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Five new species of the genus *Papuadytes* Balke, 1998 from New Guinea (Coleoptera: Dytiscidae)

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Abstract
Five new species of New Guinean *Papuadytes* Balke are described. Based on distally fused and modified ventral sclerites of the median lobe of the aedeagus, the *P. broschii* species group is suggested for *P. broschii* Balke, 1998, *P. marinae* sp. nov., and *P. hintelmannae* sp. nov. This group is only known from Papua New Guinea where the species occur allopatrically in different mountain ranges. The other new species are *P. atowaso* sp. nov., *P. munaso* sp. nov., and *P. vladimiri* sp. nov.

Keywords: *Papuadytes, new species, Copelatinae, Dytiscidae, New Guinea*

Introduction

Described as a subgenus of *Copelatus*, *Papuadytes* Balke, 1998 was recently assigned generic status following an analysis of copelatine phylogeny based on mitochondrial DNA sequence data (Balke et al. 2004). *Papuadytes* was suggested to be the sister-group of all other Copelatinae. It is delimited to the Australo-Pacific region, with the exception of one Chinese species (Balke & Bergsten 2003). *Papuadytes* is the most species rich diving beetle group in New Guinean running water habitats, especially low-order streams and habitats associated with wider mountain streams (i.e. backflows, interstitial and small water holes on river banks). To date, 35 species have been described from New Guinea, 18 of which occur in Papua New Guinea (PNG) (Balke 1998, 1999, 2001; Nilsson 2001). Local species endemism is pronounced as confirmed by recent fieldwork conducted by K. Sagata in the course of the Water Beetles of PNG project, launched in 2003. These samples contained more than 10 hitherto undescribed species. Here, we describe three characteristic ones of them, along with two other rather conspicuous species from a museum collection.

Our recent efforts in PNG underpin the need for a nationwide survey of running water beetles, or invertebrates in general, which are remarkably diverse yet almost unknown to science. Such a survey will certainly form the basis for an improved understanding of freshwater diversity from which sound awareness-rising as well as management strategies can be expected to emerge.

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Material and methods

Measurements were taken with a Wild M10 stereomicroscope at 20x. The following abbreviations are used: Tl-h (total body length without head), TW (total width of body). Drawings were made with the aid of a camera lucida attached to an Olympus BH-2 microscope. For detailed study and drawing, genitalia and protarsi were mounted on glass slides with DMHF (dimetil hydantoin formaldehyde; Bameul 1990) as temporary preparations. For ventral aspects of median lobes, SEM micrographs were taken with a Philips SEM 515 at 130x in The Natural History Museum SEM unit. When referring to the ventral aspect of the median lobes the recommendation of Miller and Nilsson (2003) is considered, i.e. referring to that side that is in a ventral position during copulation (and which was previously usually referred to as "dorsal" aspect).

All specimen data were quoted as they appear on the labels attached to the specimens. Abbreviations for museums: BMNH—The Natural History Museum, London, UK (Mrs C. Taylor); NHW—Naturhistorisches Museum Wien, Vienna, Austria (Dr. M.A. Jäch); PNGC—National Agricultural Insect Collection, P.O. Box 1691, Boroko, N.C.D. 111, Papua New Guinea (Mark Ero).

We extracted DNA and obtained DNA sequence data for some of the species/specimens, marked with individual DNA extraction numers (e.g. "256 DNA M. Balke"). These data will be presented in an upcoming cladistic analysis of the genus *Papuadytes* (Balke, in prep.).

Systematic account

The *Papuadytes broschii* group

We suggest this group for three species that can be easily identified by their peculiar structure of the median lobe of the aedeagus: ventral sclerites apically fused and modified, forming a shovel/fork-like structure (Figures 1–3). We studied all other known species of *Papuadytes*, where such a modification does not occur, and according to an unpublished cladistic analysis of the genus (Balke, in prep.), the fused sclerites represent the derived character state.

Besides this apomorphy, the three species of the *P. broschii* group all exhibit: continuous lateral outline of median lobe (in ventral aspect); numerous short setae on apical part of median lobe (in lateral aspect); paramere with long setae occupying whole lateral margin (in external aspect); male protarsomere 5 elongate (in lateral aspect); male antennomeres simple.

