswaldoi*.

The other species name which must be considered is *gorgasi* D. and K. (18). This was described from a single female in poor condition, collected on the Pacific side of the Canal Zone, at La Boca. Knab believed it to be an aberrant form of *tarsimaculatus*, differing only in the markings of the hind tarsi. Dr. D. P. Curry is of the opinion that *gorgasi* should be referred to the synonymy of *albimanus*, as *aquasalis* has been found only once breeding in any large numbers on the Pacific side of Panama, during the twenty years of his term as Assistant Chief Health Officer of the Canal Zone. This was in 1937, when dredging operations created a brackish swamp opposite Corozal, in which large numbers of larvae of *aquasalis* Curry were found. On the other hand, *albimanus* is the commonest Anopheline of the Pacific side. The present writer has taken two aberrant specimens of *albimanus* in the Canal Zone, in which an extra black band was present on the third hind tarsal segment. He concurs in Curry's belief that *gorgasi* should be referred to *albimanus*, not to *aquasalis*. At any rate, *gorgasi* could not be a synonym of Goeldi's "*tarsimaculatus*," but rather of *aquasalis* Curry.

ECOLOGY OF *A. EMILIANUS*

Very little is known of the ecology of the new species from Pará. It is undoubtedly widespread in the Amazon basin, but in view of the confusion in nomenclature which has hitherto existed, little that can be definitely connected with *emilianus* can be cited.

The writer's observations in Pará showed that the species had a definite ecological niche. The larvae were very common in parts of the city of Belém, and in its suburbs. Larvae were found in several localities: in a grassy, sunlit pool in an unpaved street in the southeastern section of the city; in a small grassy sunlit pool at which cattle drank, on the northern outskirts in the edge of a grassy swamp, among water-hyacinth (*Piaropus*

crassipes) and grass; in an extensive rain-pool, grassy and sunlit, near the banks of the Guararé river to the north of Belém. All these situations possessed several ecological elements in common: they were all collections of fresh water, all were grassy, and all were open to the full sun. The associated mosquito larvae found in these pools were various species of *Uranotaenia* and *Culex*, normal inhabitants of rain-pools.

DISTRIBUTION OF *A. EMILIANUS*

The writer believes that *emilianus*, breeding in fresh water, may be widespread in the Amazon Valley. In the Amazon interior, it may occur with or be replaced by another similar species of the complex, with mesosomal leaflets, to be described by Rozeboom and Gabaldon from the Rio Tapajos. *Emilianus* may also occur in British Guiana, breeding in irrigation ditches in the rice-fields. But in this region *aqualis* probably also occurs, as a salt water form has been reported from this region by Cleare (19) and by Giglioli (20). Gabaldon reports *aquasalis* from Venezuela. *Emilianus* is not known to occur in Panama, the fresh water form there being probably *oswaldoi*, and the salt water form being *aquasalis* Curry. The species occurring throughout the West Indies and on the coast of Trinidad, B. W. I., is probably *aquasalis* Curry. The writer has eggs of *aquasalis* obtained from a female from the Island of St. Lucia. In Trinidad there may be a mixture of *aquasalis*, *oswaldoi*, and *emilianus*, and *rangeli* may also occur there (21). The species occurring on the coast of Ecuador is probably *aquasalis*. *A. rangeli* has been found in the interior of Colombia (Villavicencio) by the writer.

DISTINCTIONS BETWEEN *A. EMILIANUS* AND *A. AQUASALIS*

To all intents and purposes the larvae of *emilianus* and *aquasalis* are not separable, and both resemble those of *oswaldoi* very closely. The male terminalia are not particularly distinctive, although the mesosome of *aquasalis* has a shorter and broader tip than that of *emilianus*, and the hairs fringing the free margins of the basal lobules of the fused claspette lobes are shorter than in *emilianus*. These differences are subject to variation, and are rather indefinite. The species are most easily separable in the egg stage, and it is by this criterion that the presence of *aquasalis* and *emilianus* in any locality should be judged. The difference between the eggs of *emilianus* and

aquasalis can best be shown by drawings of the two eggs. In the egg of *emilianus* the upper surface is almost flat, when viewed from the side, while the egg of *aquasalis* is very concave, as mentioned by Rozeboom, and as shown in fig. 4 of this paper. The two ends of the egg of *aquasalis* are similarly shaped, with a wide exposure of the endochorion between the frills, and a wide central area of the endochorion is exposed between the floats. The two ends of the egg of *emilianus* are different, the anterior end being wider, with a frill surrounding an elliptical exposed area of endochorion; the posterior end has a very narrow U-shaped frill surrounding a small opening, and there is hardly any exposure of the endochorion on the upper surface between the floats. The egg of *emilianus* more closely resembles the egg of *oswaldoi* from Panama, shown on page 100 of Rozeboom's paper (8). The frill present on the posterior end is absent in the egg of *oswaldoi*.

