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DESCRIPTION OF *AEDES* (*AEDIMORPHUS*) *GANDARAI*, A NEW SPECIES FROM THE ISLAND OF SÃO TOMÉ, WITH KEYS TO ALL KNOWN SPECIES OF THE TARSALIS GROUP (DIPTERA: CULICIDAE)

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ABSTRACT. The adults of both sexes, pupa, and fourth-instar larva of *Aedes* (*Aedimorphus*) *gandarai*, a new species of the Tarsalis Group, are described and illustrated. The systematics of *Ae. gandarai* is discussed, as well as its affinities with the other species of the Tarsalis Group. Keys to all described females, male genitalia, larvae, and pupae of the Tarsalis Group are given.

INTRODUCTION

Aedes (*Aedimorphus*) *gandarai* n. sp. is based on several specimens collected during the 1984 expedition of the Departamento de Zoologia e Antropologia, Faculdade de Ciências de Lisboa and the Museu Nacional de História Natural (Museu Bocage) to the island of São Tomé.

Although closely allied to *Ae.* (*Adm.*) *albocephalus* (Theobald, 1903), these specimens represent a distinct, new species that may be distinguished in the larva by the comb, which consists of 9–14 peculiar scales instead of spines, and in the adult by the absence of postspiracular scales, the predominantly dark decumbent scales of the head, the much reduced knee-spots, and the reduced pale markings of the abdominal terga. In the male genitalia, the setae of the basal mesal lobe are smaller than in *Ae. albocephalus* and the branches of the gonostylus are somewhat shorter and more divergent than in that species.

With the present description there are seven endemic species of mosquitoes in the islands of São Tomé and Príncipe: *Ae. gandarai* n. sp.; *Culex* (*Cx.*) *tamsi* Edwards, 1934; *Cx.* (*Culiciomyia*) *cambournaci* Hamon and Gândara, 1955; *Uranotaenia* (*Pseudoficalbia*) *micromelas* Edwards, 1934; *Ur.* (*Ps.*) *capelai* Ramos, 1993; *Ur.* (*Ps.*) *principensis* Ramos, 1993; and *Toxorhynchites capelai* Ribeiro, 1993.

Aedimorphus is of medical importance as it includes vectors of arboviruses, namely Middleburg, Sindbis, Yellow Fever, Rift Valley Fever, Semliki Forest, Wesselsbron, Spondweni, and Uganda S viruses (McIntosh 1975, Monath 1988), and general nuisance mosquitoes.

Twenty species of the Tarsalis Group of Edwards (1941) are now known in the Afrotropical Region: *Ae. adami* Geoffroy, 1971; *Ae. albocephalus* (Theobald, 1903); *Ae. chamboni* Cornet, 1967 (1968); *Ae. dialloi* Hamon and Brengues, 1965; *Ae. falabreguesi* Hamon, 1957; *Ae. filicis* Ingram and De Meillon, 1927; *Ae. gandarai* n. sp.; *Ae. grenieri* Hamon, Service, Adam, and Taufflieb, 1961; *Ae. lokojensis* Service, 1959; *Ae. lottei* Hamon and Brengues, 1965; *Ae. minutus* (Theobald, 1901); *Ae. nyounae* Hamon and Adam, 1958 (1959); *Ae. phyllolabis* Edwards, 1929; *Ae. pseudotarsalis* van Someren, 1946; *Ae. reali* Hamon and Adam, 1958 (1959); *Ae. smithburni* van Someren, 1950; *Ae. tarsalis* (Newstead, 1907); *Ae. wendyae* Service, 1959; *Ae. yangambiensis* De Meillon and Lavoipierre, 1944; and *Ae. yvonneae* Edwards, 1941 (Knight and Stone 1977, Knight 1978, White 1980, Ward 1984).

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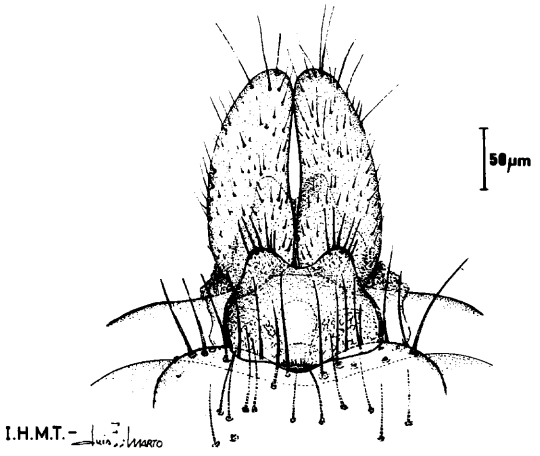

Fig. 1. *Aedes (Adm.) gandarai,* female genitalia.