The species of the *broschii* group are only known from PNG so far.

Papuadytes broschii Balke, 1998

The species was described from PNG: Madang Province. The ventral aspect of the median lobe was incorrectly illustrated by Balke (1998) [the apical fusion of ventral sclerites was not recognized then], therefore we provide here a SEM micrograph (Figure 1) for clarification.

Papuadytes marinae sp. nov.

Type locality. PNG: Sandaun Province, trail from Telefomin to Eliptamin.

Type material. Holotype: ♂ "Papua N. G.: Sandaun Prov. Telefomin, 16–17.V.1998 trail to Eliptamin 1700–1800 m; leg. Riedel" (NMW).

Figures 1 – 6. Median lobe of aedeagus, ventral aspect, SEM (at 130x): (1) *Papuadytes broschii*, paratype; (2) *P. marinae*, holotype; (3) *P. hintelmannae*, holotype; (4) *P. atowaso*, holotype; (5) *P. munaso*, holotype; (6) *P. vladimiri*, holotype.

Diagnosis. The species can be distinguished from other members of the *broschii* group by the less concolorous and rather dull dorsal surface of the body, with strongly impressed microreticulation and dense coarse punctation, as well as the shape of the median lobe and paramere.

Description

Size and shape. Beetle small (Tl-h 3.6 mm, TW 1.9 mm), with elongate habitus, broadest at elytral base.

Coloration. Head reddish in anterior half (especially pale on clypeus) and brownish black in posterior part; pronotum brownish black, with reddish lateral margins (especially pale at anterolateral angles) and very narrowly reddish at anterior and posterior margins; elytron brownish black with narrow reddish band along suture.

Surface sculpture. Head with dense and coarse punctation, finer anteriorly; diameter of punctures equal to or slightly smaller than diameter of cells of microreticulation. Pronotum and elytra with distinct coarse punctation that is slightly denser on pronotum (spaces between punctures 1 – 5 times the size of punctures); diameter of punctures equal to or slightly smaller than the diameter of cells of microreticulation. Head, pronotum, and elytra with strong microreticulation, dorsal surface thus not obviously shiny, rather matt. Metasternum and metacoxa distinctly microreticulate, metacoxal plates with longitudinal strioles and transverse wrinkles. Abdominal sternites with distinct microreticulation, strioles, and fine sparse punctation, coarser and denser on two last abdominal sternites.

Structures. Pronotum with distinct lateral bead. Prosternum with distinct but not sharp ridge, no lateral extensions visible anteriorly. Prosternal process lanceolate, less narrow, with very slight longitudinal convexity, almost flat, with distinct bead, and with few setae; prosternal ridge and prosternal process convexity more or less evenly joint. Sternite 7 slightly truncate apically.

Male. Protarsomeres 1 – 3 (ProT 1 – 3) not expanded laterally. Protarsomere 4 (ProT 4) cylindrical, narrow, with large anterolateral hook. Protarsomere 5 (ProT 5) simple, long and narrow, without expansion and concavity, ventrally with anterior row of 14 short sparse setae and posterior row of five smaller setae (Figure 7). Anterior protarsal claw simple, slightly longer than posterior. Antenna simple. Sternite 7 with 9 – 10 lateral striae. Median lobe as in Figures 2, 12a, in lateral aspect with apex curved and broadly pointed, in ventral aspect with continuous lateral outline, apex almost rounded, ventral groove deep, and ventral sclerites fused. Paramere shape as in Figure 12b.

Female. Unknown.

