

Elevation of *Anopheles chiriquiensis* from Synonymy with *Anopheles parapunctipennis* and Designation of Name-bearing Types for *Anopheles parapunctipennis* and *Anopheles parapunctipennis guatemalensis* (Diptera: Culicidae)¹

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ABSTRACT. *Anopheles (Anopheles) chiriquiensis* is retrieved from synonymy with *An. (Ano.) parapunctipennis* based on differences in wing spotting, extent of pale scaling on the maxillary palpus and color of the halter. *Anopheles chiriquiensis* has the sector pale spot present on vein C, a condition not previously reported in species of the subgenus *Anopheles*. A neotype is designated for *An. parapunctipennis* and a lectotype for *An. parapunctipennis guatemalensis*. Though the difference between *An. parapunctipennis* and *An. parapunctipennis guatemalensis* could be attributed to variation, the latter is retained as a subspecies until more material becomes available.

INTRODUCTION

Anopheles (Anopheles) chiriquiensis Komp, *An. (Ano.) parapunctipennis* Martini and *An. (Ano.) parapunctipennis guatemalensis* De León are morphologically similar taxa encountered at higher elevations (>1000 m) in Central America. *Anopheles parapunctipennis* was described from the State of Chiapas in southern México (Martini 1932) and *An. chiriquiensis* from Chiriquí Province in western Panamá (Komp 1936). De León (1938) apparently was unaware of the more similar *An. parapunctipennis* when he described *guatemalensis*, from western Guatemala, as a variety of *An. chiriquiensis*. Based on three male genitalia, Dampf (1939) synonymized both *An. chiriquiensis*, and what he assumed was a variety of *An. chiriquiensis*, *guatemalensis*, under *An. parapunctipennis*. Vargas (1940a) also recognized *An. chiriquiensis* as a synonym of *An. parapunctipennis*, but treated *guatemalensis* as a variety of *An. parapunctipennis*. Since that time *guatemalensis* has sometimes been treated as a subspecies of *An. parapunctipennis* (Vargas 1942, Russell et al. 1943, Lane 1953), but most recently it was listed as a variety (Knight and Stone 1977). In accordance with Article 45g of the International Code of Zoological Nomenclature (1985) it is treated here as subspecies *guatemalensis*.

The status of these three taxa was investigated during the preparation of a key to Central American anophelines. As a result of this investigation *An. chiriquiensis* is resurrected from synonymy with *An. parapunctipennis*. This report provides a summary of the literature and salient adult morphological characters for all three taxa. Insufficient immature specimens were available to corroborate the results.

¹ The views of the author do not purport to reflect the views of the supporting agency.

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MATERIALS AND METHODS

Harbach and Knight (1980, 1981 [1982]) is followed for morphological terminology and Wilkerson and Peyton (1990) for wing spot definitions. Specimens examined for this study are in the National Museum of Natural History (NMNH), Museum Support Center, Smithsonian Institution, Washington, DC, USA and in the Laboratorio de Entomología, Instituto de Salubridad y Enfermedades Tropicales (ISET), México, DF, México. Abbreviations used in the synonymies and material examined are as follow: E = egg, L = larva, P = pupa, ♂ = male, ♀ = female, p = pupal exuviae, G = slide-mounted male genitalia. A life stage followed by an asterisk (*), e.g. P*, indicates that at least some portion of the stage was illustrated in the reference cited.

TAXONOMIC TREATMENT

Anopheles (Anopheles) chiriquiensis Komp
(Figs. 1A, 1D, 1E)

Komp 1936: 156-160, lectotype ♂, Volcán de Chiriquí, Panamá, NMNH [examined] (♀*, ♂*, L).

Anopheles (Anopheles) chiriquiensis Komp of Hoffmann 1939: 347-352 (♀*, ♂*); Stone and Knight 1956: 277 (lectotype designation); Belkin et al. 1965: 43 (type information).

Anopheles parapunctipennis Martini of Dampf 1939: 280 (♂, in part, synonymy).

Anopheles chiriquiensis Komp of Kumm et al. 1940: 410, 419 (Costa Rica, bionomics note, ♀ key).

Anopheles (Anopheles) parapunctipennis Martini of Komp 1941: 93 (♀ key); Simmons and Aitken 1942: 43, 70 (♀ key, bionomics note); Knight and Stone 1977: 26 (catalog).

