Received 04 November 2008; revised 05 January 2009; accepted 06 May 2009

Two new species of *Argiolestes* from Papua New Guinea (Odonata: Megapodagrionidae)

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Key words: Odonata, dragonfly, Zygoptera, Megapodagrionidae, Papua New Guinea, new species, *Argiolestes*.

Abstract

Two new species of the New Guinean megapodagrionid genus *Argiolestes* are described: *A. tuberculiferus* (holotype ♂: Papua New Guinea, Simbu Province, 6°43'S, 145°05'E; 900 m, 14 xii 2003) and *A. verrucatus* (holotype ♂: Papua New Guinea, Sandaun Province, 4°48'S, 141°39'E; 1,700-2,100 m, 08 ix 2004). We further provide additional descriptions and ecological data of new specimens of *A. fornicatus*. We briefly discuss the status of several other nominal taxa in *Argiolestes* based on observations of some recent collections.

Introduction

Argiolestes Selys, 1862 is a diverse genus of megapodagrionid Zygoptera currently comprising 45 recognized species (Lieftinck 1956; Theischinger & Richards 2006, 2007; Englund & Polhemus 2007; Kalkman 2007, 2008; van Tol 2008). Most species occur in New Guinea and two species are endemic to New Caledonia and the Bismarck Archipelago, respectively.

Our recent collections in Papua New Guinea's (PNG) Simbu and Sandaun Provinces (Fig. 1) have revealed new and distinctive species. In this paper we first present additional notes on the recently described *A. fornicatus* Theischinger & Richards, 2007, and then provide formal descriptions for two new species of *Argiolestes*. We then discuss the taxonomy of the genus and suggest that a reconsideration of the status of some species of *Argiolestes* may be warranted, and a revised key to the species of this genus is needed (Kalkman 2008).

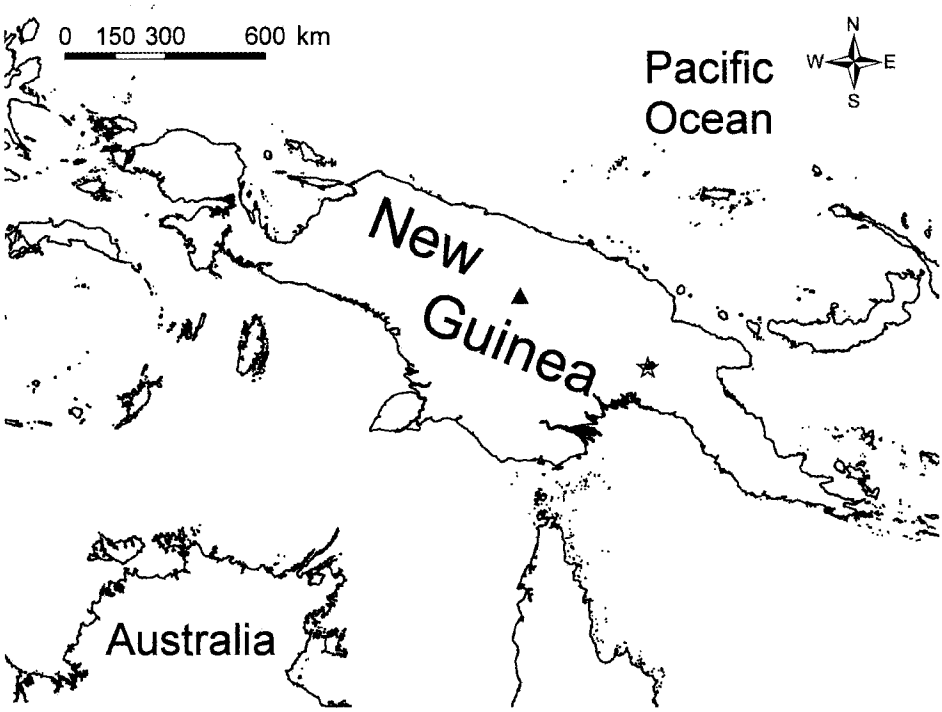

Figure 1: Map of the Island of New Guinea indicating collection locations for the species of *Argiolestes* described in this work. • *A. fornicatus*; ☆ *A. tuberculiferus* sp. nov.; ▲ *A. verrucatus* sp. nov.