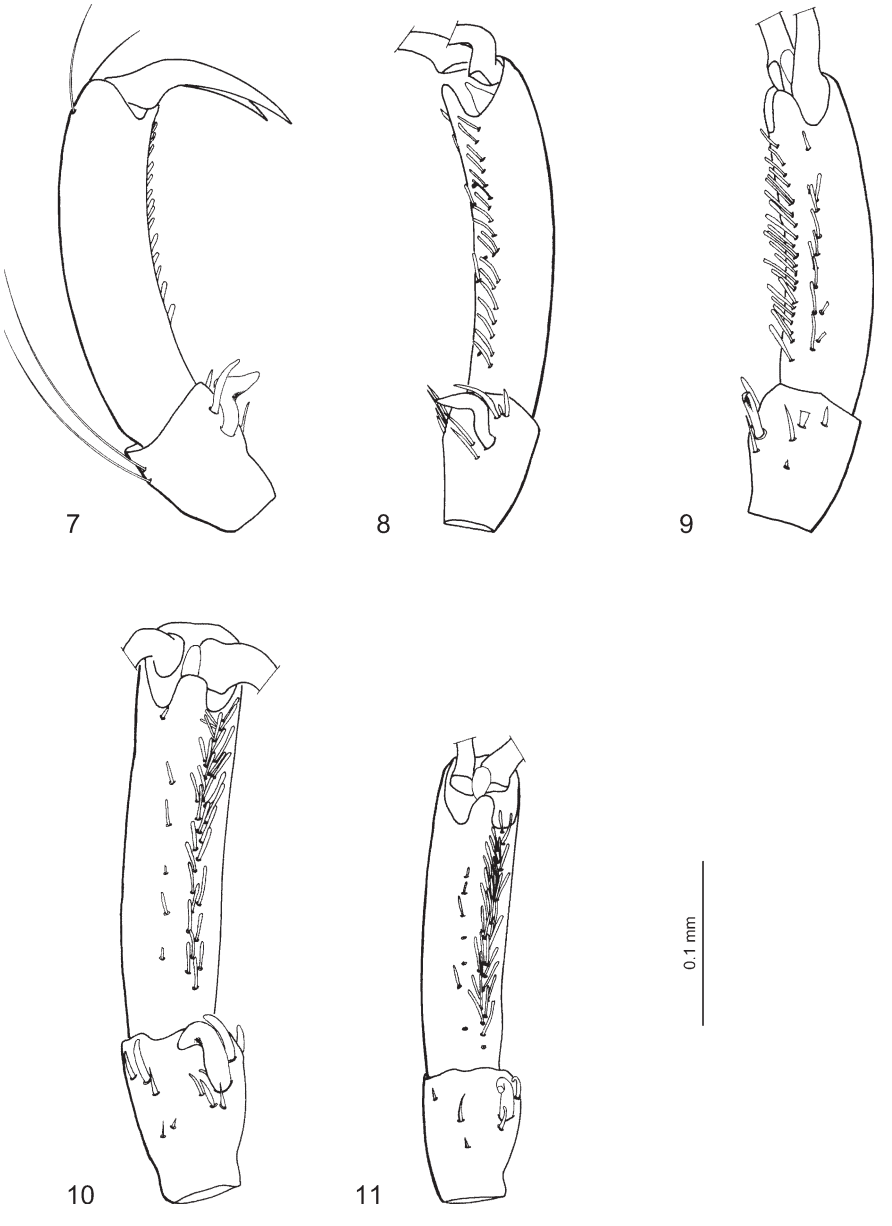
Distribution and habitat. The species is known only from the type locality; the habitat was running water associated but no specific information is available.

Etymology. The species is named after Marina Iosifovna Shaverdo, the mother of the first author, who was often upset with her daughter roaming about the treacherous bogs and swamps.

***Papuadytes hintelmannae* sp. nov.**

Type locality. PNG: border Simbu – Eastern Highlands Provinces: Crater Mountain, between Wara Sera Station and Herowana Village, River (= Wara) Hulene.