Anopheles (Anopheles) parapunctipennis parapunctipennis Martini of Vargas 1942: 70 (♀ key); Pelaez 1945: 76 (♀*, ♀ key).

Diagnosis. Large dark brown and pale yellow species with conspicuous pattern of wing spots. FEMALE. *Head* (Fig. 1E): Frontal tuft with long pale yellowish white scales and setae, scales of the vertex pale yellowish white, remaining head scales dark brown; maxillary palpus (MPlp) dark brown-scaled with pale scales at apex of palpomere 2 and base and apex of palpomere 3, palpomere 4 pale-scaled with dark median band and palpomere 5 entirely pale-scaled or with a narrow dark median band. *Thorax*: Scutum with very broad median silvery pollinose stripe; wing (Fig. 1A) brown-scaled with pale yellowish spots, costa with basal (BP), humeral (HP), sector (SP), subcostal (SCP) and apical (AP) pale spots, sector pale spot present on veins C, Sc and R, pale scales and pale fringe spots (PFS) absent at apices of veins R₄₊₅, M₁, M₂ and M₃₊₄; coxae, trochanters and bases of femora pale yellowish white, contrasting with dark brown legs and pleura, narrow apical bands of pale scales on all femora and tibiae, broadest band on hindfemur, a few pale scales at apices of hindtarsomeres 1-4; integument of halter (Fig. 1D) pale yellowish white, capitellum with pale yellowish

scales. *Abdomen*: Without scales; integument brown with numerous long yellowish setae, anterior 0.25 of integument of sterna and sometimes terga II-VII pale yellowish.

Discussion. Based primarily on recently redefined wing spot nomenclature (Wilkerson and Peyton, 1990) I consider that *An. chiriquiensis* is a valid species. The salient character distinguishing *An. chiriquiensis* from its former senior synonym, *An. parapunctipennis*, is the presence of the sector pale (SP) spot on veins C, Sc and R (Fig. 1A). This spot is absent in *An. parapunctipennis*. In addition, *An. chiriquiensis* has other wing spot differences, more extensive pale scales on the maxillary palpus and an entirely pale halter (see "Results and Discussion" below).

Anopheles chiriquiensis is known only from the western slopes of the Volcán de Chiriquí in western Panamá. There is a doubtful reference to larvae of this species from northern Costa Rica, Alajuela Province, Zarcerro (Komp 1941). The larvae of *An. chiriquiensis* and *An. parapunctipennis* apparently are quite similar and it is not known if Komp verified his identifications by rearing larvae to the adult stage.

Material examined (all in NMNH). **PANAMA. Chiriquí.** Lectotype ♂ bearing the following data: "Lectotype/Stone&Knight 1956//#1//W.H. Komp Coll.//Cotype No. /51882/U.S.N.M.//Volcan de/Chiriqui, Panama/II.7.35 6500 ft."; cotype ♀ same data; 1 larval exuviae same data; 8♂, 1♀, 5 fourth instar larvae, 10-X-1985, Río Chiriquí Viejo, near Tisingal, 8° 48'N 82° 40'W, 1290 m, PN 95 -101 p -102 p -104 p 105 p -106 p -109 p -112 p -116 p, G 88/491 and 88/492, Strickman and Peyton; 3♂, 1♀, El Volcán, about 6500 ft, "original material", KO 105-17, W.H.W. Komp; 1♀, 6-III-1943, El Volcán, Rd. Camp, T.H.G. Aitken; 2♀, 14-XI-1955, Cerro Punta, light trap.

Anopheles (Anopheles) parapunctipennis Martini
(Figs. 1B, 1F, 1G)

Martini 1932: 101. Neotype ♂, here designated, bearing the following data: "C. Las Casas, Chis./VII-1940/Col. M. Macias" (ISET).

Anopheles parapunctipennis Martini of Martini 1935: 23 (republication of original description); Dampf 1939: 280 (♂*, in part); Vargas 1940a: 66-68 (L key); Castellanos et al. 1949: 34 (Veracruz State, México); Mattingly 1955: 27 (type material not found, Hamburg); Belkin 1968: 10 (type material not found).

Anopheles (Anopheles) chiriquiensis guatemalensis De León of Hoffmann 1939: 347-352 (♀*, ♂*).