The terminology used in the description is based on Belkin (1962) and Harbach and Knight (1980).

DESCRIPTION

Aedes (Aedimorphus) gandarai, new species

Female. *Head*: Mainly clothed with narrow, dark decumbent scales, area of golden scales adjoining each eye and behind; erect scales dark. Proboscis and palpi entirely black. Tori light brownish, darker on inner surface, with very few scales. *Thorax*: Scutum with narrow and largely golden scales evenly mixed with dark scales. *Apn* with light broad scales. *Ppn* with narrow scales, some dark, others pale. No postspiracular or prealar scales. Few subspiracular scales present. Paratergite with narrow scales. Mesokatepisternum with large patch of white scales and an additional small patch below. Mesepimeron with patch of white scales. Meron bare. Scutellum with relatively narrow white and dark scales on median lobe; lateral lobes with moderately broad white scales. *Legs*: Black, silvery-white knee-spots strongly reduced, quite inconspicuous; mid- and hindtibiae with small white area at tip, only above; hindfemur dark on anterior surface, with very small knee-spot, the posterior surface dark dorsally, but with light scales ventrally. Tarsi dark. Claws subequal, toothed on fore- and midtarsi, simple on hindtarsus. *Wings*: Dark, with a small line of pale scales at base of costa, underneath. *Abdomen*: All terga with well-developed basolateral patches of white scales; narrow continuous basal band present only on tergum VII, remaining terga all dark above or with only few light median scales, especially on terga I, II and IV. Sterna creamy-white, with narrow dark apical bands. *Female genitalia* (Fig. 1): Distal margin of sternum VIII slightly concave in middle, with row of moderately long setae; postgenital lobe moderately concave distally, with small hairs; insula relatively small, with a few fine hairs; lobes of tergum IX very well marked, separated by a deep sinus, each bearing several strong setae; cerci long.

Male. Essentially as in female, but with somewhat more pale scaling on sides of head. Claws also toothed on fore- and midtarsi, but clearly unequal on foretarsus. *Male genitalia* (Fig. 2): Gonocoxite with row of long hairs apically on sternal surface; basal mesal lobe poorly developed but distinct, with several moderately long hairs. Gonostylus forked near middle into 2 slender, strongly divergent prongs, one bearing a strong terminal spine, other with small but conspicuous seta at tip and a few fine hairs along outer margin that extend onto body of gonostylus. Lateral plate of phallosome with a few teeth in middle. Paraproct pointed, without cercal setae. Lobes of tergum IX poorly developed, each with 6 relatively short setae.

Larva (Fig. 3). General morphology and chaetotaxy of the 4th-instar larva as figured. *Head* (Fig. 3A): Wider than long, cephalic index about 0.8. Antenna slender, curved, very slightly spiculate, about half length of head, not infuscated; seta 1-A at midlength, with 8–12 plumose branches. Seta 4-C with 5(4–6) delicate short branches; 5,6-C plumose, with 9(8–12) and 5(4–6) branches, respectively; bases of 4,5-C very close together; 7-C with 12(10–14) branches. Mentum with 8 teeth on each side of median tooth. *Thorax* (Fig. 3B): Integument glabrous; seta 3-P double, shorter than 1,2-P, which are subequal in length and single; 4-P double; 5,6-P single;

7-P very strong and double; 8-P short, single; 14-P delicate, double. Setae of mesothorax and metathorax as figured. *Abdomen*: Spiculation not developed. Seta 6-I with 4 branches, 7-I double; 6-II-VI with 2,3 branches; 3-II-VI with 1–3 branches; 1-III-V strong, with 1–3 branches. Comb of segment VIII (Fig. 3C) with 10(9–14) pale-colored scales, a few somewhat spiniform or spine-like. *Siphon* (Fig. 3C): Moderately short, index (in mounted specimens) about 2; pecten extending to near middle, with 14(12–15) spines that have only a few basal denticles and are almost regularly spaced; seta 1-S inserted at about two-thirds, well beyond distal pecten spine, with 6(4–8) simple branches arising independently from large base, almost as long as width of siphon at point of attachment. *Segment X* (Fig. 3C): Saddle incomplete, almost as long as broad, posterior margin smooth; seta 1-X about midway between dorsal and ventral margins of segment, single, simple, about as long as saddle; 2-X with 5,6 branches; 3-X single. Seta 4-X of about 5 pairs of multiple tufts, 3–5 median tufts outside barred area; anal papillae subequal, the longer about as long as saddle, broadly lanceolate.

