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Description of two new Ecuadorian *Zilchistrophia* Weyrauch, 1960, with the clarification of the systematic position of the genus based on anatomical data (Gastropoda, Stylommatophora, Scolodontidae)

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Abstract

Two new species of the genus *Zilchistrophia* Weyrauch, 1960 are described from Eastern Ecuadorian rain forest: *Zilchistrophia hilaryae* **sp. n.** and *Z. shiwiarorum* **sp. n.** These two new species extend the distribution of the genus considerably northwards, because congeners have been reported from Peru only. For the first time we present anatomical data (radula, buccal mass, morphology of the foot and the genital structure) of *Zilchistrophia* species. According to these, the genus belongs to the family Scolodontidae, subfamily Scolodontinae (="Systrophiini"). The previously assumed systematic relationship of *Zilchistrophia* with the Asian Corillidae and Plectopylidae based on the similarly looking palatal plicae is not supported.

Keywords

Systrophiidae, Plectopylidae, *Plectopylis*, Corillidae, anatomy, taxonomy

Introduction

In the collection of the Natural History Museum, London, we encountered some shells and ethanol-preserved specimens collected in Eastern Ecuador during an expedition organized by The Shiwiar Rainforest Initiative 2000. Some of these specimens represent two species new to science. The small (3.5–5 mm), translucent, flat shells possess two or three horizontal palatal plicae standing one above the other, approximately a third to a half whorl behind the aperture. Similar species have been reported from Peru under the name *Zilchistrophia* Weyrauch, 1960. Weyrauch (1960) created the genus for three species: *Z. tridentata* Weyrauch, 1960 (type species by original designation), *Systrophia* (*Systrophia*) *obvoluta* Haas, 1949 and *Systrophia* (*Systrophia*) *angigyra* Haas, 1949. Although the two Ecuadorian new species differ somewhat from the Peruvian ones in terms of the formation of the last quarter of whorl, we classify them as "true" *Zilchistrophia* species, and use the information on their soft anatomy to clarify the taxonomic status of *Zilchistrophia*.

Material and methods

The two new Ecuadorian species were compared with the holotype of *Zilchistrophia tridentata* ("C-Peru, Pichita Caluga, 2200 m, im Canchamayo-Becken", leg. Weyrauch 18.08.1959., SMF 162006), and the original descriptions and photos of the other two Peruvian species. Ethanol-preserved specimens were dissected under Leica stereomicroscope, a camera on which provided photographs. To describe the reproductive system, we used the terms "proximal" and "distal" in relation to the centre of the body.

The buccal mass was removed and soaked in 2 molar KOH solution for 5 hours before extracting radula, which was preserved in 70% ethanol. Radulae were directly observed without coating under a low vacuum SEM (Miniscope TM-1000, Hitachi High-Technologies, Tokyo).

The nomenclature of plicae follow Páll-Gergely and Hunyadi (2013): horizontal folds (=parallel with the suture) are called plicae, whereas vertical folds (=perpendicular to the suture) are named lamellae.

The geographical coordinates of localities mentioned in this paper are the following: Chuintsa 02°00.891'S, 076°40.866'W; Nuevo Corrientes 01°59.870'S, 076°45.968'W.

Abbreviations

D	shell diameter
H	shell height
NHMUK	The Natural History Museum (London, United Kingdom)
SMF	Senckenberg Forschungsinstitut und Naturmuseum (Frankfurt am Main, Germany)

Taxonomic descriptions

Scolodontidae Baker, 1925

1925 Scolodontidae Baker, The Nautilus 38(3): 88.

Type genus. *Scolodonta* Döring, 1875.

Remarks. For taxonomic and nomenclatural notes see Hausdorf (2006).

Genus *Zilchistrophia* Weyrauch, 1960

1960 *Zilchistrophia* Weyrauch, Archiv für Molluskenkunde 89 (1/3): 26.

Type species. *Zilchistrophia tridentata* Weyrauch, 1960, by original designation.

Zilchistrophia hilaryae Páll-Gergely, sp. n.

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Figs 1B–C, E, 2A–H, 3A–B, 4B, D, F, 5A–D

Type material. Ecuador, Pastaza Province, Chuintsa, transect 7, (samples 360–369), leg. Hilary Kingston, 17.09.2000., NHMUK 20020375.1 (holotype), NHMUK 20020375.2–10 (9 paratypes); Ecuador, Pastaza Province, Nuevo Corrientes, transect 6, 02°00.224'S, 076°45.712'W (sample 175), leg. Hilary Kingston, 11.09.2000., NHMUK 20020384/1 paratype; Ecuador, Pastaza Province, Nuevo Corrientes, transect 6, 02°00.224'S, 076°45.712'W (sample 163), leg. Hilary Kingston, 11.09.2000., NHMUK 20020385/1 paratype; Ecuador, Pastaza Province, Chuintsa, transect 7, (sample 426b), leg. Hilary Kingston, 17.09.2000., NHMUK 20020372/1 paratype; Ecuador, Pastaza Province, Chuintsa, transect 7 (samples 419–425), leg. Hilary Kingston, 17.09.2000., NHMUK 20020374/7 paratypes; Ecuador, Pastaza Province, Chuintsa, transect 7, (samples 461–466), leg. Hilary Kingston, 17.09.2000., NHMUK 20020370/6 paratypes; Ecuador, Pastaza Province, Chuintsa, transect 7, (sample 305), leg. Hilary Kingston, 17.09.2000., NHMUK 20020387/1 paratype; Ecuador, Pastaza Province, Nuevo Corrientes, (sample 200), leg. Hilary Kingston, 13.09.2000., NHMUK 20020388/1 paratype; Chuintza, Pastaza, Ecuador, sample 308, Tissue sample J5, leg. Hilary Kingston, 17.09.2000., NHMUK 20020422 (dissected, ethanol-preserved animal).

Diagnosis. A small *Zilchistrophia* species with regularly growing whorls, rounded body whorl, relatively wide umbilicus and three palatal plicae approximately a half whorl behind the aperture. The uppermost two plicae are situated very close to each other, forming a single-looking plica.

Description of the shell (Figs 1–2): Shell dextral, yellowish, glossy and translucent, smooth, only irregular, very fine growth lines can be seen; shell shape discoid,

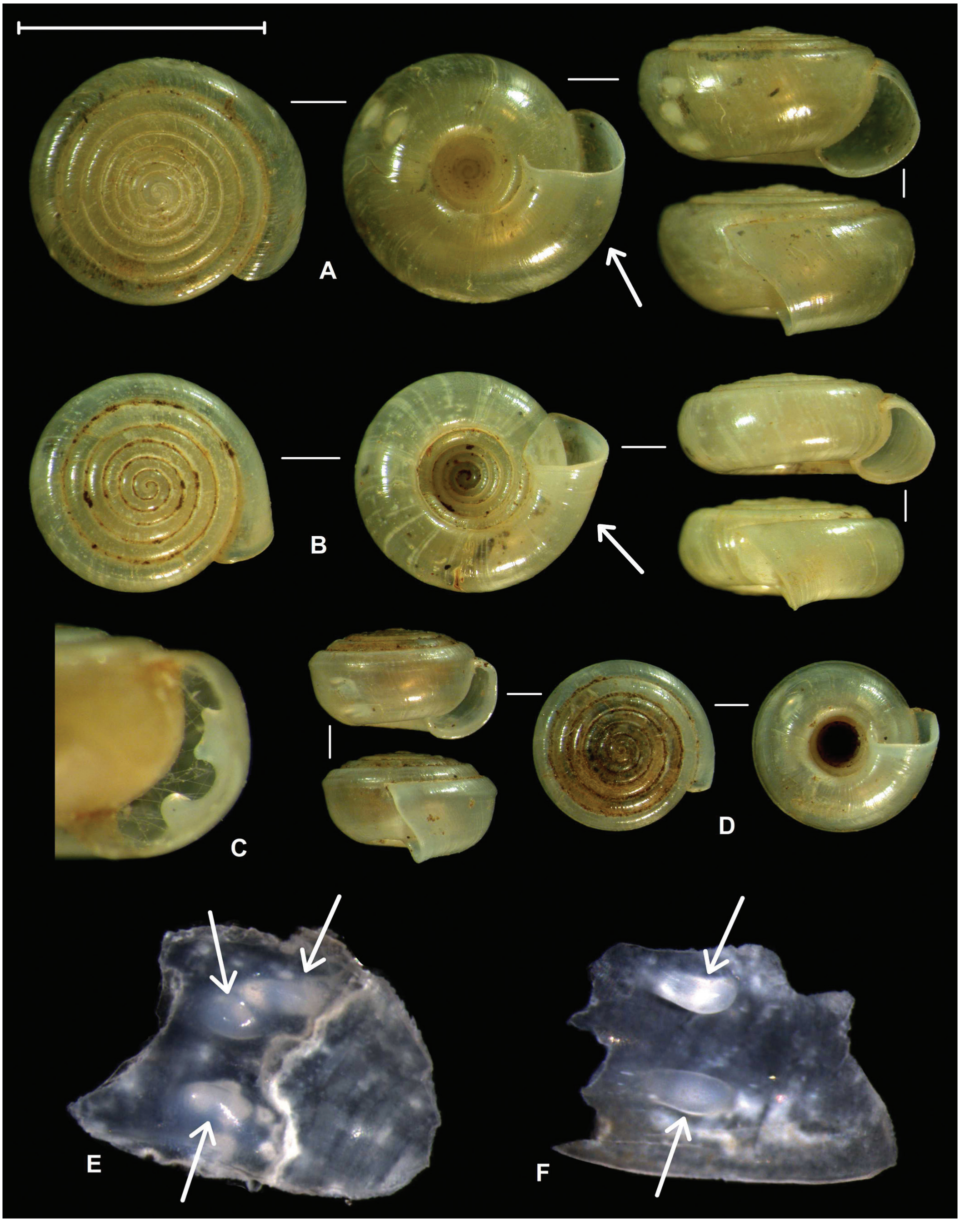

Figure 1. Shells of *Zilchistrophia* Weyrauch, 1960 species. **A** Holotype of *Zilchistrophia tridentata* Weyrauch, 1960 (SMF 162006; type species of the genus), arrow shows the inflated part of the last whorl **B** holotype of *Zilchistrophia hilaryae* sp. n. (NHMUK 20020375.1), arrow shows the non-inflated part of the body whorl **C** paratype of *Z. hilaryae* sp. n. (subadult shell with the last quarter of whorl removed in order to show palatal plicae) **D** holotype of *Zilchistrophia shiwiarorum* sp. n. (NHMUK 20020382) **E** plicae bearing shell fragment of the anatomically examined specimen of *Z. hilaryae* sp. n. (arrows indicate the plicae) **F** plicae bearing shell fragment of the anatomically examined specimen of *Z. shiwiarorum* sp. n. (arrows indicate the plicae). The two shell fragments (**E** and **F**) are left together with the ethanol-preserved body. Scale represents 5 mm, and refers to **A, B** and **D**.

with slightly domed apical surface; whorls 6 (n=4), regularly growing, the last whorl and especially the apertural part is conspicuously wider than the penultimate whorl; body whorl rounded; whorls are separated by relatively deep suture; umbilicus relatively wide, funnel-shaped; aperture crescent-shaped, with slightly thickened peristome; parietal callus not conspicuous, present as slight, blunt thickening, its sculpture is extremely finely granulated, rather matt; in corroded shells the callus is whitish, whereas the penultimate whorl can remain translucent (in those shells the callus is better visible).

One, two or three sets of plicae are situated in various positions behind the aperture (see Fig. 2 and remarks). One set consists of three horizontal, short palatal plicae. The first two plicae are very close to each other, forming a single-looking plica.

Measurements (in mm). D: 4.1–5.0, H: 2.0–2.4 (n=3).

Description of the anatomy. One specimen was anatomically examined (Chuintza, Pastaza, Ecuador, sample 308, Tissue sample J5, leg. Hilary Kingston, 17.09.2000., NHMUK 20020422).

Body. Foot seemingly holopod, but it was laterally very much depressed (probably also decayed internally), therefore the real morphology could not be clearly examined (Fig. 4B, 4D); caudal horn absent, jaw absent, buccal mass conspicuously elongated (Fig. 4F); the pallial complex could not be examined due to the decay of the body.

Radula (Fig. 5). Long and narrow; central tooth small, pointed oval; the central and first lateral teeth are clearly separated; lateral teeth dagger-like, 19 in number on each side in each V-shaped row; the curved cusps of the lateral teeth point toward the centre and are connected by an extension to the basal plates that point away from the centre; first lateral tooth similar in shape to the other laterals, and it is conspicuously smaller than the second lateral tooth.

Genitalia (Fig. 3A–B). The right ommatophoral retractor runs between penis and vagina; penis long, slender, simple thin-walled tube, without any notable inner structure; penis surrounded by a thick, fibrous tunica; the end point of the penis is considered where the tunica narrows; epiphallus slightly shorter and slimmer than the penis (including the tunica), although tapers until proximal end; the short retractor muscle inserts on the epiphallus-vas deferens transition; vas deferens enters epiphallus subapically, slender, it is attached to the epiphallus almost along the complete length of the epiphallus; atrium relatively long, internally with fine longitudinal sculpture; vagina very short, it is attached to the body wall with a few fibres; inner wall of vagina finely reticulated; spermoviductus with swollen distal part with folded/reticulated inner surface; no embryos were found within the uterus; the distal end of the stalk of the bursa copulatrix forms a sheath which partly covers the vagina; the bursa copulatrix and the posterior part of the spermoviductus could not be investigated because the decayed condition of the examined specimen.

Differential diagnosis. *Zilchistrophia hilaryae* sp. n. differs from *Z. shiwiarorum* sp. n. by the larger size, weaker peristome, wider umbilicus, the rounded body whorl and the upper plica which consists of two joint plicae. Moreover, *Z. shiwiarorum* sp. n. has more regularly growing whorls, (the apertural part is wider in *Z. hilaryae* sp. n. from dorsal view). There are some differences in the anatomy between the two Ecua-

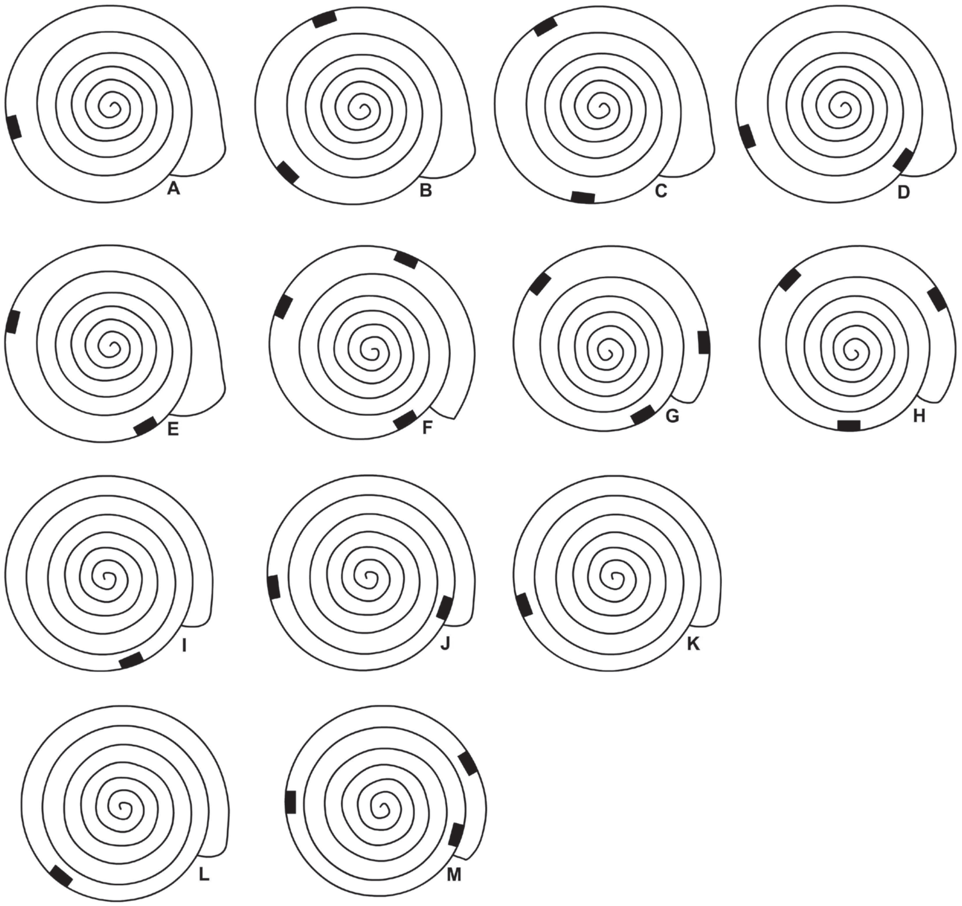

Figure 2. Schematic drawings showing the position of plicae sets in *Zilchistrophia hilaryae* sp. n. (**A–H**) and *Zilchistrophia shiwiarorum* sp. n. (**I–M**). Adult shells: **A–E, I–L**; juvenile shells: **F–H, M**. **A** NHMUK 20020375.1 (holotype) **B** NHMUK 20020370 **C** NHMUK 20020375, paratype1 **D** NHMUK 20020388 **E** NHMUK 20020374 **F** NHMUK 20020375, paratype2 **G** NHMUK 20020375, paratype3 **H** NHMUK 20020372 **I** NHMUK 20020381 **J** NHMUK 20020378 **K** NHMUK 20020382 (holotype) **L** NHMUK 20020380 **M** NHMUK 20020376.

dorian species, such as the length of the retractor muscle and the presence or absence of the hook of the proximal epiphallus, although more material is needed to see if these represent reciprocally stable characters.

All three Peruvian *Zilchistrophia* species have more whorls than the Ecuadorian ones, and the area just behind the peristome margin conspicuously inflated, whereas this part is not inflated in the two new Ecuadorian species. The umbilicus of all three Peruvian species is regularly funnel-shaped with the last quarter of whorl being more far from the preceding whorl from ventral view.

Addition to this difference, The Peruvian species are larger than *Z. hilaryae* sp. n. and have narrower umbilicus. Moreover, *Z. tridentata* has three short palatal plicae in equal distance between each other. See also remarks.

Etymology. *Zilchistrophia hilaryae* sp. n. is dedicated to Mrs. Hilary May (maiden name: Kingston), who collected the snails during the expedition to Ecuador.

Type locality. Ecuador, Pastaza Province, Chuintsa.

Distribution (Fig. 6). *Zilchistrophia hilaryae* sp. n. is known only from the vicinity of Chuintsa and Nuevo Corrientes, Pastaza Province, Ecuador.

Ecology. The snails were collected among the leaf litter in open areas on the floor of the rain forest.