Anopheles (Anopheles) parapunctipennis Martini of Vargas 1940b: 202 (♀ key); Komp 1941: 95 (L key); Simmons and Aitken 1942: 49, 59, 70 (bionomics note, ♂ and L keys, in part); Belkin et al. 1965: 34 (type information, location unknown); Knight and Stone 1977: 26 (catalog).

Anopheles parapunctipennis var. *guatemalensis* De León of Vargas 1941: 112 (E*).

Anopheles parapunctipennis parapunctipennis Martini of Russell et al. 1943: 26, 33 (♀ and L keys, in part); Vargas 1949: 233 (P, Oaxaca and Veracruz states, México).

Anopheles (Anopheles) parapunctipennis parapunctipennis Martini of Lane 1953: 158, 159, 163 (♀*, ♂*, L*, ♀ and L keys, in part); Vargas and Martínez Palacios 1956: 47, 49, 52, 56, 59, 80, 141 (♀*, ♂*, P*, L*, E; ♂, ♀, L, P, E keys, México coll. recs.); Vargas 1956: 27-34 (L key, in part).

Diagnosis. FEMALE. As in *An. chiriquiensis* except for the following. *Head:* Maxillary palpus (Fig. 1G) without pale scales at apex of palpomere 2 and base of palpomere 3, palpomere 4 mostly dark-scaled with pale base and apex and palpomere 5 pale-scaled with dark median band. *Thorax:* Wing (Fig. 1B) without sector pale (SP) spot, pale scales and pale fringe spots (PFS) present at apices of veins R₄₊₅, M₁, M₂ and M₃₊₄; pale bands on legs narrower; halter (Fig. 1F), pedicel with pale yellow integument, capitellum with dark brown integument and dark brown scales.

Discussion. The original description of *An. parapunctipennis* is sketchy and not illustrated. The description is primarily a comparison of the male genitalia of *An. parapunctipennis* to that of *An. pseudopunctipennis* Theobald. I found the genitalia of specimens from the type locality of *An. parapunctipennis* to differ, as stated by Martini (1932), from genitalia of *An. pseudopunctipennis* from Costa Rica. Martini's comments on the female wing are vague and of little use.

Martini (1932) did not designate type specimens for *An. parapunctipennis* and neither Mattingly (1955) nor Belkin (1968) were able to locate any original material in European museums. To ensure nomenclatural stability, a neotype is designated here from material available from the type locality of San Cristóbol de Las Casas, Chiapas, México.

Material examined. MEXICO. Chiapas. Neotype ♂, VII-1940, C. Las Casas, Chis. (San Cristóbol de Las Casas, Chiapas, México), M. Macias (ISET); 4♂, 1♀ and 3 unassociated ♂ genitalia, same locality as neotype, 2♂, IX-1940, M. Macias (ISET), 1♂, VII-1940, M. Macias, G 740627-87 (NMNH), 1♂, 17-IX-1956, V. Molina and A. Rodriguez (ISET), 1♀, VII-1940, M. Macias G. (ISET), 3♂ genitalia, VIII-1940, "2712" and "2715", M. Macias, and VII-1940 no other data. Veracruz. 1♀ X-1950, 2♀ 18-X-1956, Acajete, V. Molina and A. Rodriguez (ISET). Oaxaca. 1♀, X-1942, Ixtlan, M. Macias (ISET). GUATEMALA. 1♀ without data except "Guatemala" and box label "Komp leg" (NMNH).

Anopheles (Anopheles) parapunctipennis guatemalensis De León
(Fig. 1C)

De León 1938: 416, (as *An. (Ano.) chiriquiensis* var. *guatemalensis*) Cumbre del Aire, Department of Totonicapán, Guatemala (♂*, ♀*, L*). Lectotype ♀, here designated, bearing the following data: "Sanidad Publica: Guatemala. - A.C.-/Anopheles (Anopheles) A. Chiriquiensis (?? Komp)/"Cumbre del aire" Dpto Totonicapán.-/Dr. J. Romeo De León.- Malariologo de S.P." (NMNH).

