

ANOPHELES (AN.) REIDI, A NEW SPECIES OF THE BARBIROSTRIS SPECIES COMPLEX FROM SRI LANKA (DIPTERA:CULICIDAE)¹BRUCE A. HARRISON²Department of Entomology, Walter Reed Army
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ABSTRACT—The female of *Anopheles (Anopheles) reidi* n. sp. from Sri Lanka is described, illustrated and compared morphologically with the other members of the *barbirostris* species complex, and the members of the *bancrofti* species complex. Variations in the adult habitus of *An. barbirostris* Van der Wulp, and *An. barbumbrosus* Strickland and Choudhury are also discussed.

Carter (1925, 1950) discussed a species of *Anopheles* in the Ceylon fauna which he considered conspecific with *Anopheles pseudobarbirostris* Ludlow 1902. Reid (1962) examined two specimens seen by Carter and decided on the basis of morphological and zoogeographic differences that they were not conspecific with *pseudobarbirostris*, and probably represented a new species. However, since the two specimens were in poor condition, he chose not to describe them as new, but called them the "Ceylon species".

Recently, Smithsonian Institution personnel working under Smithsonian Research Foundation Grant SFG-0-2854, Biosystematic Studies of the Insects of Ceylon, collected a near perfect female specimen in Sri Lanka that I consider the same species as the specimens seen and discussed by Carter and Reid. I have been unable to borrow the two original specimens for comparison or those seen by Reid, but I am convinced of this association because this female has all of the characters described by Reid (1962) for the "Ceylon species". A comparison of this specimen with the lectotype and original description (Ludlow 1902) of *An. pseudobarbirostris* quickly confirmed Reid's opinion. This new species is very distinct from the other known species of the *barbirostris* and *bancrofti* complexes.

Anopheles (Anopheles) reidi, n. sp.
fig. 1

Anopheles (Anopheles) pseudobarbirostris of Carter 1925, Ceylon J. Sci. (D) 1: 69 (♀); Baisas 1931, Philippine J. Sci. 44: 429 (in part); Christophers 1933, Fauna of British India. Diptera, 4: 162 (in part); D'Abrera 1944, J.

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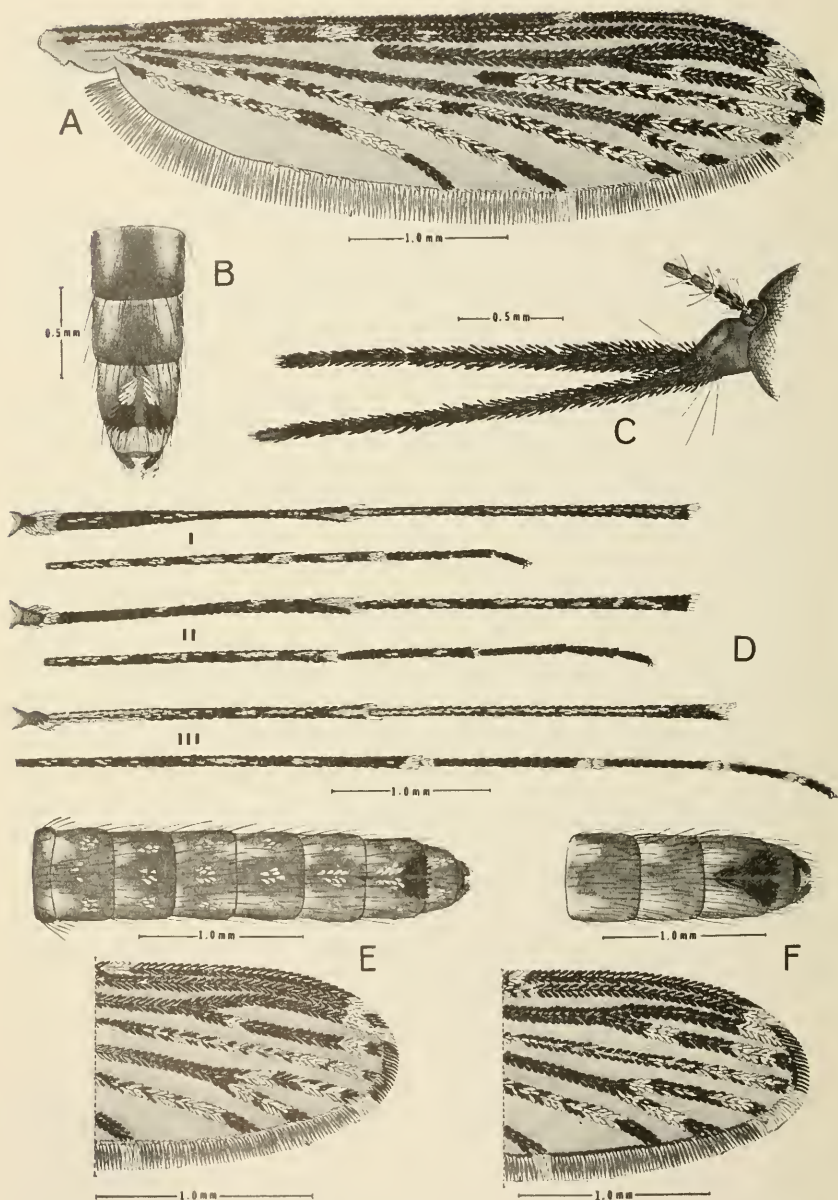