Conservation status. Like in case of all other species inhabiting rain forest ecosystems, the main threats are deforestation and disturbance of the natural forests. The Shiwiar tribe has already called international attention, volunteering programs are focusing on them. We might assume that this would be positive in the conservation of the rain forest inhabited by the Shiwiar tribe.

Remarks. The plicae can be observed in case of fresh, translucent shells only. Although in some corroded shells a single set of plicae is visible behind the aperture, we have not depicted them on Fig. 2, because additional sets of plicae may be present deeper in the shell, which are invisible due to the non-transparent shell wall. Even in crystal clear shells there might be plicae other than in the last whorls, but these cannot be observed without breaking the shell. Regardless of the difficulties in observing the inner plicae, it seems that juvenile shells have three sets of plicae, approximately a third whorl distance between each other. We assume that the previous sets of plicae (or some of them) are dissolved during growth.

We examined the inner morphology of the plicae in a subadult shell by breaking a part of less than a quarter of whorl off (Fig. 1C). The upper plica (=plica closer to the upper suture) was "double", by having the upper and lower edges more elevated than its middle portion, and the lower plica (=plica closer to the lower suture) was "simple". The shell of the anatomically examined specimen had to be broken, which offered the possibility to examine the inner side of the palatal wall. The upper plica in fact consists of two plicae which are situated close to each other and are in contact (Fig. 1E). This results the strange concave shape of the upper plica from apertural view.

A part of the shell of the paratype of *Zilchistrophia tridentata* bearing two of the palatal plicae is deposited in the Senckenberg Museum (SMF 162900). On that shell fragment both of the plicae were simple.

***Zilchistrophia shiwiarorum* Páll-Gergely, sp. n.**

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Figs 1D, F, 2I–M, 3C–D, 4A, C, E

Type material. Ecuador, Pastaza Province, near Nuevo Corrientes, transect 5 (sample 141), leg. Hilary Kingston, 08.09.2000., NHMUK 20020382/1 holotype; Ecuador, Pastaza Province, near Nuevo Corrientes, transect 5 (sample 137), leg. Hilary Kingston, 08.09.2000., NHMUK 20020381/1 paratype; Ecuador, Pastaza Province, near Nuevo Corrientes, transect 5 (sample 101), leg. Hilary Kingston, 08.09.2000., NHMUK 20020378/1 paratype; Ecuador, Pastaza Province, near Nuevo Corrientes,

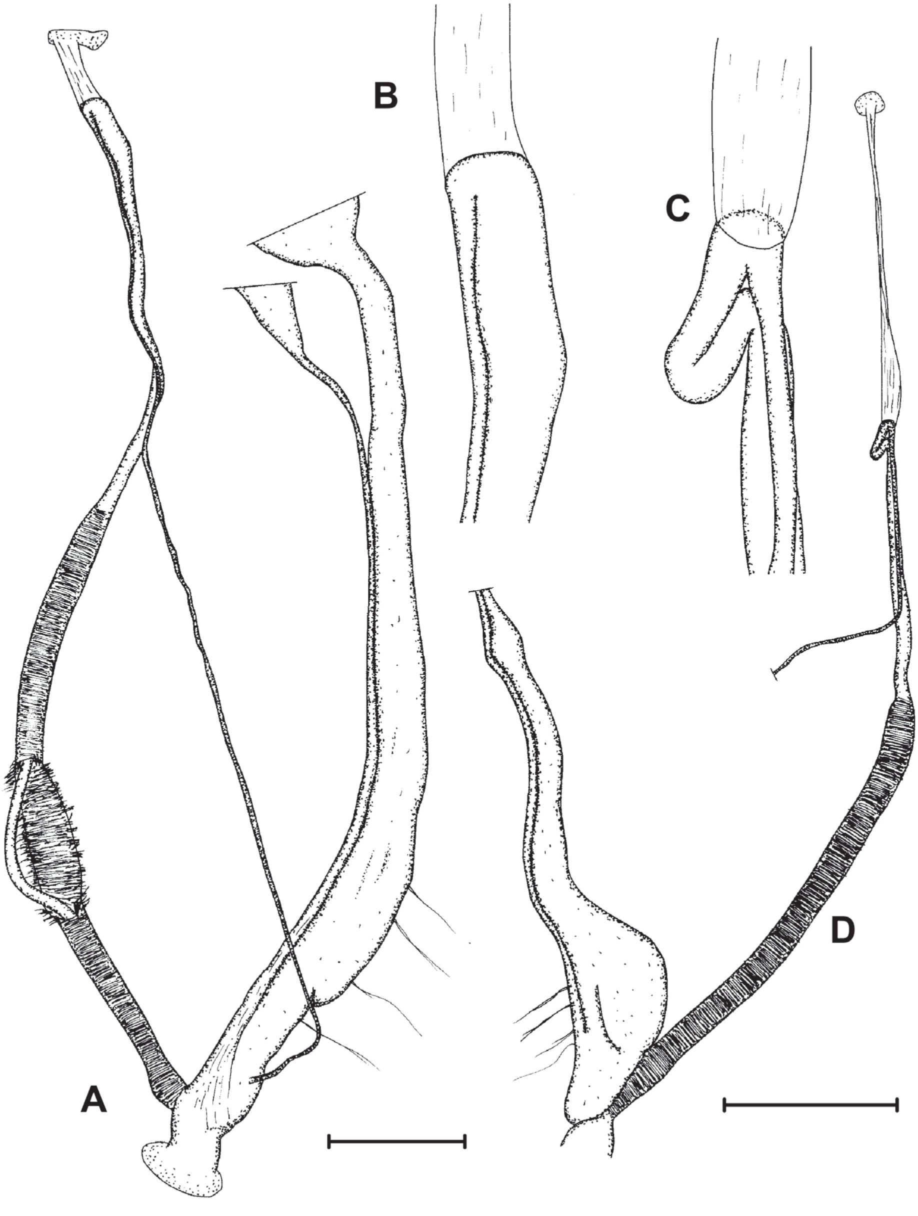

Figure 3. Genital anatomy of a paratype (NHMUK 20020422) of *Zilchistrophia hilaryae* sp. n. (**A–B**) (penis partly removed from its tunica), and a paratype (NHMUK 20020421) of *Z. shiwiarorum* sp. n. (**C–D**). **B** and **C** show the epiphallus-vas deferens transition enlarged. Scales represent 1 mm, and refer to **A** and **D**.

transect 5 (sample 128), leg. Hilary Kingston, 08.09.2000., NHMUK 20020380/1 paratype; Ecuador, Pastaza Province, near Nuevo Corrientes, transect 5 (sample 125), leg. Hilary Kingston, 08.09.2000., NHMUK 20020379/1 paratype; Ecuador,

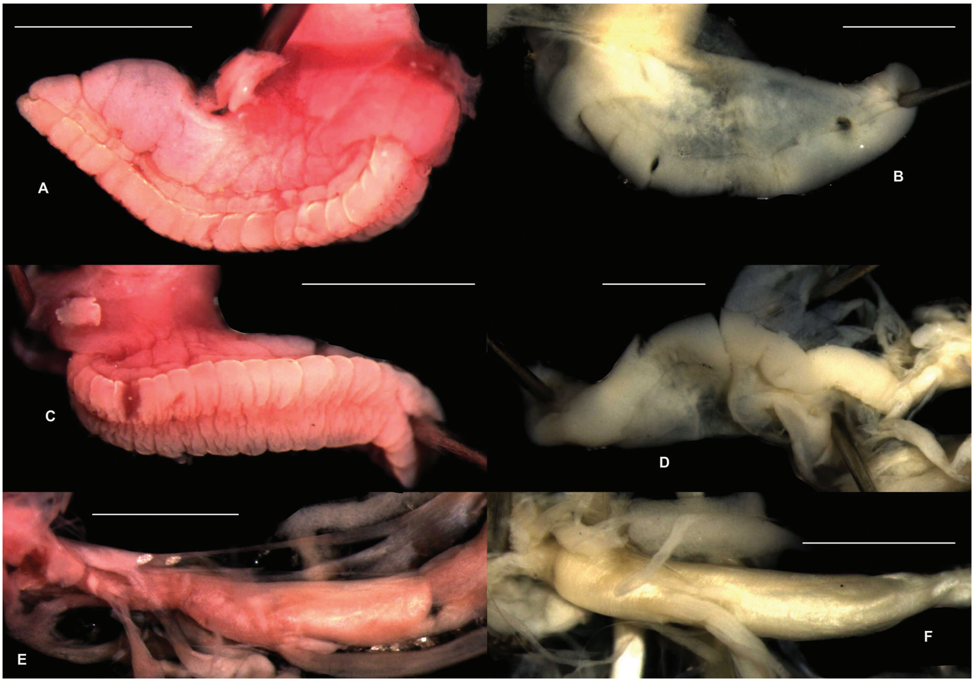

Figure 4. Lateral (**A–B**) and basal (**C–D**) side of the foot and buccal mass (**E–F**) of *Z. shiwiarorum* sp. n. **A, C, E** (paratype, NHMUK 20020421) and *Zilchistrophia hilaryae* sp. n. **B, D, F** (paratype, NHMUK 20020422). Scales represent 1 mm.

Pastaza Province, near Nuevo Corrientes, transect 5 (sample 143), leg. Hilary Kingston, 08.09.2000., NHMUK 20020383/1 paratype; Ecuador, Pastaza Province, valley south of Nuevo Corrientes, transect 3, 02°00.365'S, 076°45.933'W, 321 m asl. (sample 37), leg. Hilary Kingston, 01.09.2000., NHMUK 20020368/1 paratype; Ecuador, Pastaza Province, valley south of Nuevo Corrientes, transect 3, 02°00.365'S, 076°45.933'W, 321 m asl. (sample 39), leg. Hilary Kingston, 01.09.2000., NHMUK 20020377/1 paratype; Ecuador, Pastaza Province, Nuevo Corrientes (sample 90), leg. Hilary Kingston, 05.09.2000., NHMUK 20020376/1 paratype; Transect 3, forest floor near Nuevo Corrientes, Pastaza, Ecuador, sample 33, leg. Hilary Kingston, 01.09.2000., NHMUK 20020421 (dissected, ethanol-preserved animal).

Diagnosis. A small *Zilchistrophia* species with regularly growing whorls, angled body whorl, narrow umbilicus and two palatal plicae approximately half a whorl behind the aperture.

Description of the shell. Shell dextral, whitish, glossy and translucent, smooth, only irregular, very fine growth lines can be seen; shell shape discoid, with domed apical surface; whorls 6.5 (n=2), regularly growing, only the apertural part is slightly wider than the penultimate whorl; body whorl with blunt but conspicuous upper keel; whorls are separated by relatively deep suture; umbilicus narrow, regular funnel-shaped; aperture deformed crescent-shaped (because of the upper keel), with thickened peristome;

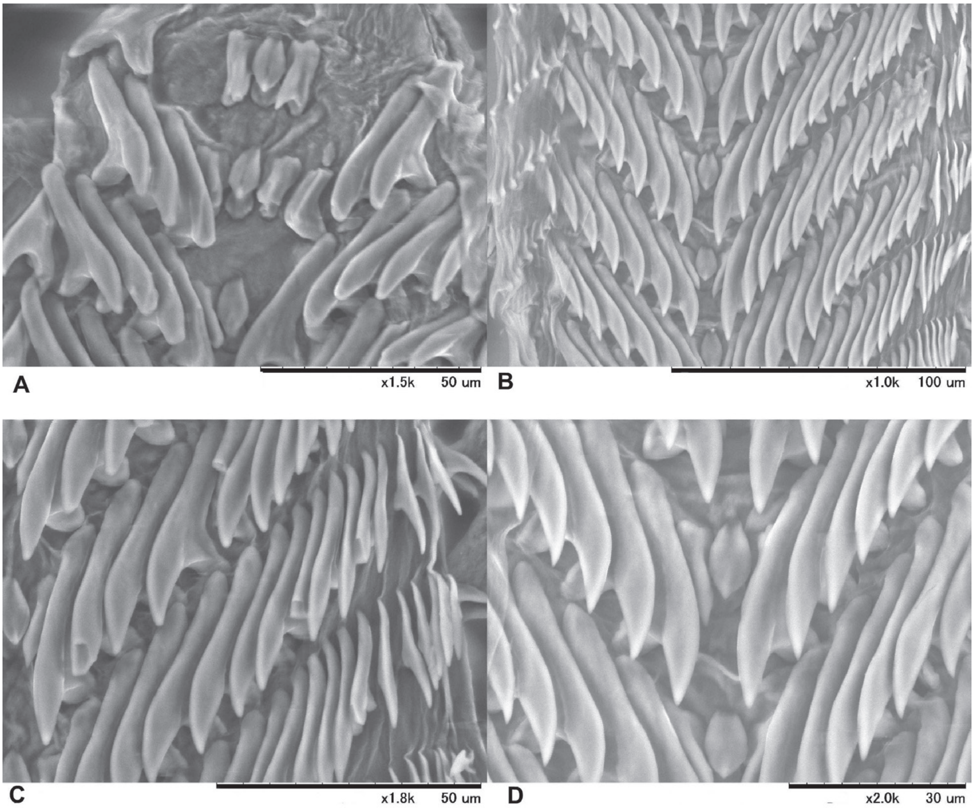

Figure 5. Radula of *Zilchistrophia hilaryae* sp. n. (NHMUK 20020422) **A** Central region at the terminal portion of the radula, **B** and **D** central region **C** lateral teeth.

parietal callus not conspicuous, present as slight, blunt thickening, its sculpture is extremely finely granulated, rather matt.

One, two or three sets of horizontal, short plicae are situated behind the aperture (Fig. 2I–M). Both plicae are simple, horizontal thickenings on the parietal wall (Fig. 1F). These plicae can be observed in the case of fresh, translucent shells only. A juvenile shell had three sets of plicae, whereas all adult shells had one or two sets of plicae only. In this species as well, we assume that the previous sets of plica are in most cases dissolved during growth. See also remarks under *Z. hilaryae* sp. n.

Measurements (in mm). D: 3.5–3.9, H: 2.2–2.5 (n=4).

Description of the anatomy. One specimen was anatomically examined (Transect 3, forest floor near Nuevo Corrientes, Pastaza, Ecuador, sample 33, leg. Hilary Kingston, 01.09.2000., NHMUK 20020421).

Body. The part of the body which filled the last whorl of the ethanol-preserved specimen had an intensive pink/orange colour, whereas the ethanol was slightly pinkish. The remaining parts of the animal were brown. It is unknown whether this was the original colour of the living specimen, or it is the result of a secondary chemical

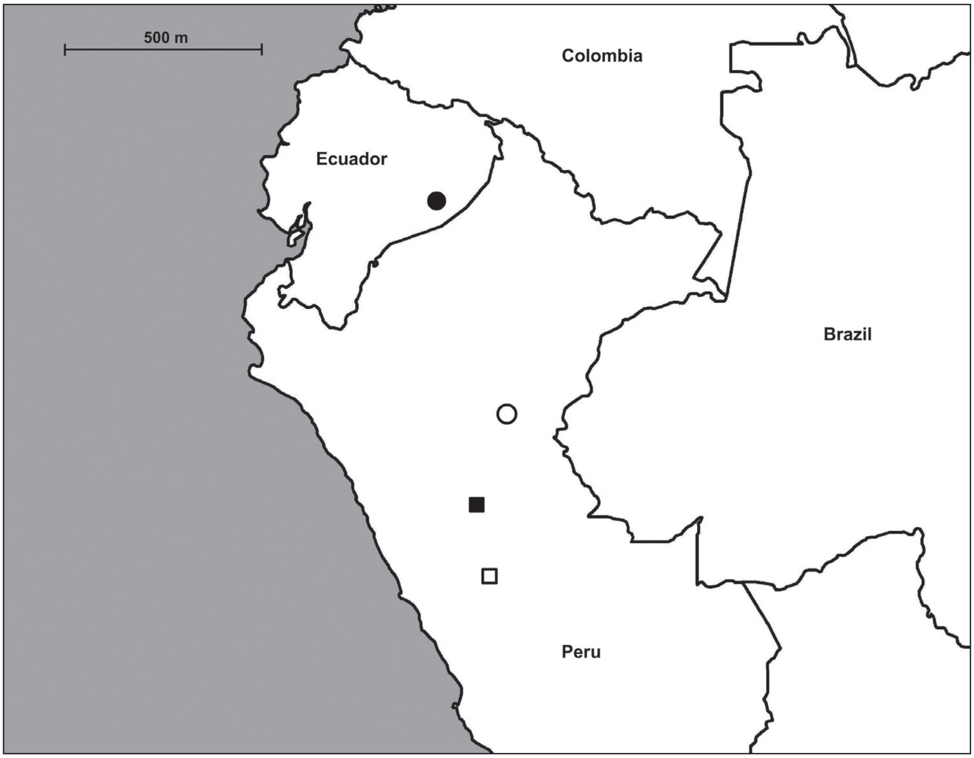

Figure 6. Distribution of *Zilchistrophia* Weyrauch, 1960 species. Filled circle: *Zilchistrophia hilaryae* sp. n. and *Zilchistrophia shiwiarorum* sp. n.; empty circle: *Zilchistrophia obvoluta* (Haas, 1949); filled square: *Zilchistrophia angigyra* (Haas, 1949); empty square: *Zilchistrophia tridentata* Weyrauch, 1960.

reaction. Foot clearly aulacopod (Fig. 4C); caudal horn absent, but there is a seemingly inflated thickening above the tail in the ethanol-preserved animal (probably glandula, see Fig. 4A); jaw absent; buccal mass conspicuously long (Fig. 4E); the pallial complex could not be examined due to the decay of the body.

Radula. Indistinguishable from that of *Z. hilaryae* sp. n.

Genitalia (Fig. 3C–D). The right ommatophoral retractor runs between penis and vagina; penis long, slender, simple thin-walled tube, without any notable inner structure; penis surrounded by a thick, fibrous tunica; the end point of the penis is considered where the tunica narrows; epiphallus is approximately half of the size of the penis, and it is more slender than the penis including the tunica; the proximal end of the epiphallus forms a loop before the insertion of the retractor muscle; the long retractor muscle is thickened distally, and inserts on the epiphallus-vas deferens transition; vas deferens slender, enters epiphallus subapically, it is attached to the epiphallus almost along the complete length of the epiphallus; vagina very short, it is attached to the body wall with a few fibres; the thickened part of the spermoviductus is in fact a cavity which joins the rest of the inner space through a narrowing; no embryos were found within the uterus; the bursa copulatrix and the posterior part of the spermoviductus could not be investigated because the decayed condition of the body.