Argiolestes fornicatus Theischinger & Richards, 2007

(Fig. 2)

Specimens studied

2 ♂: Papua New Guinea, Simbu Province, village of Herowana (6°39'06.4"S, 145°11'49.6"E; 1,370 m), in native coffee gardens, 21 vii 2004, O. Shyston leg; 1 ♂: Crater Mountain Biological Research Station (CMBRS; 6°43'S, 145°05'E; 900 m), B44 creek, 16 vii 2004; 1 ♂: CMBRS, G37.5 forest creek, 02 i 2004, SO leg. All specimens will be deposited at the National Museum of Natural History Naturalis, Leiden, The Netherlands (RMNH).

Diagnostic remarks

The specimens described here were collected <50 km from the locality of the holotype described by Theischinger & Richards (2007) on the southern side of the

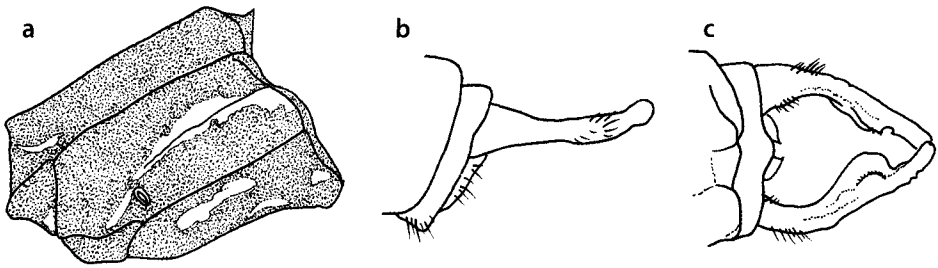

Figure 2: *A. fornicatus* — (a) male thoracic pattern, left lateral view; (b) male terminalia, left lateral view; (c) male terminalia, dorsal view.

Crater Mountain massif in Papua New Guinea. The species appears to be most closely allied to *A. kula* Englund & Polhemus, 2007, *A. sidonia*, and *A. tenuispinus*, but differs from all three by its blackish legs and overall dark body coloration. *A. fornicatus* lacks the pronounced interior, subapical spines that are found on the cerci of both *A. sidonia* and *A. tenuispinus*. Instead, the inner projections present on the cerci of *A. fornicatus* are broad and rounded. In *A. kula* the two projections differ in shape, with a short, broad dorsal projection similar to the one in *A. fornicatus* coupled with an angulate ventral projection markedly different from *A. fornicatus* (Englund & Polhemus 2007). In addition, *A. fornicatus* differs from *A. kula* by its much narrower, rather irregular mesepimeral stripe, and its predominantly dark metepimeron. *A. fornicatus* was referred to as *Argiolestes* sp. nov. A in Oppel (2006). The female of this species is unknown.

Descriptive notes

The adult males collected here differ from the holotype described by Theischinger & Richards (2007) as follows: Smaller size overall, Px 20-22 in Fw, 19-20 in Hw; Length of abdomen (excl. appendages) 34.0; Hw length 30.0.

Head: Labium dark brown with a pair of small paler spots near posterior margin. Labrum brilliant metallic green. Anteclypeus yellow, postclypeus dark brown to blackish, with faint coppery reflections. Frons blackish, orange on sides reaching to margins of compound eyes. Dorsal surface of head mostly dark, with a small, poorly-defined paler spot exterior to each lateral ocellus.

Thorax: Pale areas of synthorax, particularly on metepimeron, much reduced, broad unbroken pale stripe in type series represented in the present specimens as two or more narrow, isolated spots or stripes as shown in Figure 2a. — Wings: Membrane hyaline but becoming slightly smoky beginning a few cells beyond the nodus, and increasingly apparent at the level of the Pt and beyond. Ac slightly beyond Ax_1 in Fw, Arc situated well beyond Ax_2. 2.5-3 postquadrangular Ax before level of nodus in Fw. R_{4+5} arising at subnodus, IR_3 arising at Px_1. Pt yellow-brown

or a little darker in color. Two cell rows between C and R_1 beyond Pt, for 1-2 cells only, occasionally only one cell row in this space.

