

SOME OBSERVATIONS ON THE *NYSSORHYNCHUS* GROUP
OF THE *ANOPHELES* (*CULICIDAE*) OF PANAMA.*

By

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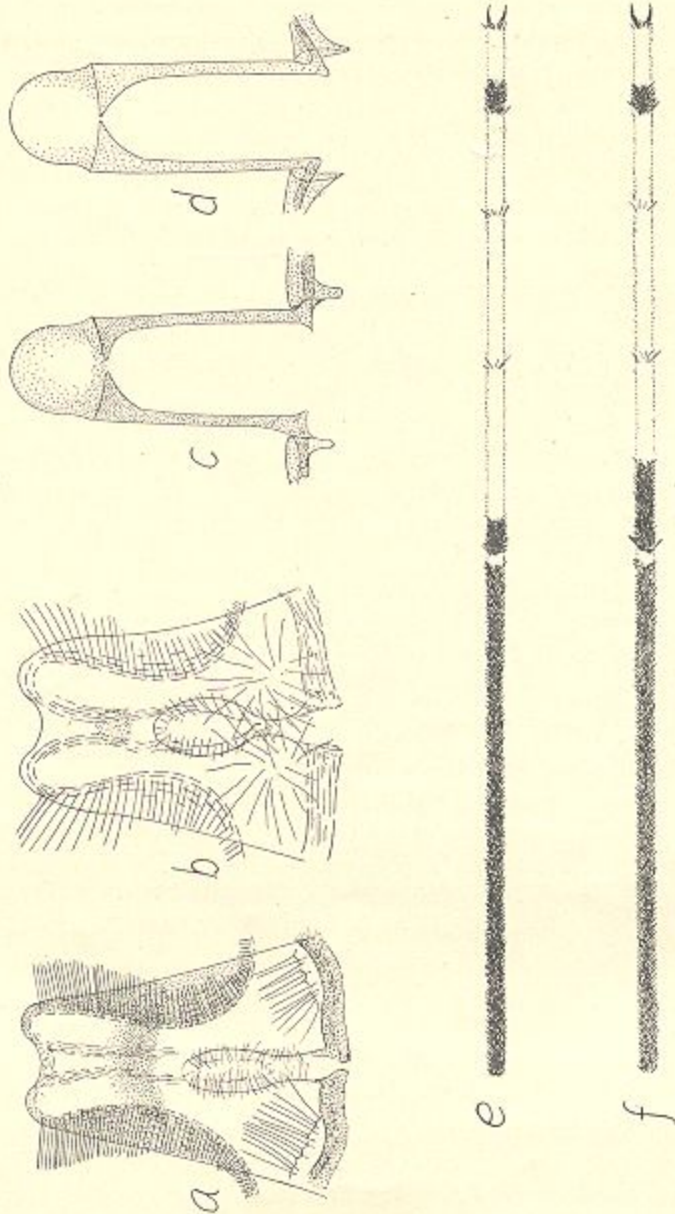
The subgenus *Nyssorhynchus*, comprised of the white hind-footed *Anopheles*, is of the greatest interest to workers in Panama because in it are probably the only carriers of malaria of real importance in this region. Of the five species of that subgenus that have been listed here,† only one, *A. albimanus* Wiedemann, is, in the opinion of some of us, of truly great importance, the others far less so, despite the classic work of Darling (1910) which indicates that *A. tarsimaculatus* Goeldi is perhaps equally infectible in the laboratory. I shall refer to this phase of the subject later.

While the subgenus *Nyssorhynchus* is ordinarily divided into a *Myzorhynchella* group and a *Nyssorhynchus* group, only the latter is found here, and I shall, for convenience in discussing certain of the local species, speak of a "subgroup" of these, comprised of those that have in the female adult an intermediate white band on the palpi, making it difficult to distinguish one from the other by coloration alone. This local subgroup includes *A. strodei* Root, *A. bachmanni* Petrocchi, *A. tarsimaculatus* Goeldi, and one recently discovered here which may be *A. oswaldoi* Peryassú but does not appear to be *A. tarsimaculatus* as we have known that species, although I have, for the present, called these last two *A. tarsimaculatus* var. *aquasalis* and *A. tarsimaculatus* var. *aquacaelestis*, respectively. The latter name is an old pharmaceutical term signifying "rain water."