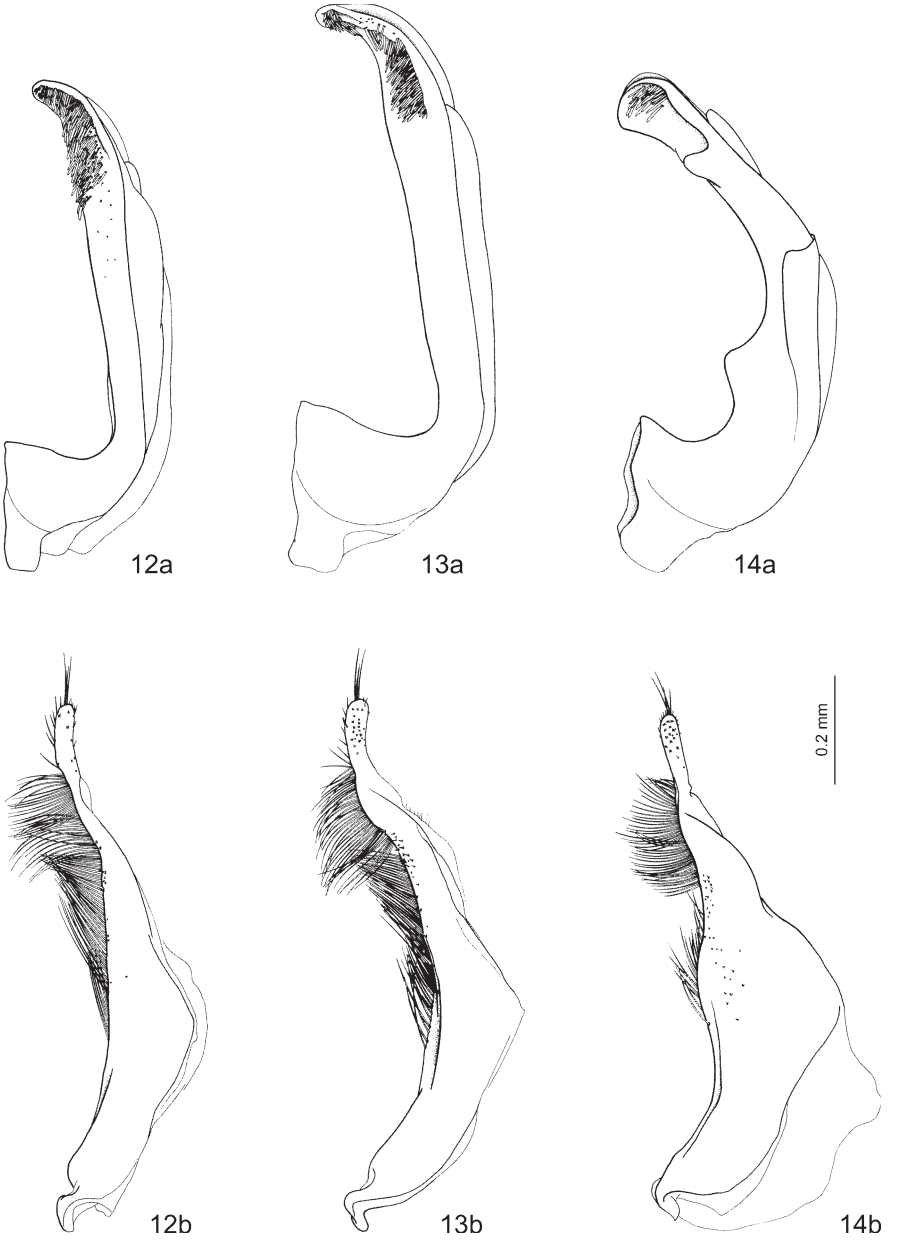
Type material. Holotype: ♂ ''PNG Simbu / EHPr. Crater Mountain, Sera-Herowana, Wara Hulene, 1000 m, 16.IX.2002 Sagata (PNG 17)'', ''264 DNA M. Balke'' [green label] (BMNH). *Paratypes*: ♂ ''PNG Simbu/EHPr. Crater Mountain, Sera-Herowana, upper Oh River, 1200 m, 15.IX.2002 Sagata (PNG 12)'', ''260 DNA M. Balke'' [green label] (NMW).



Figures 7 – 11. Protarsomeres 4 and 5, ventral and anterior aspect, long dorsal setae are not illustrated on Figures 8 – 11: (7) *Papuadytes marinae*, holotype; (8) *P. hintelmannae*, paratype; (9) *P. atowaso*, holotype; (10) *P. munaso*, paratype; (11) *P. vladimiri*, paratype.

♂ "Papua New Guinea Simbu/EHPr. Crater Mountain, Wara Sera Station, 800 m, 14.IX.2002 Sagata (PNG 10)", "256 DNA M. Balke" [green label] (PNGC).

