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Notes on the endemic Philippine genus *Orthosaldula* (Hemiptera: Heteroptera: Saldidae), with descriptions of two new species

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Abstract. The endemic Philippine genus *Orthosaldula* Gapud, 1986 and the type species *O. rubroalata* Gapud, 1986 from central and southern Luzon are redescribed. A male from Quezon Province, Central Luzon, is designated as the lectotype of *O. rubroalata*; the year of original publication is corrected. Two species are described as new to science, *Orthosaldula stysi* sp. nov. from Leyte and *O. flavonigra* sp. nov. from Cebu.

Key words. Heteroptera, Saldidae, *Orthosaldula*, redescription, new species, endemism, Philippines, Luzon, Leyte, Cebu

Introduction

Little is known about the Saldidae or shore bugs of the Philippines. A single comprehensive study was published by GAPUD (1986) in a book that is difficult to obtain outside the Philippines. GAPUD (1986) treats seven species (inclusive three new to science) in five genera. *Orthosaldula* Gapud, 1986 is the only leptopodomorphan genus that is endemic in the Philippines (GAPUD 1986, DUDGEON 1999). This spectacular taxon can be easily recognized by its vivid colours and some unique features of its pronotum. In addition to the type species, *Orthosaldula rubroalata* Gapud, 1986 from Luzon, we add two new species from Leyte and Cebu.

Material and methods

Specimens are dry mounted on card squares or triangles. Material is referred by citing the original locality labels, which are marked with ‘’; the backslash sign \ indicates the break of a line.

Acronyms of repositories:

HZWA H. & S.V. Zettel Collection, Vienna, Austria;
NHMW Natural History Museum, Vienna, Austria;
UPLB Museum of Natural History, University of the Philippines, Los Baños, Laguna, Philippines;
USC University of San Carlos, Cebu City, Philippines;
VPGP V. P. Gapud Collection, Department of Entomology, University of the Philippines, Los Baños, Laguna, Philippines.

Examination of specimens was chiefly done with a Leica M10 binocular microscope (maximum magnification 128 ×). Drawings (Figs. 7-14) were made with the help of a camera lucida attached to this microscope. The digital photographs (Figs. 1-6) were taken with a Leica DFC camera attached to a Leica MZ16 binocular microscope with the help of Image Manager IM50 and processed with Auto-Montage Pro and Adobe Photoshop 7.0 programmes.

We take the terminology mainly from Polhemus (1985), but in the terms mesoscutum, scutellum, and anteocellar furrows (= 'sillon antéocellaire') we follow Péricart (1990).

Taxonomy

Orthosaldula Gapud, 1986

Orthosaldula Gapud, 1986: 7 (key), 16-17 (description) (originally quoted as Gapud, 1977 [sic!], see Taxonomic notes below).
Orthosalda [sic!]: Dudgeon (1999): 356 (mentioned as a Philippine endemic genus).

Type species. *Orthosaldula rubroalata* Gapud, 1986 (by monotypy).

Diagnosis. Body small, slender. Colour (Figs. 1-6) unique. Black, thorax and some areas on head with more or less metallic, bluish or violet traces. Head with yellow, orange, or reddish patches near anterodorsal eye margin and on mandibular plates; maxillary plates, anteclypeus, gular lobes, and labrum totally yellow, orange, or reddish. Metapleura pale. Forewing with ground colour red or yellow and with prominent black mark in centre, lateral areas pale. Antenna and legs chiefly pale, or with reddish traces, but procoxa always black; fourth antennomere infuscated in some specimens. Sternites 2-6 in both sexes with reddish hind margins, at least narrow and laterally; sternite 7 of female pale, almost transparent, except black stripe at base. Pilosity reduced, without long standing setae; short decumbent whitish pilosity present on some parts of head and thorax, most dominant on sides; hemelytron with short dark, appressed or decumbent setae. Vertex narrow. Ocelli located on distinct tubercle that is laterally delimited by deep, posteriad prolonged anteocellar furrows. Rostrum very long, reaching apex of hind coxa, third segment ca. 2.2 times as long as fourth. Antenna: antennomere 2 longest, relative lengths of antennomeres approximately as 5 : 10 : 9 : 9, antennomeres 1 and 2 cylindrical in both sexes. Pronotum coarsely sculptured, with sides slightly concave and strongly converging anteriad, with posterior margin almost straight (slightly convex laterally, slightly concave medially); collar very narrow; callus narrow (median length less than two thirds of posterior lobe length) and domed, with impressed median line; transverse furrow separating callus from posterior lobe deeply punctured and reaching lateral margins; posterior lobe more or less

