J. Med. Ent. Vol. 8, no. 2: 116–119 30 July 1971

PYLORIC ARMATURE OF NEW WORLD PHLEBOTOMINE SANDFLIES (DIPTERA, PSYCHODIDAE)[1]

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Abstract: The occurrence of spiculate armature in the pylorus of Neotropical Phlebotominae is reported. The armature occupies slightly more than the posterior 1/3 of the pylorus, and is similar in appearance to the pharyngeal armature of several Neotropical species. Spines are directed posteriad in both structures. More than 100 Panamanian sandflies, comprising over a dozen species, were dissected and all possessed this structure. We propose that the pyloric armature may function in the disruption of the undigested hematin blood-meal residue and its enclosing peritrophic membrane, thus facilitating passage through the hindgut. The occurrence of this structure is particularly interesting because certain *Leishmania* strains frequently localize in the pylorus of Panamanian sandflies. What influence, if any, pyloric armature exerts on this phenomenon is not known.

Theodor (1948) recommended generic separation of Old World and New World Phlebotominae. In a more recent paper (Theodor 1965) he discussed the morphological difference between these genera in more detail. Descriptions of the internal anatomy of Old World species have been rather thoroughly treated (Adler & Theodor 1926, Lewis & Minter 1960, Davis 1967). Unfortunately, a similar treatment of New World sandflies has not been published. Most of our knowledge stems from observations on internal structures of taxonomic importance in species descriptions, extrapolation from Old World sandfly descriptions, and from studies characterizing flagellate growth patterns within the alimentary canal (Johnson et al. 1963, Johnson & Hertig 1970).

Morphological variation in the alimentary tract of sandfly species may reflect physiological differences as well. These may directly or indirectly influence agent-vector relationships. Davis (1967) suggested that morphological differences he observed in the midguts of 2 Old World species, *Phlebotomus papatasi* Scopoli and *P. orientalis* Parrot, may be of some significance in their respective roles as vectors of cutaneous and visceral leishmaniasis.

The characteristic occurrence of promastigote flagellates in the hindgut, as well as mid and foregut regions, of wild-caught and experimentally infected Panamanian phlebotomine sandflies has been well documented (Hertig & McConnell 1963, Johnson et al. 1962, Johnson et al. 1963, Johnson & Hertig 1970, McConnell 1963). Coelho et al. (1967) showed that several species of Brazilian sandflies experimentally infected with *Leishmania braziliensis* develop promastigote flagellates in the hindgut. Promastigote growth in the hindgut of several wild-caught sandfly species from British Honduras has also been reported (Disney 1968, Williams 1970). This type of growth pattern is quite distinct from the "anterior station" growth pattern which characterizes *L. tropica* and *L. donovani* infections in Old World sandflies. The pyloric portion of the hindgut, sometimes referred to as the "hind-triangle," often shows a heavy concentration of flagellates among infected Panamanian sandfly species. Because of this unusual growth pattern we have paid particular attention to this structure during dissections.

MATERIALS AND METHODS

Sandflies were collected from several areas in central Panama. Collections were made from forest floor litter, tree buttresses and caves using aspirators. Light trap collections were also studied. The dissection techniques described by Hertig & McConnell (1963) were used in our study.

RESULTS

The spiculate nature of the internal walls of the pylorus was first observed in *Lutzomyia vespertilionis* Fairchild & Hertig. Longitudinal folds in the pyloric wall of this species resulted in a tree-like appearance of this armature when observed for the first time (FIG. 3). Peristalsis in this region results in a compression of the longitudinal folds and armature (FIG. 4). The spines arise from transverse invaginations of the pyloric wall. Darkfield illumination (FIG. 1, 2, 6) shows this armature as a transverse band occupying slightly more than the posterior 1/3 of the pylorus. The spines are directed posteriad, and are smaller and less numerous anteriorly.

We have observed pyloric spines in over a dozen

[1]The work reported here was supported in part by a research grant (AI-1251) from the NIAID, NIH, U. S. Public Health Service.