Abdomen: Color pattern differs slightly as follows: Black, with S1 pale on ventral half, this color rising higher along posterior margin; S2 with a pair of almond-shaped pale ventral spots. Cerci yellowish-brown or a little darker, paraprocts dark brown, shaped as shown in Figures 2b, c.

Ecological notes

The holotype described by Theischinger & Richards (2007) did not include ecological information. In our study area the species was found in small gravel streams under closed canopy, ca 1-2 m wide with very irregular water flow and gravel bed. The creeks were fully shaded. It was also found in temporarily dry flood channels adjacent to a larger river. It appeared to be a shade-loving species avoiding sunny spots along the watercourses, and was found in areas with high moss cover. It was found in two study areas, the Crater Mountain Biological Research Station (CMBRS), and the nearby village of Herowana (Oppel 2006).

The CMBRS was situated within a large continuous tract of pristine, aseasonal, lower montane rainforest, and featured a large number of clear rocky mountain streams, small creeks, and temporary streams that existed only after heavy or persistent rainfall.

The village of Herowana was ca 10 km north-east of CMBRS and was situated slightly higher (1,300 m). It consisted of a small airstrip and an area of ca 4 km^2 comprising mostly subsistence gardens, small coffee plantations and scattered huts. Herowana had ca 200 inhabitants. Native forest was still present, but had been degraded by cutting. The village area had several artificial ditches with grassy shoreline vegetation and almost stagnant water. Three specimens of this species were collected along shady ditches in the village.

Argiolestes tuberculiferus sp. nov.

(Figs 3, 4)

Etymology

The species is named for the bifurcated tubercle that projects conspicuously beyond the distal margin of S10. This species is the only known member of the genus to display this distinctive process. The name is an adjective.

Specimens studied

Holotype ♂: Papua New Guinea, Simbu Province, Crater Mountain Biological Research Station (CMBRS; 6°43'S, 145°05'E; 900m), in forest, 14 xii 2003. — Para-

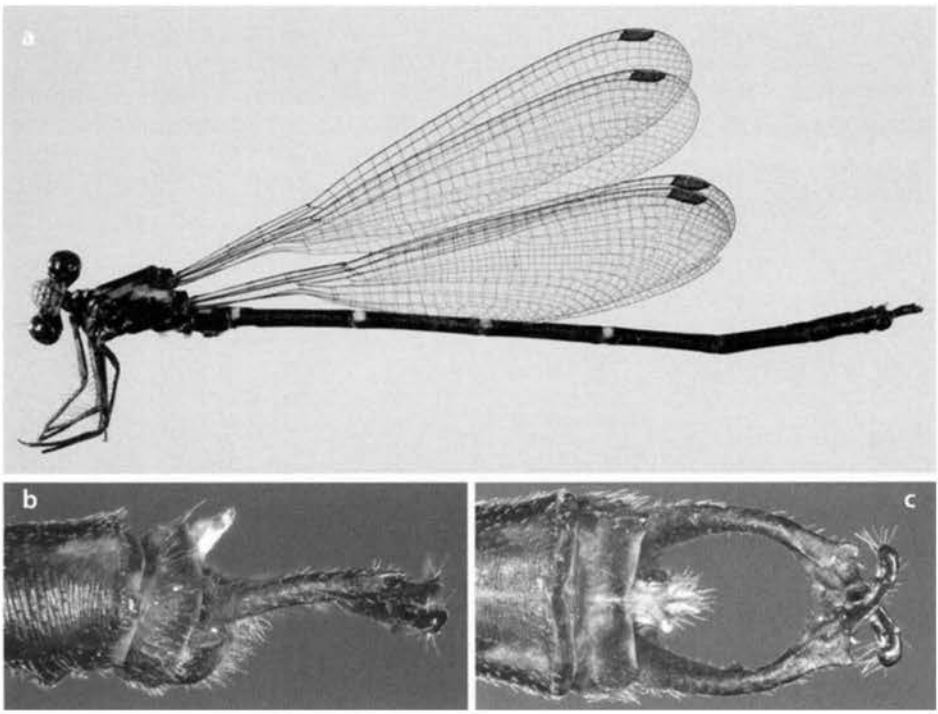

Figure 3: *A. tuberculiferus* sp. nov., male — (a) habitus of holotype, left lateral view; (b) terminalia, left lateral view; (c) same, dorsal view.