Pupa (Fig. 4). Pupal chaetotaxy as illustrated. *Cephalothorax* (Fig. 4A): Setae not remarkably developed; 8-CT at level of trumpet bases, with 6(3–8) branches; 10-CT with 3 slightly pilous branches; 11,12-CT double, well developed. *Trumpet* (Fig. 4B): Uniformly pigmented, light brown; short and relatively broad at tip; without well-developed tracheoid area in proximal portion of meatus, but with integumentary denticles on all surfaces; distal portion of meatus strongly reticulate. Index about 2.6; pinna ratio about 0.77; meatus ratio about 0.28. *Abdomen* (Fig. 4C): Moderately and uniformly pigmented; seta 1-II small, dendritic; 1-III-V with 4,5 branches; 2-II-VII more or less spiniform, removed from caudal border on III–VI; 3-III single or double, strongly spiniform, pilous at tip; 5-IV-VI double or triple, as long as following tergum on IV,V; 9-VIII with 5 branches (4–7). *Paddle*: Uniformly pale, except base darker; midrib strongly sclerotized; marginal spicules small; seta 1-P relatively short, branched at tip. Paddle index about 1.1.

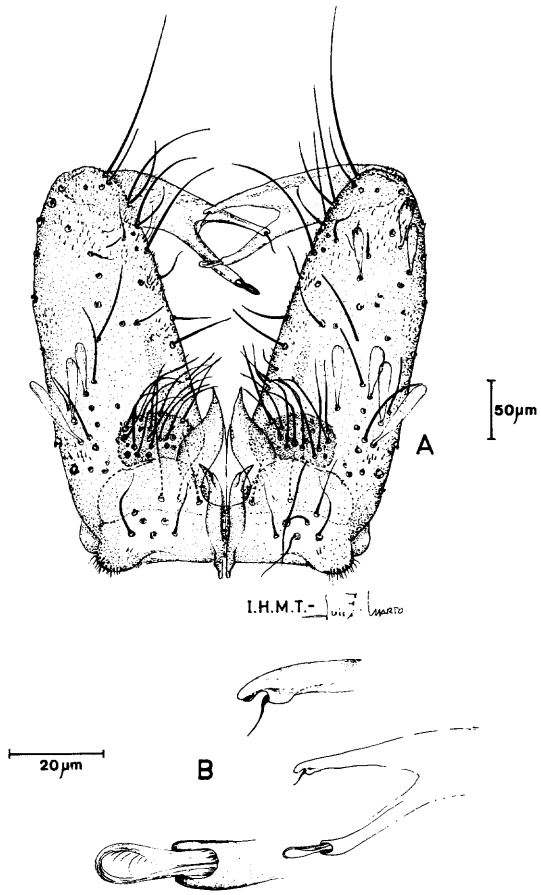

Fig. 2. *Aedes* (*Adm.*) *gandarai*, male genitalia of holotype. A, General aspect; B, gonostylus details.

Material. *Holotype* male (no. E 32576), mangrove area on coast, São Tomé, Praia das Conchas (*ca.* 0° 24′ S, 6° 37′ E), 16 June 1984, R.A. Capela. *Paratypes*: Female (no. E 32577); male (no. E 32578) with genitalia mounted on slide; 6 pupal exuviae (nos. E 32579–E 32584) mounted on slide; 3 4th-instar larvae (nos. E 32585–E 32587) mounted on slide; same data as holotype. All type material is deposited in the Disciplina de Entomologia Médica, Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa.

