

Four new species of *Palaiargia* Förster, 1903 (Odonata: Platycnemididae) from New Guinea with revised distribution records for the genus

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Four new species of *Palaiargia* from New Guinea, *P. benkeni*, *P. clarillii*, *P. quandti* and *P. tydecksjuering*, are described and figured. Maps are provided of the known distributions of all species of the genus which occurs in the Moluccas and on the main island of New Guinea. Previous unpublished records are provided for *P. carnifex*, *P. c. ceyx*, *P. charmosyna*, *P. ernstmayri*, *P. humida* and *P. stellata*.

Keywords: Odonata; dragonfly; Platycnemididae; *Palaiargia*; new species; New Guinea; Moluccas distribution records

Introduction

The genus *Palaiargia* Förster 1903 includes 20 described species and several subspecies ranging from the main island of New Guinea to the northern Moluccas. Along with the related New Guinean genera *Papurgaria* Lieftinck, 1938, *Hylaeargia* Lieftinck, 1949 and *Archboldargia* Lieftinck, 1949, the genus was originally placed in Coenagrionidae because of a supposed relationship to the new world genus *Argia*. Based on recent DNA analysis it is now believed all these genera belong to the family Platycnemididae, subfamily Idiocnemidinae (Dijkstra, Kalkman, Dow, Stokvis, & van Tol, 2013). They differ from other New Guinean members of the subfamily in lacking crenulated margins to the wingtips, and probably represent a natural division within the group.

Palaiargia species range in size from moderately small to moderately large, are of robust stature, with generally a relatively short abdomen, and are noted for their brilliant body coloration. All but four species were described by M.A. Lieftinck between 1932 and 1972. In 1957 he illustrated the dorsal views of the bodies of 16 of the 19 species then known in a series of watercolour drawings and provided monochrome photographs of *P. rubropunctata* in life (Lieftinck, 1957). Along with the male appendages, these male colour patterns are of great diagnostic value within the genus. Similar dorsal views, largely following Lieftinck (1957), and some coloured habitus drawings were provided for most New Guinea species by Kalkman and Orr (2013).

Recent collecting on the island of New Guinea by the second and third authors has yielded considerable material of the genus originating from remote mountain streams. Among these are four obvious new species which are named and described below. In addition there are several cases

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in which only very teneral specimens are available and identification is uncertain, particularly as the male colour pattern is often undeveloped and obscure. It is therefore possible that among this material are one or two new species which cannot at present be properly diagnosed. Throughout the text the following museum acronyms are used: QM (Queensland Museum, Brisbane, Australia), RMNH (Naturalis Biodiversity Centre, Leiden, the Netherlands), SAM (South Australian Museum, Australia).

Descriptions of new species

Palaiargia benkeni sp. nov.

(Figures 1a, 3a, 4a, 5a, b)

Material examined

Holotype ♂. Indonesia, Papua province, Lelambo, alt. 900 m asl [04°01'59" S, 139°47'13" E], small mostly shaded brook, V.J. Kalkman leg., 26 October 2008. Deposited in RMNH (RMNH.INS.500635). Paratypes 2♂♂ same locality and collector as holotype; 1♂ 24 October 2008 (RMNH.INS.500627), 1♂ 25 October 2008 (RMNH.INS.500628). Both deposited in RMNH.

Etymology

The specific epithet *benkeni* is a noun in the genitive case, named after Theo Benken in recognition of his generous support for Odonata research in New Guinea through the International Dragonfly Fund (IDF).

Diagnosis

A medium sized robustly built damselfly with longish abdomen (Figure 1a). Bright blue markings anteriorly on head, sides of thorax and dorsally on abdominal segments 1–4 and 8–10. Head with red postocular spots on some specimens which may be common in life. Male readily separated from *P. halcyon* Lieftinck, 1938, which species it most closely resembles, by the shape of the male anal appendages, and by the red postocular markings where present.

Description of male holotype

Head. Labium black. Labrum with strongly convex anterior margin; black. Anteclypeus narrow and black. Postclypeus mainly bright cerulean blue, a little obscured anteriorly. Frons and upper part of genae with broad transverse bright blue band running from eye to eye and extending posteriorly to hind margin of antennal sockets. Remainder of head black with red postocular spots, small and weakly defined. Antennal segment 1 blue, remaining segments black.

Thorax. Prothorax sepia to black, sides of median lobe pale blue. In profile anterior lobe slightly raised and separated from the median lobe by a transverse groove; median lobe with bulbous dorsal prominence on either side separated by a longitudinal median furrow; only very slight groove between median and posterior lobe which is narrow and slightly raised, produced laterally to form thin rounded projections bearing tufts of long dark setae (Figure 3a). Synthorax robust, overall bearing fine sparse black setae. Dorsum (mesepisternum) entirely black. Mesepimeron dark reddish brown, ventral half with narrow pale blue streak on posterior margin contiguous with a broad pale blue band covering much of metepisternum but with anterior squarish infuscation dorsally; metepimeron with similar obscure blue patch, separated from that on metepisternum by chocolate



Figure 1. *Palaiargia* species in life: (a) *P. benkeni* ♂ type; (b) *P. quandti* ♂ type; (c) *P. clarillii* holotype ♂.