Fig. 1. *Anopheles (An.) reidi*, n. sp., holotype ♀: A, right wing; B, abdominal sternite V-VIII; C, head; D, fore, mid and hind legs, lateral view. *Anopheles (An.) pseudobarbirostris* Ludlow, lectotype ♀: E, abdominal sternite I-VIII, and distal half of right wing. *Anopheles (An.) barbumbrosus* Strickland and Choudhury, (Sri Lanka ♀): F, abdominal sternite V-VIII, and distal half of right wing.

- Mal. Inst. India 5: 344; Bonne-Wepster and Swellengrebel 1953, Anopheline Mosq. Indo-Australian Region, p. 221 (in part); Stone et al. 1959, Thomas Say Found., Entomol. Soc. Am. 6: 26 (in part).
- Anopheles* (*Anopheles*) *bancrofti* of Covell 1927, Indian Med. Res. Mem. 7: 14 (in part); Edwards 1932, Genera Insect. 194: 40 (in part).
- Anopheles* (*Anopheles*) *bancrofti* var. *pseudobarbirostris* of Carter 1950, Ceylon J. Sci. (B) 24: 106.
- Anopheles* (*Anopheles*) "Ceylon species" of Reid 1962, Bull. Entomol. Res. 53: 38 (♀); Reid 1968, Stud. Inst. Med. Res. Malaysia 31: 120.