Etymology. This species is named in honor of the late Dr. Álvaro F. Gândara, medical

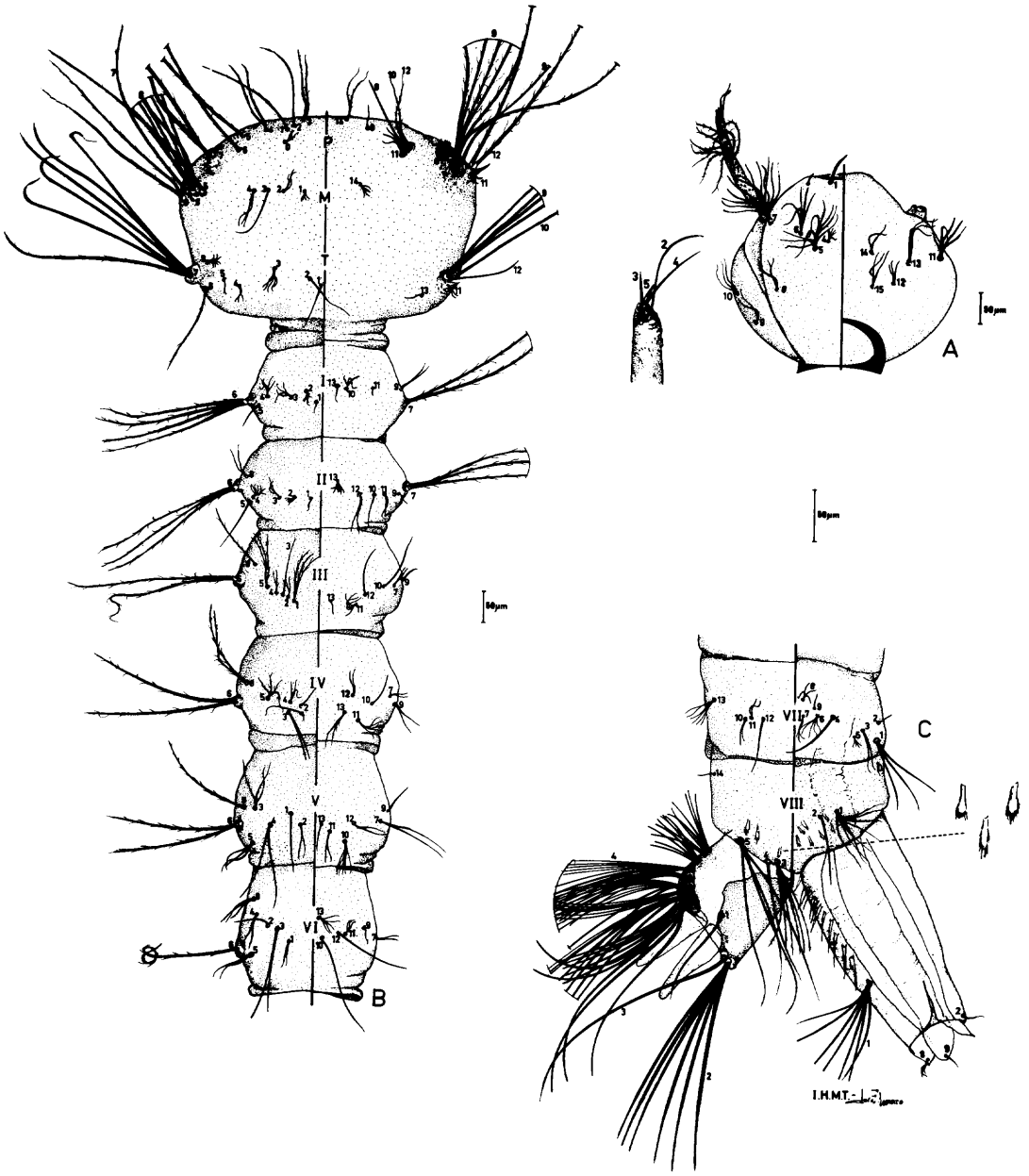

Fig. 3. *Aedes* (*Adm.*) *gandarai,* fourth-instar larva. A, Head; B, thorax and abdominal segments I–VI; C, terminal segments of abdomen.

entomologist of the Instituto de Investigação Médica de Angola, who made valuable contributions to the study of Afrotropical mosquitoes, including those of São Tomé.

Taxonomy and diagnosis. Within subgenus *Aedimorphus, Ae. gandarai* clearly belongs to the Tarsalis Group, a heterogeneous group characterized by Edwards (1941) as having the scutellum with white scales mostly broad, the abdominal terga with lateral spots usually snowy-white, and the tarsi dark.