Differential diagnosis. *Zilchistrophia shiwiarorum* sp. n. can be distinguished from the other four species by the small shell size and the angled body whorl. See also the differential diagnosis under *Z. hilaryae* sp. n.

Etymology. *Zilchistrophia shiwiarorum* sp. n. is named after the Shiwiar tribe, which inhabits the area where both new species live.

Type locality. Ecuador, Pastaza Province, near Nuevo Corrientes.

Distribution (Fig. 6). *Zilchistrophia shiwiarorum* sp. n. is known only from the vicinity of Nuevo Corrientes, Pastaza Province.

Ecology. Same as in *Z. hilaryae* sp. n.

Conservation status. See under *Z. hilaryae* sp. n.

Discussion

Systematic position of *Zilchistrophia*

Zilchistrophia is the member of the Scolodontidae based on the reduced jaw, the aulacopod foot, and the dagger-like lateral teeth with basal plates, which point away from the centre. The small central tooth, the first lateral tooth which is considerably smaller than the second, the lack of a caudal horn, and the position of the right ommatophoral retractor, which passes between penis and vagina, indicate that *Zilchistrophia* belongs to the subfamily Scolodontinae (=Systrophiini Thiele, 1920, see Tillier 1980 and Schileyko 2000). Other genera of Scolodontinae are the following: *Entodina* Ancey, 1887, *Drepanostomella* Bourguignat, 1889, *Guesteria* Crosse, 1872, *Happia* Bourguignat, 1889, *Hirtudiscus* Hylton Scott, 1973, *Systrophia* L. Pfeiffer, 1855, and *Systrophiella* Baker, 1925. In contrast, the other subfamily of Scolodontidae, Tamayoinae Tillier, 1980 (including the genera, *Happiella* Baker, 1925, *Prohappia* Thiele, 1927, *Tamayoa* Baker, 1925 and *Tamayops* Baker, 1928) is characterized by the presence of a caudal horn, their ommatophoral retractor passes outside the peni-oviducal angle, have a more developed central tooth, and the first lateral tooth is not larger than the second one. *Drepanostomella* and *Hirtudiscus* were placed in the Tamayoini and the Endodontidae Pilsbry, 1895 (Punctoidea), respectively (Tillier 1980, Hylton Scott 1973), but both were transferred to the Scolodontinae by Hausdorf (2003). *Guesteria* was moved to the Scolodontinae by the unpublished work of Ramírez (1993) (see also Cuezzo and Miranda 2009).

The genera *Hirtudiscus* Hylton Scott, 1973 and *Drepanostomella* probably form a distinct subgroup within Scolodontinae by their peculiar suture, an incision at the parietal angle of the aperture, the general shell shape, the morphology of the inner structure of the penis (papillae with corneous hooks) and the presence of hairs and other periostracal structures on the shell (Hausdorf 2003, Cuezzo and Miranda 2009). *Guesteria* Crosse, 1872 is probably also a relative of *Hirtudiscus* and *Drepanostomella*, although its anatomy is insufficiently known. These three genera are probably only distantly related to *Zilchistrophia*. Interestingly, the number of teeth (19) is the same in *Hirtudiscus* and *Drepanostomella* and *Zilchistrophia*, but the above mentioned anatomical differences suggest that this trait is probably a coincident.

The genital anatomy of *Zilchistrophia* is also similar to those of most of the genera of Scolodontinae sensu Tillier (1980) (with the exception of *Hirtudiscus*, *Drepanostomella* and *Guesteria*) by the simple penis with no notable inner structure and a thick outer tunica, the vas deferens which enters the epiphallus subterminally, the retractor muscle which attaches on the proximal end of the epiphallus and the short vagina.

The genital anatomy of *Happia* is not known, but Schileyko (2000) assumed close relationship between *Happia* and *Systrophiella* by classifying the latter as the subgenus of the former. *Zilchistrophia* differs from *Happia* sensu Schileyko (2000) by the absence of circular fascia at the proximal end of the penis, the presence of a penial tunica, the lack of a globular penial caecum near the distal end of the penis, the fewer lateral teeth and the relatively larger central tooth. The vas deferens of *Scolodonta* (see Hausdorf 2006) is not attached to the epiphallus (attached in *Zilchistrophia*), but is connected to the proximal end of the penial tunica (similarly to the circular fascia in *Systrophiella*). Moreover, *Scolodonta* has shorter and more muscle fibres attaching the vagina to the body wall, it has relatively shorter epiphallus, longer vagina and fewer teeth in the radula. The seemingly closest relative of *Zilchistrophia* in terms of genitalia is *Wayampia* Tillier, 1980 (originally described as the subgenus of *Systrophia*), which also lacks the penial caecum, and its vas deferens is attached to the epiphallus. On the other hand, *Wayampia* has more rows of teeth and possess a thin jaw, which was not found in the two *Zilchistrophia* species. The anatomy of *Entodina* is unknown, but it is similar to *Zilchistrophia* in possessing a shell with slightly thickened peristome; a trait which is possibly a synapomorphy of these two genera. *Entodina* differs from *Zilchistrophia* by the smaller number of lateral teeth, the flatter shell, the absence of the palatal denticles behind the aperture, and by the presence of palatal tubercle on the peristome.

Conchologically *Zilchistrophia* differs from all other members of Scolodontinae by the presence of two or three palatal plicae. The taxonomic relationship between the Peruvian and Ecuadorian *Zilchistrophia* is questionable without knowing the anatomy of Peruvian species. Peruvian species have an inflated last quarter of whorl, whereas this part is not conspicuously widened in Ecuadorian species.

Relationship with Plectopyloidea

Zilchistrophia species have a typical systrophiid appearance (translucent, glossy, sculptureless, flat shells with several slowly growing whorls and crescent-shaped, toothless aperture. The two or three short, horizontal plicae, which are situated approximately a third to half whorl behind the aperture is unusual in the family. *Zilchistrophia* was provisionally classified within the Corillidae because of the "striking" similarity between its palatal plicae with those of the genus *Plectopylis* (see Weyrauch 1960). Weyrauch probably referred to Corillidae in the understanding of Zilch (1959–1960), according to which, four genera belong to the Corillidae: the Chinese *Amphicoelina* Haas, 1933, the Sri Lankan and South Indian *Corilla* H. & A. Adams, 1885, the East Asian *Plectopylis* Benson, 1860 and the African *Sculptaria* L. Pfeiffer, 1855. In the classification of Bouchet et al. (2005), Corillidae, Plectopylidae and Sculptariidae form the superfamily Plectopyloidea, whereas in Schileyko's (2000) classification, which is followed here, Sculptariidae is placed in the superfamily Acavoidea Pilsbry, 1894, and Corillidae and Plectopylidae form the superfamily Plectopyloidea. Although the anatomy of *Amphicoelina* is unknown, it rather belongs to Camaenidae, not to Plectopyloidea (see Páll-Gergely and Asami 2014). Corillidae is a monotypic family, whereas Plectopylidae includes seven genera, such as *Chersaecia* Gude, 1899, *Endoplon* Gude, 1899, *Endothyrella* Gude, 1899, *Gudeodiscus* Páll-Gergely, 2013, *Sicradiscus* Páll-Gergely, 2013, *Sinicola* Gude, 1899 and *Plectopylis* Benson, 1860 (Schileyko 1999, Páll-Gergely and Hunyadi 2013). Both Corillidae and Plectopylidae possess palatal plicae which are situated at most a half whorl behind the peristome. These palatal plicae rarely visible from the aperture, but they never reach the peristome. *Corilla* primarily have four or five long, horizontal or oblique palatal plicae, which are reduced to one or zero in two species. Plectopylidae primarily possess six short horizontal palatal plicae (5 or 7 in few species), which are modified in many species (united to each other or divided in the middle, the middle plicae are often oblique, see Gude 1914 and Páll-Gergely and Hunyadi 2013, and references therein). Some *Sicradiscus*, *Sinicola* and *Gudeodiscus* species (e.g. *Gudeodiscus multispira* [Möllendorff, 1883]) certainly show strong resemblance to *Zilchistrophia* species in terms of the shell size, glossy surface and toothless aperture. The main conchological difference between *Zilchistrophia* and those Asian families is that in the Corillidae there are horizontal plicae, and in the Plectopylidae there are horizontal plicae as well as vertical lamellae on the parietal side. Parietal plicae or lamellae are entirely missing in *Zilchistrophia*. Moreover, most plectopylid genera have finely ribbed embryonic whorls, which are sculptureless in *Zilchistrophia*.

The overall genital structure of *Zilchistrophia* and Plectopylidae may look similar because both groups have "simple" reproductive organs lacking dart sacs, glandulae, etc. The main differences are the following: Plectopylidae lack the penial tunica which is well-developed in *Zilchistrophia*; the inner wall of the penis of Plectopylidae is complicated, usually with longitudinal or reticulated, often with calcareous granules, whereas in *Zilchistrophia* there is no penial sculpture visible; in *Zilchistrophia* the retractor muscle inserts on the epiphallus-vas deferens transition, but in Plectopylidae it inserts on the penial caecum, or if the caecum is missing, than on the penis-epiphallus transition; the vagina of *Zilchistrophia* is very short, but relatively long in Plectopylidae, usually with a "vaginal bulb" in the middle; most Plectopylidae have a diverticulum which originates from the wall of the pedunculus, but *Zilchistrophia* probably lacks a diverticulum, or at least it does not originate from the wall of the pedunculus (see Stoliczka 1871, Schileyko 1999, Páll-Gergely and Hunyadi 2013 and references therein).

The genitalia of Corillidae mainly differs from that of *Zilchistrophia* in the following: penial tunica missing (well-developed in *Zilchistrophia*); retractor muscle inserts on the middle of the epiphallus (on the epiphallus-vas deferens transition in *Zilchistrophia*), and penial papilla well-developed (not found in *Zilchistrophia*).

In the molecular phylogeny published by Ramírez et al. (2012) Systrophiidae represent the "third stylommatophoran clade" next to the "achatinoid" and "non-achatinoid" clades defined by Wade et al. (2006). Their results also confirm that the morphological similarities between *Zilchistrophia* and *Corilla* (member of the "non-achatinoid-clade"), especially the presence of palatal plicae can be explained by parallel evolution. Plectopylidae were not used in the molecular phylogeny of these studies, but its position is expected to be similar to that of the genus *Corilla*.

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References

Baker HB (1925) Agnathomorphous Aulacolopoda. The Nautilus 38(3): 86–89. http://www.biodiversitylibrary.org/item/34893#page/100/mode/1up

Bouchet P, Rocroi J-P, Frýda J, Hausdorf B, Ponder W, Valdés Á, Warén A (2005) Classification and nomenclator of gastropod families. Malacologia: International Journal of Malacology 47(1–2): 1–397.

Cuezzo MG, Miranda MJ (2009) Systematic position and anatomy of *Drepanostomella tucma* Hylton Scott, 1948 (Stylommatophora: Scolodontidae). Journal of Conchology 39(6): 683–691. http://www.conchsoc.org/resources/show-abstract-39.php%3Fid%3D%20161

Döring A (1875) Apuntes sobre la Fauna de Moluscos de la República Argentina (segunda parte). Boletin de la Academia Nacional de Ciencias Exactas Univ. Córdova 1: 432–460.

Gude GK (1914) The Fauna of British India including Ceylon and Burma. Mollusca.–II. (Trochomorphidae–Janellidae). Taylor and Francis, London, 520 pp. http://www.biodiversitylibrary.org/item/46617#page/5/mode/1up

Haas F (1949) Land and fresh-water Mollusks from Peru. Fieldiana Zoology 31(28): 235–250. http://www.biodiversitylibrary.org/item/21459#page/7/mode/1up

Hausdorf B (2003) Systematic position and taxonomy of the genus *Hirtudiscus* from Colombia (Gastropoda: Scolodontidae). Journal of Molluscan Studies 69: 179–186. doi: 10.1093/mollus/69.3.179, http://mollus.oxfordjournals.org/content/69/3/179.full.pdf+html

Hausdorf B (2006) The Systematic Position of *Scolodonta* Döring, 1875 and Scolodontidae H. B. Baker, 1925 (Gastropoda: Pulmonata). Zoologischer Anzeiger 245(3/4): 161–165. doi: 10.1016/j.jcz.2006.05.007, http://www.sciencedirect.com/science/article/pii/S004452310600043X

Hylton Scott MI (1973) Endodontidos neotropicales V (Gastropoda Pulmonata). Neotropica, 19: 126–131.

Páll-Gergely B, Asami T (2014) Additional information on the distribution, anatomy and systematics of living and fossil Chinese Plectopylidae (Gastropoda: Pulmonata). Genus 25(3): 527–564.

Páll-Gergely B, Hunyadi A (2013) The family Plectopylidae Möllendorff 1898 in China (Gastropoda, Pulmonata). Archiv für Molluskenkunde 142(1): 1–66. http://www.ingentaconnect.com/content/schweiz/afmijm/2013/00000142/00000001/art00001

Ramírez R (1993) A generic analysis of of the family Systrophiidae (Mollusca: Gastropoda): Taxonomy, Phylogeny and Biogeography. Magister Thesis. University of Texas, Austin, United States.

Ramírez R, Borda V, Romero P, Ramirez J, Congrains C, Chirinos J, Ramírez P, Velásquez LE, Mejía K (2012) Biodiversity and endemism of the western Amazonia land snails Megalobulimus and Systrophia. Revista Peruana de Biología 19(1): 59–74. [in Spanish] http://www.scielo.org.pe/scielo.php?pid=S1727-99332012000100008&script=sci_arttext

Richardson L (1986) Polygyracea: Catalog of species (Parts 1, Polygyridae; 2, Corillidae; 3, Sagdidae). Tryonia Miscellaneous Publications of the Department of Malacology of the Academy of Natural Sciences of Philadelphia 13: 1–139.

Schileyko AA (1999) Treatise on Recent Terrestrial Pulmonate Molluscs, Part 4. Draparnaudiidae, Caryodidae, Macrocyclidae, Acavidae, Clavatoridae, Dorcasiidae, Sculptariidae, Corillidae, Plectopylidae, Megalobulimulidae, Strophocheilidae, Cerionidae, Achatinidae, Subulinidae, Glessulidae, Micractaeonidae, Ferrussaciidae. Ruthenica, Supplement 2: 435–564.

Schileyko AA (2000) Treatise on recent terrestrial pulmonate molluscs: Rhytididae, Chlamydephoridae, Systrophiidae, Haplotrematidae, Streptaxidae, Spiraxidae, Oleacinidae, Testacellidae. Ruthenica, Suppl. 2, Part 6: 731–880.

Stoliczka F (1871) Notes on Terrestrial Mollusca from the Neighbourhood of Moulmein (Tenasserim provinces), with Description of New Species. Journal of the Asiatic Society of Bengal 40(2): 217–223.

Thiele J (1926) Mollusca = Weichtiere. In: Kükenthal W, Krumbach T (Eds) Handbuch der Zoologie, Vol. 5. Walter de Gruyter, Berlin and Leipzig, 177–256.

Tillier S (1980) Gastéropodes terrestres et fluviatiles de Guyane Française. Mémoires du Muséum national d'Histoire naturelle, Série A, Zoologie 118: 3–189.

Wade CM, Mordan PB, Naggs F (2006) Evolutionary relationships among the Pulmonate land snails and slugs (Pulmonata, Stylommatophora). Biological Journal of the Linnean Society

87: 593–610. doi: 10.1111/j.1095-8312.2006.00596.x, http://onlinelibrary.wiley.com/doi/10.1111/j.1095-8312.2006.00596.x/full

Weyrauch WK (1960) Zwanzig neue Landschnecken aus Peru. Archiv für Molluskenkunde 89(1/3): 23–48.

Yen T-C (1939) Die Chinesischen Land-und Süßwasser-Gastropoden des Natur-Museums Senckenberg. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft, Frankfurt am Main, 234 pp.

Zilch A (1959–1960) Handbuch der Paleozoologie, 6(2) Euthyneura. Gebrüder Borntraeger, Berlin, 481–834.

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RESEARCH ARTICLE

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The planthopper genus *Spartidelphax*, a new segregate of Nearctic *Delphacodes* (Hemiptera, Delphacidae)

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Abstract

The new genus *Spartidelphax* is described to house three species removed from the polyphyletic genus *Delphacodes*. The members of *Spartidelphax* are coastal species native to eastern North America, and probably feed exclusively on cordgrass (Poaceae, *Spartina* Schreb.). The taxonomy and nomenclature of the included species (viz. *S. detectus*, *S. luteivittus*, and *S. penedetectus*) are reviewed. *Spartidelphax luteivittus* is a *nomen dubium*, whose type material is inadequate to provide diagnostic features contrasting with *S. detectus* and *S. penedetectus*. Diagnoses and a key are provided for the remaining *Spartidelphax*.

Keywords

New genus, Delphacidae, planthopper, Fulgoroidea, Auchenorrhyncha, Hemiptera, Poaceae, *Spartina*, *Delphacodes*

Introduction

Delphacodes Fieber, 1866, is a polyphyletic genus (e.g., Urban et al. 2010) with approximately 158 nominative species worldwide at this time (Bourgoin 2014, Bartlett 2014). *Delphacodes sensu stricto* is composed of 10 species from the western Palearctic

(Asche and Remane 1983). The three North American "*Delphacodes*" species, *D. luteivitta* (Walker), *D. detecta* (Van Duzee) and *D. penedetecta* Beamer, are morphologically similar (e.g., Beamer 1950), and the latter two have been phylogenetically placed within the advanced Delphacini as basal to the clade of *Prokelisia* + *Neomegamelanus* + *Tumidagena* (collectively called the *Spartina*-clade) by Urban et al. (2010). This clade is predominately coastal and cordgrass-feeding (*Spartina* Schreb., Poaceae). The coastal marsh planthopper fauna has been extensively studied in a variety of ecological-evolutionary contexts (e.g., Davis and Gray 1966, Denno 1976, 1977, 1978, 1980, Raupp and Denno 1979, Denno et al. 1980, Rey 1981, Olmstead et al. 1997, Ferrenberg and Denno 2003). *Delphacodes detecta* has been reported along the Atlantic coast from Canada to Florida and the Gulf coast to Texas plus the Caribbean (Beamer 1950, Bartlett et al. 2014), where it can be abundant. Denno (1978) reported 23,868 collected over a year from *Spartina patens* (Aiton) Muhl. in New Jersey. *Delphacodes penedetecta* has been reported from the Gulf Coast (AL, FL, LA, MS, TX) and New Jersey. This species probably occurs along much of the east coast, but is evidently uncommon because of competition with the abundant *Prokelisia dolus* Wilson, 1982 on *Spartina alterniflora* Loisel. (Ferrenberg and Denno 2003).