FEMALE (Fig. 1). *Head*. Palpus with very dense, erect black scales, most distal scales more decumbent; palpus slightly shorter than proboscis; proboscis with black scales, most distal scales more decumbent, labellum nearly bare; fore femur/proboscis ratio 1.01; clypeus without scales; vertex with erect broad dark brown-black scales except several broad white scales just above the interocular space; interocular space with short narrow white scales and long brown setae forming dark frontal tuft; antennal pedicel with small dark scales on upper and outer aspects; first antennal flagellomere with short black scales, remaining flagellomeres without scales. *Thorax*. Scutal integument frosty gray-brown, with dark longitudinal lines on the dorsocentral and supraalar bare areas; anterior promontory with narrow erect pale scales mesally, darker and broader scales laterally; scutum with short fine, pale curved scales, especially dense on acrostichal and prescutellar areas; scutal setae tan to dark brown, in anterior promontory, acrostichal, dorsocentral, lateral prescutal, fossal, antalar and supraalar groups; scutellum with long brown setae and narrow pale curved scales; anterior pronotum with dark erect scales on cephalic half, pale short setae on caudal half; pleuron generally dark brown, with 1 pale scale on left propleuron, 1-4 pale scales on lower sternopleuron just cephalad of lower sternopleural setae, and 3-9 pale scales in median patch on mesepimeron; pleural setae number, 4-5 propleural, 6-7 spiracular, 3-4 upper and 6-8 lower sternopleural, 15-19 prealar, 10-12 upper and 0 lower mesepimeral. *Wing*. Costa mainly dark scaled, with small humeral pale spot, several scattered individual pale scales on basal $\frac{1}{3}$, small subcostal pale spot and small preapical pale spot; subcosta with several pale scales adjacent to sector spot on vein R, and 1-2 pale scales at apex adjacent to subcostal pale spot on costa; preapical pale spot involves fringe scales and tip of vein R₁; remigium with dark scales except small central pale spot; humeral cross vein with 3-4 large dark scales; R-R₁ mostly dark scaled, with 3-4 small groups of pale scales proximal to more distinct pale sector spot, 15-20 scattered pale scales beyond sector spot out to level of subcostal pale spot on the costa, only 1-2 pale scales in preapical dark area beyond level of subcostal pale spot; tip of R₁ with pale scales; R₂ with dark scales; R_{2,3} with dark scales to fork; R₂ with dark scales except pale scales on tip; R₃ with dark scales except small pale spot on basal half and slightly larger preapical pale spot, tip with dark scales; R_{4,5} with distinct dark basal spot, distinct pale preapical spot and tip with dark scales, remainder with mixed pale and dark scales; M with dark scales to fork; M_{1,2} base and tip with dark scales, mixed pale and dark scales in between; M_{3,4} base and tip with dark scales, mixed pale and dark scales in between; extreme base of Cu with pale scales and 1-2 dark scales, followed by distinct dark patch of scales, remainder to fork with mixed pale and dark scales; Cu₁ with small dark spots at base, M-Cu crossvein and

tip, distinct pale spot between dark spots at base and M-Cu crossvein, remainder mixed pale and dark scales; Cu_2 with pale scales mixed with infrequent dark scales on basal $\frac{3}{4}$, apical $\frac{1}{4}$ with dark scales; 1A with mixed pale and dark scales on basal $\frac{1}{2}$, distinct dark mark at midpoint followed by large preapical pale area, tip with dark scales; apical dark mark on Cu_2 longer than apical dark mark on 1A; primary, secondary and tertiary fringe scales dark except preapical pale fringe spot immediately above and down to level of R_1 , small accessory pale apical fringe spot adjacent to R_2 , long apical pale fringe spot from R_{4+5} caudally to slightly beyond M_{1+2} , and small pale fringe spot on caudal margin of wing adjacent to tip of Cu_2 ; *Halter*. With dark scales. *Legs*. Fore and mid coxae with upper and lower patches of pale scales, hind coxa with only lower scale patch; mid coxa with 1 upper coxal seta; hind coxa with 2 large caudo-mesally projecting setae. Fore leg: femur swollen on basal half and dark scaled except narrow basal band of pale scales, anterior and posterior apical pale spots and scattered, often grouped, pale scales along anterior and posterior surfaces; tibia with dark scales, without pale basal or apical band, with scattered, often grouped, pale scales along entire length of anterior and posterior surfaces; tarsomeres 1 and 2 with pale apical bands approximately equal to segment width and scattered, usually grouped pale scales; tarsomeres 3-5 with only dark scales. Mid leg: femur with dark scales except small basal pale band, anterior and posterior apical pale spots and scattered pale scales that nearly form continuous line on posterior surface; tibia with dark scales except scattered pale individual or groups of scales that form broken lines on anterior and posterior surfaces; tarsomere 1 with dark scales, apical pale band approximately equal width of segment, and scattered pale individual or groups of scales mostly on anterior and posterior surfaces; tarsomere 2 with dark scales, a small dorso-apical pale spot and several mostly anterior and posterior patches of scattered pale scales; tarsomeres 3-5 with dark scales. Hind leg: femur with dark scales except small basal pale band, anterior apical pale spot and scattered pale individual or groups of scales that form broken lines on anterior and posterior surfaces; tibia with dark scales except dorso-apical pale spot and scattered pale individual or groups of scales that form broken lines on anterior and posterior aspects; tarsomeres 1-5 with dark scales except tarsomere 1 with scattered individual or groups of pale scales on anterior and posterior surfaces, tarsomeres 1-4 with apical pale band approximately equal segment width, and tarsomeres 2-5 with basal pale band approximately equal or smaller than segment width. *Abdomen*. Integument light to dark brown, without tergal scales, but with numerous long dark setae; sterna without scales except 3 median black scales near caudal margin of sternum VI, and sternum VII with 15 median white scales on cephalic half and more than 20 median black scales on caudal half.