It is suggested that, when the specific identity of the species occurring in any definite region is undetermined, the non-committal term "a species of the *tarsimaculatus* complex" be used, instead of the specific name "*tarsimaculatus*," which is untenable, and which refers to a complex of species.

RELATION TO MALARIA

Very little is known of the ability of *A. emilianus* to transmit malaria. There are two reasons for this, one being that the distribution of the species is unknown, so that records referring to *emilianus* are inextricably confused with those of *oswaldoi* and *aquasalis*; the other reason is that only a few records are available of dissections and malaria rates in the region around Belém, where *emilianus* is definitely known to occur. In 1930 N. C. Davis (22) dissected 22 specimens of what he called *tarsimaculatus* from Belém, finding all negative for malaria parasites. Recent observations by the staff of the Instituto de Patologia Experimental Evandro Chagas, in Belém, show that a blood parasite rate of about 5 per cent is found in the population living in districts of the city of Belém in which *emilianus* is the dominant Anopheles. Observations made by the present writer in Belém showed that *emilianus* did not frequent houses, even in the immediate vicinity of its breeding-places, and that it preferred the blood of cattle to that of man, which accords with the observations of Davis. Apparently *emilianus* is not a potent vector of malaria in its type locality.

THE IDENTITY OF *A. EMILIANUS* WITH THE SPECIES FOUND
IN BELEM BY GOELDI

In 1905, at the time Goeldi made his observations on the supposed *argyrotarsis* var. *albipes* in Belém, the systematic entomology of mosquitoes was in its infancy. Attention had been drawn only a few years previously to the role of mosquitoes as vectors of disease, and little was known of the methods and criteria now in use to differentiate closely related species. Goeldi's pioneer work should be judged with these facts in mind.

In determining the species with which he worked, too much emphasis should not be placed on his figures and descriptions, as these are not adequate to distinguish species, according to modern knowledge. As an instance, his excellent figure of the adult of *argyrotarsis* given in Est. II, fig. 10 of "Os Mosquitos no Pará," shows the terminal segments white, without the basal black bands which are present. The same may be said of his figures of the egg of the Pará species. Goeldi states that his figures of the eggs are photomicrographs, but it is easily seen that they are drawings from photomicrographs. The elevations of the exochorion are not shown in the ventral view of the egg, and the dorsal view may have been taken from a photograph of a shriveled egg. Anyone who has worked with the eggs of *Anopheles* knows how delicate and fragile they are, and how nearly impossible it is to preserve them. In drying, the exochorion shrinks away from the endochorion, and great distortion results. Galvão and Lane (14) have mentioned the impossibility of accurately counting the float-chambers in Goeldi's drawings.

Emphasis should rather be laid on the relative commonness of the species of the group, in the region in which Goeldi worked. The writer's observations made in Belém show that one species of the *Nyssorhynchus* group is the commonest sort found in the city. Near the site of Goeldi's home is a large fresh-water swamp, as yet only partially drained, and in the rainy season there are numerous grassy pools in the vicinity, in which *Anopheles* larvae may be present. In such circumstances, it is most probable that the commonest species in the neighborhood of Goeldi's home is the species that entered his house and bit members of his family, as he notes on page 130 of "Os Mosquitos no Pará." The only species which fulfills these requirements is the species found breeding in numbers within the city limits, in grassy pools of fresh water, and which is here described.

SUMMARY

What was formerly considered one species of the "*tarsimaculatus*" series of the subgenus *Nyssorhynchus* of *Anopheles*, is now known to consist of a complex of species. A history of the development of knowledge of this complex is given. One of the species forming this complex, formerly known as *tarsimaculatus* Goeldi, is shown to have an invalid name, and is here described and renamed *Anopheles (Nyssorhynchus) emilianus* n. sp. This new species differs from *Anopheles aquasalis* Curry, hitherto confused with *emilianus*, and the differences between the two species are shown.

Two other possible names for the new species from Pará are discussed, and both *evansi* and *gorgasi* are discarded for reasons given.

As the species of the "*tarsimaculatus*" complex are very similar, and are easily separable only by examination of the eggs, it is suggested that in mentioning a species of the complex, the identity of which is unknown, the term "a species of the *tarsimaculatus* complex" be used, instead of the invalid and meaningless name "*tarsimaculatus*."

Notes are given on the ecology and distribution of the new species, and its identity with the species mentioned by Goeldi.

ACKNOWLEDGMENTS

The writer acknowledges with sincere thanks the co-operation of the staff of the Instituto de Patologia Experimental Evandro Chagas, which is situated in Belém. He is particularly indebted to Dr. Sousa Castro, Director, who gave him access to the facilities of the Instituto, and to Dr. Orlando Costa and Arthur Marques, who accompanied him on many field trips, and to Dr. Reinaldo Damasceno, who presented him with much valuable entomological material. Their assistance in providing working-quarters and transportation, and their knowledge of local conditions, contributed materially to the success of his undertaking. He is also under obligation to Dr. Aristides Moll, Secretary of the Pan American Sanitary Bureau, for assistance with the translation of the paragraph from Goeldi, and to Mr. G. B. Fairchild for criticism of the manuscript.