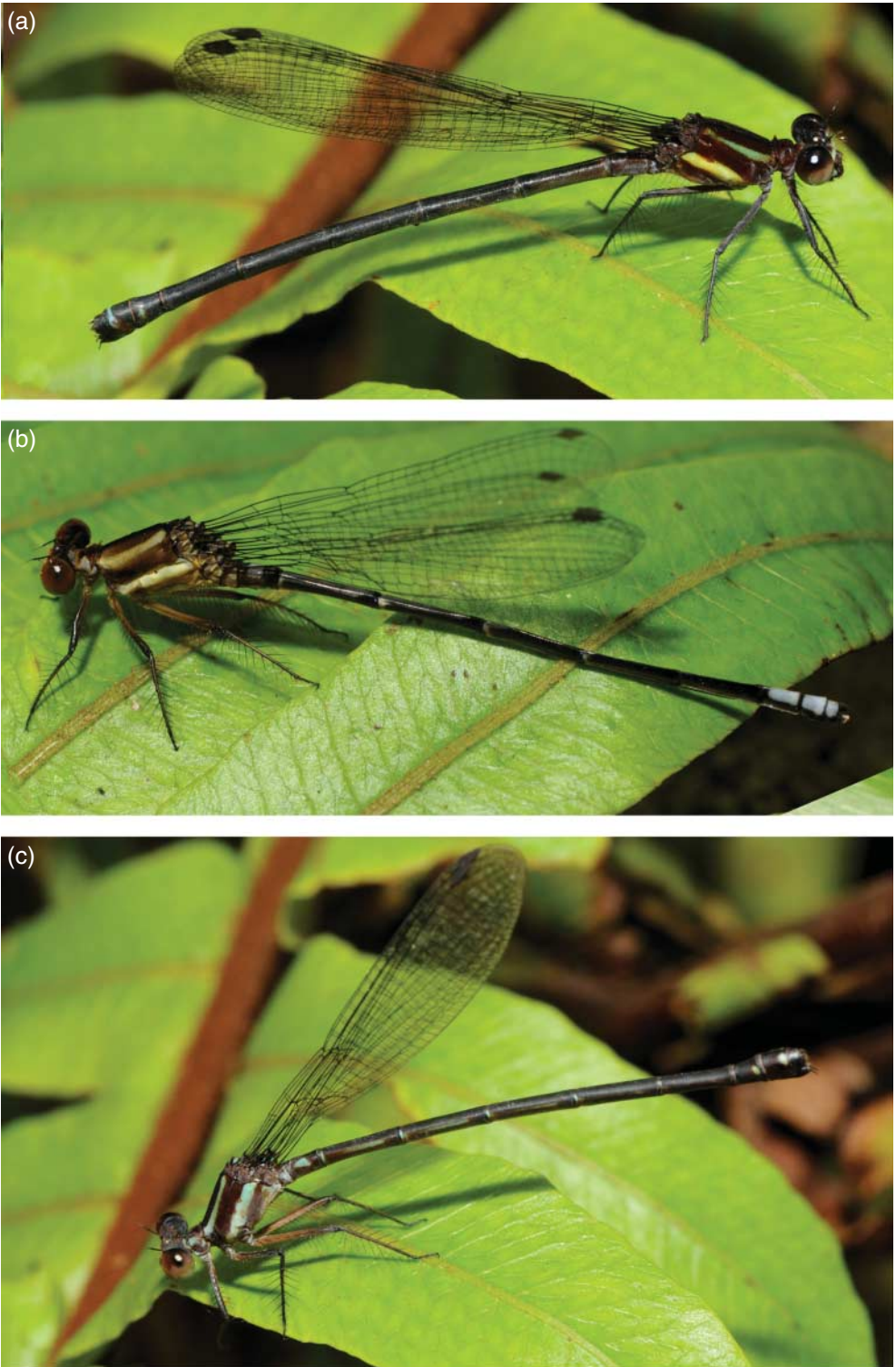


Figure 2. *Palaiargia* species in life: (a) *P. clarillii* ♀ paratype; (b) *P. tydecksjuerging* ♂ holotype; (c) ?*P. tydecksjuerging* ♀ (non type).

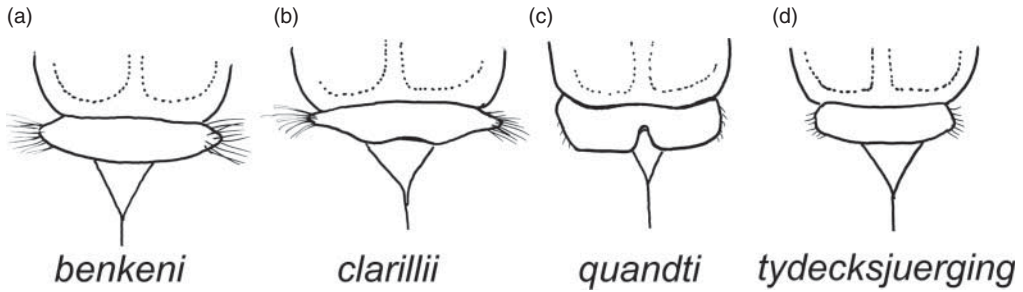


Figure 3. Posterior lobe of ♂ prothorax: (a) *P. benkeni*; (b) *P. clarillii*; (c) *P. quandti*; (d) *P. tydecksjuerging*.

band along metapleural suture. Venter pale blue with indistinct infuscation, especially posteriorly. Legs long, black, femora and tibiae bearing long dark spines. All coxae with posterolateral pale blue patch.

Wings. Long and narrow with rounded tips. Overall hyaline (specimen young). Venation normal for genus but moderately dense; Px–17,16:16,17. Pterostigmata slightly skewed narrow diamond shape, dark sepia.