- Anopheles parapunctipennis* Martini of Dampf 1939: 280 (♂, in part, synonymy).
- Anopheles parapunctipennis* var. *guatemalensis* De León of Vargas 1940a: 66-68 (L key, new combination).
- Anopheles (Anopheles) parapunctipennis* var. *guatemalensis* De León of Vargas 1940b: 202 (♀ key); Belkin et al. 1965: 28 (type information); Knight and Stone 1977: 26 (catalog).
- Anopheles (Anopheles) parapunctipennis guatemalensis* De León of Vargas 1942: 71 (♀ key); Simmons and Aitken 1942 (49, 59, 70, bionomics note, ♂ and ♀ keys, in part); Lane 1953: 158, 159, 166 (♀ and L keys, in part).
- Anopheles parapunctipennis guatemalensis* De León of Russell et al. 1943: 26, 29, 34 (♀ and L keys, in part).

Diagnosis. FEMALE. As in *An. parapunctipennis* except subcostal pale (SCP) spot present on vein C but not R₁.

Discussion. No primary type specimen was designated by De León and the type depository (Entomoteca de Sandidad Publica de Guatemala, Guatemala City, Guatemala) no longer exists (Knight and Stone 1977). Chuck Porter (personal communication, 1990) reported that he did not recall seeing pinned specimens when he inspected De León's collection for slide-mounted material. However, some De León original material, partly without individual labels, was found by the author in the NMNH collection. All of the adult specimens are mounted on pieces of cardboard similar to those in Fig. 18 of the original description. The handwriting on the label in the unit tray containing these specimens seems to match the handwriting on a map published with the original description. There is therefore justification in assuming that the unlabeled material in the unit tray is also part of the syntype series. Three of the specimens carry their own labels but the lectotype was chosen from among those without labels since it best matches the characters given in the original written description. None of the males, but all of the females, have vein R₁ dark at the subcostal pale (SCP) spot. This character separates *An. parapunctipennis guatemalensis* from the nominotypical subspecies and is the only difference I see to distinguish the two.

The original description contains some interesting discrepancies. De León states (translated from Spanish): "the lateral hairs [seta 6] of the abdominal segments are branched, which can be noted on the hairs of the third segment, in this structure it differs from the larva of *Chiriquiensis* [sic] in which this hair is simple." Figure 8 of De León clearly shows a simple aciculate seta just as in *An. chiriquiensis*. Figure 13 is labeled "Wing of *Anopheles Guatemalensis* [sic]" but it shows vein R₁ pale at the subcostal pale spot (as in *An. parapunctipennis*), not pale only at its base and apex as stated in the written description. Finally, Fig. 18 appears to be a male of *An. parapunctipennis guatemalensis* not *An. xelajuensis* De León as labeled.

Material examined (all in NMNH). **GUATEMALA. Totonicapán.** Lectotype ♀ and 6♀, 3♂ (2 with genitalia dissected, WRBU preps. 88/493, 88/494) paralectotypes all in unit tray with label as above (presumably in De León's handwriting), 3 ♀ also bear individual labels with additional information of "10,500 p/s/m" (feet above sea level), 1 slide-mounted unassociated ♂ genitalia, and 2 slide-mounted whole larvae labeled as above but also with "1937". In addition, 3♀, 4♂, "Esquipulas 4,000 ft." (could be Dept.

of Chiquimula, Retalhuleu or San Marcos). Also 2 larval exuviae, the labels presumably in De León's handwriting, "Maria Tecun, IV-1941, De León".

RESULTS AND DISCUSSION

The species considered here, along with *An. (Ano.) hectoris* Giaquinto-Mira, can be distinguished in the adult female from other species of the subgenus *Anopheles* in Central America by the following combination of characters: legs mostly dark with at most small bands of pale scales at articulations of leg segments and tarsomeres; coxae, trochanters and bases of femora pale yellowish white with pale white or pale yellow scales and setae, contrasting with dark brown pleura and legs; scutum with broad silvery pollinose stripe; wings with conspicuous spotting, costa with basal (BP) and/or humeral pale (HP) spot(s), subcostal pale (SCP) spot and preapical and/or apical pale (AP) spots. *Anopheles hectoris* differs by having the entire broad middorsal silvery pollinose stripe of the scutum overlain by slender white fusiform scales and by having the sector pale (SP) spot present on vein R only.