Larvae of *A. strodei* are found usually during the early part of the dry season, along the grassy margins of fresh pools and quiet streams of the Pacific side of the Isthmus. They are never very plentiful and have been recorded but once that I know of from the Atlantic side of the Isthmus (Root, 1926). These larvae are usually easy to

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† Since the above was written, *A. albitarsis* Lynch Arribalzaga has been discovered breeding in surface patches of bladderwort (*Utricularia mixta*) in remote parts of Gatun Lake. It, too, may prove to be an important vector of malaria.



a. Membranous (ventral) lobes of claspette of *A. tarsimaculatus* var. *aquasalis* (balsam mount). b. Membranous (ventral) lobes of claspette of *A. tarsimaculatus* var. *aquasalis* (balsam mount). c. Sheath of mesosome of *A. t.* var. *aquacaelensis*. d. Sheath of mesosome of *A. t.* var. *aquacaelensis*. e. Hind tarsi of *A. t.* var. *aquacaelensis*. f. Hind tarsi of *A. t.* var. *aquacaelensis*. g. Hind tarsi of *A. t.* var. *aquasalis*. h. Hind tarsi of *A. t.* var. *aquasalis*.

recognize by the clypeal hairs (finely branched, inner ones long and closer together than the distance from the inner to the outer ones, the outer ones much shorter than the inner and curving inward at the tips), by the submedian anterior thoracic hairs (palmate, about 15 leaflets, less than width of tuft apart), and by the abdominal palmate float-hairs (leaflets very long and delicately acuminate). The genitalia of the male are characteristic. The adult female perhaps cannot with certainty be distinguished from the *A. tarsimaculatus* var. *aquasalis* that breeds in brackish water on the Atlantic side of the Isthmus, but, since males and larvae of the latter are never found on the Pacific side, it may be considered safe to conclude that females of this appearance taken on the Pacific side are not *tarsimaculatus*. I may add that I have not failed to "guess" correctly as to males of *A. strodei*, judging them by the amount of black on the basal end of the second hind tarsus, which is intermediate between that on the corresponding joints of the two varieties of *A. tarsimaculatus*.

Larvae of *A. bachmanni* are frequently encountered in the quiet inlets of Gatun Lake and other bodies of still water, but only within the crowns of waterlettuce (*Pistia stratiotes*). Several of us have spent hours in pools where it was plentiful, searching both within and without the crowns of the plants, and not a single larva was found outside the circumference of the plants, where these had not been previously disturbed so as to dislodge the larvae. The adult female can be recognized by the spots on the costa of the wing as described by Root (1929), and the male genitalia are unmistakable.

Larvae of what we have heretofore believed to be true *A. tarsimaculatus* have been collected by myself and my coworkers only in the lowlands of the Atlantic side of the Isthmus and only from brackish water. They have not in my experience in the last thirteen years, been taken in water or areas to which the tide does not have at least occasional access. A number of the waters in which they have been found breeding have been examined and the lowest salt content in any specimen indicated, at the time the larvae were collected (after copious rains), an admixture of about 3 per cent of sea water; the highest sea water content in any specimen examined was 66.8 per cent, but doubtless this proportion may be exceeded at times. I have called this brackish water variety *A. tarsimaculatus* var. *aquasalis*. This variety breeds in abundance at times in the enormous tidal flats of the Atlantic seacoast. It prefers fairly well shaded places and is relatively far-flying. Before the large coastal swamps within a few miles to the east of Colon and Cristobal were drained, countless