Abdomen. Moderately stout; overall black marked with cerulean blue as follows (Figure 4a): S1 with dark, convex basal patch dorsally reaching about halfway, elsewhere entirely blue on dorsum and sides; S2 with dorsal goblet-like mark with base, directed caudad, rounded and not quite reaching posterior margin; S3 broad dorsal streak almost meeting apex, narrowed caudad with subapical constriction; S4 with dorsal streak in basal 2/3rds tapering to a rounded point; S8–10 almost entirely blue dorsally except for fine black margin separating segments and a narrow basal black band on S8. Appendages matt black. In lateral view (Figure 5a) superiors thin, straight and tapered to a rounded point, about same length as dorsum of S10; thin sub-basal ventral tooth present; in lateral view inferiors considerably shorter than superiors; broad based and tapering abruptly to a fine point apically. In dorsal view (Figure 5b) superior appendages long, thin and tapering to a rounded point; tips of inferiors strongly incurved; tips visible in dorsal view and obviously forcipate in ventral view.

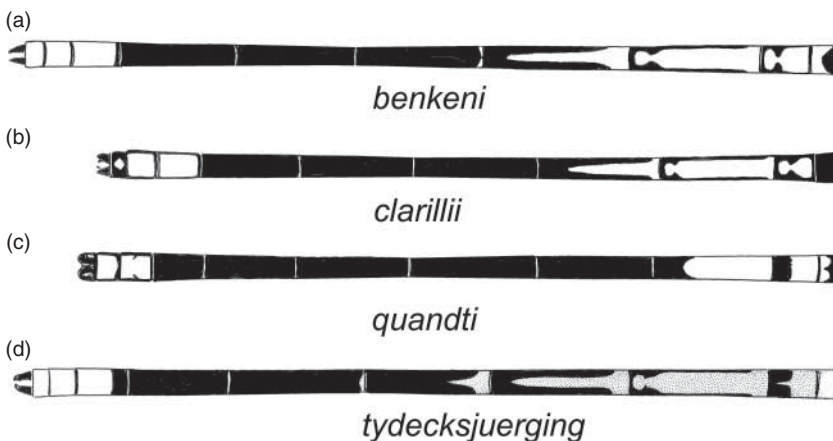


Figure 4. Dorsal view of ♂ abdomen: (a) *P. benkeni*; (b) *P. clarillii*; (c) *P. quandti*; (d) *P. tydecksjuerging*.

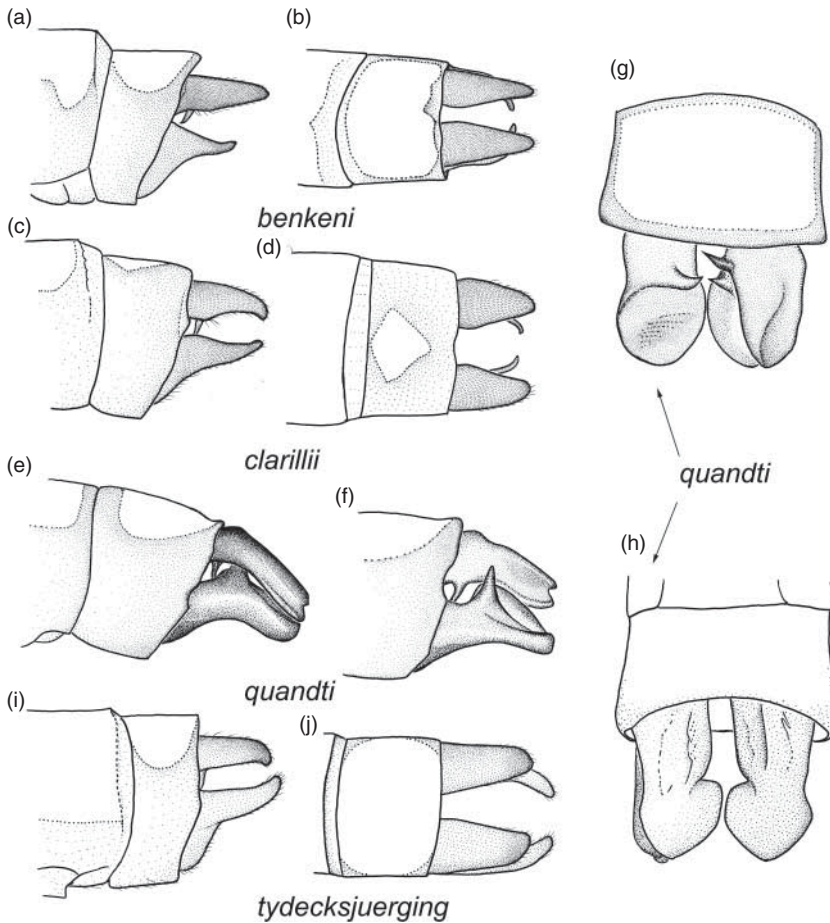


Figure 5. Male appendages: (a) *P. benkeni* lateral; (b) *P. benkeni* dorsal; (c) *P. clarillii* lateral; (d) *P. clarillii* dorsal; (e) *P. tydecksjuerging* lateral intact; (f) *P. tydecksjuerging* lateral left superior removed; (g) *P. tydecksjuerging* dorsal, left superior removed; (h) *P. tydecksjuerging* ventral view, left superior removed; (i) *P. tydecksjuerging* lateral; (j) *P. tydecksjuerging* dorsal.

Measurements (mm)

Hind wing 21.8; abdomen + appendages 36.1.

Variation in paratypes

The type series includes three specimens of different ages. A teneral specimen has the best-developed red postocular spots whereas in the most mature specimen these are not evident except as light brown smudges. The blue markings show no significant variation. The wings of the mature specimen are very lightly tinted with pale brown. There is slight variation in the number of Px (18 present in the forewings of the paratypes) and in size: Hind wing 21.8–22.9 mm; abdomen + appendages 36.1–36.5 mm.