Although the species described as *Delphax luteivitta* Walker, 1851, appears to be related to *D. detecta* and *D. penedetecta* its identity cannot be reliably ascertained due to the poor condition of its type (see below). It was described from a single male specimen from 'United States' ("presented by E. Doubleday") as being straw-colored, with a produced head and dark front bordered by pale straw (Walker 1851: 354). It was subsequently transferred to *Dicranotropis* (with uncertainty) by Van Duzee (1916). Metcalf (1923: 148) excluded it from his treatment of eastern planthoppers because "the male genitalia have not been described". Subsequently, Muir and Giffard (1924: 12) provided a brief description of the genitalia and transferred it to *Stenocranus*. Beamer (1946: 1) placed the species into *incertae sedis*, commenting "…judging from descriptions and drawings of the type in the British Museum by W. E. China, [it] does not belong in *Stenocranus*." Bartlett (2010: 472) reported that the type specimen labels consist only of "the registration number on a circular white label clockwise from left "5 41 17 229.1", indicating entry 229 of the 17th May 1841", and that the Doubleday specimens were from St. Johns Bluff, Florida (Duval County, near Jacksonville; based on communications from M. Webb, British Museum Natural History, and K.G.A. Hamilton, Canadian National Museum). Bartlett (2010: 473) transferred *luteivitta* to *Delphacodes*, and suggested that it may be conspecific with a subsequently described species of that genus, although "further investigation will be needed to firmly establish the synonymy and explore nomenclatural implications".

Here we investigate the taxonomy and nomenclature of *Delphacodes detecta*, *D. penedetecta* and *D. luteivitta*. Each species is photographed and illustrated, and a diagnosis and key are provided. A new genus is described to partition them from the western Palearctic *Delphacodes sensu stricto*.

Materials and methods

Specimens were examined from the following collections:

AMNH	American Museum of Natural History, New York, NY.
BMNH	The Natural History Museum, London, U.K.
DENH	University of New Hampshire, Department of Entomology, Durham, NH.
ISUI	Iowa State University Insect Collection, Department of Entomology, Ames, IA.
LSUC	Louisiana State University Arthropod Museum, Baton Rouge, LA.
NCSU	North Carolina State University, Department of Entomology, Raleigh, NC.
SEMC	University of Kansas Biodiversity Institute, Snow Entomological Museum Collection, Lawrence, KS.
UDCC	University of Delaware Insect Research Collection, Newark, DE.
URIC	University of Rhode Island Insect Collection, Department of Plant Sciences and Entomology, Kingston, RI.
USNM	National Museum of Natural History (United States National Museum), Washington D.C.

Diagnoses are provided for each species emphasizing putatively distinguishing features (full descriptions of *detecta* and *penedetecta* were provided by Beamer 1950). For the diagnoses, topotypic paratype males of *D. penedetecta* (Cedar Keys, FL) were dissected and illustrated and compared to available specimens of *D. detecta*. The male lectotype (designated by Oman 1947: 211) of *D. detecta* could not be located for this study, although the female paralectotype was found (Figure 5; at ISUI) and included. *Delphacodes luteivitta* (Walker) is recorded only from the holotype in the British Museum (Natural History). For primary types, labels were quoted verbatim using "/" to indicate a line break and "//" to indicate a new label and with supplemental information given in brackets. For other material examined, label data are arranged into a consistent sequence, beginning with country, state or province, specific locality, collection date, and collector, with number, gender (as 'm' for males, 'f' females) and specimen depository given in parentheses. Specimens examined were provided 2D barcode labels and data were captured for online presentation (visualized at discoverlife.org and iDigBio.org) using "Arthropod Easy Data Capture" (Schuh et al. 2010, Schuh 2012, Arthropod Easy Capture 2013).

Photographs and measurements of *D. detecta* and *D. penedetecta* were taken using a digital imagery system consisting of a Nikon SMZ1500 microscope, Nikon Digital Sight DS-U1 camera and NIS Elements Imaging software (version 3.0). Line art was digitally traced from photographs. All measurements are in millimeters (mm).

The holotype of *Delphax luteivitta* (as the BMNH) was examined and photographed (by MDW) to assess features of this specimen in comparison to *Delphacodes detecta* and *D. penedetecta*. Photographs were taken using a Leica M125 Stereomicroscope, Canon Digital EOS 550D camera with EOS Utility and Helicon Focus software.

Morphological terminology follows Asche (1985, 1990) and subsequent authors (e.g., Bartlett and Deitz 2000, Gonzon and Bartlett 2008, Bartlett and Hamilton 2011, Bartlett et al. 2014). Plant names are from USDA PLANTS database (USDA, NRCS 2014).

Results

Systematics

Spartidelphax gen. n.

http://zoobank.org/FC460372-49D0-41E7-A9B1-449274706188

Type species. *Delphacodes penedetecta* Beamer, 1950.

Diagnosis. Body robust, stramineous with dark markings on intracarinal region of face (anterior to the Y-shaped carina of vertex), including areolet, genae, and usually also lateral portions of abdominal terga. Body not compressed (unlike *Prokelisia*). Head, including compound eyes, slightly larger than pronotum, vertex in dorsal view weakly projecting between eyes. Carinae of head strong and conspicuous, except median carina of vertex; median carina of frons forked on fastigium near dorsal margin of compound eye. Frons with lateral margins subparallel, narrowed between eyes. Lateral carinae of pronotum diverging, not reaching posterior margin; median carina reaching hind margin at shallow notch. Lateral carinae of mesonotum diverging, reaching posterior margin, median carina becoming obsolete in scutellum. Forewings of brachypter clear, subtruncate, leaving several tergites exposed. Apex of hind tibiae bearing 7 (3+4) spines, with 5 (2+3) on basitarsus and 4 on second tarsomere. Calcar with 18–31 teeth ($\bar{x}$ = 24.0, n=26).

Male terminalia with pygofer rather quadrate in lateral view, dorsocaudal margin of pygofer weakly projecting. Opening of pygofer broad, wider than long, with lateral margins of opening carinae, ventral margin smoothly rounded. Diaphragm strong and conspicuous, dorsal margin broadly U-shaped, bearing median, bilobed armature subtending the aedeagus, much wider than tall. Parameres exerted through broad opening in diaphragm; parameres strongly flattened, sides subparallel, strongly diverging, basal and apical angles weakly developed. Aedeagus widest in basal third, then abruptly narrowed with distal 2/3 strongly downcurved; suspensorium U-shaped, weakly apparent. Segment 10 broad, bearing strongly developed pair of weakly sinuate processes on caudal margins near lateral margins. Segment 11 about 2/3 height of segment 10.

Macropters darker than brachypters, with abdomen and lateral portion of mesonotum more strongly embrowned. Macropterous wings are clear (no dark marking at apex of clavus), exceeding length of abdomen nearly by length of abdomen.

Remarks. *Spartidelphax penedetectus* was chosen as the type species since the holotype of *Delphax luteivitta* is in unsatisfactory condition and the lectotype of *Liburnia detecta* could not be located (although putatively at the USNM). The holotype of *Delphacodes penedetecta* Beamer, 1950, is at SEMC.

Spartidelphax is phylogenetically placed at the base of a strongly supported clade with the genera *Prokelisia* Osborn, *Neomegamelanus* McDermott, and *Tumidagena* McDermott based on the phylogenetic investigation of Delphacidae using DNA nucleotide sequence data from four genetic loci (18S rDNA, 28S rDNA, wingless and cytochrome oxidase I) and 132 coded morphological characters by Urban et al. (2010). These three genera and *Spartidelphax* are associated with *Spartina* Schreb. (Poaceae, cordgrass), and are abundant in salt marshes in eastern North America. *Prokelisia*, *Neomegamelanus*, and *Tumidagena* are more slender forms with their body weakly to strongly compressed, and their vertex more strongly projecting. Members of *Prokelisia* are most similar, including having the carinae on their frons bordered by dark (except *P. crocea*), but they are more slender, usually with the frons broadest ventrally, parameres either distally converging or slender and diverging, and the aedeagus is usually upturned. Superficially more similar to *Spartidelphax* are species now placed in *Muirodelphax* Wagner, but North American species in this genus lack processes on segment 10. Also similar are *Toya* Distant, *Metadelphax* Wagner, and *Syndelphax* Fennah, but the dorsocaudal angles of the male pygofer of these genera are greatly expanded (Gonzon and Bartlett 2008).

In the "Key to genera of Delphacidae North of Mexico" of Bartlett et al. (2014), *Spartidelphax* keys to couplet 75, where *Spartidelphax* can be inserted in place of the entry for *Delphacodes detecta* and *D. penedetecta*.

Etymology. The generic name is an arbitrary combination of letters formed by combining a truncation of *Spartina* (the host grass genus) with *-delphax*, a common termination used in delphacids. The name is to be treated as masculine (*Delphax* was affirmed as masculine by ICZN 1961).

Key to species of *Spartidelphax* (males)

1 Aedeagus with ventral teeth or fine serrulations (Fig. 4D); vertex nearly 1.5× longer than wide; body length (brachypterous male) 2.18–2.57 mm .... ***Spartidelphax penedetectus***

– Aedeagus with long rows of lateral teeth extending beyond distal third of aedeagus (Fig. 4B); vertex usually 1.3× longer than wide; body length (brachypterous male) 1.89–2.43 mm .... ***Spartidelphax detectus***

Spartidelphax penedetectus (Beamer, 1950), comb. n.

Figures 1B, D; 2B, D; 3B, D; 4C, D

= *Delphacodes penedetecta* Beamer, 1950: 70.

Type locality. Florida, Levy County, Cedar Keys.

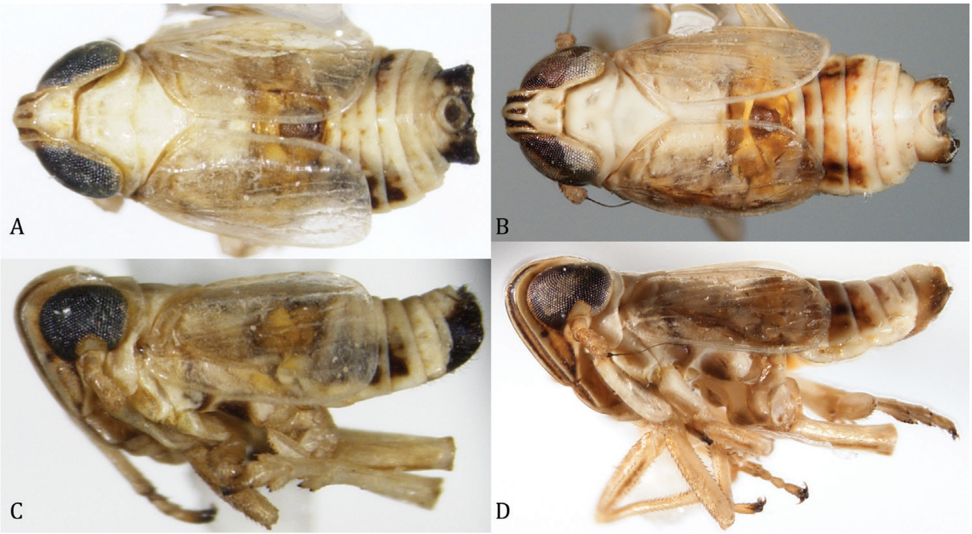

Figure 1. Dorsal and lateral views of *Spartidelphax detectus* (New Castle Co., DE) and *S. penedetectus* (Franklin Co., FL). **A** Dorsal view of *S. detectus* **B** same *S. penedetectus*; **C** lateral view of *S. detectus* **D** same, *S. penedetectus*.

Diagnosis. Slightly larger than *S. detectus*, with vertex longer than wide (l:w 1.34–1.48), aedeagus with a pair of rows of fine ventral serrulations in distal third; base less abruptly narrowed than in *S. detectus*. Parameres in widest view subtly more narrowed on outer angle than *S. detectus*, outer angle slightly curled.

Dimensions. Male brachypter: body length 2.33 mm (2.18–2.57, n=6), vertex l:w (1.48, n=9); male macropter: body Length 3.79 (including wings, 3.62–3.96, n=6), vertex l:w (1.44, n=6). Female brachypter: body length 3.06 (2.87–3.27, n=6), vertex l:w (1.34, n=6); female macropter: body length 4.07 mm (3.62–4.45, n=4), vertex l:w (1.39, n=5). Count of calcar teeth 25 (21–31, n=10).

Reported hosts. *Spartina alterniflora* Loisel. (smooth cordgrass) (Wilson et al. 1994, Ferrenberg and Denno 2003).

Distribution. USA: FL, LA, NC, TX; also reported AL, MS, NJ (Ferrenberg and Denno 2003, Bartlett et al. 2014).

Type material examined. Paratypes: "Cedar Keys. Fla. / 3-8-1947 / R. H. Beamer // ♂[yellow paper] // Paratype / Delphacodes / penedetecta / R. H. Beamer" (2m, SEMC).

Other material examined. USA: Florida: *Franklin Co.:* Ochlockonee Bridge, Highway 98 near Panacea, 29.96884°N, 84.38366°W, 27 Jul 2000, C. R. Bartlett (10m, 6f; UDCC). **Louisiana: *Cameron Par.:*** Cameron Parish, 03 Apr 1974, no collector provided (1m, 1f; LSUC); 15 Apr 1974, no collector provided (2m; LSUC); Holly Beach, 27 May 1983, E. G. Riley (3f; LSUC); same, 20 Apr 1984, D. A. Rider (1m; LSUC). **North Carolina: *Carteret Co.:*** near Atlantic, drum inlet, 19 Aug 1975, N. Newton (1m; UDCC).

Spartidelphax detectus (Van Duzee, 1897), comb. n.

Figures 1A, C; 2A, C; 3A, C; 4A, B, 5

= *Liburnia detecta* Van Duzee, 1897: 248.
= *Liburnia circumcincta* Van Duzee, 1909: 203-204.
= *Megamelus vanduzeei* Crawford, 1914: 607, 622.
= *Megamelus circumcinctus* (Van Duzee, 1909); comb. by Crawford 1914: 629.
= *Liburnia vanduzeei* (Crawford, 1914); comb. by Van Duzee 1916: 84.
= *Liburnia circumcincta* Van Duzee, 1909; syn. by Van Duzee 1917: 777.
= *Delphacodes detecta* (Van Duzee, 1897); comb. by Muir and Giffard 1924: 26.
= *Megamelus vanduzeei* Crawford, 1914; syn. by Muir and Giffard 1924: 26.
= *Delphacodes vanduzeei* (Crawford, 1914); comb. by Osborn 1938: 338; Moore 1950a: 257; 1950b: 32.

Type locality. New York City, NY.

Diagnosis. Slightly smaller than *S. penedetectus*, with wider vertex (l:w ratio averaging between 1.25–1.31). Aedeagus with 2–3 rows of lateral teeth in distal third on both sides of aedeagus; base of aedeagus abruptly narrowed at about 2/3 length; distal portion of base with fine flange on right side. Parameres in widest view more rounded on outer angle than *S. penedetectus*.

Dimensions. Male brachypter: body length 2.28 mm (1.89–2.43, n=4), vertex l:w ratio (1.25, n=3), male macropter: body length 3.29 mm (including wings, 2.88–3.67, n=5), vertex l:w ratio (1.33, n=5). Female brachypter: body length 2.89 mm (2.58–3.12, n=4), vertex l:w ratio (1.25, n=3); female macropter: body length 3.61 mm (3.29–4.24, n=5 [paralectotype = 4.24 mm]), vertex l:w (1.31, n=5). Number of calcar teeth 22 (18-24, n=10).

Reported hosts. *Spartina patens* (Aiton) Muhl. (Poaceae, saltmeadow cordgrass), *Spartina alterniflora* Loisel. (smooth cordgrass) (Denno 1977, 1978), with *S. alterniflora* "…an inferior host plant for development" (Denno 1977: 366). *Distichlis spicata* (L.) Greene (saltgrass, Poaceae) was reported on specimen labels.

Distribution. USA: CT, DE, FL, GA, LA, MA, MD, ME, MS, NC, NJ, NY, RI, SC, TX, VA, VT; CAN: NS, PE, QC; Anguilla, Bahamas (Exuma, Berry, Eleuthera); Bermuda, British Virgin Islands (Guana, St. Thomas), Jamaica, Mexico, Puerto Rico (inc. Vieques Is.), Turks & Caicos (Bartlett et al. 2014).

Remarks. *Liburnia detecta* Van Duzee, 1897, was described from 2 specimens (1 male, 1 female) from New York City (Van Duzee 1897). The male was designated lectotype by Oman (1947), and at the time both specimens were located in the collection at Iowa State (ISUC). Primary types were subsequently transferred to the National Museum of Natural History (USNM). The lectotype could not be located at either ISUI or USNM, but the female paralectotype was at ISUI.

Beamer (1950: 70) described *S. penedetectus* as having "...crown about one-third longer than basal width instead of as wide as long and distinctly narrowed toward apex.

Figure 2. Heads of *Spartidelphax detectus* (New Castle Co., DE) and *S. penedetectus* (Franklin Co., FL). **A** Frontal view of *S. detectus* **B** same *S. penedetectus* **C** dorsal view of head and anterior thorax of *S. detectus* **D** same, *S. penedetectus*.