domed, laterally with sharply impressed longitudinal furrows separating humeri from disk. Mesoscutum domed. Scutellum anteriorly strongly raised, posterior flattened. Hemelytron (Fig. 7) with short embolar fracture (ef), not reaching level of apex of radius (R); membrane with four cells, innermost cell (relative to wing the posterior one) shorter and narrower than the following cell; hypocostal ridge simple, secondary costal ridge absent. Genital capsule of male with horn-shaped parandria (Fig. 8); proctiger (Fig. 9) subtrapezoidal, with moderately convex hind margin; paramere (Fig. 10) strongly curved, with weakly developed processus sensualis. Phallus complex, containing numerous minute sclerites. Subgenital plate of female (Fig. 11) caudally produced, in middle of hind margin with very small, indistinct lobe.

Comparative notes. *Orthosaldula* belongs to the subfamily Saldinae (Gapud 1986). The modifications of the pronotum and the vivid colour pattern are unique. Especially noteworthy are the coarse sculpture of the pronotum, and the narrow collar and callus as compared with the long, domed, posterior lobe with almost straight hind margin, which distinguish *Orthosaldula* from all other Saldidae in the Oriental Region. The relationships with other saldine genera are not resolved.

Distribution and species diversity. Endemic to the Philippines. Hitherto known from three islands, Luzon, Leyte and Cebu, each home of one species. A fourth species has been collected in northern Luzon (J. T. Polhemus, pers. comm.), but was not made available for our study.

Taxonomic notes. Gapud (1986) introduced the new genus *Orthosaldula* and four new species names, *Orthosaldula rubroalata*, *Saldula mimica* Gapud, 1986, and *Chartoscirta mayona* Gapud, 1986 in Saldidae, *Corallocoris cinereus* Gapud, 1986 in Omaniidae. By a lapsus calami, these taxa were referred to 'Gapud, 1977', a publication that does not exist. However, the study by Gapud (1986) provides descriptions of all new taxa and therefore all names are fully available according to the requirements by the ICZN, Third Edition (ICZN 1985).

Key to species

1 Vertex behind ocelli finely punctured and with short pilosity (Fig. 1). Luzon. .... ***O. rubroalata*** Gapud, 1986

– Vertex behind ocelli smooth, shining, without any pilosity (Figs. 2-3). 2

2 Forewings chiefly red (Fig. 2). Mandibular plate anteriorly with small yellow or orange mark (Fig. 5), or totally dark. Leyte. ..... ***O. stysi* sp. nov.**

– Forewings chiefly yellow (Fig. 3). Mandibular plate completely yellow (Fig. 6). Cebu. ..... ***O. flavonigra* sp. nov.**

Orthosaldula rubroalata Gapud, 1986

(Figs. 1, 4, 7-12)

Orthosaldula rubroalata Gapud, 1986: 17-18 (description, illustration, habitats, habits, distribution, ecology) (in original description quoted as Gapud, 1977 [sic!], see Taxonomic notes on *Orthosaldula*).

Type locality. Philippines, Luzon Island, Quezon province, Quezon National Park, Atimonan.