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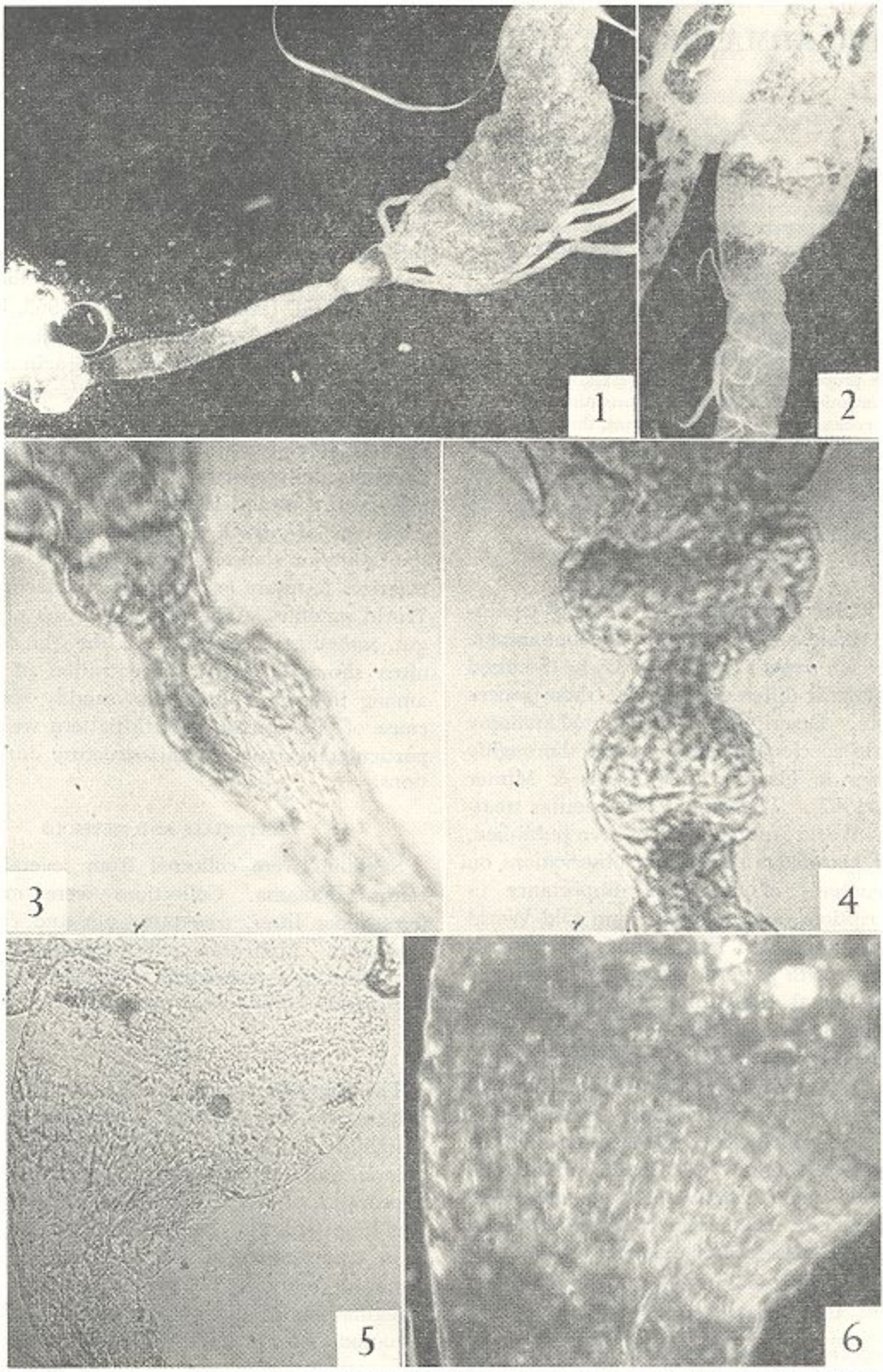