Length ♂2.5 mm, ♀3 mm" (for brachypters). Beamer (1950) redescribed *S. detectus* did not report body lengths except by quoting Van Duzee (1897: 248), who specified male 3½ mm, female 4 mm for the macropterous syntypes (yielding a length comparison between brachypterous *penedetectus* and macropterous *detectus*). Here we clarify that *penedetectus* is the larger species (*detectus* brachypterous males 2.28 mm, macropterous males 3.29 mm, vs. *penedetectus* brachypterous males 2.33 mm, macropterous males 3.78), although body length does broadly overlap between species. The vertex l:w ratio is approximately 1.25–1.31 for *detectus* and 1.34–1.48 for *penedetectus*. For *penedetectus* Beamer (1950) also noted that crown is narrowed toward the apex. This

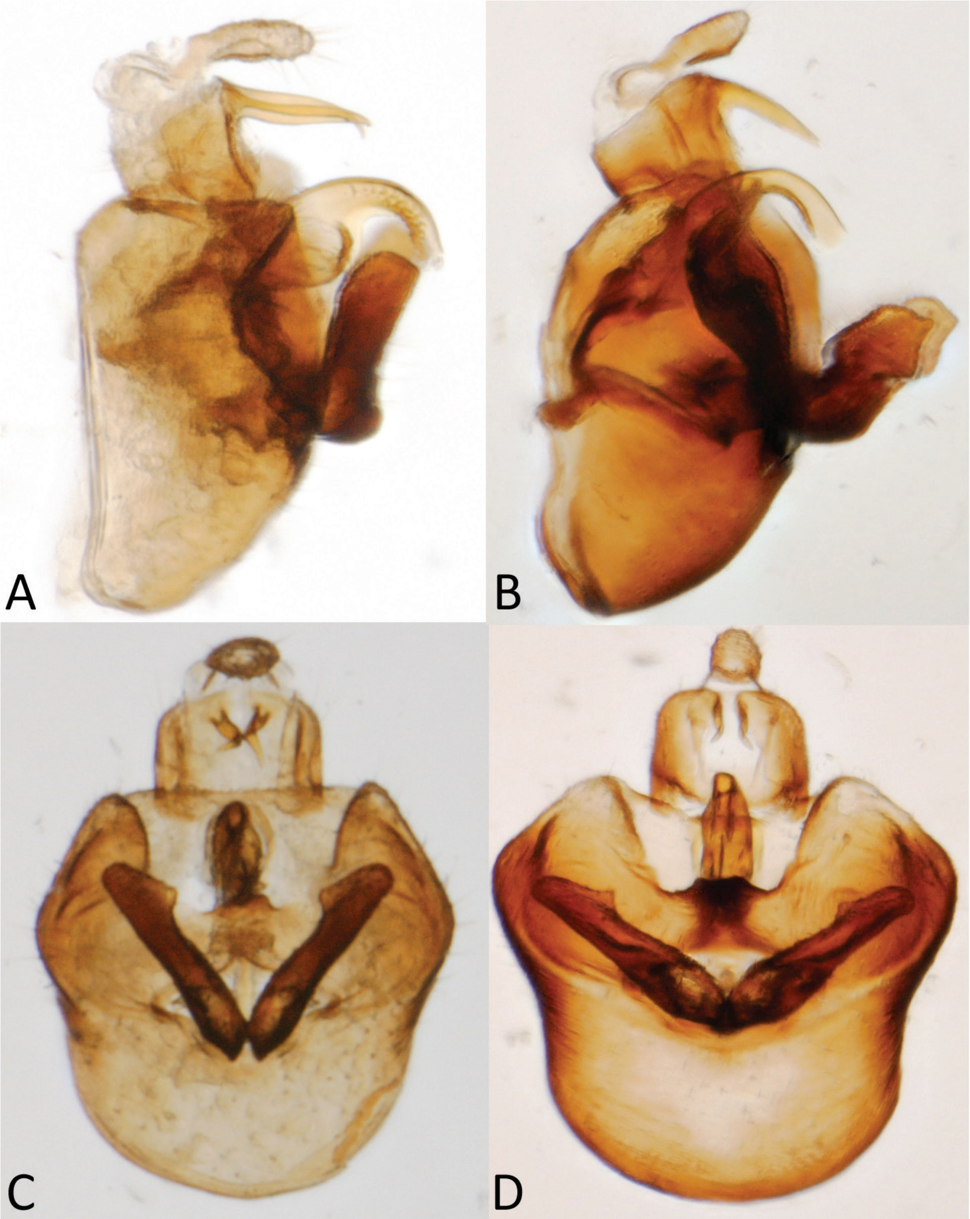

Figure 3. Male terminalia of *Spartidelphax detectus* (Kent Co., DE) and *S. penedetectus* (topotypic paratype, Cedar Keys, FL). **A** Lateral view of *S. detectus* **B** same *S. penedetectus* **C** caudal view of head and anterior thorax of *S. detectus* **D** same, *S. penedetectus*.

feature seems valid for the paratypes from Cedar Keys (vertex width near base 0.25, at apex 0.16 versus average measurements of 0.23 near base and 0.22 near apex for *detectus*), but not for other specimens examined.

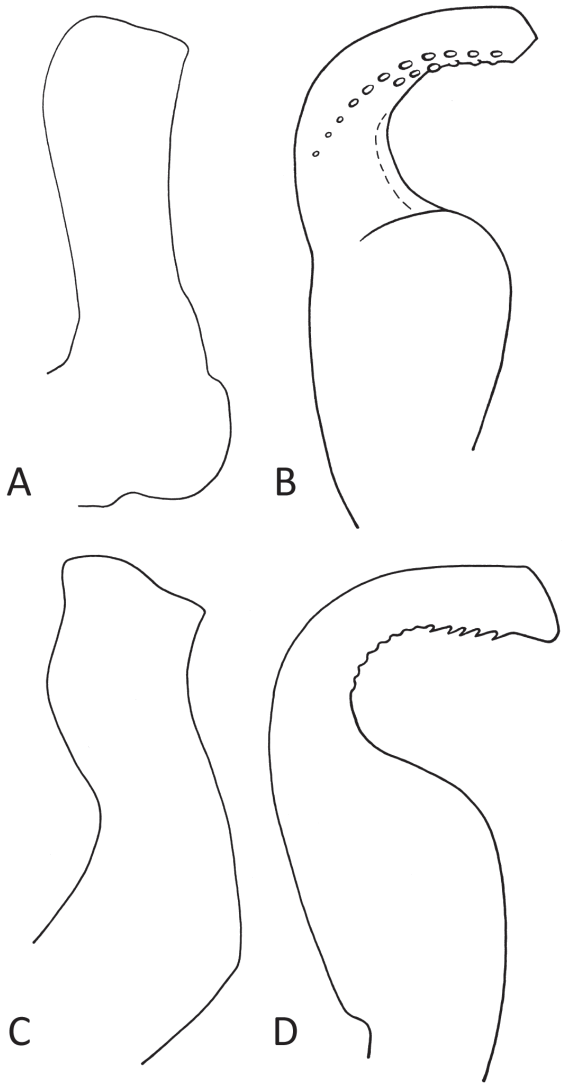

Figure 4. Line art of left paramere (widest view) and aedeagus (rotated 90° clockwise, apex up) of *Spartidelphax detectus* (Sanford, FL) and *S. penedetectus* (paratype, Cedar Keys, FL). **A** Paramere of *S. detectus* **B** aedeagus of *S. detectus* **C** paramere of *S. penedetectus* **D** aedeagus of *S. penedetecus*.

The most definitive feature that distinguishes the two species is the aedeagus (Fig. 4B, D). In *S. detectus* the aedeagus has rows of small teeth on both sides of the apical third, tracing the curve of the aedeagus, with one row extending nearly to the expanded basal portion of the aedeagus. In *S. penedetectus*, the aedeagus bears a pair of rows of ventral aedeagal teeth, reduced to fine serrulations in the type series.

Raupp and Denno (1979) found that the density of *Spartidelphax detectus* on *Spartina patens* exceeded 400 per kg of live grass sampled over a 6-month period, and was described as a dominant herbivore on *S. patens* by Denno (1977). It appears to have 3 non-synchronous generations per year in New Jersey, and overwinters as 4th or 5th instar (Denno 1976, 1977). Populations are wing polymorphic (both brachypters and macropters present within a population), with proportions of wing brachyptery and macroptery varying based on complex interactions of seasonal, environmental and population variables. An overall annual brachyptery rate of 86% (out of 23,868 specimens) was reported by Denno (1980) in New Jersey. Denno (1980) described niche differentiation among sap-feeding taxa on *Spartina patens*, including *S. detectus*.

Type material examined. Paralectotype. *Liburnia detecta* Van Duzee, 1897 (female, ISUC) "[blank 'purple' tab] // E.B. Southwick // ♀ // type // Liburnia / detecta Van D. [handwritten] // UDCC_TCN 00017671 [2D barcode]" (reported by Van Duzee 1897 as from New York City).

Other material examined. USA: Connecticut: ***New London Co.:*** Mystic, 19 Aug 1934, P. W. Oman (1f, 1m; USNM). **Delaware:** ***Kent Co.:*** Dover, 25 Aug 1927, H. L. Dozier (1m; UDCC); Little Creek, Port Mahon Road, 19 Aug 1999, C. R. Bartlett (1m; UDCC); Pickering Beach, 19 Aug 1999, C. R. Bartlett (1m, 12f; UDCC); Taylors Bridge, Jul 1999, C. R. Bartlett (10f, 4m; UDCC); near Fleming's Landing, Rt. 9 near Leipsic River, C. R. Bartlett (5f; UDCC); near Port Mahon, 19 Aug 1999, C. R. Bartlett (1m; UDCC); near Woodland Beach, 07 Jul 1999, R. L. Snyder (4m, 9f; UDCC); ***New Castle Co.:*** Middletown, Brick Mill Farm; 522 St Michael Drive, 28 Aug 2003, A. Gonzon (1m; UDCC); Newark, UD farm, Wildlife Refuge, 18 May 2009, C. R. Bartlett (1m; UDCC). near Woodland Beach, 07 Aug 1994, C. R. Bartlett (15m, 13f; UDCC); ***Sussex Co.:*** Bayard, Assawoman Wildlife Management Area, 11 Sep 2010, M. A. Johnston (1m; UDCC); Rehoboth Beach, 30 Aug 1921, H. G. Dyar (2m; USNM); South Bethany, Assawoman Wildlife Area, 29 Jun 2002, C. R. Bartlett (1f, 1m; UDCC); Thompson's Island, 0.25mi from trailhead, 09 Sep 2004, A. Gonzon (1m, 1f; UDCC); near Lewes, Oyster Rocks Road, 06 Jul 1994, C. R. Bartlett (8m, 5f; UDCC). **Florida:** ***Duval Co.:*** Paradise Key, Jacksonville, 10 Apr 1921, D. M. DeLong (2m; UDCC); ***Franklin Co.:*** Bald Point, near Panacea, 27 Jul 2000, C. R. Bartlett (2f, 12m; UDCC); ***Hillsborough Co.:*** Tampa, 01 Nov 1928, E. D. Ball (1m; USNM); ***Miami-Dade Co.:*** Miami Beach, Apr 1937 (1m, 1f; NCSU); ***Seminole Co.:*** Sanford, 1 m, 29 Oct 1926, E. D. Ball (1m; USNM). **Louisiana:** ***Cameron Parish:*** Cameron, 1 m, 20 Jun 1930 (3m, 2f; NCSU). **Maryland:** ***Anne Arundel Co.:*** 6 km S Edgewater SERO, 15 Jun 1976, J. H. Falk (1m; USNM); ***St. Mary's Co.:*** 2.3 mi E of Piney Point, 1 m, 12 Jul 1931, P. W. Oman, *Spartina patens* (1m, 1f; USNM); Piney Point, 26 Aug 1946, R. I. Sailer (1m; USNM). **Massachusetts:** ***Barnstable Co.:*** Falmouth, 17 Jul 1926 (1f, 2m; USNM); Woods Hole, 3 m, 10 Jul 1925, E. D. Ball (1m; USNM). **Mississippi:** ***Jackson Co.:*** Pascagoula, 30.3484°N, 88.55655°W, 3 m, 08 Aug 1921 (1m; ISUI). **New Hampshire:** ***Rockingham Co.:*** Rye Beach, 11 Aug 1985, G. F. and J. F. Hevel (2m; USNM); Rockingham, Odiorne Point State Park, 43.04791, -70.71871; 13 Aug 2008, D. S. Chandler (2m, 3f; DENH). **New Jersey:** ***Gloucester Co.:*** Williamstown, 43 m, 14 Sep 2009, A. M. Colavecchio (1f; UDCC); ***Salem Co.:*** 166 Maskells Mill Road, 16 Aug 2000, C. R. Bartlett & F. Robbins (5f; UDCC). **North Carolina:** ***Brunswick Co.:***

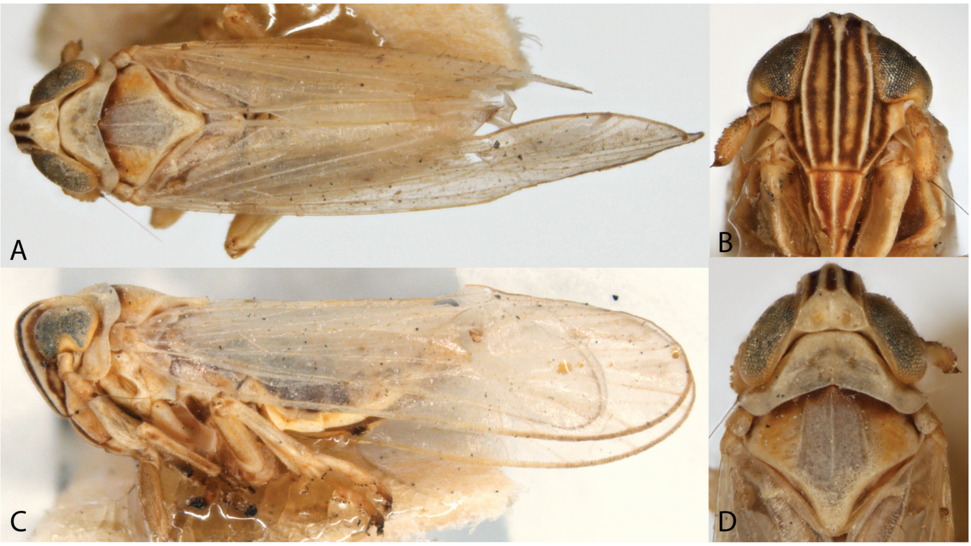

Figure 5. Female paralectotype of *Liburnia detecta* Van Duzee, 1897 (New York, NY). **A** dorsal habitus **B** front **C** lateral habitus **D** dorsal view head and anterior thorax.

Bald Head Island, Bald Head Creek, 02 Jul 2007, N. H. Nazdrowicz (1m, 2f UDCC); Southport, 28 Jul 1919, Osborn & Metcalf (1m, 3f; NCSU); 10 Oct 1948, C.W. Sabrosky (1m; USNM); ***Carteret Co.:*** near Atlantic, 29 Sep 1973, N. Newton (6f, 5m; UDCC); ***Dare Co.:*** Bodie Island, 14 Jun 1989, R. L. Blinn (3f; NCSU); ***Hyde Co.:*** Ocracoke Island, 2 m, 25 Aug 1962, T. Daggy (1m; NCSU); 15 Jun 1976, N. Newton (1m; UDCC); ***New Hanover Co.:*** Carolina Beach, May 1934, Z. P. Metcalf (19f, 29m; NCSU); Fort Fisher, 28 Oct 1934, Z. P. Metcalf (2m; NCSU); Wrightsville Beach, 27 Jul 1919, Osborn & Metcalf (21f, 11m; NCSU); ***Onslow Co.:*** Ashe Island, 04 Jun 1975, J. C. Dukes, *Distichlis spicata* (26m, 13f; NCSU); 19 Aug 1975, J. C. Dukes, *Spartina patens* (2m; NCSU); 15 Jun 1976, T. D. Edwards (1m; NCSU); 21 Jun 1976, T. D. Edwards (1f, 1m; NCSU); ***Pender Co.:*** Burgaw, May 1925, [*Spartina*] *patens* (1m; NCSU). **South Carolina:** ***Charleston Co.:*** Charleston, 02 Jul 1958, D. A. Young (2m; NCSU); 10 Jul 1958, D. A. Young (1m NCSU). **Texas:** ***Cameron Co.:*** Brownsville, 11 Mar 1936, P. A. Glick (1m; USNM). **Virginia:** ***Hampton Co.:*** Hampton, Jul 1908 (1m, 3f; URIC); ***Northampton Co.:*** Cape Charles, 31 Jul 1920, D. M. DeLong (3f, 1m; NCSU); ***Virginia Beach Co.:*** Cape Henry, 03 Jul 1938, P. W. Oman (2m; USNM). **PUERTO RICO:** Vieques Island, 23 Oct 1947, J. S. Caldwell, 1f (USNM). **VIRGIN ISLANDS (BRITISH): Guana Island:** North Beach, 18.48178°N, 64.57515°W, 25 Oct 2012, A. G. Wheeler (2m, 2f; UDCC). **BAHAMAS: Exuma Cays**, Leaf cays of Allen cays, 07 Jan 1953, E. B. Hayden, Van Voast AMNH Bahama Islds. Exped. (12m, 4f, AMNH); **Eleuthera Island**, New Portsmouth (Rock Sound District), 28 Mar 1953, E. B. Hayden & L. Giovannoli, Van Voast AMNH Bahama Islds. Exped. (1m, AMNH).

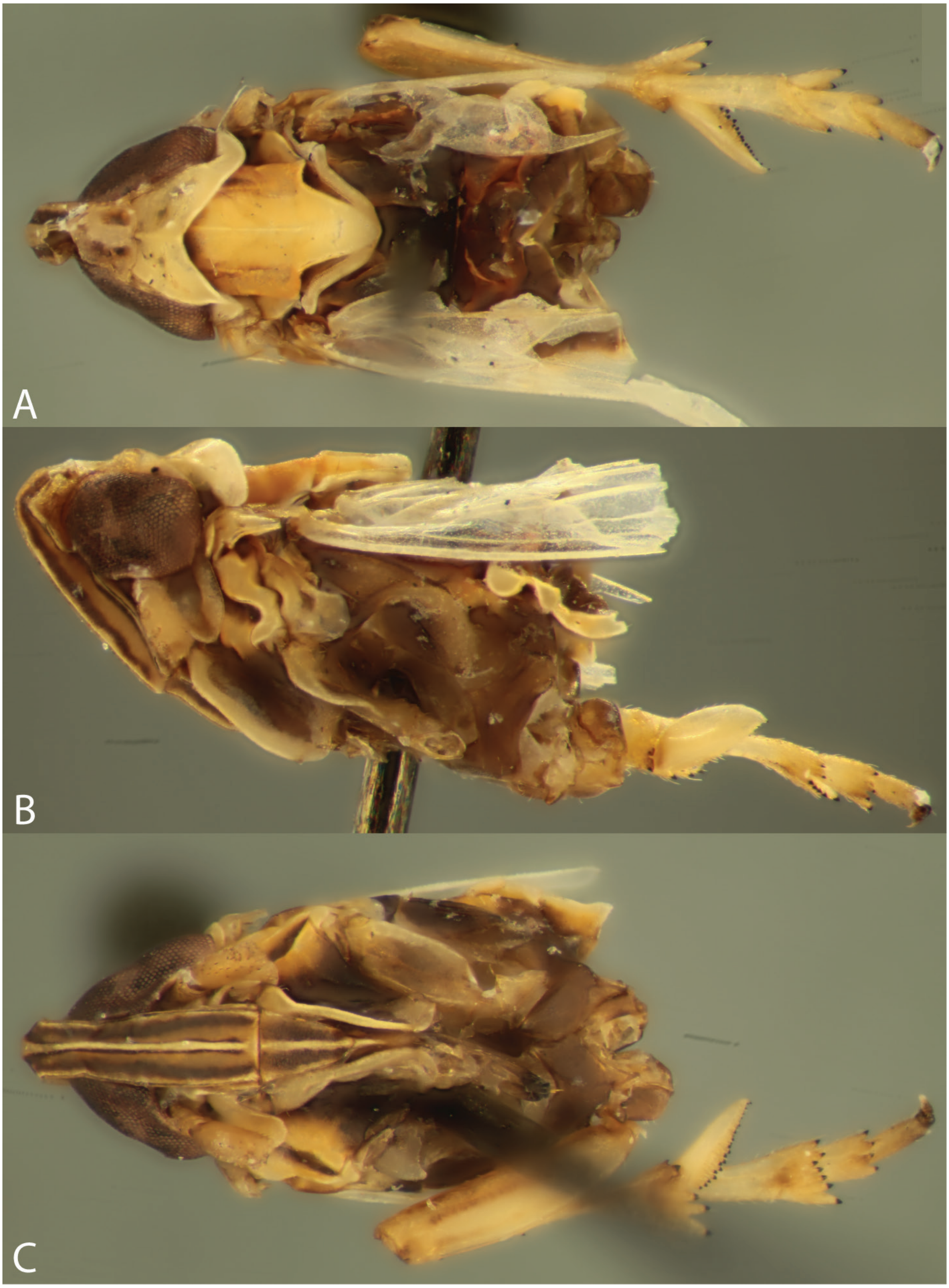

Figure 6. Holotype of *Delphax luteivitta* Walker, 1851. **A** dorsal view **B** left lateral view **C** ventral view.