thousands of these mosquitoes would swarm into those cities in the early weeks of the rainy season each year when breeding was at its maximum. I myself some years ago counted nearly a hundred of them on a single panel of a window screen at the Mt. Hope cemetery office. Yet, despite the evidence of the laboratory in regard to its infectibility, these enormous flights were not followed by a corresponding rise in the malaria rate. Had *A. albimanus* invaded the cities in similar numbers the rate would have gone sky-high. *A. tarsimaculatus* has not to my own 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 the other similar species named above (*A. strodei* and *A. bachmanni*). My own observations have been confirmed by larval and genitalic identifications when this was possible.

Larvae of *A. tarsimaculatus* var. *aquacaelestis* have in the past year been taken in numbers from fresh water pools on the Atlantic side of the Isthmus at elevations far above the reach of the tides. They have not been found in brackish water. The larvae of var. *aquacaelestis* appear to differ from those of var. *aquasalis* only in that the anterior clypeal hairs of the former are somewhat less strongly branched than those of the latter variety. They, too, prefer shaded locations in which to breed and they have been found in the same pool with *A. eiseni* Coquillett, *A. apicimacula* Dyar and Knab, *A. punctimacula* D. and K., *Chagasia bathanus* Dyar, and other shade-preferring culicines. The adults of var. *aquacaelestis* differ rather strikingly from those of var. *aquasalis*, in that the former have black on the basal end of the 2d hind tarsi to the extent of less (usually much less) than $1/6$ of the length of the segment, whereas in the latter variety the black runs to nearly $1/2$ the length of the segment in every specimen, and *there is no intergradation of this character here*. The genitalia of the male of var. *aquacaelestis* closely resemble those of var. *aquasalis*; the differences, though minute, are constant, however. In var. *aquasalis* the upper parts of the fused, hairy, membranous (morphologically ventral) lobes of the claspette are not bridged by sclerotized chitin, but exhibit at the junction a tiny diffuse or ring-like area of sclerosis. In var. *aquacaelestis* these parts of the fused lobes are distinctly joined by a crescent shaped bridge of sclerotized chitin, the margins of which are not sharply defined. Even with a low power lens, in cleared and mounted specimens this bridge is easily seen. The distal portion and the lateral arms of the penis sheath of var. *aquacaelestis* are more heavily sclerotized than those of the brackish

water variety. I have but one record of capture of an adult of var. *aquacaelestis*, a female (Colon Hospital screens, June 20, 1929, C. H. Bath); it apparently is not prone to seek out human habitations, or else its flight range is limited.* It does not attack man readily, for even in the shaded jungle where it was breeding in numbers it did not attack, nor was it seen on the wing; it was induced to bite in the laboratory, although it did not do so anything like as readily as did *A. albimanus*.

The differences between *A. tarsimaculatus* var. *aquasalis* and *A. tarsimaculatus* var. *aquacaelestis* are constant for the Canal Zone and do not intergrade, even when found breeding within the same square mile of territory. They may be summarized as follows:

	Var. <i>aquacaelestis</i>	Var. <i>aquasalis</i>
Larva		
Breeding place	Fresh water always	Brackish water always
Ant. elypeal hairs	Less heavily branched	More heavily branched
Adult		
Second hind tarsi	Less than 1/6 black	Nearly 1/2 black
Flight range	Not far	Fairly far
Biting habits	Does not attack man under ordinary conditions	Bites man freely
Male genitalia		
Membranous lobes of claspette	Bridged by sclerotized chitinous crescent	Not bridged by sclerotized chitin
	Dorsally reflected folds strongly sclerotized and densely pilose	Dorsal folds weakly sclerotized and less densely pilose
	Hairs at base of lobes fringe-like and directed dorso-apically	Hairs at base of lobes directed radially from mound-like protuberances
Sheath of mesosome	Lateral arms and tip rather strongly sclerotized	Lateral arms and tip weakly sclerotized