Female

Unknown.

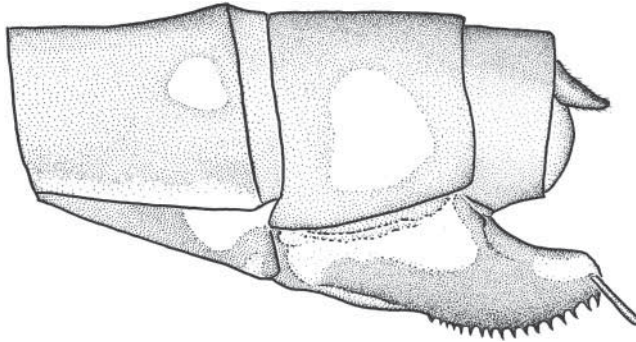


Figure 6. *P. clarillii* ♀, detail of ovipositor and anal appendages.

Notes on habitat and behaviour

Males were found at a one to two metre wide, largely unshaded stream in the low intensity agricultural area surrounding the small mountain village of Lelambo (900 m). They were found sitting on vegetation along the stream.

Remarks

Although superficially similar in coloration to *P. halcyon*, the male anal appendages of *P. benkeni* sp. nov. are quite distinct, possibly suggesting a relationship with *P. alcedo* Liefwinck, 1949. Two *Palaiargia* females of similar size to the male and with similar wing characters were collected at the same locality on 26 October 2008 but they clearly belong to two different species. In one the prothoracic structure suggests it is probably the female of *P. benkeni* sp. nov., but the second shares other characters with the male. Under the circumstances we deem it unwise to designate a female paratype until a specimen can be positively associated with the male by DNA analysis or by collecting a mating pair.

***Palaiargia clarillii* sp. nov.**
(Figures 1c, 2a, 3b, 4b, 5c, d, 6)

Material examined

Holotype ♂. Papua New Guinea, Western Province, Dablin Creek, alt. 910 m asl [5° 12' 54" S, 141° 13' 54" E], S.J. Richards leg. 2 March 2013, QM registration no T189837. Paratype 1♀, same data as holotype, QM registration no T189838. Both deposited in QM.

Etymology

The specific epithet *clarillii* is a noun in the genitive case, of cryptic origin, so named at the request of Klaus-Peter and Mechtilde Seiler in recognition of their generous support for Odonata research in New Guinea through the International Dragonfly Fund (IDF).

Diagnosis

A medium sized robustly built damselfly with shortish abdomen (Figures 1c, 2a). Narrow pale greenish yellow marking on head and sides of thorax. Abdominal segments 2–4 and 8–10 with

dorsal cream coloured markings. Appendages superficially similar to those of *P. halcyon*, but coloration quite different.

Description of male holotype

Head. Labium black. Upper surfaces of head black except as follows: a broad transverse greenish yellow band running across the frons and genae from eye to eye and reaching the antennal sockets posteriorly; small greenish spot on outer face of mandible; 1st antennal segment with some pale colour anteriorly, remaining segments black.

Thorax. Prothorax sepia to black. In profile anterior lobe slightly raised and separated from the median lobe by a transverse groove; median lobe with bulbous dorsal prominence on either side separated by a longitudinal median furrow; only very slight groove between median and posterior lobe which is broad with posterior margin slightly sinuous and upturned, produced laterally to form small rounded projections bearing tufts of long dark setae (Figure 3b). Synthorax moderately robust, overall bearing rather short, fine, sparse setae. Dorsum (mesepisternum) black to dark sepia at lateral margins. Remainder dark reddish brown with thin pale greenish streak in anterior half of metepisternum touching spiracle and tapering towards wings. Legs with coxae reddish brown, remainder black, femora and tibiae bearing long dark spines.

Wings. Moderately narrow with rounded tips. Membrane overall with faint yellowish brown tinge. Venation normal for genus but moderately dense; Px–16,16:15,16. Pterostigmata slightly skewed, narrow kite shape with longer point directed apicad; dark sepia.

Abdomen. Moderately stout and short; ground colour reddish brown on S1 and becoming darker on S2; S3–10 black. Marked dorsally with creamy patches as follows (Figure 4b); S2 with flared goblet-like mark with base directed caudad, rounded, narrow and not reaching posterior margin; S3 with broad streak almost meeting apex, gently tapering caudad with tiny subapical constriction; S4 with narrow streak in basal 4/5ths tapering to a point; S8 and S9 with broad pale marks with narrow basal and apical black borders; S10 with small triangular patch with apex directed caudad. Appendages matt black. In lateral view (Figure 5c) superiors thin, apically tapered and slightly down-turned with a sub-basal shoulder ventrally; about same length as dorsum of S10; prominent thin sub-basal ventral tooth present, its tip obscured by inferiors; in lateral view inferiors slightly shorter than superiors; base moderately broad thence tapering upward to a rounded point apically. In dorsal view (Figure 5d) superior appendages moderately broad, tapering apically; tips of inferiors thin and strongly incurved; obviously forcipate and visible in dorsal view.

Measurements (mm)

Hind wing 22.8; abdomen + appendages 31.5.

Description of female paratype (Figure 2a)

Head. Marked much as in male except anterior transverse pale band less well defined on posterior margin; antennal segment 1 with a clear narrow green axial line anteriorly.

Thorax. Prothorax reddish brown. In form similar to male but posterior lobe slightly narrower with lateral projections slightly more prominent. Synthorax ground colour reddish brown marked with pale yellowish green as follows: mesepisternum bearing a narrow antehumeral band strongly tapered posteriorly; mesepisternum with broad band covering much of sclerite except for brown band directly behind spiracle running along mesopleural suture; pale streaky smudge on metepimeron. Legs as in male.