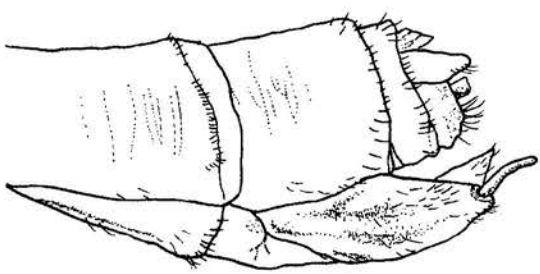

Figure 4: *A. tuberculiferus* sp. nov. — female terminalia left lateral view.

types: 1 ♂, same data as holotype; 1 ♂: CMBRS, between river and house on track, 07 i 2004. 1 ♂: CMBRS, on trail, 04 ii 2004. 1 ♀: CMBRS, on track just above river to house, 26 iii 2004. All SO leg. — Other specimens: 8 ♂, 2 ♀: Papua New Guinea, Southern Highlands Province, Muller Range, Conservation International Muller Range expedition Camp 1 (5°44'S, 142°16'E; 515 m) (Gugusu) , 04-11 ix 2009 leg. V.J. Kalkman. All specimens will be deposited at the RMNH.

Diagnosis

A predominantly black *Argiolestes* with a bluish face, a broad, zigzagged, pale stripe slashing horizontally across the side of the synthorax, large black Pt, toothed black cerci, and a unique and prominent pale, Y-shaped median tubercle on the hind margin of S10. This species shows similarities to *A. australis* (Guérin-Méneville), 1830, most notably the strongly toothed male cerci, but is easily distinguished from it by the black male terminalia, the stark black-and-pale thoracic pattern, the blackish venter and legs, and the forked pale tubercle.

Male holotype

Head: Labium dark brown. Labrum pale cream, with a slight greenish iridescence suffusing the shallow median and lateral depressions. Clypeus pale (pale blue in life) with small blackish spot to either side of the median line on dorsal surface. Frons pale up to about bases of antennae, this pale color continuous to each compound eye, and running in a fine line a little rearward along margin of each eye. Dorsal surface of head mostly dark, with two small, bean-shaped pale spots to either side of, and slightly before, the median ocellus. A roughly rectangular pale area encompasses lateral ocelli and reaches rear of head.
Thorax: Prothorax jet-black on the sides, pale dorsally, with a large black spot between the two rounded median lobes. Posterior lobe simple, much wider than long, the side edges evenly rounded. Synthorax dull black, vaguely suffused with coppery reflections, marked with pale areas as shown in Figure 3a; small isolated crescent-shaped mark along lower (anterior) edge of mesepisternum; dorsal half of mesepimeron and metepisternum marked with a large, roughly M-shaped pale area, one branch of which runs ventrad along humeral suture, central branch running down interpleural suture but stopping well before metathoracic spiracle, and third branch reaching back to upper end of metapleural suture. Small, isolated sliver of pale color appears along metapleural suture further down, just below metathoracic spiracle. Venter completely blackish. — Legs: Black with slender reddish spurs. — Wings: Shaped very much as in *A. australis*; veins dark brown or black, membrane somewhat smoky overall. Px 23-24 in Fw, 21-24 in Hw. Ac slightly beyond Ax_1 in forewing, Arc situated well beyond Ax_2. Only 1 postquadrangular Ax before level of nodus in Fw, 1-2 to oblique subnodal crossvein. R_{4+5} arising distinctly before subnodus, IR_3 arising distinctly past subnodus. Pt shaped similarly to *A. australis*, dark blackish-brown in color. Two staggered cell rows between C and R_1 beyond Pt.
Abdomen: Black, marked with pale as follows: S1 with a pale dorsal crescent along its distal margin; S2 with a pair of oval baso-dorsal spots; S4-7 each with a pair of small baso-lateral oval spots; S8 and S9 each with a pair of indistinct brownish (pale in life?) baso-lateral spots; S10 indistinctly paler dorsally, very dark brown