MALE, PUPA AND LARVA. Not known.

TYPE DATA. Holotype female, SRI LANKA (Ceylon): Central Province, Kandy District, Peradeniya Botanical Gardens, January 1971, Piyadasa & Somapala collectors. The holotype is deposited in the Smithsonian Institution, U.S. National Museum (Natural History), Washington, D.C., and is in excellent condition with all body parts present and only minor rubbing damage evident on the wings and legs.

DISTRIBUTION. SRI LANKA. Examined: Female holotype from Central Province, Kandy District, Peradeniya Botanical Gardens. Carter (1925) listed two females collected in Western Province, Colombo District, Colombo and Ganemulla, and Reid (1962) examined a female collected in 1936 in the Province of Uva, Badulla District. All previous records of *pseudobarbirostris* from the Indian subregion (Sri Lanka) probably apply to *reidi*. Accordingly, *pseudobarbirostris* Ludlow now has its western most extension in the Philippines and the Celebes.

BIOLOGY. No data.

TAXONOMIC DISCUSSION. Carter's (1925) association of specimens of this species with *pseudobarbirostris* was apparently based on both having spotted legs and a pale fringe spot adjacent to the tip of wing vein R_2 . These similarities are superficial, for *reidi* belongs to the *barbirostris* species complex, while *pseudobarbirostris* is a member of the *bancrofti* species complex (Reid 1962). Adult members of the *barbirostris* complex have the following characters that will differentiate them from the *bancrofti* complex: wing with an apical pale fringe spot at vein R_{4+5} and often from R_{4+5} to M_{1+2} ; wing without a prehumeral pale spot on the costa; wing with scattered pale scales on the basal half of the costa; and abdominal sternum VIII without pale scales. These two complexes also have distinct zoogeographical distributions, with only a small area of overlap. The *bancrofti* complex has basically an Australasian distribution with records from Australia, Celebes, Ceram, the Moluccas, New Guinea and the Philippines. The *barbirostris* complex has a distinct Oriental distribution that extends from India east to the Philippines, Ambon, Celebes, Ceram and the western tip of New Guinea. Only 4 of the 11 species in the latter complex are known to be sympatric with members of the *bancrofti* complex.

Besides the above species complex differences, *reidi* can be differentiated from *pseudobarbirostris* by having the following additional characters: pale spots on the legs formed by groups of scales; hind tarsomere 2 with a distinct basal pale band; and abdominal sterna II-VI without pale scales.

Anopheles reidi can be separated from all the other members of the *barbirostris* species complex by possessing the following primary characters: (1) spotted legs; (2) a pale basal band on hind tarsomere 2; and (3) pale bands crossing all 4 of the hind tarsal joints. Additional characters on *reidi* that have secondary value are: (1) wing with an accessory apical pale fringe spot at vein R_2 ; (2) wing with an apical pale fringe spot from vein R_{4+5} to M_{1+2} ; and (3) abdominal sterna II-VI without pale scales. The possession of the two latter characters places *reidi* in Reid's (1962) *vanus* subgroup of the *barbirostris* complex, along with *ahomi* Choudhury (Assam), *barbum-*

brosus (Oriental), *manalangi* Mendoza (Philippines) and *vanus* Walker (Philippines, Borneo, Celebes and Moluccas).