Wings. As in male.

Abdomen. Moderately stout and short; ground colour reddish brown basally obscurely marked with paler areas becoming black from S4–S10. S8 subapically with two small, dorsolateral, vertical, pale bluish streaks; S9 with narrow apical bluish semi ring; anal appendages short and narrowly conical, about half length of S10; paraproct flattened, scarcely evident in lateral view; valves of ovipositor short, broad basally tapering apically; lower margins bear well developed serrations (Figure 6).

Measurements (mm)

Hind wing 23.8; abdomen + appendages 32.2.

Notes on habitat and behaviour

Dablin Creek is a steep, rocky stream that drains the southern slopes of the Star Mountains above Tabubil town. At the type locality the creek is approximately 5–10 m wide, and consists of numerous torrents and small waterfalls rushing through boulders in moderately disturbed rainforest. The water was both cold and clear. Both specimens were captured approximately 50 m downstream of a large vertical waterfall, where a fallen tree over a smaller waterfall had produced a tangle of logs and broken foliage. The male specimen (holotype) was perched on a leaf overhanging the small waterfall in a patch of sun, while the female was perched on a dead log among the debris formed by the tree-fall. No other males were observed, and only one additional female, which eluded capture, was seen. It too was perched on the debris of the tree-fall.

Remarks

This species appears to have affinities with *P. halcyon*. The female bears a sufficient resemblance to the male, allowing for normal sexual differences in coloration, for us to be reasonably confident with this association.

***Palaiargia quandti* sp. nov.**
(Figures 1b, 3c, 4c, 5e, f, g, h)

Material examined

Holotype ♂. Papua New Guinea, Western Province, Yakalgubip above Bilbilokabip Hamlet, alt. 1817 m asl [5° 07' 13" S, 141° 15' 29" E], M. Hammer leg. 19 February 2013. Deposited in QM, registration no T189839. Paratype 1♂ Papua New Guinea, same locality as holotype but S.J. Richards leg. 18 February 2013. Deposited in SAM, registration no SAMA 07-000984.

Etymology

The specific epithet *quandti* is a noun in the genitive case, named after Ludwig Quandt in recognition of his exceptionally generous support for Odonata research in New Guinea through the International Dragonfly Fund (IDF).

Diagnosis

A medium sized robustly built damselfly with relatively short abdomen (Figure 1b). Brilliant orange-vermilion covering most of dorsal surface of head and light blue dorsal marking on abdominal segments 1–3 and 9–10. Readily separated from *P. charmosyna* by the reduced blue dorsal abdominal marking and entirely black thorax. Appendages distinctive.

Description of male holotype

Head. Labium black. Labrum with strongly convex anterior margin; golden yellow with fine black basal margin and narrow central black bar intruding from base to beyond midpoint. Outer faces of mandibles with golden yellow spots. Anteclypeus narrow and black. Postclypeus black with obscure vermilion spot centrally. Genae with large pale yellow streaks. Vertex and posterior part of dorsum of head bright orange-vermilion except for a narrow dark band along the anterior margin of the frons, paired narrow diagonal black bars slanting forwards from the antennal socket to the eye margin, small black areas immediately behind the antennal sockets, and the ocelli. Clypeus and hind part of postocular lobes bearing long heavy black setae. Antennal segment 1 orange-vermilion; remaining segments black.

Thorax. Prothorax entirely matt black. In profile anterior lobe distinctly raised and separated from the strongly humped median lobe by a deep depression; similar depression between median and posterior lobe which is sharply raised to form a transverse flange with a well-developed medial notch creating overall a distinctive bilobed structure (Figure 3c). Synthorax robust, box-like and entirely matt black, overall bearing long fine sparse black setae. Light tuft arising from low swelling on posterior part of venter. Legs long, black tending to dark sepia subapically on the femora, femora and tibiae bearing long dark spines.

Wings. Long and narrow with rather acute tips. Overall a light brownish tint. Venation normal for genus but rather dense; Px–19, 16:16, 18. Pterostigmata trapezoidal, costal margin almost twice length of posterior margin and distal angle strongly acute; dark sepia in colour.

Abdomen. Comparatively short and stout; overall black marked on dorsum with cerulean blue as follows (Figure 4c): S1 dark anteriorly with paired semicircular spots conjoined medially in apical half; S2 anterior 2/3rds blue; S3 with anterior 4/5ths blue with broadly rounded posterior margin; S4 and S5 with tiny basal blue flecks; S9 entirely blue dorsally except for fine black margin beyond posterior carina and small, posteriorly slanted, median notches on either side; S10 almost entirely blue above except for narrow basal black band and thin lateral wedges on posterior margin not meeting dorsally, resulting from rounded margin of blue patch. S10 dorsoventrally slightly flattened with distinct rounded lips at outer posterior corners seen from above. Appendages shining black, somewhat down-turned, dorsoventrally flattened and dorsally slightly shorter than S10 (Figure 5e). Superior appendages in outer lateral view bent downwards from a sub-basal angle then almost parallel-sided with well-developed apical notch (Figure 5e); in interior view distinctly concave with long sub-basal ventral spine directed inwards (Figure 5f). In dorsal view superiors robustly sculptured, broad basally tapered slightly to a rounded point, ventral sub-basal spine clearly visible (Figure 5g). Inferiors dorsoventrally flattened with complex dorsal structure. In lateral view lower margin smoothly convex, upper margin with robust internally directed middorsal spine only partially visible with superiors intact (Figure 5e). When this structure is revealed it appears as a broadly conical structure succeeded apicad by a rounded spatulate process (Figure 5f); in dorsal view the inferiors are broad basally with a broad terminal spatulate area in their distal half, partly delineated from the base by the inward projecting mid-dorsal spine (Figure 5g); in ventral view these spatulate processes clearly defined by post-median lateral contractions, especially on the inner margins (Figure 5h).