in preserved specimens. Terminalia dark brown or black, shaped as shown in Figures 3b, c. At distal margin of S10 there is a distinct, pale, dorso-medial, posteriorly directed Y-shaped tubercle that projects well beyond distal margin of S10.
Measurements [mm]: Length of abdomen (excl. appendages) 36.0-38.0; Hw length 28.0-30.5; Pt Fw 1.3-1.5.

Female paratype

Head and thorax: Colored as in male, with same distinctive zigzagged pale horizontal stripe across side of synthorax. Prothorax not distinctively developed. — Legs: Brown with brown spines, darker at the femero-tibial joint. — Wings: As in male, enfumed brownish throughout, two staggered cell rows between C and R_1 beyond Pt.
Abdomen: Terminalia as in Figure 4; ovipositor extends beyond apex of S10.
Measurements [mm]: Length of abdomen (excl. appendages) ± 33 (specimen disfigured); Hw length 39.0.
Comments: The association of the female is a supposition, but with its body coloration and pattern, wing venation, and place of origin we feel confident that the series described above represents both sexes of a single species.

Taxonomic notes

A. tuberculiferus is placed near *A. australis* and *A. pallidistylus* Selys, 1878 in the key to the genus provided by Lieftinck (1956). It was referred to as *Argiolestes* sp. nov. B in Oppel (2006).

The series from Muller Range shows some clear differences to the specimens from the type locality. It is not unlikely that the specimens from Muller Range will turn out to represent a different but closely related species. The most striking differences are: (1) postclypeus black instead of pale; (2) side of thorax with two pale marks instead of one roughly M-shaped pale area; (3) Pt pale instead of dark; and (4) a smaller tubercle at the distal margin of S10 with a less distinct Y-shape in comparison with the specimens from the type locality. The series from Muller Range is also smaller with a Hw length of 24-25.5 mm. More specimens from other localities are needed to judge the taxonomic relevance of these differences.

Ecological notes

This species was discovered in small creeks or temporary water courses forming on footpaths under closed canopy. The water bodies were ca 1-2 m wide, very shallow, with very irregular water flow, and gravelly or rocky substrate. The creeks were fully shaded, and the species was never found in the sun, even where a creek was adjacent to a sunny clearing. We found this species only at CMBRS in pris-

tine, aseasonal, lower montane rainforest. The species was not found in a nearby village with secondary forest and slightly lower rainfall.

Argiolestes verrucatus sp. nov.

(Fig. 5)

Etymology

The species is named for a wart-shaped tubercle that adorns the upper margin of each cercus. It is the only known species within this genus possessing this unique character. The name is an adjective.

Specimens studied

Holotype ♂: Papua New Guinea, Sandaun Province, Telefomin District, Mekil Research Station (4°48'S, 141°39'E; 1,700-2,100 m), 08 ix 2004. — Paratype: 1 ♂ (teneral): same data, "on G-road below helipad, no water nearby," 25 viii 2004. Both SO leg. The specimens will be deposited at the RMNH.

Diagnosis

The mature male insect is a predominantly black *Argiolestes* with a metallic green labrum, blackish legs with a faint yellowish stripe, and a peculiar wart-like tubercle along the dorsal edge of each cercus. Although the key provided by Lieftinck (1956) would place *A. verrucatus* close to *A. sidonia* Martin, 1909 and *tenuispinus* Lieftinck, 1938, the species appears to be more closely related to *A. tristis* Lieftinck, 1935 and *A. lamprostomus* Lieftinck, 1949. *A. verrucatus* can be distinguished from *A. tristis* and *A. lamprostomus* by the unique tubercle, which is a feature that also distinguishes *A. verrucatus* from other known species of this genus. The female of this species is unknown.