Type material examined. Lectotype (present designation; VPGP): ♂, 'QUEZON NATL PARK \ ATIMONAN, QUEZON \ PROV.: 17 JAN. 1976 \ ON MOSSY ROCK \ BESIDE STREAM \ A.A. BARROSO'. Paralectotypes:

2 ♂♂, same label data as lectotype (NHMW, HZWA); 3 ♂♂ 2 ♀♀, 'LUZON \ National Botanic Garden, REAL, QUEZON, 4/82 \ VP GAPUD' (VPGP); 2 ♂♂ 2 ♀♀, 'LUZON \ BICOL NATIONAL PARK, DAET, CAMARINES NORTE \ 12/4/76 \ AA BARROSO' (VPGP); 5 ♂♂ 3 ♀♀, 'LUZON \ MT MAYON NATIONAL PARK, ALBAY \ 12/6/76 \ AA BARROSO' (VPGP); 1 ♀, 'LUZON \ Mt. Makiling \ Molawin Crk. \ MBG: 8/23/78 \ F.A. MULIMBAYAN' (HZWA); 1 ♀, 'LUZON \ Mt. Makiling \ Molawin Crk. \ MBG: 8/27/78 \ F.A. MULIMBAYAN' (HZWA); **Additional material examined. PHILIPPINES: Luzon Island:** Laguna Province, Mt. Makiling, from UP Los Baños campus up to ca. 800 m a.s.l., 3.xi.2002, 1 ♀, H. Zettel lgt. (# 322a) (NHMW).

Diagnosis. Vertex finely punctured and pilose. Callus relatively flat and short. Mandibular plates completely yellow or red. Area between dorsal eye margin and anteocellar furrows with yellow spot. Corium of forewing vermilion red to pinkish with pale side margin and medium-sized black dot in centre. Antennae and legs with vermilion red traces, in some specimens of minor extent.

Additional descriptive notes. Measurements. Body length of males 2.8-2.9 mm, of females 3.3-3.4 mm. Maximum body width of males 1.20-1.31 mm, of females 1.52-1.65 mm. Head width of males 0.83-0.85 mm, of females 0.92-0.93 mm. Pronotum width of males 1.02-1.05 mm, of females 1.21-1.23 mm.

Colour. See Figures 1 and 4. Thorax with dark bluish to violet shimmer, almost black in some specimens. Antennomere 4 not infuscated. Clavus of hemelytron red, with broad black base and narrow black lateral margin.

Structures. Callus low, median impression not deep, median length 0.46-0.49 times median length of pronotal lobe. Posterior lobe of pronotum with dense, not coarse rugosity, strongly convex in lateral aspect (Fig. 12).

Comparative notes. *Orthosaldula rubroalata* is unique within the genus by the punctured and pilose vertex, the relatively flat and short callus, and the combination of colour characteristics. The head width (relative to pronotum width) is slightly smaller in *O. rubroalata* than in the following two species.

Habitats. According to Gapud (1986), *O. rubroalata* is 'strictly confined to moist rocks with dense mossy growth in shaded areas of streams running through secondary growth forests and at relatively high elevations ranging from 800 feet to as high as 2,500 feet. On one occasion, several adults were recovered from a similar habitat along a dead [...] mountain stream [...]'. The first author collected a single specimen on a fallen log with rich mossy growth far away from any water. Gapud (1986) emphasised that, in comparison with species of *Saldula* Van Duzee, 1914 which can be found in similar stream habitats, *O. rubroalata* is found on the moss itself.

Distribution. Luzon Island. Recorded from the provinces of Laguna, Quezon, Camarines Norte, and Albay.

Taxonomic notes. Gapud (1986) gives the distribution of this species as 'Mt. Makiling (Laguna side), Quezon National Park in Atimonan, Quezon, Bicol National Park in Daet, Camarines Norte, and Mt. Mayon National Park in Albay'. No types were stated by Gapud (1986); accordingly, all specimens used for description are syntypes. A lectotype is designated here from the series originating from the Quezon National Park in Central Luzon.