These differences would seem to justify the recognition of a new species instead of regarding both as merely varieties. My reasons for not doing so at this time are as follows: First, there is much uncertainty as to early descriptions of *A. tarsimaculatus*, nor do I know what was the character of its breeding place, therefore I am not

* Since writing the above, numbers of females of *A. t.* var. *aquacaelestis* have been taken with a sweep-net, and also in the act of attacking, in the densely shaded jungle swamps along the lower Chagres river on the Atlantic side of the Isthmus.

absolutely sure that our *A. tarsimaculatus* var. *aquasalis* is really of that species. I have specimens from Trinidad, sent by Dr. Eric de Verteuil of the Malaria Survey Office, Port of Spain, which appear to be identical with our brackish water variety, some of which he declares to have been taken from absolutely fresh water, although the greater number, he says, come from brackish water similar to that in which it breeds on the Isthmus. Dr. de Verteuil also states that in Trinidad these mosquitoes are potent vectors of malaria. They do not appear to have *A. albimanus* there, but they do have *A. albitarsis*, which is, presumably, a dangerous carrier of malaria. Second, the variety I have called *aquacaelestis* is undoubtedly quite similar in appearance to *A. oswaldoi* from Brazil, which Root (1926) places in the synonymy of *A. tarsimaculatus*. Since I have no specimens of this mosquito to compare with mine, and no information regarding its breeding habits, I have, for convenience, preferred to treat the Panama one as a separate variety of *A. tarsimaculatus* for the present. I have specimens from Trinidad, male and female, similar in every way to our var. *aquacaelestis*, which distribution inclines me still more to believe that upon further study it will be found to be *A. oswaldoi* Peryassú and a valid species, not merely a variety of *A. tarsimaculatus*.

This and other interesting problems, which are really important from a malaria control viewpoint, can be cleared up only by much more study in all parts of neotropical America. Study of the male genitalia has not received anything like the attention it deserves, and its ease of performance, certainty and practicability have not been appreciated by field workers in general. To boil the end of the abdomen of the male for a few seconds in a 10 per cent solution of caustic potash, wash, dehydrate in alcohol, clear in creosote or oil of cloves, and mount in balsam, is the work of but a few minutes, and the equipment, outside of a good microscope, may be carried in one's coat pockets. All, including a folding compound microscope, can be carried in a satchel slung from the shoulder. It provides many an excellent evening's entertainment in one's home.

The male genitalia of *Anopheles* require but little manipulation to cause them to lie in a good position for examination. The cover glass should not be placed directly upon the specimen, but there should be interposed between the slide and the cover glass a few bits of a broken up very thin (no. 1) cover glass, or, better still, small strips of even thinner "cellophane" such as comes wrapped around certain brands of candy and chewing gum. The minute space thus provided between the two glass surfaces is enough to prevent the specimen from being

crushed, and permits every part to be seen in its normal relation to the others. Much can be learned from study of the male terminalia in the freshly killed state, and also of the boiled out specimen after washing out the caustic but before dehydration with alcohol. The alcohol sometimes causes much shrinking of delicate membranous parts, such as the ventral lobes of the claspette and the anal lobe. A better view of the penis sheath and its leaf-like appendages may be obtained by turning back the anal lobe or removing it entirely. This can be done with dissecting tools made by inserting fine entomological pins (*minuten nadeln*) into handles made from the slender wooden "applicators" used so largely in the treatment of the ear, nose and throat. Staining as a routine procedure is not necessary.

Another procedure that will facilitate the solution of these problems is the exchange of specimens between those who are really interested in them. The writer will be very glad to exchange unmounted specimens of larvae and adults, male and female, with any one else so interested. Full notes as to date and place of collection, character of breeding place, and any other pertinent facts, should accompany every specimen. This tropical American region offers a rich field for study and research, and many men in many places may garner for years to come without exhausting its treasures or uncovering all its mysteries.

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