In the adult female stage *An. chiriquiensis* can be separated from *An. parapunctipennis* and *An. p. guatemalensis* as follows (Figs. 1A, 1B, 1D-G). *Anopheles chiriquiensis*: sector pale (SP) spot present on veins C, Sc and R; pale scales and pale fringe spots (PFS) absent at apices of veins R_{4+5} , M_1 , M_2 and M_{3+4} ; maxillary palpus with pale scales on apex of palpomere 2 and base of palpomere 3, all of palpomere 4 and 5 pale-scaled except for dark median band on palpomere 4 and sometimes on 5; halter entirely pale yellowish with pale yellowish scales on capitellum. *Anopheles parapunctipennis*: sector pale spot absent; pale scales and pale fringe spots present at apices of veins R_{4+5} , M_1 , M_2 and M_{3+4} ; maxillary palpus with pale scales on apex of palpomere 3, base of palpomere 4, apex of palpomere 4 and base and apex of palpomeres 4 and 5; halter, integument of pedicel pale yellowish, integument of capitellum dark brown with dark brown scales. *Anopheles parapunctipennis guatemalensis* differs, in the female only, from the nominotypical subspecies by having the subcostal pale (SCP) spot present on the costa, but not on vein R_1 (Fig. 1C).

The presence of the sector pale (SP) spot on vein C in *An. chiriquiensis* is apparently unique among species of the subgenus *Anopheles*. In a survey of all spotted-wing species of this subgenus, Wilkerson and Peyton (1990) found no other species with this character.

Wing characters used by others to separate *An. parapunctipennis parapunctipennis* from *An. parapunctipennis guatemalensis* usually have included the pattern of spots on veins R_{4+5} and 1A (Vargas 1940a, Simmons and Aitken 1942, Vargas 1942, Russell et al. 1943, Lane 1953). The material before me of the three taxa treated here shows no consistency in the spotting on these veins.

These three taxa cannot be distinguished at this time using male genitalia. The clubbed setae of the dorsal lobe of the claspette are quite variable. There can be either two separate setae, two partly fused setae or a single fused seta. In one specimen they were nearly fused on one side and completely separate on the other. Two examples of *An. chiriquiensis* examined have the setae fused, quite slender and capitate, but in the lectotype they are broader. Likewise the two pairs of aedeagal leaflets vary. All have a distinctive first pair which are weakly serrate, but some have less serration at the base

and more toward the apex while others also have serrated edges on the second smaller pair. It is possible that these characters will prove useful after a careful study of more material.

Larvae of all three taxa are unusual among species of the subgenus *Anopheles* because seta 6-III is not branched, but long and aciculate. Komp (1936) noted this for *An. chiriquiensis*, as did De León (1938, Fig. 8) for *An. parapunctipennis guatemalensis*, and Vargas and Martínez Palacios (1956) for *An. parapunctipennis parapunctipennis*.

In addition to striking morphological differences, *An. chiriquiensis* apparently is found only in a limited geographical area in western Panamá, quite far from the known distribution of *An. parapunctipennis*. The type localities of *Anopheles parapunctipennis* and ssp. *guatemalensis* are about 250 km apart.

I believe that a careful study of more material will show that ssp. *guatemalensis* is a synonym of the nominotypical form. Until such time, it should be retained as a subspecies.

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REFERENCES CITED

- Belkin, J.N. 1968. Mosquito studies (Diptera, Culicidae). IX. The type specimens of New World mosquitoes in European museums. *Contrib. Am. Entomol. Inst. (Ann Arbor)* 3(4): 1-69.
- Belkin, J.N., R.X. Schick and S.J. Heinemann. 1965. Mosquito studies (Diptera, Culicidae). V. Mosquitoes originally described from Middle America. *Contrib. Am. Entomol. Inst. (Ann Arbor)* 1(5): 1-95.
- Castellanos, J.B., L.C. Murrieta, G. Lassman and C. Ortiz. 1949. A malaria reconnaissance of the state of Veracruz, Mexico. *Am. J. Trop. Med.* 29: 23-35.
- Dampf, A. 1939. Los hipopigios masculinos de *Anopheles hectoris* y *Anopheles parapunctipennis* (Insecta, Diptera, Culicidae). *An. Esc. Nac. Cienc. Biol. Mex.* 1: 279-291.
- De León, J.R. 1938. El anophelismo de altura en Guatemala. *Bol. Dir. Gen. Sanid. Publ.* 9: 411-424.
- Harbach, R.E. and K.L. Knight. 1980. *Taxonomists' glossary of mosquito anatomy*. Plexus Publishing, Inc., Marlton, New Jersey. xi + 415 pp.
- Harbach, R.E. and K.L. Knight. 1981 (1982). Corrections and additions to *Taxonomists' Glossary of Mosquito Anatomy*. *Mosq. Syst.* 13: 201-217.