Fig. 1. *Orthosaldula rubroalata* Gapud, 1986, female, body length 3.3 mm. (© NHMW Hemiptera Image Collection, published with permission).

***Orthosaldula stysi* sp. nov.**

(Figs. 2, 5, 13)

Type locality. Philippines, Leyte Island, Leyte Province, Baybay, slopes of Mt. Pangasugan behind Leyte State University, banks of Calbiga-a River, ca. 100 m a.s.l.

Type material. Holotype: ♂, 'Philippinen: Leyte, Baybay \ LSU,50-100m, Calbiga-a Riv. \ 20.-21.3.2005, leg. Zettel \ & C. Pangantihon (422)' (UPLB). Paratypes: 12 ♂♂ 10 ♀♀, same label data as holotype (HZWA, NHMW, UPLB, USC); 1 ♂ 1 ♀, 'LEYTE: MT. PA- \ NGASUGAN: \ CALBIGA-A RI- \ VER: 10-30-1980 \ V.P.GAPUD \ Ex. mossy rock' (HZWA); 3 ♂♂, 'LEYTE \ Baybay \ MT PANGASUGAN \ CALBIGA-A RIVER: 3/3/84 \ VP GAPUD' (VPGP); 3 ♂♂, 'LEYTE \ MT PANGASUGAN \ CALBIGA-A RIVER: 3/3/84 \ M ALMOREDA' (VPGP).

Fig. 2. *Orthosaldula stysi* sp. nov., female, body length 3.2 mm. (© NHMW Hemiptera Image Collection, published with permission).

Diagnosis. Vertex smooth, without any pilosity. Callus very high and moderately long. Mandibular plates only with small yellow or orange area anteriorly, or totally dark. Area between dorsal eye margin and anteocellar furrows with yellow or orange spot. Corium of forewing vermilion red with pale side margin and medium-sized black dot in centre. Antennae and legs with vermilion red traces, in some specimens of minor extent.

Additional descriptive notes. Measurements. Body length of males 2.7-3.0 mm, of females 3.0-3.3 mm. Maximum body width of males 1.26-1.39 mm, of females 1.46-1.62 mm. Head width of males 0.85-0.90 mm, of females 0.91-0.95 mm. Pronotum width of males 1.04-1.12 mm, of females 1.13-1.23 mm.

Colour. See Figures 2 and 5. Thorax with distinct violet shimmer. In three male paratypes, antennomere 4 infuscated. Clavus of hemelytron red, with broad black base and narrow black lateral margin.

Structures. Callus very high, median impression deep, median length 0.58-0.65 times median length of pronotal lobe. Posterior lobe of pronotum with coarse rugosity, strongly convex in lateral aspect (Fig. 13).

Comparative notes. *Orthosaldula stysi* sp. nov. is similar in colour to *O. rubroalata* with the exception that the light patch on the mandibular plates is much smaller (cf. Figs. 4-5). Important structural differences between the two species are found in the vertex (punctured and pilose in *O. rubroalata*, smooth and bare in *O. stysi* sp. nov.) and in the callus of the pronotum (relatively low and very short in *O. rubroalata*, very high and moderately short in *O. stysi* sp. nov.; cf. Figs. 12-13).

Etymology. We dedicate this beautiful new species to our colleague Prof. Pavel Štys on the occasion of his 75th birthday.

Habitats. Clister V. Pangantihon and the first author collected *O. stysi* sp. nov. along the bank of the Calbiga-a River not far from the campus of the Leyte State University, at an altitude of about 100 m a.s.l. Specimens were sampled from large boulders and from rock faces on the banks. Some specimens were running on the mosses, others on the bare wet rocks. The second author collected other specimens in the same place, all from mossy rocks.

Distribution. Leyte Island: only recorded from the slopes of Mt. Pangasugan.

Orthosaldula flavonigra sp. nov.

(Figs. 3, 6, 14)

Type locality. Philippines, Cebu Island, Boljoon, Poblacion, GPS N 9°37′, E 123°28′, ca. 10 m a.s.l.