Diagnosis. The species is similar to *P. broschii* sharing a shiny dorsal surface of the body, with weak microreticulation and inconspicuous punctation but can be distinguished from it by its larger size (Tl-h 3.9 – 4.2 mm), slightly truncate apical sternite 7, in male with 10 – 11 lateral



Figures 12–14. Median lobe of aedeagus, lateral aspect, (a) and paramere, external aspect, (b): (12) *Papuadytes marinae*, holotype; (13) *P. hintelmannae*, paratype; (14) *P. atowaso*, holotype.

striae (in *P. broschii*: Tl-h 3.4–3.6 mm, sternite 7 gently rounded and in male with 3–5 lateral striae, as well as by the shape of the median lobe and paramere).

Description

Size. Beetle medium sized (Tl-h 3.9–4.2 mm, TW 2.0–2.2 mm).

Coloration. Head dark reddish brown or black (piceous), with anterior margin reddish; pronotum piceous, with reddish lateral margin; elytra concolorous piceous.

Surface sculpture. Head with dense and fine punctation, finer anteriorly; diameter of punctures smaller than diameter of cells of microreticulation. Pronotum and elytra with very fine and sparse punctation that is denser than that on the pronotum; diameter of punctures smaller than the diameter of the cells of the microreticulation. Head, pronotum, and elytra with weekly impressed microreticulation that is stronger on the head; the dorsal surface is thus obviously shiny. Metasternum and metacoxa distinctly microreticulate, metacoxal plates with longitudinal strioles and transverse wrinkles. Abdominal sternites with distinct microreticulation, strioles, and very fine, inconspicuous, sparse punctation, more conspicuous on two last abdominal sternes.

Structures. Pronotum with distinct lateral bead. Prosternum with distinct but not sharp ridge, no lateral extensions visible anteriorly. Prosternal process lanceolate, rather narrow, with longitudinal convexity, distinct bead, and with few very fine setae; prosternal ridge and prosternal process convexity evenly joint. Sternite 7 slightly truncate apically.

Male. ProT 1–3 not expanded laterally. ProT 4 cylindrical, narrow, with large anterolateral hook. ProT 5 simple, long and narrow, without expansion and concavity, ventrally with anterior row of 18 short sparse setae and posterior row of seven shorter setae (Figure 8). Anterior protarsal claw simple, slightly longer than posterior. Antenna simple. Sternite 7 with 10 – 11 lateral striae. Median lobe as in Figures 3 and 13a, in lateral aspect with apex strongly curved and broadly pointed, in ventral aspect with continuous lateral outline, apex truncate and slightly concave, ventral groove deep, and ventral sclerites fused. Paramere shape as in Figure 13b.

Female. Unknown.

Distribution and habitat. The species is known only from Crater Mountain. It was collected from water holes in rocky stream margins, or water holes on large boulders, or water holes with a gravelly/stony bottom besides the river which is ca. 10 m wide.

Etymology. To Elisabeth Hintelmann to acknowledge the R. Hintelmann award for systematic biologists, which helped many colleagues during their early careers.

Other species

Papuadytes atowaso sp. nov.

Type locality. PNG: Madang Province, river below Bundi.

Type material. Holotype: ♂ "Papua New Guinea Madang Pr. below Bundi, 500 m, 26.IX.2002 Sagata (PNG 23)", "267 DNA M. Balke" [green label] (BMNH). *Paratype*: ♂ same data but without DNA extraction number (PNGC).

Diagnosis. The species can be distinguished from all other *Papuadytes* species by the shape of the median lobe of the aedeagus: in ventral aspect there is a discontinuous lateral outline, which is broadly triangular at the base and narrow, parallel-sided towards the apex with a triangular extension on both sides almost halfway to the apex, few setae apicolaterally, as well as a shiny dorsal surface of the body, with weak microreticulation and fine sparse punctation with the male antennomeres simple.

Description

Size. Beetle medium sized (Tl-h 4.1 mm, TW 2.3 mm).

Coloration. Head dark reddish brown or black (piceous), with anterior margin reddish; pronotum piceous, with reddish lateral margin; elytra concolorous piceous.