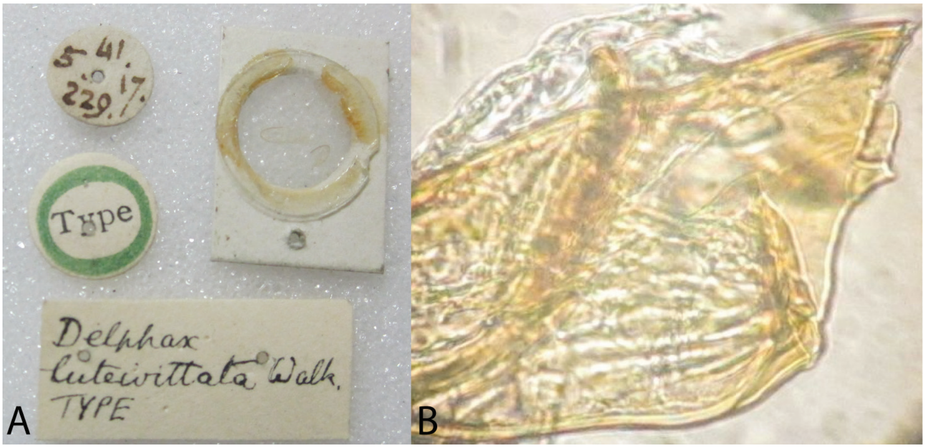

Figure 7. Labels and aedeagus of *Delphax luteivitta* Walker, 1851 (holotype). **A** specimen labels and forewing card mount **B** base of aedeagus (obscured by unidentified adhered membrane).

Spartidelphax luteivittus **(Walker, 1851), comb. n.**
Figures 6, 7

= *Delphax luteivitta* Walker, 1851: 354.
= *Dicranotropis* (?) *luteivitta* (Walker, 1851); comb. by Van Duzee 1916: 84.
= *Stenocranus luteivitta* (Walker, 1851); comb. by Muir and Giffard 1924: 12; to *incertae sedis* by Beamer (1946: 1).
= *Delphacodes luteivitta* (Walker, 1851); comb. by Bartlett 2010: 472.

Type locality. Florida, Duval County, St. Johns Bluff.

Remarks. The male holotype of *Delphax luteivitta* (at BMNH) is in poor condition (Figs 6–7). The specimen is shriveled and damaged, making the proportions of the head suspect. The coloration and habitus are similar to the other species of *Spartidelphax*. The wings are frayed and fragmentary with the forewing of only one side complete (mounted on specimen card, Fig. 7A). The abdomen has been removed for dissection, and only portions of the abdomen remain. The aedeagus (Fig. 7) although similar to the other species of *Spartidelphax* is missing the distal third, which bears the most definitive features separating *S. detectus* and *S. penedetectus*, with much of the base obscured by an adhered membrane.

Type material examined. Holotype *Delphax luteivitta* Walker, 1851 (male, BPBM) "5 41 17 229 (circular label, reading clockwise, meaning entry 229 of May 17, 1841)) // Type (circular label, green boarder) // Delphax / luteivittata [sic] Walk. / TYPE (handwritten)".

Discussion

Spartidelphax detectus and *S. penedetectus* are closely allied species. The lack of published records of *S. penedetectus* on the Atlantic coast may be because of the great similarity of these species, the numerical over-dominance of *S. detectus* in coastal marshes, and that most records of *S. penedetectus* were from the Gulf coast, so planthopper workers may not have expected, or sought, *S. penedetectus* on the Atlantic coast. Targeted collections on *Spartina alternifolia* should find *Spartidelphax penedetectus* throughout the Atlantic coast.

Our original intention was to determine whether *S. luteivittus* was a senior synonym or a valid species. The very poor condition of the holotype obscured all of the most useful features distinguishing *S. detectus* from *S. penedetectus*, and also did not obviate the possibility that *S. luteivittus* represents a third valid *Spartidelphax* taxon. We also studied morphological variation within the species over the geographic distribution of *Spartidelphax*, and found variation in size, shape details of the parameres, armature of the diaphragm, and shape and serration of the aedeagus; but were able to attribute males of all the examined specimens to either *S. detectus* or *S. penedetectus*. However, a field investigation to collect *Spartidelphax* from the different species of *Spartina* (including species not yet implicated as hosts such as *Spartina bakeri* Merr., *S. cynosuroides* (L.) Roth, *S. pectinata* Bosc ex Link, and *S. spartinae* (Trin.) Merr. ex Hitchc.) is needed to determine if there are additional species of *Spartidelphax*. In the meantime *S. luteivittus* is best treated as a *nomen dubium*.

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References

Arthropod Easy Capture (2013) Version: 1.34. http://sourceforge.net/projects/arthropodeasy [accessed on Sept. 4, 2013]

Asche M (1985) Zur Phylogenie der Delphacidae Leach, 1815 (Homoptera: Cicadina: Fulgoromorpha). Marburger Entomologische Publikationen 2(1), volume 1: 1–398, volume 2: 399–910.

Asche M (1990) Vizcayinae, a new subfamily of Delphacidae with revision of *Vizcaya* Muir (Homoptera: Fulgoroidea) - a significant phylogenetic link. Bishop Museum Occasional Papers 30: 154–187.

Asche M, Remane R (1983) Zur Problematik von *Delphacodes mulsanti* (Fieber 1866) und zur Kenntnis einiger benachbarter Taxa (Homoptera Auchenorrhyncha Fulgoromorpha Delphacidae) (Vorlaufige Mitteilung). Marburger Entomologische Publikationen 1(8): 25–56.

Bartlett CR (2010 dated 2009) Diversity in New World stenocranine planthoppers (Hemiptera: Delphacidae). Transactions of the American Entomological Society 135: 443–486. doi: 10.3157/061.135.0407

Bartlett CR, contributors (2014) Delphacid planthoppers of North America. http://ag.udel.edu/enwc/research/delphacid/index.html [accessed on May 27, 2014]

Bartlett CR, Hamilton KGA (2011) *Aethodelphax prairianus* gen. et sp. nov. (Hemiptera: Delphacidae) and seven congeneric species from North American *Delphacodes*. Zootaxa 2837: 48–66.

Bartlett CR, Deitz LL (2000) Revision of the New World delphacid planthopper genus *Pissonotus* (Hemiptera: Fulgoroidea). Thomas Say Publications in Entomology: Monographs, 234 pp.

Bartlett CR, O'Brien LB, Wilson SW (2014) A review of the planthoppers (Hemiptera: Fulgoroidea) of the United States. Memoirs of the American Entomological Society 50: 1–287.

Beamer RH (1946) The genus *Stenocranus* in America North of Mexico (Homoptera: Fulgoridae). Journal of the Kansas Entomological Society 19: 1–11.

Beamer RH (1950) *Delphacodes detecta* (Van D.) and a new closely related species (Homoptera: Fulgoridae: Delphacinae). Journal of the Kansas Entomological Society 23: 68–71.

Bourgoin T (2014) FLOW (Fulgoromorpha Lists on The Web): a world knowledge base dedicated to Fulgoromorpha. Version 8, updated May 27, 2014. http://hemiptera-databases.org/flow/

Crawford DL (1914) A contribution toward a monograph of the homopterous insects of the family Delphacidae of North and South America. Proceedings of the United States National Museum 46: 557–640, + 6 plates.

Davis LV, Gray IE (1966) Zonal and seasonal distribution of insects in North Carolina salt marshes. Ecological Monographs 36: 275–295. doi: 10.2307/1942419

Denno RF (1976) Ecological significance of wing polymorphism in Fulgoroidea which inhabit tidal salt marshes. Ecological Entomology 1: 257–266. doi: 10.1111/j.1365-2311.1976.tb01230.x

Denno RF (1977) Comparison of the assemblages of sap-feeding insects (Homoptera-Hemiptera) inhabiting two structurally different salt marsh grasses in the genus *Spartina*. Environmental Entomology 6: 359–372.

Denno RF (1978) The optimum population strategy for planthoppers (Homoptera: Delphacidae) in stable marsh habitats. Canadian Entomologist 110: 135–142. doi: 10.4039/Ent110135-2

Denno RF (1980) Ecotope differentiation in a guild of sap-feeding insects on the salt marsh grass, *Spartina patens*. Ecology 61: 702–714. doi: 10.2307/1937435

Denno RF, Raupp MJ, Tallamy DW, Reichelderfer CF (1980) Migration in heterogeneous environments: Differences in habitat selection between the wing forms of the dimorphic planthopper *Prokelisia marginata* (Homoptera: Delphacidae). Ecology 61: 859–867. doi: 10.2307/1936756

Ferrenberg SM, Denno RF (2003) Competition as a factor underlying the abundance of an uncommon phytophagous insect, the salt-marsh planthopper *Delphacodes penedetecta*. Ecological Entomology 28: 58–66. doi: 10.1046/j.1365-2311.2003.00479.x

Gonzon AT, Bartlett CR (2008, dated 2007) Systematics of *Hadropygos* n. g., *Metadelphax* Wagner and New World *Toya* Distant (Hemiptera: Delphacidae). Transactions of the American Entomological Society 133: 205–277. doi: 10.3157/0002-8320-133.3.205

ICZN (International Commission on Zoological Nomenclature) (1961) Opinion 602. *Delphax* Fabricius, 1798 (Insecta, Hemiptera); Interpretation under the plenary powers. Bulletin of Zoological Nomenclature 18: 246–248.

Metcalf ZP (1923) A key to the Fulgoridae of eastern North America with descriptions of new species. Journal of the Elisha Mitchell Scientific Society 38: 139–230, plus 32 plates.

Moore GA (1950a) Catalogus des hémiptères de la province de Québec. Le Naturaliste Canadien 77: 233–271.

Moore GA (1950b) Check-list of Hemiptera of the province of Quebec. Contributions de l'Institut de Biologie de l'Université de Montréal 26: 1–49.

Muir FAG, Giffard WM (1924) Studies in North American Delphacidae. Bulletin of the Experiment Station of the Hawaiian Sugar Planters' Association, Entomological series no. 15: 1–53.

Olmstead KL, Denno RF, Morton TC, Romeo JT (1997) Influence of *Prokelisia* planthoppers on amino acid composition and growth of *Spartina alterniflora*. Journal of Chemical Ecology 23: 303–321. doi: 10.1023/B:JOEC.0000006361.59085.22

Oman PW (1947) The types of Auchenorrhynchous Homoptera in the Iowa State College Collection. Iowa State College Journal of Science 21: 161–228.

Osborn H (1938) The Fulgoroidea of Ohio. Bulletin of the Ohio Biological Survey 6: 283–349.

Raupp MJ, Denno RF (1979) The influence of patch size on a guild of sap-feeding insects that inhabit the salt marsh grass *Spartina patens*. Environmental Entomology 8: 412–417.

Rey JR (1981) Ecological biogeography of arthropods on *Spartina* islands in northwest Florida. Ecological Monographs 51: 237–265. doi: 10.2307/2937265

Schuh RT, Hewson-Smith S, Ascher JS (2010) Specimen databases: A case study in entomology using Web-based software. American Entomologist 56: 206–216.

Schuh RT (2012) Integrating specimen databases and revisionary systematics. ZooKeys 209: 255–267. doi: 10.3897/zookeys.209.3288

Urban JM, Bartlett CR, Cryan JR (2010) Evolution of Delphacidae (Hemiptera: Fulgoroidea): combined-evidence phylogenetics reveals importance of grass host shifts. Systematic Entomology 35: 678–691. doi: 10.1111/j.1365-3113.2010.00539.x

USDA, NRCS (2014) The PLANTS Database. National Plant Data Center, Baton Rouge, LA 70874–4490 USA. http://plants.usda.gov [accessed 28 May 2014]

Van Duzee EP (1897) A preliminary review of the North American Delphacidae. Bulletin of the Buffalo Society of Natural Sciences 5: 225–261.

Van Duzee EP (1909) Observation of some Hemiptera taken in Florida in the spring of 1908. Bulletin of the Buffalo Society of Natural Sciences 9: 149–230.

Van Duzee EP (1916) Check list of Hemiptera (excepting the Aphididae, Aleurodidae and Coccidae) of America north of Mexico. New York Entomological Society, New York, 111 pp.

Van Duzee EP (1917) Catalogue of the Hemiptera of America north of Mexico (excepting the Aphididae, Coccidae and Aleurodidae). University of California Publications, Technical Bulletins, vol. 2. University of California Press, Berkeley, i-xiv, 1–902.

Walker F (1851) List of the specimens of Homopterous Insects in the collection of the British Museum. British Museum, London. Volume 2: 261–636.

Wilson SW (1982) The planthopper genus *Prokelisia* in the United States (Homoptera: Fulgoroidea: Delphacidae). Journal of the Kansas Entomological Society 55: 532–546.

Wilson SW, Mitter C, Denno RF, Wilson MR (1994) Evolutionary patterns of host plant use by delphacid planthoppers and their relatives. In: Denno RF, Perfect TJ (Eds) Planthoppers: Their Ecology and Management. Chapman and Hall, New York, 7–45 + appendix.

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Review of Afrotropical Figitinae (Figitidae, Cynipoidea, Hymenoptera) with the first records of *Neralsia* and *Lonchidia* for the region

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Abstract

The cynipoid subfamily Figitinae is poorly represented in the Afrotropical region with two genera (*Figites* Latreille and *Xyalophora* Kieffer) and six species currently known. Here we record an additional two genera (*Neralsia* Cameron and *Lonchidia* Thomson) for the region and describe three new species: *Neralsia haddocki* **sp. n.**; *Xyalophora tedjoansi* **sp. n.**; *Xyalophora tintini* **sp. n.** Benoit's species described in 1956 are synonymized under *Figites aciculatus* (Benoit, 1956): *Figites effossus* **syn. n.**; *F. favonius* **syn. n.**; *F. furvus* **syn. n.**; *F. fraudator* **syn. n.** Identification keys to the figitine genera and species occurring in the Afrotropical region are provided. Online interactive Lucid Phoenix and Lucid matrix keys are available at: http://www.waspweb.org/Cynipoidea/Keys/index.htm

Keywords

Africa, Afrotropical, Cynipoidea, Figitidae, identification key, species description, taxonomy

Introduction

The subfamily Figitinae is a heterogenous, and probably a paraphyletic, group of cynipoid wasps (Ronquist 1999, Buffington et al. 2007). The Afrotropical fauna is poorly known, with the first figitines from the region being described by Benoit in 1956. His treatise of the Figitidae housed in the Royal Museum of Central Africa (Tervuren), from what was then known as the Belgian Congo, included the description of four *Figites* Latreille species and a single *Xyalophora* Kieffer species all from the Democratic Republic of Congo (Benoit 1956). *Xyalophora aciculata* was subsequently transferred to *Figites* by Jiménez et al. (2008c). Since then only a single additional species, *Xyalophora provancheri* Jiménez & Pujade-Villar from Burkina Faso, has been described in Jiménez et al. (2008c). To date these are the only two figitine genera to have been recorded from the Afrotropical region.

We record two additional genera, *Lonchidia* Thomson and *Neralsia* Cameron, describe three new species, and provide identification keys to the genera and species of Afrotropical Figitinae. Benoit's *Figites* species are synonymized with the result that *Figites*, *Lonchidia* and *Neralsia* are currently monotypic in the region.

Materials and methods

Freshly collected specimens were point-mounted on black, acid-free cards for examination (using a Leica 205c stereomicroscope with LED light sources), photography and long-term preservation. Images were acquired using either the EntoVision multiple-focus imaging system or the Leica LAS 4.4 imaging system to illustrate diagnostic characters. The former comprised a Leica® M16 microscope with a JVC® KY-75U 3–CCD digital video camera attached that fed image data to a notebook computer. The program Cartograph® 5.6.0 was then used to merge an image series into a single in-focus image. The Leica LAS 4.4 imaging system comprised a Leica® Z16 microscope with a Leica DFC450 Camera with 0.63× video objective attached. The imaging process, using an automated Z-stepper, was managed using the Leica Application Suite V 4.4 software installed on a desktop computer. Methods for generating these photographs follow those in Buffington and van Noort (2009). Diffused lighting was achieved using techniques summarized in Buffington et al. (2005), Kerr et al. (2008) and Buffington and Gates (2009).

Morphological terminology follows that of Fontal-Cazalla et al. (2002); Ronquist and Nordlander (1989) and Jiménez et al. (2008c); cuticular surface terminology follows Harris (1979). Abbreviations and definition of measurements:

F1–F12: antennal flagellomeres 1 to 12.
T1–T8: metasomal tergites 1 to 8 (T1 = abdominal petiole).

POC (postocellar distance): shortest distance between the internal margins of the posterior ocelli.

OOC (ocello-ocular distance): shortest distance between the external margin of the lateral ocellus and the internal margin of the compound eye.

COC (ocellar distance): shortest distance between the lateral and frontal ocelli.

Relative length of the scutellar spine to length of scutellum (excluding spine) is measured in dorsal view with orientation of each surface adjusted to a horizontal plane for recording of absolute length.