FIG. 1–6. Lightfield and darkfield photomicrographs of the alimentary tract of *Lutzomyia vespertilionis* showing the spiculated armature of the pylorus. (1) Darkfield view of mid and hindgut from cardia to rectal ampulla. The pylorus is the somewhat triangular portion of the hindgut just posterior to the Malpighian tubules. (2) Darkfield view showing the transverse band of armature in the posterior 1/3 of the pylorus. (3) Lightfield view of pylorus. The longitudinal infoldings in the pyloric wall result in a tree-like appearance of the armature. (4) Lightfield view of the pylorus showing the result of peristaltic action in the region of the armature. (5) Lightfield view showing the spiculate nature of the pyloric armature. (6) Darkfield view showing the spiculate nature of the pyloric armature.

sandfly species during recent dissections of more than 100 Panamanian specimens. Although the armature is present in all species thus far studied, the degree of spiculation differs somewhat among various species. In *L. vespertilionis* and *L. trinidadensis* Newstead the spines are quite strong. In the anthropophilic species *L. sanguinaria* Fairchild & Hertig, *L. panamensis* Shannon, *L. trapidoi* Fairchild & Hertig and *L. gomezi* Nitzulescu however, the spines are almost imperceptible under bright-field microscopy at 400 × magnification.

Spiculate armature was also observed in the pylorus of some adult male sandflies.

DISCUSSION

Pyloric armature has been observed in mosquitoes (Christophers 1960, de Boissezon 1930, Eysell 1905, Richins 1938, Thompson 1905, Trembley 1951). Wigglesworth (1947) suggested that cuticular spicules in the hindgut of insects which possess a peritrophic membrane may function to assist the movement of this membrane and its contents into the hindgut in conjunction with peristaltic waves. We propose that the pyloric armature of sandflies may also function as a post-ventricular abrasive structure which breaks up the undigested hematin blood-meal bolus and its enclosing peritrophic membrane. Violent peristaltic action in the region of this armature (FIG. 4) fragments the hematin residue, thus facilitating its passage through the hindgut.

The fact that we have found this armature in males as well as females appears to negate the hypothesized function of hematin-residue disruption; however it is quite possible that both sexes of ancestral sandflies were hematophagous, and that the structure in males remains for lack of selective pressures for its deletion. Present-day males lack mandibles, and most authorities consider them incapable of penetrating vertebrate skin. Coelho et al. (1967) published a photograph showing the dissected alimentary tract of a blood-engorged male *L. longipalpis* Lutz & Neiva which had fed upon a hamster. Shakirzyanova (1951) reported collecting a total of 19 blood-engorged Old World male sandflies from various burrows of the great gerbil, *Rhombomys opimus*. Although it is possible that such males penetrated the skin of these animals with their mouthparts, it seems likely that they obtained blood from open wounds.

The localization of certain strains of *Leishmania* in the pylorus of Panamanian sandfly species indicates that the promastigote flagellates are not adversely affected by the armature. Just what influence, if any, pyloric armature in Panamanian sandflies plays in the characteristic posterior station infection is not known.

Pyloric armature appears very similar structurally to pharyngeal armature; the spines are directed posteriad in both parts of the gut. Pharyngeal armature is a characteristic feature of the Old World genus *Sergentomyia*, but is rare in New World sandflies. It has been described from only 9 Neotropical species, *L. chiapanensis* Dampf, *L. ctenidophora* Fairchild & Hertig, *L. cayennensis* Floch & Abonnenc, *L. duppyorum* Fairchild & Trapido, *L. atroclavata* Knab, *L. trinidadensis*, *L. baduelensis* Floch & Abonnenc, *L.* sp. de Saul Floch & Abonnenc, and *L.* sp. no. 768 Floch & Abonnenc (Fairchild & Hertig 1948, Floch & Abonnenc 1952, Theodor 1965).

In the light of our findings, it would be interesting to study Old World sandfly species for the presence or absence of pyloric armature.

Our observations on the occurrence of pyloric armature in sandflies is presented with the view that a more thorough knowledge of internal anatomical structures is essential to the understanding of flagellate growth patterns within the arthropod hosts, as well as agent-vector relationships.

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