Surface sculpture. Head with dense and fine punctation, evidently coarser posteriorly; diameter of most of the punctures smaller than the diameter of cells of microreticulation. Pronotum and elytra with fine and sparse punctation which is denser than in *P. hintelmannae*; diameter of punctures smaller than the diameter of cells of microreticulation. Head, pronotum, and elytra with weekly impressed microreticulation, dorsal surface thus obviously shiny. Metasternum and metacoxa distinctly microreticulate, metacoxal plates with longitudinal strioles and transverse wrinkles. Abdominal sternites with distinct microreticulation, strioles, and fine sparse punctation, more conspicuous on two last abdominal sternes.

Structures. Pronotum with distinct lateral bead. Prosternum with distinct but not sharp ridge; no lateral extensions visible anteriorly. Prosternal process lanceolate, rather narrow, with longitudinal convexity, distinct bead, and with few very fine setae; prosternal ridge and prosternal process convexity evenly joint. Sternite 7 more or less rounded apically.

Male. ProT 1–3 not expanded laterally. ProT 4 cylindrical, narrow, with small anterolateral hook. ProT 5 simple, long and narrow, ventrally with anterior row of 23 setae longer and denser than in two precious species and posterior row of 12 slightly shorter setae (Figure 9). Anterior protarsal claw simple, slightly longer than posterior. Antenna simple. Sternite 7 with 7 – 8 lateral striae. Median lobe as in Figures 4 and 14a, in lateral aspect with apex more or less rounded, in ventral aspect with discontinuous lateral outline; lateral margins make folds, apex truncate and slightly concave, ventral groove deep, and two distinct, long, subequal ventral sclerites. Paramere shape as in Figure 14b.

Female. Unknown.

Distribution and habitat. The species is known only from the type locality. It was collected from semi-shaded, shallow water holes on granitic bedrock at the margin of the stream below Bundi. *Papuadytes* were observed mainly in those parts of the water holes where large boulders or trees would shade the water.

Etymology. The species is named after Katayo Sagata's daughter.

***Papuadytes munaso* sp. nov.**

Type locality. PNG: Eastern Highlands Province: Crater Mountain, Wara Sera Station, 06°43.4′S, 145°05.6′E.

Type material. Holotype: ♂ "Papua New Guinea Simbu/EHPr. Crater Mountain, Wara Sera Station, 800 m, 14.IX.2002 Sagata (PNG 10)", "255 DNA M. Balke" [green label] (BMNH). *Paratypes*: ♂ "PNG Simbu / EHPr. Crater Mountain, Sera-Herowana, Wara Hulene, 1000 m, 16.IX.2002 Sagata (PNG 17)", "262 DNA M. Balke" [green label] (NMW); ♂ same data but without DNA extraction number (PNGC).

Diagnosis. The species can be distinguished from all other *Papuadytes* species by the dark brown coloration of median lobe of the aedeagus and its shape: rather stout, in ventral aspect basal 2/3 very broadly triangular in outline and apex as a broadly rounded dome, as well as by

dull dorsal surface of the body, with more strongly impressed microreticulation and dense coarse punctation and male antennomeres simple.

Description

Size. Beetle large (Tl-h 4.8 – 5 mm, TW 2.6 mm).

Coloration. Head, pronotum, and elytra concolorous piceous, pronotum slightly reddish at anterior part of lateral margin.

Surface sculpture. Head with dense (some punctures conjoint or spaces between punctures 1–5 times size of punctures) and coarse punctation, finer anteriorly; diameter of punctures equal or smaller than diameter of cells of microreticulation. Pronotum and elytra with distinct coarse punctation that is slightly denser on pronotum (spaces between punctures 1 – 5 times the size of punctures); diameter of punctures equal to the diameter of cells of microreticulation. Head, pronotum, and elytra with rather strong microreticulation, dorsal surface thus not obviously shiny. Metasternum and metacoxa distinctly microreticulate, metacoxal plates with longitudinal strioles and transverse wrinkles. Abdominal sternites with distinct microreticulation, strioles, and fine sparse punctation which are coarse and denser on the two last abdominal sternes.