Besides *reidi*, there are two other members of the *barbirostris* complex known from Sri Lanka. The first, *barbirostris* (*barbirostris* subgroup), possesses none of the primary or secondary characters listed for *reidi*. The second, *barbumbrosus* (*vanus* subgroup), lacks the accessory pale fringe spot at R_2 listed under the secondary characters, and all of the primary characters listed for *reidi*. Both *barbirostris* and *barbumbrosus* from Sri Lanka have adult characters that differ from *barbirostris* and *barbumbrosus* specimens from Southeast Asia, but these differences apparently reflect infraspecific geographical variation. Adult *barbirostris* from Sri Lanka typically have dark wings and numerous pale scales on the abdominal sterna, characters that are usually found on *An. campestris* Reid, in Malaysia and Thailand. Adults of *barbumbrosus* from Sri Lanka have only narrow apical pale bands on hind tarsomeres 3 and 4, and do not have an accessory pale fringe spot on the wing at R_2 (Fig. 1), while those from Indonesia (topotypic), Malaysia and Thailand have basal and apical pale bands on hind tarsomeres 3 and 4 and have a distinct accessory pale fringe spot at R_2 . However, the larvae, pupae and male genitalia of *barbirostris* and *barbumbrosus* from Sri Lanka are essentially identical with Southeast Asian *barbirostris* and *barbumbrosus* specimens. Such disjunct adult and larval character associations and leg and wing variations have been previously noted by Reid (1963 and 1968) in *barbirostris* and other species.

The only other species in the *barbirostris* complex currently known from the Indian subregion is *ahomi* from Assam. This poorly known species does not have speckled legs, but does have a wide pale wing fringe spot from R_{4+5} to M_{1+2} and the abdominal sterna without pale scales, making it a member of the *vanus* subgroup. Currently, there is confusion regarding the presence or absence of an accessory pale wing fringe spot on *ahomi*. Wattal, Kalra and Gopal (1962) indicate *ahomi* has this pale spot, while Reid indicates it is absent. Reid (1962, p. 38 and personal communication) based his description of the *ahomi* wing on an excellent wing illustration drawn by Wattal who examined the wing of *ahomi* at Reid's request and sent him the illustration.

Anopheles vanus of Wattal, Kalra and Gopal (1962) reported from India, does not agree with the definition of *vanus* assigned by Reid (1962), after he examined Walker's type specimen. Reid (1968) considers the specimens seen by the above authors as variants of *barbirostris* sensu stricto.

The adult female of *reidi* is one of the most easily recognized members of the *barbirostris* complex. Hopefully, this will help in the discovery of other specimens, particularly the male and immatures.

The importance of the immature stages cannot be over stressed for Reid's (1962) revision of the *barbirostris* complex was based primarily on larval and pupal characters. The *barbirostris* complex in the Indian subregion needs re-evaluation in light of Reid's revision. The limited Indian material available for study consists almost entirely of adults without associated immature skins.

Anopheles reidi is named in honor of Dr. John A. Reid in recognition of his outstanding contributions to our understanding of anopheline systematics and human malaria and filarial epidemiology. His many faceted approach to anopheline taxonomy has been a major demonstration of the value of the biological species concept in taxonomy and medical entomology.

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REFERENCES

- Carter, H. F. 1925. The Anopheline Mosquitoes of Ceylon. Part I. The Differential Characters of the Adults and Larvae. Ceylon J. Sci. (D) 1(2):57-97.
- . 1950. Ceylon Mosquitoes: Lists of Species and Names of Mosquitoes recorded from Ceylon. Ceylon J. Sci. (B) 24(2):85-115.
- Ludlow, C. S. 1902. Two Philippine Mosquitoes. J. New York Entomol. Soc. 10(3):127-131.
- Reid, J. A. 1962. The *Anopheles barbirostris* group (Diptera, Culicidae). Bull. Entomol. Res. 53(1):1-57.
- . 1963. Notes on Anopheline Mosquitoes from Malaya, with Descriptions of Three New Species. Ann. Trop. Med. Parasit. 57(1):97-116.
- . 1968. Anopheline Mosquitoes of Malaya and Borneo. Stud. Inst. Med. Res. Malaysia 31:520 pp.
- Wattal, B. L., N. L. Kalra and R. Raja Gopal. 1962. A Study of *Anopheles barbirostris* Van der Wulp in the Collection of the Malaria Institute of India with First Record of *A. barbumbrosus* Strickland and Choudhury and *A. vanus* Walker in India. Ind. J. Malar. 16(1):63-74.