Male holotype

Head: Labium dark brown with a pair of small paler spots near base. Labrum brilliant metallic green. Anteclypeus yellow, postclypeus shiny black, without coppery reflections. Frons dull black, a narrow orange stripe on each side reaching to margin of compound eye. Dorsal surface of head blackish.
Thorax: Prothorax black, with a well-defined, teardrop-shaped pale spot on outer edge of median lobe. Posterior lobe flattened and raised. Synthorax black with coppery reflections, marked with pale areas as follows: no trace of any pale markings along lower (anterior) edge of the mesepisternum; pale stripe running down

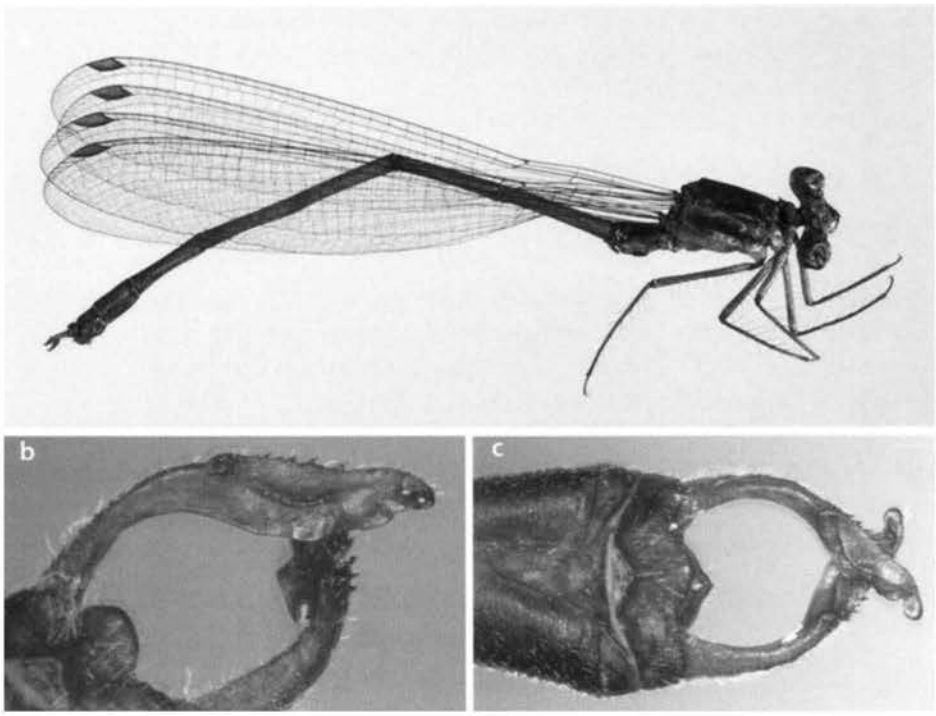

Figure 5: *A. verrucatus* sp. nov. — (a) male thoracic pattern, right lateral view; (b) male terminalia, dorso-lateral view; (c) male terminalia, dorsal view.

upper half of interpleural suture, coming to a point well above metathoracic spiracle; spiracle pale anteriorly, irregular pale spot continuing from spiracle toward venter; small pale spot on hind edge of mesinfra- and metinfraepisternites; metepimeron unevenly pale, diffuse black smudge taking up much of its center. Venter blackish. — Legs: Black, femora each with a poorly defined, median pale stripe. — Wings: membrane faintly yellowish-brown beyond quadrilateral. Px 23 in Fw, 21 in Hw. Ac at Ax_1 in Fw, Arc situated well beyond Ax_2. 2.5-3 postquadrangular Ax before level of nodus in Fw. R_{4+5} arising beyond subnodus, IR_3 arising at Px_1 in Fw. Pt dark brown in color. One cell row between C and R_1 beyond Pt, occasionally with an extra row for a single cell.

Abdomen: Black with low coppery reflections; venter of S4-7 somewhat paler. Distal third of S8, and all of S9, deeply longitudinally furrowed, blackish dorsally. Terminalia dark reddish brown, shaped as shown in Figures 5b, c; apices of cerci on holotype male broken off; taken from cerci of teneral male. Distal margin of S10 with median rounded protrusion armed with 2-4 minute teeth along either side of median protrusion, so small as to be visible only under a magnification of 60x or greater. Cerci lacking interior teeth, interior flange undulate, appearing somewhat bilobed. There is a peculiar wart-like tubercle (visible in both dorsal

and lateral views) along dorsal margin; this tubercle is studded with many tiny, gloss-black denticles and is located at the point where the interior flange begins to flare from the shaft of the cercus.
Measurements [mm]: Length of abdomen (excl. appendages) 27.0; Hw length 31.5; Pt Fw 1.3.