Structures. Pronotum with distinct lateral bead. Prosternum with distinct but not sharp ridge, no lateral extensions visible anteriorly. Prosternal process lanceolate, rather narrow, with longitudinal convexity, distinct bead, and with few very fine setae; prosternal ridge and prosternal process convexity evenly joint. Sternite 7 slightly truncate apically.

Male. ProT 1 – 3 not expanded laterally. ProT 4 cylindrical, narrow, with large anterolateral hook. ProT 5 simple, long and narrow, without expansion and concavity, ventrally with anterior row of 33 setae longer and denser than in the two first species and posterior row of six shorter setae (Figure 10). Anterior protarsal claw simple, slightly longer than posterior. Antenna simple. Sternite 7 with 13 – 21 lateral striae. Median lobe as in Figures 5 and 15a, in lateral aspect with apex strongly curved and pointed, in ventral aspect with discontinuous lateral outline; lateral margins make folds, apex rounded, ventral groove deep, and two distinct, long, subequal ventral sclerites. Median lobe mostly of dark brown color as opposed to all other species we have seen where the genital is ferruginous. Paramere shape as in Figure 15b.

Female. Unknown.

Distribution. The species is known only from Crater Mountain.

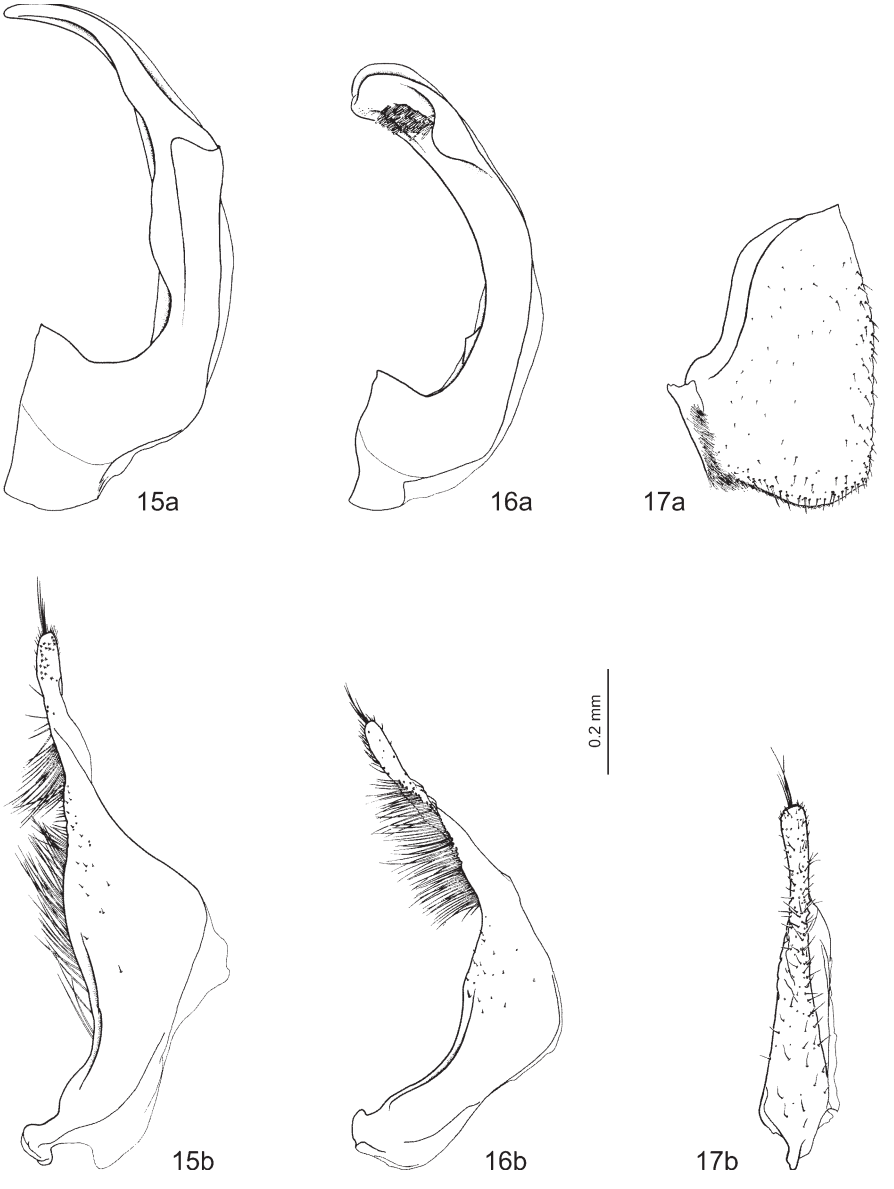
Etymology. Selected by Katayo Sagata: ''When I was first going into Crater Mountain a friend of mine requested that, if I find new species, I should name it after her. Munaso Zaemo is her name and this species is named after her''.