Online interactive keys were produced using Lucid and Lucid Phoenix meeting the requirements of publishing both static and dynamic interactive keys under an open access model (Penev et al. 2009). All keys were produced using high quality annotated images, highlighting diagnostic characters that are integrated into the key above each couplet. This is a user-friendly output making the keys readily accessible to a wide range of users with diverse expertise. This key format circumvents the requirement of familiarity with morphological terminology associated with the particular group, because the characters are visually illustrated making the keys usable by the lay person. These keys are available at: http://www.waspweb.org/Cynipoidea/Keys/index.htm. End users can choose between three different key formats depending on their personal preference. The keys are available in three formats. Although Lucid Phoenix keys are interactive keys they are still dichotomous and a choice needs to be made at each key couplet to continue. Lucid matrix keys, on the other hand, use a different approach where relevant states from multiple character features can be selected independently until identification is achieved. For more information concerning Lucid keys visit http://www.lucidcentral.org.

All images presented in this paper are freely available through http://morphbank.net and http://www.waspweb.org using the link to individual collections.

List of depositories

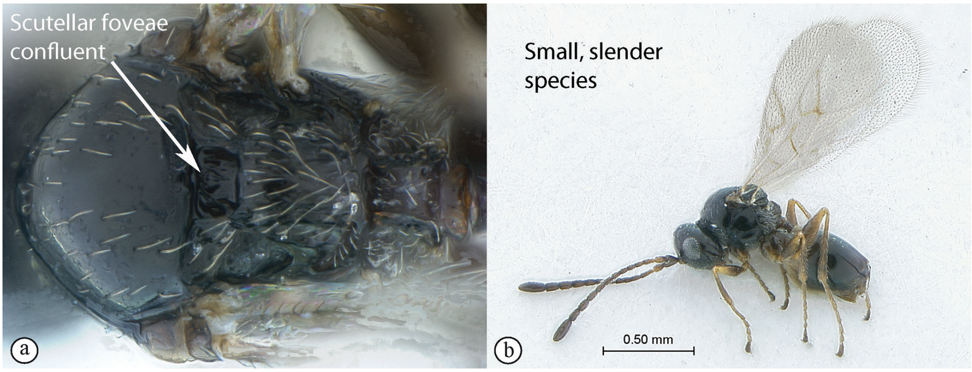
BMNH	Natural History Museum, London, UK. Curator: David Notton.
CNCI	Canadian National Collection of Insects, Ottawa, Canada. Curator: Andy Bennett.
MZLU	Zoologiska Museet Lunds Universitet, Lund, Sweden. Curator: Christer Hansson.
RMCA	Musée Royal de l'Afrique Centrale, Tervuren, Belgium. Curator: Eliane de Coninck.
SAMC	Iziko South African Museum, Cape Town, South Africa. Curator: Simon van Noort.

Figitinae

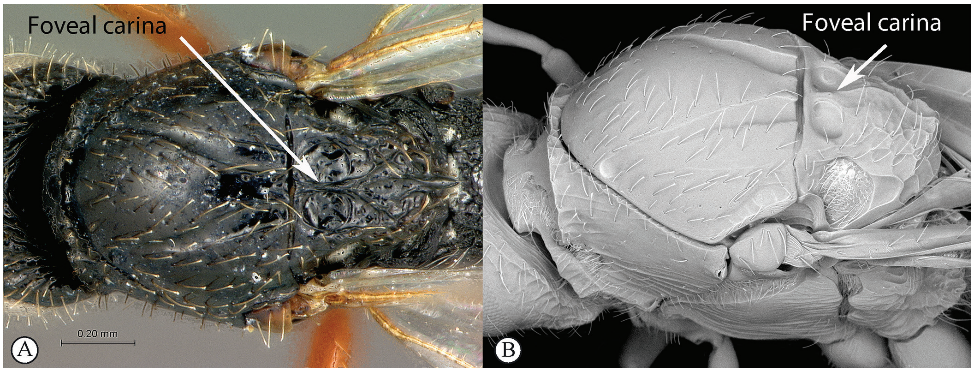
The indigenous Afrotropical genera belong to the very distinct core lineage of Figitinae, which appears to be monophyletic, and is characterised by large size, often strongly reduced wing pubescence, hairy eyes, lack of metasomal hair patch (hairy ring), and bionomics associated with attacking calyptrate Diptera in decomposing substrates. This lineage presents a very interesting morphological and life history convergence with some genera of Afrotropical Eucoilinae (e.g. *Bothrochacis*). On the contrary, the genus *Lonchidia*, of which we have so far encountered only one Afrotropical specimen of a European species, represents a separate lineage that renders the subfamily paraphyletic in phylogenetic analyses. It is easily recognizable by its confluent scutellar foveae, unusual lateral hair patches on the metasoma and sub-clavate female antennae. The recorded *Lonchidia* species may be an accidental introduction or possibly an established population of synanthropic origin.

Systematics

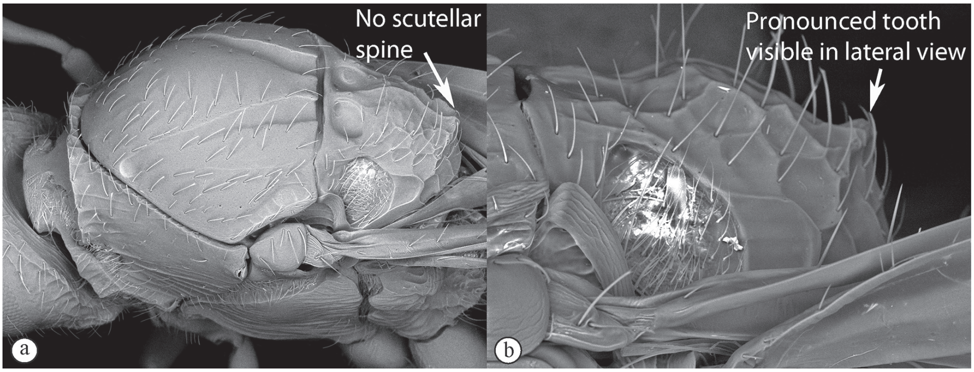
Key to Afrotropical figitine genera



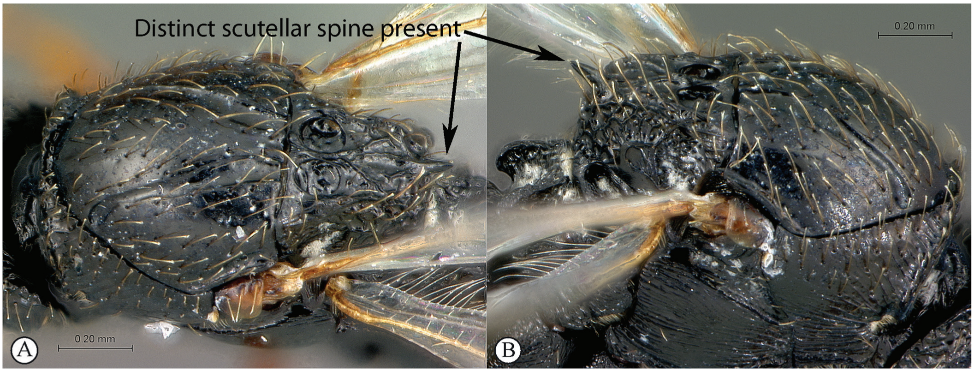
1 Scutellar foveae confluent (a). Small, rather slender species (b) .... ***Lonchidia***



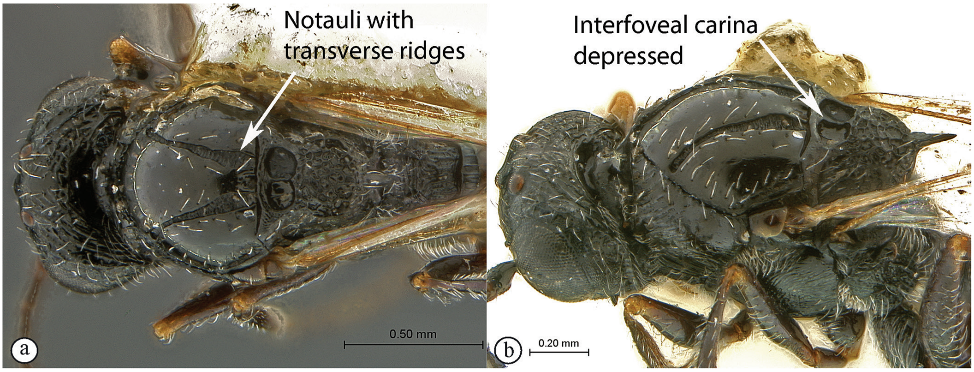
– Scutellar foveae distinctly separated by a median carina (A, B). Larger, strongly built species **2**



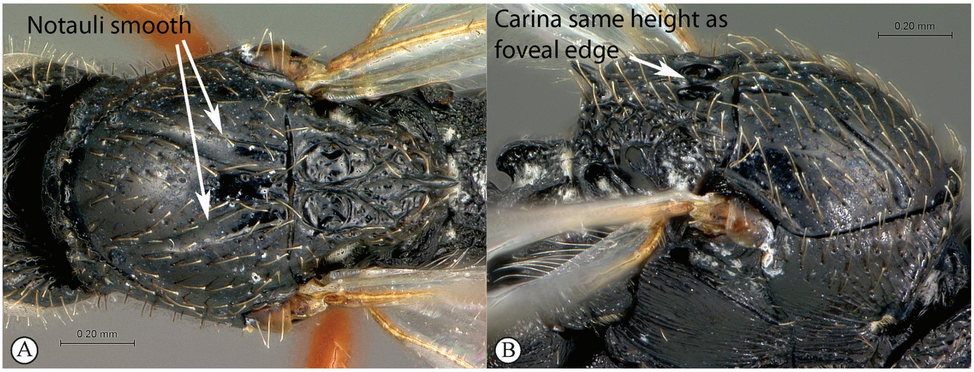
2 No distinct scutellar spine (a), outline of scutellum in dorsal view rounded (however there is often a more or less pronounced ridge at the posteriormost point of the circumscutellar carina, which may look like a small tooth in lateral view) (b)..........***Figites*** (single species currently recognised: *F. aciculatus*)



– Distinct scutellar spine present, obviously protruding from scutellar outline in dorsal view (A, B) **3**



3 Notauli sculptured with small transverse ridges (a). Interfoveal carina depressed, much lower than the level of the foveal edge (b) ....***Xyalophora***



– Notauli smooth (A). Interfoveal carina as high as the foveal edge (B) .... ***Neralsia*** (single species known from Africa: *N. haddocki*)

Figites Latreille, 1802

Figites Latreille, 1802: 307. Type species: *Cynips scutellaris* Rossi, 1794, by subsequent designation.

Psilogaster Hartig, 1840: 187 & 202. Type species: *Figites anthomyiarium* Bouché, 1834, by original designation.

Pycnotrichia Förster, 1869: 363 & 366. Type species: *Pycnotrichia erythropa* Förster, 1869 by monotypy and original designation.

Omalaspoides Hedicke, 1913: 146. Type species: *Omalaspoides letzneri* Hedicke, 1913 by original designation.

Diagnosis. Large figitines with reduced pubescence on wings (often completely hairless) and more or less striate mesosomal sides. Easily separated from *Xyalophora* and *Neralsia* by the rounded scutellum (no indication of a spine in outline in dorsal view), although the posterior scutellar rim appears as a tooth in lateral view. Stiff, stout hairs present across most of body, distally bifurcate.

Distribution. Probably worldwide, but to date no records from the Oriental and Oceanic regions have been published. Afrotropical records: Democratic Republic of Congo (Benoit 1956), Cameroon, Ethiopia, Kenya, South Africa, Uganda, Yemen (new records).

Biology. Parasitoids of calyptrate Brachycera larvae in decomposing substrates (Hennig 1976; James 1928; Thomas and Morgan 1972).

Comments. This is a rare genus in the region. On a global scale, it is poorly circumscribed versus several smaller genera, and many of its nominal species are of doubtful identity.

Figites aciculatus (Benoit, 1956)

Figures 1, 2

Xyalophora aciculata Benoit, 1956.
Figites aciculatus (Benoit, 1956). Combination by Jiménez et al. 2008c.
Figites effossus Benoit, 1956, **syn. n.**
Figites favonius Benoit, 1956, **syn. n.**
Figites fraudator Benoit, 1956, **syn. n.**
Figites furvus Benoit, 1956, **syn. n.**
Images of all the type specimens are available on waspweb: http://www.waspweb.org/Cynipoidea/Figitidae/Figitinae/Figites/index.htm

Additional material examined. CAMEROON, 1F: Nkoemvon, vii – viii 1979, Ms D. Jackson, *Figites* sp. det M. Forshage 2012 (BMNH); **DEMOCRATIC REPUBLIC OF CONGO**, 1M: Parc Nat. Albert, SL Edouard: r. Rwindi, 1000m, 4.ii.1936, L. Lippens (RMCA); 1M: Conge Belge: Kivu, Rutshuru, 1285m, 13 au 20.xii.1933, G.F. de Witte: 122 (BMNH); 1M: same data except:, 23 au 25.xii.1933, G.F. de Witte: 132 (RMCA); 2M: Conge Belge: P.N.A., N'Zulu (Lac Kivu), 1500m, 6 au 7.ii.1934, G.F. de Witte: 221 (BMNH; RMCA); 1M: Conge Belge: Kivu, Sake, (Lac Kivu), 1460m, 19/22.ii.1934, G.F. de Witte: 253 (RMCA); 1M: Conge Belge: P.N.A., Burunga (Mokoto) 2000m, 17 au 19.iii.1934 G.F. de Witte: 313 (RMCA); 1M: Conge Belge: P.N.A., Près Mt. Kambatembe (Forêt) 2200m, 12-iv-934, G.F. de Witte : 348 (RMCA); 2M: Conge Belge: P.N.A., Rutshuru, 1285m, 18 au 23.vi.1934, G.F. de Witte: 448 (BMNH; RMCA); 2M: Conge Belge: P.N.A., Nyarusambo, 2000m, 2.vii.1934, G.F. de Witte: 465 (RMCA); 1F: Conge Belge: P.N.A., Mt. Sesero, pres Bitashimva (Bambousi) 2000m, 1 au 2.viii.1934, G.F. de Witte: 505 (RMCA); 1M: Conge Belge: Uele, Monga, 450m, 18.iv. au 8.v.1935, G.F. de Witte: 1334 (RMCA); 1F: Conge Belge: Kivu, Rutshuru, 1285m, 29 au 31.v.1935, G.F. de Witte: 1395 (RMCA); 1F: same data except:, G.F. de Witte: 1396 (BMNH); 1F: Conge Belge: Kivu, Rutshuru, (riv. Musugereza), 1100m, 4.vii.1935, G.F. de Witte: 1607 (RMNH); 1M: Conge Belge: Kivu, Rutshuru, 1285m, 3.vii.1935, G.F. de Witte: 1610 (RMCA); 1M: same data except: G.F. de Witte: 1611 (RMCA); 2M: Conge Belge: Kivu, Rutshuru (riv. Fuku), 1250m, 5.vii.1935, G.F. de Witte: 1621 (BMNH); 1M: same data except: G.F. de Witte: 1622 (RMCA); 1F: Conge Belge: Kivu, Rutshuru, 1285m, 12.vii.1935, G.F. de Witte: 1639 (RMCA); 1F: same data except: G.F. de Witte: 1641 (BMNH); 1F: Conge Belge: Kivu, Rutshuru (Lubirizi), 1285m, 13.vii.1935, G.F. de Witte: 1645 (RMNH); 1F: Conge Belge: Kivu, Rutshuru, 1285m, vii.1935, G.F. de Witte: 1671 (RMNH); 1M: Conge Belge: Kivu, Nyongera (près Rutshuru), Butumba, 1218m, 17.vii.1935, G.F. de Witte: 1669 (BMNH); 2F: Conge Belge: Kivu, Rutshuru (riv. Rodahira), 1285m, 2.vii.1935, G.F. de Witte: 1675 (RMNH); 1F: Conge Belge: Kivu, Rutshuru (riv. Fuku), 1250m, 4.vii.1935, G.F. de Witte: 1678 (RMNH); 3F, 1M: Conge Belge: Kivu, Rutshuru 1285m, 2.vii.1935, G.F. de Witte: 1685 (RMNH); 1M: Democratic Republic of Congo Conge Belge: P.N.A., Ganza (860m), 4-6-vii-1949.

Figure 1. *Figites aciculatus* (Benoit), holotype female. **A** lateral habitus **B** dorsal habitus **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** mesosoma, dorso-lateral view **F** head, anterior view.

Mis G.F. de Witte: 2758a (RMNH); 1F: Conge Belge: P.N.A., Secteur Tshiaberimu, Riv. Mbulikerere, affl. Dr. Talia N, 2720m, 26–28.viii.1953, P. Vanschuytbroeck & V. Hendrickx, 4999-5005 (BMNH); 2 F 2M: Conge Belge: P.N.A., Mont Hoyo, 1280m, sur plantes basses, 7–15.vii.1955, P. Vanschuytbroeck, 13274-309 (BMNH; RMNH); 1F: Conge Belge: P.N.A., 21-iv-1955, P. Vanschuytbroeck & R. Fonteyn, 12.813-16 Secteur Tshiaberimu, Mont Musienene, 2.680 m, près de Kirungu (RMNH); 1M: Conge Belge: P.N.A., 16-vii-1957, P. Vanschuytbroeck VS 84 (2) Secteur Nord, riv.

Lesse, affl. G. Semliki, 695 m (RMNH); **ETHIOPIA**, 1M: Nazareth, 6700', 16–19. II.62, S.M. Clark (CNCI); **KENYA**, 2F: Kakamega Forest, 18.xii.1970, A.E. Stubbs, B.M. 1972-211 (BMNH); **SOUTH AFRICA**, 1F: Eastern Cape Province, Port St John, Pondoland, June 12–30 1923, R.E. Turner, Brit. Mus. 1923-363 (BMNH); 1F: [Kwazulu-Natal], Natal, Van Reenen, Drakensberg 1–22.i.1927, R.E. Turner, Brit. Mus. 1927-54 (BMNH); 1F: Eastern Cape Province, Katberg, 15–30.i.1933, R.E. Turner, Brit. Mus. 1933-108 (BMNH); **UGANDA**, 1M: Mulange, R, Dummer, Nov, 1922. *Figites* det M. Soderlund 1993, SAM-HYM-P002880 (SAMC). 1F: Kazhara, H.C. Taylor, iii.1939, Brit. Mus. 1956-25, *Figites* det. J. Quinlan, 1957 (BMNH); 1 F: Kawanda, T.H.C. Taylor, xi.1942, Brit. Mus. 1956-25, *Figites* det. J. Quinlan, 1957 (BMNH); 2M: Ruwenzori Range, Namwamba Valley, 10 100 ft., T.H.E. Jackson, xii.1934-i.1935, B.M. E. Africa. Exp., B.M. 1935-203 (BMNH); **YEMEN**, 1F: Ar Rujum, 15°27.47'N, 43°38.10'E, 16.10.00-15.01.01, in Malaise-trap, coll. A. van Harten & A.M. Hager, 5464, SAM-HYM-P046196 (SAMC).