Teneral male paratype

Head and thorax: Brown where the mature male is black, the metallic green of the labrum evident but not yet well-developed. Pale areas on the thorax are more extensive. — Legs: Yellowish-brown, the femero-tibial joint dark brown. — Wings: Hyaline throughout, the Pt yellow with black borders.
Abdomen: Segments yellowish with dark brown apical rings, the ventral edge of all tergites also dark brown; segments growing increasingly dark brown from S5 rearward, with S9-10 essentially blackish-brown. Distal margin of S10 completely lacking teeth. Cerci yellowish-brown with dark brown apices.

Ecological notes

The specimens were taken at the Mekil Research Station, in the western part of the central mountain range of Papua New Guinea near Mt. Stolle in the Telefomin District, Sandaun Province. This area comprises moss-covered pristine montane forest set aside by the Sokamin people for conservation of wildlife. The elevation of the study site ranged from 1,700 to 2,100 m and received ca 5.0 m of aseasonal rainfall annually. The mountain was protected by landowners and no tree cutting occurred within the study area. The site was on a broad ridge and did not have many creeks during the time of specimen collection. The largest water sources were the Mei River at ca 600 m at the base of the mountain and its smaller tributaries.

The collection of specimens was carried out between 25 August and 14 September 2004. During that time precipitation was very sparse and most smaller creeks had dried out or were only flowing after occasional heavy rain. The insects were collected along small forest trails by local assistants, and the stated collector (SO) had no personal recollection of having captured the insects.

Discussion

The genus *Argiolestes* is taxonomically challenging since many taxa are structurally similar, rendering identification by morphological characters alone potentially unreliable. Lieftinck (1956) provided a key to 31 taxa for which the male was sufficiently known. This key is based on a combination of morphological and color characters. While new species continue to be described, recent collections have

also shown that many of the taxa recognized by Lieftinck exhibit greater variation than previously acknowledged. This discovery may also lead to the unification of some taxa, as specimens that were described as distinct taxa may represent the opposite ends of a continuum in variation present within a single species (Kalkman 2007, 2008). For example, the four species *A. ephippiatus* Lieftinck, 1956, *A. esuriens* Lieftinck, 1956, *A. microstigma* Lieftinck, 1956, and *A. prothoracalis* Lieftinck, 1956 were originally described from very small sample sizes. While the male cerci support a division between the two former species and the two latter species, we find difficulty in maintaining all four as distinct taxa due to the lack of variation considered when species were originally described. We suggest that *A. ephippiatus* and *A. prothoracalis* could represent individual variation of a single species, and encourage researchers to carefully consider the current taxonomy in future studies about those taxa. Our description of additional specimens of the recently described *A. fornicatus* highlights the variation that may be found within a species that was originally described from a single specimen.

Further collections of specimens would also be extremely useful for both the description of structural variation within species and the delineation of geographic distribution of many species.

Acknowledgements

We would like to thank the Wildlife Conservation Society, the International Dragonfly Fund, and the Worldwide Dragonfly Association for support with the fieldwork. The Gimi, Pawaian, and Sokamin people inhabiting the study areas were kind enough to host us on their land and were also good companions in the field. The Department of Environment and Conservation of Papua New Guinea gave the generous permission to collect and export specimens. Vincent Kalkman collected additional specimens through support from the Conservation International Rapid Assessment Program, and we greatly appreciate his assistance with species descriptions and photographs. Furthermore we would like to thank Nick Donnelly of Binghamton, New York and Michael May of Rutgers University for their guidance, friendship, and technical assistance in producing the figures. Michael May, Bert Orr, Jan van Tol, and Vincent Kalkman provided helpful comments on previous drafts of this manuscript.

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