REFERENCES

- (1) Theobald, F. V. 1901. Monog. Culicidae, 1: 125.
- (2) Goeldi, Emilio. 1905. Os Mosquitos no Pará. C. Wiegandt, Pará, Brazil.

- (3) Howard, L. O., Dyar, H. G., and Knab, F. 1917. The Mosquitoes of North and Central America and the West Indies, 4 (2): 978. Carnegie Institution of Washington, D. C., Publication No. 159.
- (4) Peryassu, A. G. 1922. A Folha Medica, 3: 179.
- (5) Costa Lima, A. da. 1928. Sobre algumas Anophelinas encontradas no Brasil. Suppl. Mem. Oswaldo Cruz, 3: 91-113.
- (6) Root, F. M. 1926. Studies on Brazilian Mosquitoes. I. The Anophelines of the Nyssorhynchus group. Amer. Jour. Hyg., 6 (5): 684-717.
- (7) Curry, D. P. 1932. Some observations on the Nyssorhynchus group of Anopheles (Culicidae) of Panama. Amer. Jour. Hyg., 15 (2): 566-572.
- (8) Rozeboom, L. E. 1938. The eggs of the Nyssorhynchus group of Anopheles (Culicidae) in Panama. Amer. Jour. Hyg., 27 (1): 95-107.
- (9) Townsend, C. H. T. 1933. Note on Anopheles of the Nyssorhynchus group (Diptera, Culicidae). Ent. News, 44 (4): 101-102.
- (10) Townsend, C. H. T. 1933. On *Nyssorhynchus tarsimaculatus* Goeldi and the races of Nyssorhynchus. Rev. Entomologia, 3 (1): 7-12.
- (11) Townsend, C. H. T. 1934. Mosquitoes of the Rio Tapajos. Rev. Entomologia, 4 (4): 486-499.
- (12) Gabaldon, A. 1940. Description de Anopheles (*Nyssorhynchus*) nunez-tovari, N. Sp., y consideraciones sobre una sub-division del grupo Nyssorhynchus (Diptera, Culicidae). Estudios sobre Anofelinos. Serie I, Pub. de la Div. de Malariologia, No. 5, Ministerio de San. y Asist. Soc. Caracas, Venezuela. Aug. 15.
- (13) Gabaldon, A., Cova-Garcia, P., and Lopez, J. A. 1940. *Anopheles (Nyssorhynchus) rangeli*, una nueva especie de la subserie oswaldoi (Diptera, Culicidae) de amplia distribucion en Venezuela. Estudios sobre Anofelinos. Serie I. Pub. de la Div. de Malariologia, No. 5. Ministerio de San. y Asist. Soc. Caracas, Venezuela. Aug. 15.
- (14) Galvao, A. L. A., and Lane, J. 1938. Notas sobre os Nyssorhynchus de S. Paulo. VI. Revalidacao de *Anopheles (Nyssorhynchus) oswaldoi* Peryassu, 1922 e discussao sobre *Anopheles (Nyssorhynchus) tarsimaculatus* Goeldi, 1905. Livro Jubilar Prof. Travassos, 169-178. Rio de Janeiro, March.
- (15) Galvao, A. L. A. 1940. Contribuicao ao conhecimento dos Anofelinos do Grupo Nyssorhynchus de São Paulo e regioes vizinhas (Diptera, Culicidae). Arq. Zool. do Est. de São Paulo, Vol. 1, Art. 14, 399-484.
- (16) Brethes, Juan. 1926. Notas sobre los Anophelinos Argentinos. Physis, 8 (30): 311-315.
- (17) Davis, N. C. 1928. A consideration of variability in the Nyssorhynchus group of the genus Anopheles. Amer. Jour. Hyg., 8 (4): 549.
- (18) Dyar, H. G., and Knab, F. 1907. Jour. N. Y. Ent. Soc., 15: 198.
- (19) Cleare, L. D. 1927. Notes on Breeding-Habits of Two Mosquitoes. Bull. Ent. Res., 17 (4): 405-409.
- (20) Giglioli, G. 1938. Malaria in British Guiana. Part I. The Anopheline mosquitoes of the Colony. Agric. Jour. Brit. Guiana, 9 (2): 75-81.
- (21) Rozeboom, L. E. Personal communication.
- (22) Davis, N. C. 1931. A note on the malaria-carrying Anophelines in Belém, Pará, and in Natal, Rio Grande do Norte, Brazil. Riv. Malariologia, Anno X, No. 1: 3-11.