Measurements (mm)

Hind wing 25; abdomen + appendages 33.4.

Variation in paratype

In the paratype there is slight variation in the colour of the anterior structures of the head, ranging from golden yellow to straw yellow, possibly as a result of preservation. The red spot on the post-clypeus may be absent. The blue on the dorsum of abdominal S1 is confined to the posterior half and that in S3 extends basolaterally as a thin band along the tergite. There is a slight difference in size from the holotype: Hind wing 24.6 mm; abdomen + appendages 33.0 mm.

Female

Unknown.

Notes on habitat and behaviour

The type locality was a clearing near the base of the Hindenburg Wall, where *P. quandti* sp. nov. was found on low vegetation along a small (1–2 m wide) clear stream. The area had been cleared for a garden and individuals of this species flew down from small patches of remnant forest adjacent to the garden to perch on weedy plants near the stream during brief periods of sunshine. The climate at the site was extremely wet, and during the course of several days sampling at this site only 3–4 hours of sunshine in total were encountered.

Remarks

Although superficially similar in coloration to the widespread *P. charmosyna*, the male anal appendages of this species are unique in the genus and set it apart from all other species. The complex structure of the broad, dorsoventrally flattened inferior appendages is particularly unusual. The structure of the posterior lobe of the prothorax is also unusual in the genus, as are the narrow, densely reticulated wings. It has no near known relatives in the genus.

***Palaiargia tydecksjuerging* sp. nov.**

(Figures 2b, 3d, 4d, 5i, j)

Material examined

Holotype ♂. Papua New Guinea, Western Province, Tulenbeng Wok (second creek below Tabubil town on Kiunga Road) alt. 450 m asl [5° 18' 30" S, 141° 15' 10" E], M. Hammer leg. 2 March 2013, immature. Deposited in QM, registration no T189340.

Etymology

The specific epithet *tydecksjuerging* is a noun in apposition, named after Anke and Michael Tydecks-Jürging in recognition of their generous support for Odonata research in New Guinea through the International Dragonfly Fund (IDF).

Diagnosis

A medium sized robustly built damselfly (Figure 2b). Thorax with pale antehumeral stripes and pale lateral markings. Basal and terminal abdominal segments with extensive dorsal blue coloration, basal marking dull blue in holotype, possibly bright blue in mature specimens. Appendages distinctive.

Description of immature male holotype

Head. Labium dark brown to black, in places almost unpigmented owing to immaturity. Labrum with fine yellowish margin which may disappear with maturity. Upper surfaces of head dark sepia to black except as follows: a broad transverse pale yellowish band running across the frons and genae from eye to eye and reaching the antennal sockets posteriorly; 1st antennal segment pale; 2nd segment with pale streak anteriorly, remaining segments black.

Thorax. Prothorax pale to dark sepia marked dorsolaterally on median lobe with light purplish blue. In profile anterior lobe slightly raised and separated from the median lobe by a transverse groove; median lobe with bulbous dorsal prominence on either side separated by a longitudinal median furrow; only very slight groove between median and posterior lobe which is moderately developed and semi erect with the lateral angle not produced or bearing conspicuous setae (Figure 3d). Synthorax of medium build, overall bearing rather short, fine, sparse setae. Ground colour chocolate brown, perhaps darkening with maturity. Dorsum (mesepisternum) with broad, slightly curved antehumeral band running from mesokatepisternum to middle of anterior margin of mesepisternum, overall set well in from humeral suture (Figure 2b). Sides of synthorax with mesepimeron dark brown; remainder pale bluish except for brown triangular streak in metepimeron and along metapleural suture. Legs with coxae dark brown on prothorax, pale on synthorax; trochanters pale; remainder light brown to dark sepia, femora being paler in meso- and metathorax; femora and tibiae bearing long dark spines. All parts of legs beyond coxae probably dark in mature specimens.

Wings. Moderately narrow. Membrane hyaline, clearly teneral. Venation normal for genus, rather open; Px-15,13:13,15. Pterostigmata slightly skewed, narrow kite shape with longer point directed apicad; medium sepia, presumably dark in mature specimens.

Abdomen. Moderately long for genus, medium build; S1 entirely pale greenish; remainder black with dorsal markings as follows (Figure 4d): S2 with basal half bearing saddle of dark blue continuing as a fine, round-tipped line along middorsal carina almost to apex; S3 with long, dark blue, dorsal streak tapering to a subapically notched rounded end just before apex; S4 with similar streak tapering to a rounded point at about 5/6th the length of the segment; S5 with a short, pointed, dark blue streak in basal 1/5th; S6 with small basal blue markings dorsally; S8 to S10 with extensive pale violet blue marks on dorsum with narrow basal and apical black borders, broader at base of S8. Appendages dark brown to black. Superiors dorsoventrally flattened, moderately broad and tapering gently apicad with rounded tip distinctly and sharply down-turned; in preserved specimen tip folded inward and downward creating a truncated profile at apex but this folding is an artefact of preservation of a very soft specimen as photographs of the living specimen show the tips depressed but not folded back; long thin sub-basal ventral tooth present, barely visible behind S10 and inferiors in lateral view (Figure 5i); total length of superiors equals that of S10. Inferior appendages robust and distinctly forcipate; considerably longer than superiors. In dorsal view (Figure 5j) tips of inferiors robust and incurved; obviously but not strongly forcipate and visibly extending well beyond superiors.