***Papuadytes vladimiri* sp. nov.**

Type locality. West Papua: Yapen Island, Mantembu.

Type material. Holotype: ♂ ''Irian Jaya: Japen Isl. Mantembu 150 – 450 m, 18.II.1999 leg. Riedel'' (NMW). Paratypes: 2 ♂, 1 ♀ the same label data as in holotype (NMW).

Diagnosis. The species can be distinguished from all other *Papuadtyes* species by the shape of the median lobe of the aedeagus as depicted in Figures 6 and 16a, dull dorsal surface of the



Figures 15–17. Median lobe of aedeagus, lateral aspect, (a) and paramere, external aspect, (b): (15) *Papuadytes munaso*, paratype; (16) *P. vladimiri*, paratype; (17) *P. vladimiri*, paratype: gonocoxosternum (a) and gonocoxa (b), ventral aspect.

body, with strongly impressed microreticulation and dense coarse punctation, absence of lateral bead of the pronotum, and male antennomeres simple.

Description

Size and shape. Beetle small, with broadly oval habitus (Tl-h 3.6–3.7 mm, TW 2.1–2.2 mm).

Coloration. Head yellowish red to reddish brown; disc of pronotum and elytra pale reddish brown to dark brown, lateral sides of pronotum and sometimes base of elytra paler.

Surface sculpture. Dorsal surface with microreticulation and punctation similar to *P. marinae*. Head and pronotum with dense punctation (spaces between punctures 1–5 times size of punctures), evidently finer than in *P. marinae*, diameter of most punctures distinctly smaller than diameter of cells of microreticulation. Elytra with punctation dense and distinctly coarser than on head and pronotum; diameter of punctures of equal diameter to cells of microreticulation. Head, pronotum, and elytra with strong microreticulation, dorsal surface thus not obviously shiny, rather matt. Metasternum and metacoxa distinctly microreticulate, metacoxal plates with longitudinal strioles and transverse wrinkles. Abdominal sternites with distinct microreticulation, strioles, and fine sparse punctation, coarser and denser on two last abdominal sternes.

Structures. Pronotum without lateral bead. Prosternum with distinct but not sharp ridge, no lateral extensions visible anteriorly. Prosternal process lanceolate, rather narrow, with longitudinal convexity, distinct bead, and with few very fine setae; prosternal ridge and prosternal process convexity evenly joint. Sternite 7 slightly truncate or rounded apically.

Male. ProT 1–3 not expanded laterally. ProT 4 cylindrical, narrow, with distinct anterolateral hook. ProT 5 simple, long and narrow, without expansion and concavity, ventrally with anterior row of ca. 40 setae longer and denser than in two first species and posterior row of seven shorter setae (Figure 11). Anterior protarsal claw simple, slightly longer than posterior. Antenna simple, with antennomeres slightly broader than in female. Sternite 7 with 12–14 lateral striae. Median lobe as in Figures 6 and 16a, in lateral aspect with apex more or less truncate, in ventral aspect with continuous lateral outline and lateral margins sinuate, apex truncate and concave, ventral groove deep, and with two distinct, long, subequal ventral sclerites. Paramere shape as in Figure 16b.

Female. Antennomeres slender. Dorsal surface with punctation and microreticulation coarser. Gonocoxa and gonocoxosternum as in Figure 17a, b.

Distribution and habitat. The species is known only from the type locality where it was collected from a small forest stream.

Etymology. The species is named after Vladimir Vladimirovich Shaverdo, the father of the first author, who was probably also not very happy about the unusual activities of his daughter but still kept on making aquatic nets for her.

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