Based on adult morphology, *Ae. gandarai* appears closely related to *Ae. tarsalis, Ae. phyllolabis,* and *Ae. pseudotarsalis,* from

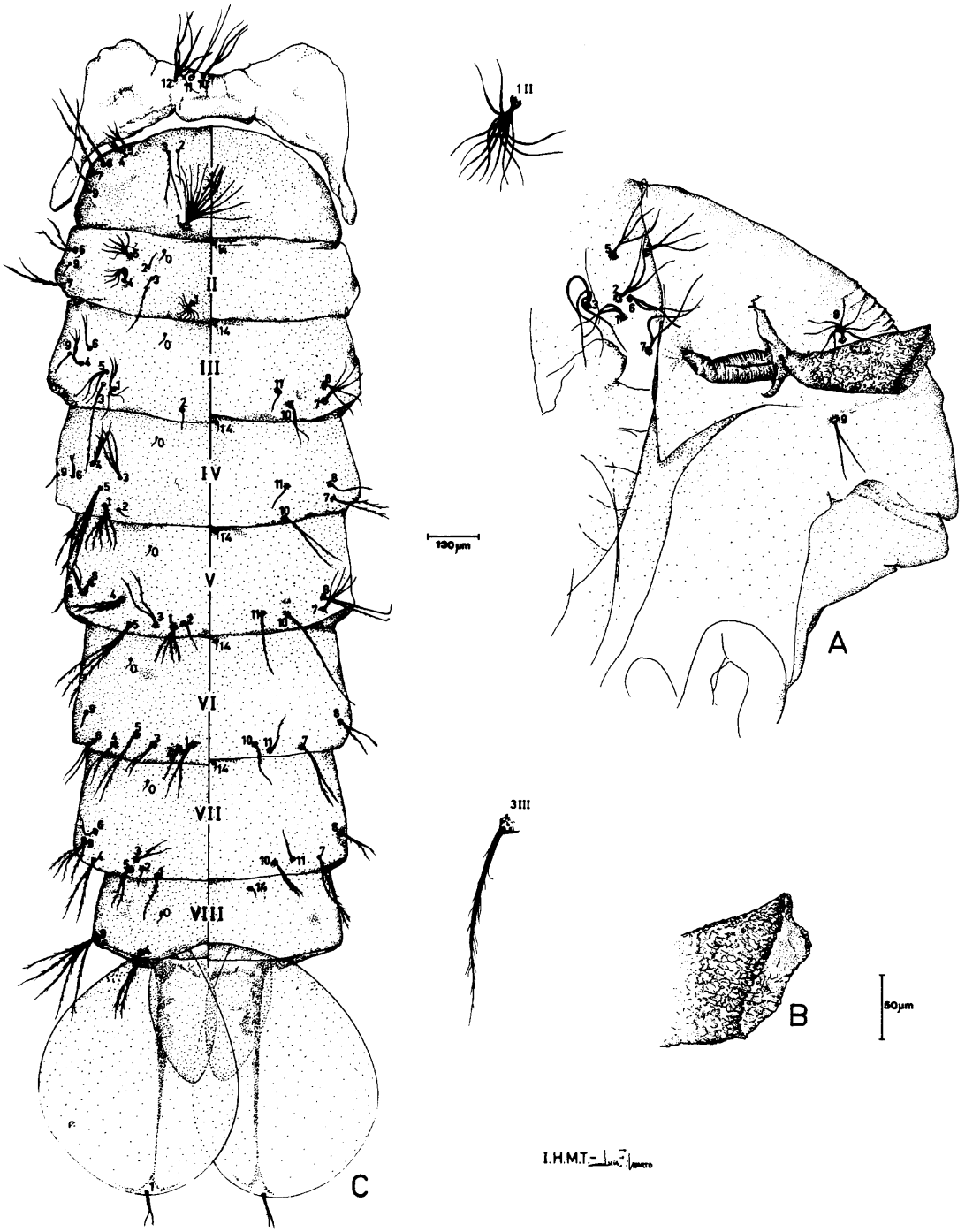

Fig. 4. *Aedes (Adm.) gandarai,* pupa. A, Cephalothorax; B, trumpet; C, metathorax and abdomen.

which it is separated by the inconspicuous knee-spots and reduced white patch at the tip of the hindtibia. In the male genitalia, on the other hand, *Ae. gandarai* can be separated easily from all other species in the Tarsalis Group, except *Ae. albocephalus,* by the morphology of its gonostylus, which is forked distally into two slender prongs that are somewhat shorter and more divergent than in *Ae. albocephalus.* Females of these two species are quite similar, but *Ae. gandarai* can be distinguished by the reduction of the white markings of the abdomen and legs and by the absence of postspiracular and subspiracular scales, even though some polymorphic variation has been reported in *Ae. albocephalus* by different authors (Haddow et al. 1951, van Someren et al. 1955, Ribeiro and Ramos 1973, McIntosh 1975).