Measurements (mm)

Hind wing 23.5; abdomen + appendages 33.4.

Female

Unknown

Notes on habitat and behaviour

The type locality was a steep, clear rocky stream approximately 5 m wide that bisects the Tabubil-Kiunga Road. Forest in the vicinity had been severely degraded through cutting for firewood and gardens, and a small village is located close to the stream. However riparian vegetation immediately adjacent to the stream remained in sufficiently good condition to support a moderately diverse stream-dwelling assemblage of odonates.

Remarks

The colours of the holotype are poorly developed and until a fully mature male is found this species will remain enigmatic. Nevertheless the male appendages, with depressed ends to the superiors, and much longer forcipate inferiors, are unlike those of any known species and by these characters specimens should be easily recognised as belonging to this species. Teneral specimens of other *Palaiargia* species can exhibit similar coloration to this specimen and on this basis it is conjectured that the pale markings on the head and thorax will develop into a distinct pale blue or green and the abdominal dorsal marking, especially that on S8–10, may become bright cerulean blue. This however requires confirmation. A mature female (Figure 2c) was taken at the same locality as the holotype and probably belongs to this species. Nevertheless as there is no certain evidence associating it with the holotype, it is not included in the type series. A very teneral male, probably of the same species, collected at the nearby Umansin Stream by M. Hammer on 27 February 2013, is similarly excluded as it offers few useful characters.

New distribution records

Note, for ease of reference, modern geopolitical names are appended to the original data labels, which have been standardised.

Palaiargia carnifex Lieftinck, 1932

19 ♂, 2 ♀: Indonesia, Papua Province, Kabupaten Sarmi, Van Rees Hills, Batavia Rapids, 3 April 1940, leg. J.F.K. van Eechoud, RMNH.

Palaiargia c. ceyx Lieftinck, 1949

8 ♂, 4 ♀: Indonesia, Papua Province, Kabupaten Tolikara, Swart Valley [Ilim], 7–8 November 1958, leg. J.L. Gressitt, formerly Bishop Museum, RMNH.

9 ♂, 5 ♀: Indonesia, Papua Province, Kabupaten Tolikara, Swart Valley [Ilim], 1600 m, various dates in 1958, leg. D. Bergman, formerly Bishop Museum, RMNH.

1 ♂, 1 ♀: [probably Indonesia, Papua Province], Kumine River, Guega, 1200–1250 m, 15 November 1958, formerly Bishop Museum, RMNH.

Palaiargia ceyx flammula Lieftinck, 1949

1 ♂: Indonesia, Papua Province, Kabupaten Tolikara, Bokondini, 40 km N of Baliem Valley, 1400 m, 20 November 1961, leg. L. & S. Quate, RMNH.

Palaiargia ceyx ssp.?

1 ♀: Indonesia, Papua Province, Kabupaten Tolikara, Swart Valley [Ilim], Kutsime, 1500 m, leg. J.L. Gressitt, RMNH.

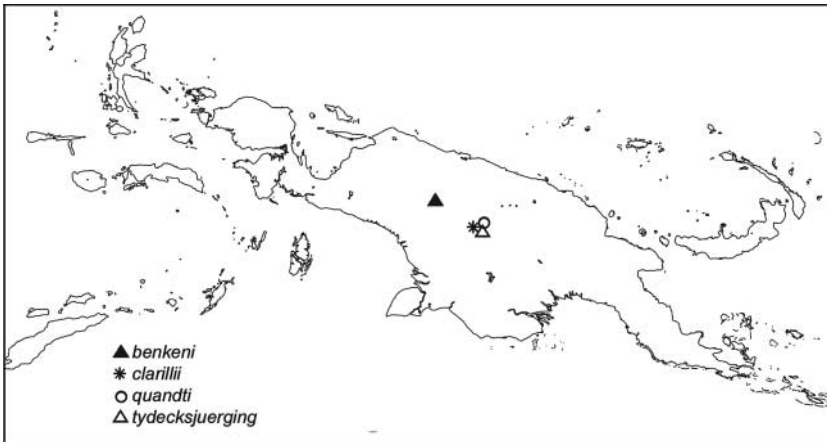


Figure 7. Map showing distribution of the newly described species *P. benkeni*, *P. clarillii*, *P. quandtii* and *P. tydecksjuerging*. Icons representing each species as indicated.

Palaiargia charmosyna Lieftinck, 1932

1 ♂: Indonesia, Papua Province, Kabupaten Jayapura, Genjem, Nimboran Vlakte, 3 November 1954, leg. L.B. Holthuis & L.D. Brongersma, RMNH.

Palaiargia ernstmayri Lieftinck, 1972

1 ♂, 1 ♀: Indonesia, Papua Province, Mokwam, 8–9 November 2011, picture by S. Lamberts, not collected; photographs in this paper (Figure 9).

Palaiargia humida Förster, 1903

1 ♂, 1 ♀ (teneral): Papua New Guinea, Morobe Province, Kabwum, 5 September 1964, leg. H.M. van Deusen, Archbold Expedition, RMNH.

Palairgia stellata (Ris, 1915)

1 ♂: Papua Barat Province, Kabupaten Fakfak, Bombarai Peninsula, Bomberi to Kalimati, 10 June 1959, leg. J.L. Gressitt, formerly Bishop Museum, RMNH.

1 ♂: Papua Barat Province, Kabupaten Fakfak, Bombarai Peninsula, Fakfak, 8 June 1959, leg. T.C. Maa, formerly Bishop Museum, RMNH.