- Hoffmann, C.C. 1939. La formación de razas de *Anopheles* mexicanos. III. *Anopheles chiriquiensis* Komp en el interior del estado de Chiapas. An. Inst. Biol. Univ. Mex. 10: 347-352.
- International Code of Zoological Nomenclature. 1985. Third Edition. Univ. Calif. Press, Berkeley and Los Angeles. 338 pp.
- Knight, K.L. and A. Stone. 1977. A catalog of the mosquitoes of the world (Diptera: Culicidae). (2nd edition) Thomas Say Found., Entomol. Soc. Am., vol. 6, xi + 611 pp.
- Komp, W.H.W. 1936. *Anopheles (Anopheles) chiriquiensis*, a new species of *Anopheles* from Panama (Diptera, Culicidae). Proc. Entomol. Soc. Wash. 38: 156-160.
- Komp, W.H.W. 1941. The classification and identification of the *Anopheles* mosquitoes of México, Central America, and the West Indies. Am. Assoc. Adv. Sci., Publ. 15: 88-97.
- Kumm, H.W., W.H.W. Komp and H. Ruiz. 1940. The mosquitoes of Costa Rica. Am. J. Trop. Med. 20: 385-422.
- Lane, J. 1953. Neotropical Culicidae. Vol. 1. Sao Paulo, Brazil. 548 pp.
- Martini, E. 1932. Dos nuevos mosquitos *Anopheles*, procedentes del Estado de Chiapas, México. Rev. Mex. Biol. 12: 99-102.
- Martini, E. 1935. Los mosquitos de México. Dep. Salubr. Publ., Bol. Tec., (A) 1, 65pp., México, D.F.
- Mattingly, P.F. 1955. Mosquitoes (Diptera: Culicidae) from the Tropical Institute at Hamburg. Proc. R. Entomol. Soc. Lond. Ser. B Taxon. 24: 27-33.
- Pelaez, D. 1945. Anofelinos de Mexico. I. Clave para la determinación de las especies y subespecies, basada en los caracteres de las hembras adultas. Ciencia (Mex. City) 6: 69-77.
- Russell, P.F., L.E. Rozeboom and A. Stone. 1943. Keys to the anopheline mosquitoes of the world. Am. Entomol. Soc., Acad. Nat. Sci., Philadelphia. 152 pp.
- Simmons, J.S. and T.H.G. Aitken. 1942. The anopheline mosquitoes of the northern half of the Western Hemisphere and of the Philippine Islands. Army Med. Bull. 59, 213 pp.
- Stone, A. and K.L. Knight. 1956. Type specimens of mosquitoes in the United States National Museum: III, The genera *Anopheles* and *Chagasia* (Diptera, Culicidae). J. Wash. Acad. Sci. 46: 276-280.
- Vargas, L. 1940a. Clave para identificar las larvas de *Anopheles* mexicanos. Ciencia Mex. 1: 66-68.

- Vargas, L. 1940b. Clave para identificar las hembras de *Anopheles* mexicanos. Rev. Inst. Salubr. Enferm. Trop. 1: 199-203.
- Vargas, L. 1941. Nota sobre los huevecillos de *Anopheles* mexicanos. Gac. Med. Mex. 71: 107-123.
- Vargas, L. 1942. Las hembras Americanas del subgenero *Anopheles* (Dit, Culicidae, *Anopheles*). Rev. Inst. Salubr. Enferm. Trop. 3: 67-74.
- Vargas, L. 1949. Caracteres morfológicos diferenciales de algunas pupas de anofelinos neotropicales (Diptera: Culicidae). Riv. Parassitol. 10: 231-235.
- Vargas, L. and A. Martínez Palacios. 1956. Anofelinos mexicanos, taxonomía y distribución. Secretaría de Salubridad y Asistencia, Comisión Nacional para la Erradicación del Paludismo. México D.F. 181 pp.
- Vargas, M.V. 1956. Llave numerica para identificación de larvas en cuarta fase de Anophelini en Costa Rica. Rev. Biol. Trop. 4: 27-34.
- Wilkerson, R.C. and E.L. Peyton. 1990. A standardized nomenclature for the costal wing spots of the genus *Anopheles* and other spotted-wing mosquitoes (Diptera: Culicidae). J. Med. Entomol. 27: in press.

Fig. 1