Type material. Holotype: ♂, 'Philippines: Cebu, Boljoon \ (Pobl.), river and banks \ 10.2.2008, leg. H. Zettel \ & C. Pangantihon (505)' (UPLB). Paratypes: 2 ♂♂ 2 ♀♀, same label data as holotype (HZWA, NHMW).

Diagnosis. Vertex smooth, without any pilosity. Callus high and moderately long. Mandibular plates completely yellow. Area between dorsal eye margin and anteocellar furrows completely yellow. Corium of forewing clayish yellow (without any red), with pale side margin and large black dot in centre. Antennae and legs yellow or light orange, never with vermilion red touches.

Additional descriptive notes. Measurements. Body length of males 2.8-2.9 mm, of females 3.3-3.4 mm. Maximum body width of males 1.28-1.30 mm, of females 1.49-1.56 mm. Head

width of males 0.90-0.91 mm, of females 0.93-0.97 mm. Pronotum width of males 1.06-1.09 mm, of females 1.19-1.23 mm.

Colour. See Figures 3 and 6. Thorax with dark violet shimmer. In holotype only, antennomere 4 infuscated. Clavus of hemelytron yellow or orange, with broad black base and black lateral margin broadened towards apex.

Fig. 3. *Orthosaldula flavonigra* sp. nov., male, body length 2.8 mm. (© NHMW Hemiptera Image Collection, published with permission).

Structures. Callus very high, median impression moderately deep, median length 0.53-0.60 times median length of pronotal lobe. Posterior lobe of pronotum with very coarse rugosity, weakly convex in lateral aspect (Fig. 14).

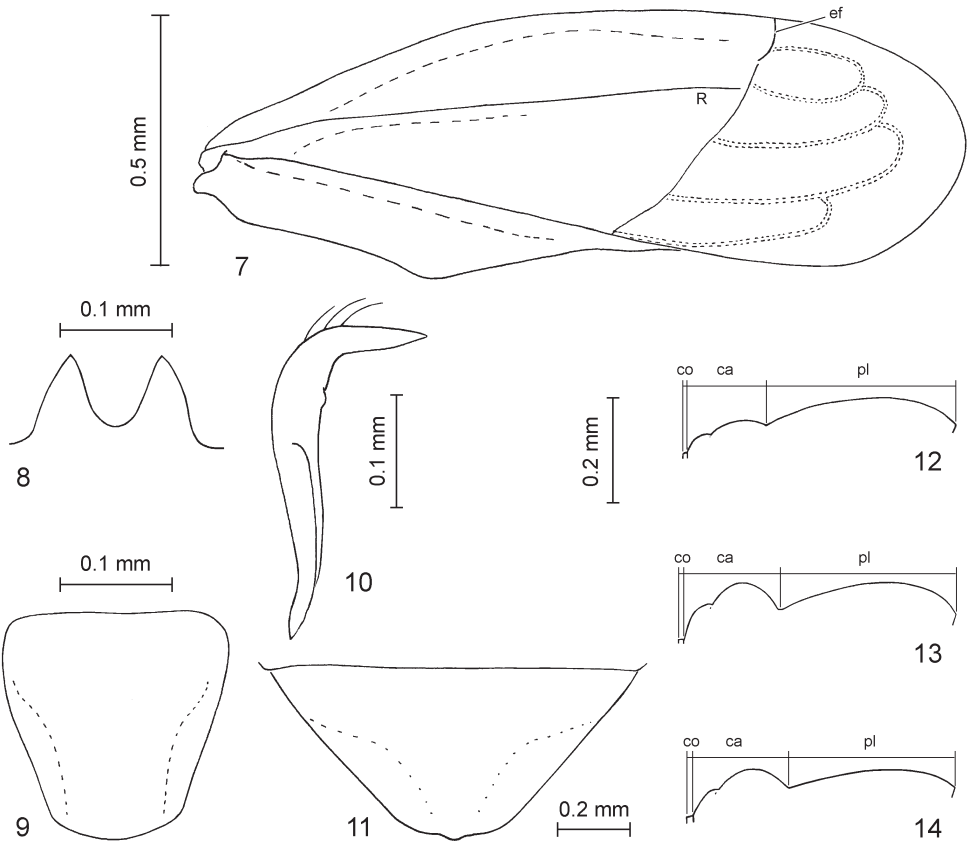
Comparative notes. *Orthosaldula flavonigra* sp. nov. differs clearly from *O. rubroalata* and *O. stysi* sp. nov. in the yellow and black colour of the hemelytron. Its smooth and bare vertex set this species in close relationship with *O. stysi* sp. nov., but beside colour, there are also differences in the structure of the pronotum, with the callus being less high in *O. flavonigra* sp. nov. than in *O. stysi* sp. nov. (cf. Figs. 13-14), and the rugosity of the posterior lobe coarser in *O. flavonigra* sp. nov. than in *O. stysi* sp. nov.