Palaiargia species a

1 ♂ (teneral), 3 ♀: Papua New Guinea, Southern Highland Province, Muller Range, CI Muller Range expedition, Camp 1 (Gugusu), 5° 43' 45" S, 142° 15' 48" E, 515 m asl, 4–11 September 2009, leg VJ Kalkman, RMNH.

Palaiargia species b

1 ♀: Indonesia, Yapan, Yobi, river partly in degraded forest and partly in virgin forest. 18 July 2006, leg. V.J. Kalkman, RMNH.

Discussion

The description of the above four species brings the total number of named *Palaiargia* species to 24, with four species occurring in the northern Moluccas and 20 in New Guinea (Figures 7, 8). Specimens from Muller Range, Papua New Guinea listed by [Kalkman, Theischinger, and Richards \(2011\)](#) probably represent a new species (*Palaiargia* sp. a), but are too teneral to describe. A single female from Yapan may also represent a new species (*Palaiargia* sp. b). Specimens listed by [Oppel](#)

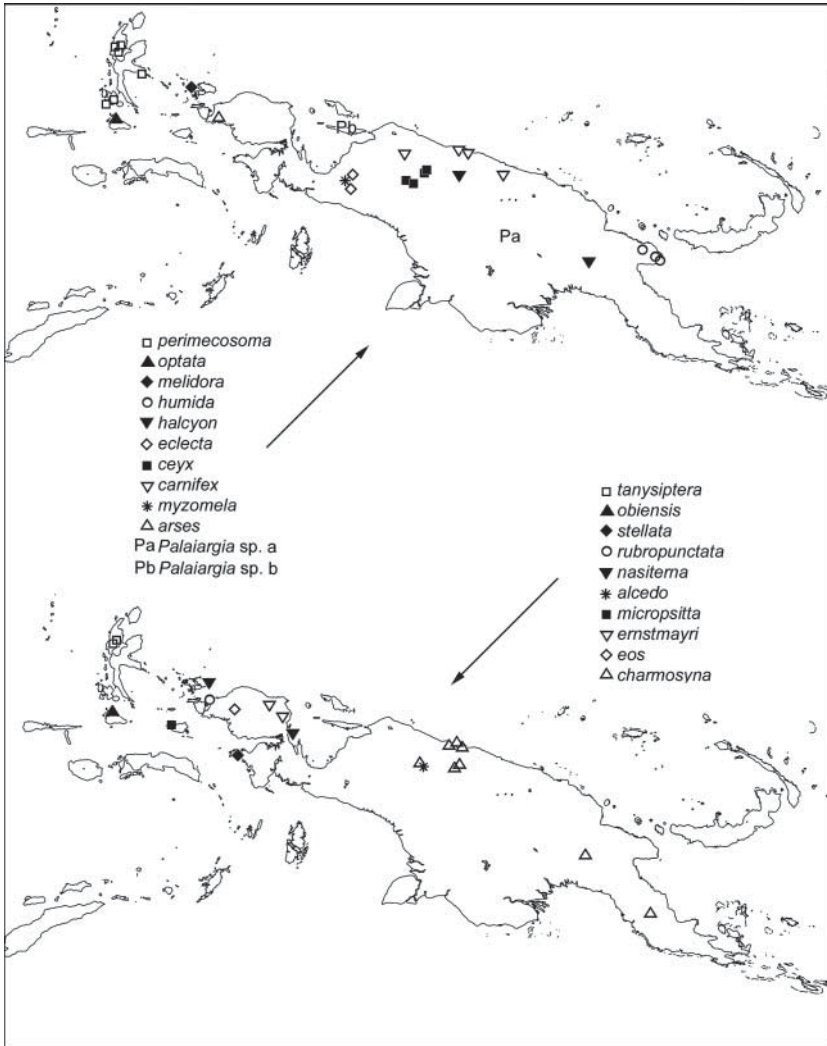


Figure 8. Maps showing distribution of all described *Palaiargia* species, plus undescribed Muller Range *Palaiargia* sp. a, and undescribed Yapen *Palaiargia* sp. b. Icons representing each species as indicated.

(2005, 2006) might also belong to an undescribed species but we have not been able to examine these. A specimen listed by Kaize and Kalkman (2011) from Kabupaten Mappi, Katan in the southern lowlands of Papua was found to be *Pseudagrion lucifer* Theischinger, 1997. This is a northern Australian species and is a new record for New Guinea.

It seems likely that at least a dozen additional species of *Palaiargia* remain to be discovered especially in the poorly explored southern slopes of the central mountain range. In New Guinea the main diversity is found in the western two-thirds with a majority of species having very restricted distributions. The main exception to this is *P. charmosyna*, which is common in the lowland surroundings of Jayapura (Indonesia) but has also been recorded from Crater Mountain Wildlife Management Area (PNG) 600 km to the east, and Kokoda (PNG), nearly 1000 km to the east (Liefertinck, 1949; Ooppel, 2005). This low diversity in the east cannot be explained by lack of exploration and the paucity of records seems to reflect a true absence of the genus in this area. The four new species were all associated with running water and the genus is believed to be strictly dependent on lotic habitats.



Figure 9. *P. ernstmayri* in life: (a) male; (b) female. Photos courtesy of Sandra Lamberts ©.

It is certain that the distributions of the known species are still very imperfectly known, and there may be more geographic variation among these than is currently recognised. As an example of a recent rediscovery, the little known species *P. ernstmayri* Lieftinck, 1972 has recently been recorded from the Arfak Mountains of West Papua (Indonesia). This is the first record of the species since its description. Figure 9 depicts for the first time the male and female of this species in life.

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