Aedes lamborni Edwards also exhibits a forked gonostylus, but this species has broad white rings embracing the tarsal joints as well as other differences in the male genitalia.

In the larval stage, *Ae. gandarai* is nearer to *Ae. yangambiensis* and *Ae. phyllolabis.* It can be separated from the former by its evenly spaced pecten spines and from the latter by its fewer comb scales.

The pupa of *Ae. gandarai* may be separated from the other known pupae of the Tarsalis Group by the following key.

Within the Tarsalis Group, males of all 20 described species are known, whereas the females, larvae, or pupae are described for only 10 species. In the keys that follow, an attempt is made to separate the known stages of all 20 species of the Tarsalis Group.

KEYS TO THE KNOWN SPECIES OF THE TARSALIS GROUP

Females

1. Scutum with 4 pairs of small white spots composed of narrow scales ..... *filicis*
– Scutum with at most a pair of yellowish spots .. 2
2. Some abdominal terga, usually III–VI, with complete basal pale bands 3
– Abdominal terga with only basolateral pale markings 5
3. Postspiracular and subspiracular areas with a few flat scales ..... *albocephalus*
– Postspiracular and subspiracular scales absent .. 4
4. Decumbent scales on vertex flat and broad .. *wendyae*
– Decumbent scales on vertex narrow ... *smithburni*
5. Decumbent scales on vertex mostly broad 6
– Decumbent scales on vertex mostly narrow 7
6. Postspiracular scales present; subspiracular scales absent ..... *chamboni*
– Postspiracular scales absent; subspiracular scales present ..... *minutus*
7. Femora without obvious knee-spots; white spot at tip of hindtibia reduced, about as long as wide ..... *gandarai*
– Femora with conspicuous silvery-white knee-spots; white area at tip of hindtibia at least twice as long as wide ..... *tarsalis*
phyllolabis
pseudotarsalis

Male genitalia

1. Gonostylus forked at middle into 2 slender prongs 2
– Gonostylus shaped otherwise 3
2. Basal mesal lobe with several long hairs; branches of gonostylus somewhat longer and less divergent, inner prong bearing a short terminal spine ..... *albocephalus*
– Basal mesal lobe with shorter hairs; branches of gonostylus slightly shorter and more divergent, terminal spine larger (Fig. 2) ... *gandarai*
3. Gonostylus not or only very slightly swollen 4
– Gonostylus markedly swollen 5
4. Gonostylus long, narrow, and sinuous, with a short, curved, pointed gonostylar claw and a strong, curved spine on outer aspect of distal portion, away from apex ..... *smithburni*
– Gonostylus narrow only at middle, slightly swollen at base and apex, with a small, rounded gonostylar claw and a strong, hooked spine close to the apex ..... *adami*
5. Gonostylus short and thick, with small pedicel ..... *dialloi*
– Gonostylus swollen apically, clubbed, with long pedicel 6
6. Basal mesal lobe large, with many long hairs .. 7
– Basal mesal lobe small or absent, with at most only a few long hairs 8
7. Spine of swollen portion of gonostylus about midway between gonostylar claw and fingerlike process ..... *falabreguesi*
– Spine nearer gonostylar claw than to fingerlike process ..... *grenieri*
8. Gonostylus club very hairy 9
– Gonostylus club almost bare 10
9. Gonocoxite without basal mesal lobe .. *lokojensis*
– Gonocoxite with a small cylindric basal mesal lobe ..... *minutus*
10. Gonostylus club without projecting, well-developed fingerlike process 11