Etymology. The species epithet is an adjective composed of the Latin words *flavus* for yellow and *niger* for black; it refers to the colour of the hemelytron.

Habitats. *Orthosaldula flavonigra* sp. nov. was collected by Clister V. Pangantihon and the first author on the banks of a stream in southeastern Cebu. Specimens were found on and near mosses on rock boulders and steep rock faces together with *Saldula* sp. The type locality is not far from the sea, approximately 10 m a.s.l.

Distribution. Cebu Island: only known from the type locality in the island's southeast.

Figs. 4-6. Head, frontal aspect: 4 – *Orthosaldula rubroalata* Gapud, 1986; 5 – *O. stysi* sp. nov.; 6 – *O. flavonigra* sp. nov. (© NHMW Hemiptera Image Collection, published with permission).



Figs. 7-14. 7-11 – *Orthosaldula rubroalata* Gapud, 1986: 7 – right forewing (ef = embolar fracture, R = radius); 8 – parandria, caudal view; 9 – proctiger, dorsal view; 10 – left paramere, lateral view; 11 – subgenital plate of female, ventral view. 12-14 – dorsal outline of pronotum, lateral view (co = collar, ca = callus, pl = posterior lobe). 12 – *O. rubroalata*; 13 – *O. stysi* sp. nov.; 14 – *O. flavonigra* sp. nov. Pilosity omitted, except in Fig. 10.

Notes on the species concept

We clearly distinguish three allopatric populations of *Orthosaldula* from Luzon, Leyte and Cebu. Differences are in colour, size of heads, and structure of pronota. However, we could not find clear differences in the major genital structures (genital capsule with parandria, paramere, proctiger), which would support the populations' status as biological species; intraspecific variation seems to be greater that interspecific differences. In Leptopodomorpha, these structures frequently express a reduced diversity compared with many taxa in Nepomorpha and Gerromorpha. As an exception, the phallic sclerites of Saldidae are highly complex (see, e.g., Péricart 1990); however, due to their extremely small size and variable position inside the phallus, they are difficult to examine and problematic to use as distinguishing characters.

Based on a few males dissected, there seem to be one small difference between *O. rubroalata* and the other two species, specifically in the shape of one certain small pair of sclerites, which was only recognizable after dissection of the phallus. Presently we regard all three island populations as different 'morphospecies'. This corresponds with similar distribution patterns in many plant and animal taxa, including many stream-inhabiting water bugs, that are submitted to the same or similar evolutionary isolation processes. Ong et al. (2002) subdivide the Philippines into sixteen biogeographical regions. *Orthosaldula rubroalata* is a faunal element of the main region 'Greater Luzon', *O. stysi* sp. nov. of 'Greater Mindanao', and *O. flavonigra* sp. nov. of 'Greater Negros – Panay'. However, it is possible that the *Orthosaldula* 'species' are subspecies in a biological species concept.

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