- Gonostylus club with well-developed fingerlike process projecting outward 16
11. Gonostylus with pedicel short and thick; gonostylar claw small, less than half diameter of club ..... *phyllolabis*
- Gonostylus with pedicel long and slender; gonostylar claw large, almost as long as greatest diameter of club 12
12. Gonostylus club symmetrical 13
- Gonostylus club asymmetrical, expanded on inner side 14
13. Gonostylus club with very small fingerlike process ..... *chamboni*
- Gonostylus club without fingerlike process *nyounae*
14. Gonostylus with claw inserted at apex of inward expansion of club ..... *yvonneae*
- Gonostylus with claw inserted well before inward expansion of club 15
15. Gonostylus club with large, flattened spine and a few fine hairs; gonocoxite without basal mesal lobe ..... *wendyae*
- Gonostylus club with long cylindrical spine, a few fine hairs, and a strong striated seta at base of inward expansion; gonocoxite with small but distinct basal mesal lobe ..... *reali*
16. Gonostylus club with spine straight and strongly flattened ..... *yangambiensis*
- Gonostylus club with spine curved and cylindrical, not flattened ..... *tarsalis*
filicis
pseudotarsalis
lottei

Larvae

1. Siphon with row of appressed spines near apex ..... *pseudotarsalis*
- Siphon without such spines 2
2. Segment VIII comb of spines only 3
- Segment VIII comb a patch of numerous scales, sometimes with 1,2 spines 4
3. Siphon with seta 1-S located between the 2 most distal pecten spines ..... *lokojensis*
- Siphon with seta 1-S located beyond last pecten spine ..... *albocephalus*
4. Pecten with all spines rather evenly spaced 5
- Pecten with 1 or 2 distal spines more widely spaced than others 6
5. Segment VIII comb a patch of about 10 scales, sometimes with 1,2 spines or spinelike scales; pecten extending only to 0.5 of siphon ... *gandarai*
- Segment VIII comb a patch of 50–60 scales; pecten longer, extending beyond 0.66 of siphon ..... *phyllolabis*
6. Siphon with seta 1-S inserted well beyond last pecten spine 7
- Siphon with seta 1-S inserted between the 2 most distal pecten spines 8
7. Setae 5,6-C with 7 and 8 branches, respectively ..... *wendyae*
- Setae 5,6-C with 5 and 4 branches, respectively ..... *yangambiensis*
8. Seta 7-C with 7–9 branches; comb of 40–60 scales; pecten usually with about 8 spines *tarsalis*
- Seta 7-C with 10 or more branches; comb of 20–30 scales; pecten with 15–17 spines 9
9. Siphon index nearly 4; seta 6-C with 5,6 branches; spines of pecten dark ..... *filicis*
- Siphon index 3–3.5; seta 6-C with 6–8 branches; spines of pecten pale ..... *nyounae*

Pupae

1. Seta 9-VIII with about 10 branches ..... *lokojensis*
- Seta 9-VIII with about 7 or fewer branches 2
2. Seta 1-P about half length of paddle ..... *wendyae*
- Seta 1-P distinctly shorter, at most 0.25 length of paddle, usually much less 3
3. Paddle index 1.3–1.4; seta 1-P about 0.11–0.13 length of paddle 4
- Paddle index smaller, 0.7–1.2; seta 1-P usually longer 5
4. Trumpet index about 5; seta 9-VIII with 4 branches ..... *nyounae*
- Trumpet index about 3; seta 9-VIII with 2,3 branches ..... *yangambiensis*
5. Paddle index about 0.70–0.80 6
- Paddle index about 1.1–1.2 8
6. Trumpet darker at apex ..... *albocephalus*
- Trumpet dark throughout 7
7. Seta 1-P 0.13 length of paddle; trumpet index 4.5; pinna ratio 0.25 ..... *filicis*
- Seta 1-P 0.17–0.20 length of paddle; trumpet index about 5.5; pinna shorter, ratio about 0.15 ..... *tarsalis*
8. Seta 1-VI,VII single; trumpet slightly darker at base and tip ..... *gandarai*
- Seta 1-VI,VII with 2–6 branches; trumpet dark throughout or darker at tip only 9
9. Seta 8-CT with 2,3 branches; 10-CT with 2 branches; 5-VII with 3–6 branches; trumpet darker at tip only ..... *phyllolabis*
- Seta 8-CT with 5,6 branches; 10-CT with 6–9 branches; 5-VII single or bifid; trumpet dark throughout ..... *pseudotarsalis*

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