Distribution. Democratic Republic of Congo (Benoit 1956), Cameroon, Ethiopia, Kenya, South Africa, Uganda, Yemen (new records).

Description synopsis with overview of morphological variation. *Female*. Head, mesosoma, metasomal tergite 1, coxae black; rest of metasoma reddish brown; scape black, rest of antennae pale to dark reddish brown, multiporous plate sensilla (MPS) concolourous with segment or more silver, legs testaceous, femora darker. Antennae pale to dark reddish-brown, 11 flagellar segments; flagellar segment 1 longer than segment 2; flagellar segments 1–4 with no MPS; remaining 7 segments with single row of MPS except for the club segment which has 2 rows; club segment about twice the length of penultimate segment and 1.5× longer than wide. Occiput with reticulate sculpturing or parallel carina, but may be fairly smooth with only a few weak parallel carina on posterior edge of vertex orientated parallel to genal carina. Pronotal plate cordate, smooth. Medial posterior impression present or absent between notauli. Scutellar posterior rim raised into what appears to be a tooth visible in lateral view. Mesopleuron completely striate or with smooth medial patch. Marginal cell open or closed. Marginal vein often present, but hyaline and only pigmented for basal half to three-quarters of vein. Cell usually less than twice as long as wide 1.3×–1.8× but may be 2.0×. Basal vein usually shorter (0.65–0.85×) than portion of subcostal vein forming 1st cubital cell, but may be longer (1.25×). Propodeal shelf as long as metasomal petiole in lateral view. Metasomal tergite 2 smooth or with longitudinal striations that can form a short collar or extend almost the length of tergite. Tergite 3 smooth or sometimes with lateral striate patch, striations often weak. Fore tarsal basal segment = the remaining segments in length.

Male. Colour as in female. Twelve flagellomeres. First two flagellar segments equal in length and each equal to scape & pedicel combined. 1st flagellar segment 3× longer than wide. Scape 3× pedicel length. Face reticulate to centrally smooth with weak lateral carina. Occiput reticulate to rather smooth, with faint indications of carinae in reticulate pattern. Toruli separated by a third to a half of their own diameter. Eyes separated by just over 1.1× eye length. Pronotal collar smooth. Mesopleuron with dor-

Figure 2. *Figites aciculatus* (Benoit), holotype female. **A** metasoma, lateral view **B** propodeum and metasoma, dorsal view **C** propodeum and partial metasoma, lateral view **D** mesosoma and partial metasoma, dorso-lateral view **E** forewing **F** data labels.

sal medial smooth patch. Slight medial posterior depression between notauli. Scutellar tooth strong in lateral view or may be almost absent with scutellar rim very low in specimens that are generally less sculptured. Vertical parallel carina on scutellar posterior vertical surface. Pronotal shelf same length as metasomal tergite 1 petiole in lateral view. Pronotum with two parallel raised longitudinal carinae bounding medial rectangular area. Marginal cell may be obviously closed with pigmented vein or may be open with vein loosing pigment. 1.5×–2.0× longer than wide. Basal vein usually shorter (0.7–0.9×) than portion of subcostal vein forming 1st cubital cell. Tergite 2 smooth or with very faint weak striations near base. Tergite 3 may have a very small patch of very weak striations.

Comments. Benoit described five species (in two genera) based on single specimens using differential characters that are highly variable and likely to be indicative of intraspecific variation. Benoit deemed that *F. aciculatus* possessed a scutellar spine and hence placed this species in *Xyalophora*. Examination of the holotype clearly shows this specimen to possess the same character state as in the rest of the *Figites* species that he described, i.e. a rounded scutellum with no indication of a spine in outline in dorsal view (distinguishing this genus from both *Xyalophora* and *Neralsia*), although the posterior scutellar rim appears as a small tooth in lateral view. Jiménez et al. (2008c) correctly transferred this species to *Figites*. Although we initially attempted to find correlating characters across an examined series of 57 specimens to corroborate Benoit's species delimitation, there was no consistency in reliably diagnostic character states, alone or in combination. In particular, the degree of closure of the radial vein, and degree of sculpturing, including presence (and extent of) or absence of striations on metasomal tergites 1 and 2, which are two of the main characters used by Benoit to define his species, are variable across the series of specimens that we have examined. Specimens cannot always reliably be placed in one or the other of Benoit's species, because of possession of different character state combinations and a continuous range of variation across body size (specimens range in body length from 2–4 mm). The degree and extent of sculpturing varies with specimen size with smaller specimens tending to be smoother overall with reduced sculpturing on the occiput, pronotum, mesopleuron, metacoxae and metasomal tergites. A potential useful character state is the type of sculpturing present on the occiput, which may be reticulate or have the cross-carina absent creating parallel carina. Although appearing very different, this latter character state is likely to be related to a reduction in sculpturing and is not consistently correlated with other potentially diagnostic characters. Larger specimens tend to be more sculptured with reticulate occipital sculpturing and a closed marginal cell and smaller specimens less sculptured with parallel carina on the occiput and an open marginal cell, but there are intermediates and exceptions. Many of the specimens with occipital reticulate sculpturing and a closed marginal vein could be assigned to *F. aciculatus* (the holotype is a large specimen with a 4 mm body length), but there were also specimens with a closed marginal cell and parallel carina. There are even specimens that have different degrees of closure of the marginal cell on each wing, so clearly this is a plastic character e.g. a female from Kivu, Rutshuru (Democratic Republic of Congo) has one wing with the marginal cell open and other wing with the marginal cell closed. In many specimens the vein is often present along the entire wing margin, but not completely pigmented and therefore depending on lighting, background colour and magnification strength, the marginal cell can be interpreted as open or closed, compounding reliable identification. The relative dimensions of the marginal cell also exhibit a range of variability (1.6–2.1× as long as wide), and the basal vein is usually much shorter (0.67–0.71×) than the portion of the subcostal vein forming the 1st cubital cell. However, in the Cameroon specimen, the marginal cell can be a little more than twice as long as wide and the basal vein is longer (1.25×) than the portion of subcostal vein forming the 1st cubital cell. Together with an extended hypopygium, this specimen could represent an undescribed species, but it appears to fit at the end of the range of variability of these characters. The hypopygium usually does not extend beyond the end of the metasoma, but depending on the extension or contraction of the metasomal segments the hypopygium (and ovipositor sheaths) may extend beyond the end of the metasoma, as in the Cameroon specimen.

The degree of striation on the pronotum is also variable with the posterior medial lateral section usually smooth and this smooth area can extend to the anterior medial margin. The mesopleuron can be completely striate or with a smooth medial patch, the latter state more typical of males. Two other characters used by Benoit are also variable and difficult to characterize: the medial depression, sometimes present posteriorly between the notauli, is highly variable in depth and presence and difficult to discern if weakly present; the presence or absence of the forewing areolet is also variable, usually very difficult to discern and arguably closed or open if it is visible.

Based on re-interpretation and subsequent appreciation that the diagnostic characters used by Benoit are highly plastic, in combination with the fact that his species concepts are based on single specimens that are representative of different points in a continuous range of variation, we synonymize these taxa under *F. aciculatus*. We chose this name because the type is in good condition and is representative of the most common morphology (within the range of intra-specific variation) exhibited by the specimens we have examined.

Lonchidia Thomson, 1862

Lonchidia Thomson, 1862: 413. Type-species: *Figites maculipennis* Dahlbom, 1842, by subsequent designation.

Diagnosis. Small, rather slender, and more or less strongly pubescent figitines, easily recognised by the confluent scutellar foveae. Pubescence is dense on patches on the sides of the large metasomal tergite, as a collar on the pronotum, on the propodeum, and rather dense also on metapleura and metacoxae. The marginal cell of the forewing is characteristically short, and the antennae in females end with an enlarged apical flagellomere.

Distribution. Mostly a Holarctic genus, here reported for the first time from the Afrotropical region. Afrotropical records: South Africa.

Biology. No host records exist. Hosts are expected to be saprophagous Brachycera larvae, but these wasps appear less directly associated with decomposing substrates like dung and carrion than many other figitines. Species in North America are frequently collected in pasture land or meadow, in close approximation to domesticated bovines (Buffington, pers. obs.)

Comments. The only Afrotropical specimen seen so far is from South Africa and may be an accidental introduction. It corresponds to a form present in Europe, which is currently considered as belonging to *Lonchidia clavicornis* Thomson, but which differs from the type specimen in some minor respects. Further studies may possibly show that this is a separate, currently unnamed, species.

Lonchidia clavicornis Thomson, 1862

Figure 3

Material examined. 1F: South Africa, Cape Province, 10 km S of Citrusdal, Koornlandskloof, S32°40', E19°02', 5–9.X.1994, marshy meadow at riverside, Malaise trap, leg. Michael Söderlund, MZLU 2013 227 (MZLU).

Neralsia Cameron, 1883

Neralsia Cameron, 1883: 4. Type species: *Neralsia rufipes* Cameron, 1883, by monotypy and original designation.

Xyalosema Dalla Torre & Kieffer, 1910: 73 & 94. Replacement name for *Solenaspis* Ashmead, 1887.

Solenaspis Ashmead, 1887: 151 & 155. Unavailable junior homonym of *Solenaspis* Osten Sacken, 1881 (Diptera). Type species: *Solenaspis hyalinipennis* Ashmead, 1887 by monotypy and original designation.

Diagnosis. Along with *Xyalophora*, this is the only known figitine in the Afrotropical Region with a scutellar spine. *Neralsia* can be distinguished from *Xyalophora* by whether or not the notauli are horizontally striate: smooth in *Neralsia*, striate in *Xyalophora* (Jiménez et al. 2008c). Also, most *Neralsia* have longer, more robust scutellar spines than *Xyalophora*, but in specimens we have examined, this character varies with overall size of the specimen. This taxon also resembles *Prosaspicera* (Aspicerinae), which also possess a distinct scutellar spine, but can be separated from *Prosaspicera* by the lack of a facial impression on the head (present in *Prosaspicera*), and lack of a ligulate metasoma T2.

Comments. Rare in Afrotropical region. The genus is extremely species-rich in the Neotropical region and has recently been revised in a series of papers by Jiménez et al. (2004, 2005a, 2005b, 2006, 2007, 2008a, 2008b); Jiménez and Pujade-Villar (2009); Petersen-Silva and Pujade-Villar (2010); Petersen-Silva et al. (2010) and Pujade-Villar et al. (2006). *Neralsia* is also common throughout the Nearctic Region, but species limits have not been thoroughly established (Buffington, pers. obs.)

Distribution. Mainly Neotropical, but with single species in the Nearctic and Afrotropical regions. Purported records from the Oriental region and the east Palearctic are unconfirmed. Afrotropical records: Central African Republic, South Africa (here).

Biology. Parasitoids of calyptrate Brachycera larvae in decomposing substrates (Díaz et al. 2000; Thomas and Morgan 1972).

Figure 3. *Lonchidia clavicornis* Thomson female. **A** lateral habitus **B** dorsal habitus **C** head and mesosoma, lateral view **D** head anterio-lateral view **E** mesosoma, dorsal view **F** wings (inset: data labels).

Neralsia haddocki van Noort, Buffington & Forshage, sp. n.

http://zoobank.org/6D429A4D-D056-4BBB-918E-6DF68DBD2447

Figures 4, 5, 6

Type material. HOLOTYPE. Female: **CENTRAL AFRICAN REPUBLIC**, Prefecture Sangha-Mbaéré, Réserve Spéciale de Forêt Dense de Dzanga-Sangha, 12.7km 326° NW Bayanga, 3°00.27'N, 16°11.55'E, 420m, 16–17.v.2001, S. van Noort, Malaise trap, CAR01-M145, Lowland Rainforest; SAM-HYM-P025026

(SAMC). **Paratype.** 1M: **SOUTH AFRICA**, [Eastern Cape Province], Port St John, Pondoland, 16–28.iv.1924, R.E. Turner, Brit. Mus. 1924-235 (BMNH).

Distribution. Central African Republic, South Africa.

Etymology. The specific epithet *haddocki* is in the genitive case and is for Captain Haddock, the comic book character by Hergé. The derivation has specific reference to Captain Haddock's consistent state of inebriation and utterance of the phrases "ten thousand thundering typhoons" and "billions of bilious blue blistering barnacles", expletives commiserate with the discovery and generic determination of this novel Afrotropical record in the CAR ethanol samples.

Diagnosis. *Neralsia haddocki* can be separated from all other described world *Neralsia* species by the closed marginal cell. A defined true vein is present along the wing margin completely closing the marginal cell. A number of the Central American and West Indies species have a darkening on the wing margin, but this is not considered to be a true vein (Jiménez et al. 2008b). The carina present between the scutellar fovea is at the same height as the outer foveal edge.

Description. FEMALE. Length 3.2 mm. Head, mesosoma, coxae, antennal scapes, and metasoma T1 black; rest of metasoma dark brown to reddish-brown; antennae gradually lightening from the dark-brown pedicel to the light reddish-brown F8-F11; legs reddish-brown. Wings transparent, without any infuscation.

Head. Head subquadrate, slightly wider 1.05× than long excluding mandibles. Entire head, including eyes and mandibles, with scattered strong white pubescence. Eyes slightly bulging, projecting beyond outer margin of gena in frontal view. Antenna 13 segmented; F1 marginally longer (1.07×) than F2; flagellum widening toward apex. Vertex polished, setose; ocellar plate slightly raised, polished, setose; lateral ocellus diameter 0.93× the distance between lateral and median ocellus (COC); POC:OOC:COC = 30:20:15. Upper face with reticulate carina radiating away from outer edges of toruli towards ocelli; antennal scrobes not delimited, but inner scrobal area with parallel finer carina arcing dorsally between toruli; semi-circular polished area anterior to medial ocellus. Occiput weakly concave in dorsal view, rugulose, with some parallel carina, medially polished. Lower face rugulose, with carinae directed towards middle of face; face humped between toruli and clypeal margin, protruding in lateral view; toruli projected on shelf. Upper clypeal margin defined by two pronounced lateral excavations, each encompassing an anterior tentorial pit. Clypeus with strong medial convexity, concave ventrally with strong, pubescence; clypeal margin evenly convex. Gena finely punctate proximal to eye, rugose towards mandible and strong genal carina.

Mesosoma. With scattered strong golden pubescence dorsally, laterally glabrous. Anterior plate of pronotum smooth dorso-medially with vertical parallel carina ventrally and laterally; plate dorsally and laterally defined by strong pronotal carina, which is medially indented. Lateral surface of pronotum horizontally striate, striations radiating away from submedial pronotal depression, containing dense, white fluff; pronotum ventrally with patch of dense white setae. Mesoscutum polished. Notauli almost complete, terminating just before anterior margin of mesocutum; smooth;

Figure 4. *Neralsia haddocki* sp. n., holotype female. **A** lateral habitus **B** dorsal habitus **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** mesosoma, lateral view **F** head, anterior view.

posteriorly broadening; median mesoscutal impression present as small insignificant depression; parascutal impressions weakly defined, smooth. Mesoscutum convex, scutellum flat. Scutellar fovea not subdivided by longitudinal carinae. Foveal carina at height of outer foveal edge. Scutellum laterally areolate-rugose, medially polished with reticulate carinae. Scutellar spine short, 0.3× scutellar length (excluding spine). Mesopleural triangle defined with weak ventral carina, horizontally striate with very fine pubescence; mesopleuron horizontally striate, striations denser dorsally than ventrally; mesopleural carina present, defined dorsally by parallel impression. Mesopleural pit

Figure 5. *Neralsia haddocki* sp. n., holotype female. **A** mesosoma, dorso-lateral view **B** propodeum and partial metasoma, dorsal view **C** propodeum and partial metasoma, lateral view **D** metasoma, lateral view **E** forewing and hindwing **F** data labels.

present. Metepisternum antero-ventrally excavated with pubescence, medially rugulose. Metepimeron depressed with pubescence. Lateral propodeal carina very prominent, thick and strongly raised, dorsal margin convex in lateral view. Median and lateral propodeal areas rugulose. Lateral propodeal area with strong pubescence. Calyptra prominent, strongly raised. Rs+M and areolet of forewing weakly defined. Basalis vein present. M+Cu1 weakly defined. Marginal cell 1.8× as long as wide, closed along wing margin. Margin with fringe of setae. Coxae sculpture, rest of legs polished, pubescent.

Figure 6. *Neralsia haddocki* sp. n., paratype male. **A** lateral habitus **B** head and mesosoma, dorsal view **C** body, lateral view **D** head anterior view **E** head and mesosoma, dorso-lateral view **F** wings (inset: data labels).

Mesotibial spurs subequal in length; metatibial outer spur shorter than inner spur. Ratio of first metatibial segment to the remaining 4 segments: 0.88×.

Metasoma. Tergite 3 strongly striate; tergite 4 anteriorly striate grading into punctate laterally and posteriorly; dorso-medially polished; remaining tergites finely punctate. Abdominal petiole (T2) strong, longitudinally striate, 2.2× as wide as long in dorsal view. T4 the largest tergite. Relative dorsal length of T3–T8: 60:100:8:8:15:40. Ovipositor valves not extending beyond apex of metasoma, enclosed within hypopygium. Ovipositor clip present, elongate with well-developed ventral lobe. Hypopygium with fringe of long setae running down each side; not extending beyond T8.

MALE. Length 2 mm. Head, mesosoma, coxae, antennal scapes, and posterior two-thirds of metasoma T1 black; rest of metasoma and coxae dark reddish-brown; antennae light reddish-brown; rest of legs pale yellowish-brown except for hind femur, which is reddish-brown for proximal two-thirds. Wings transparent, without any infuscation.

Head. Head more transversely globose than in female, 1.2× wider than long excluding mandibles. Entire head, including eyes and mandibles, with scattered strong white pubescence. Eyes strongly bulging, projecting well beyond outer margin of gena in frontal view. Antenna 14 segmented; F1 same length as F2; flagellar segments gradually shortening towards apex; except for long ultimate segment (1.15× length of F1). Vertex granulate, setose; ocellar plate slightly raised, polished, setose; lateral ocellus diameter 1.2× the distance between lateral and median ocellus (COC). Upper face with reticulate carina radiating away from outer edges of toruli towards ocelli. Occiput weakly concave in dorsal view, with parallel semi-reticulate carina. Face and clypeus as in female.

Mesosoma. With scattered strong white pubescence dorsally, laterally glabrous, otherwise mesosoma as in female. Forewing more setose than in female.

Metasoma. Tergite 3 polished; tergite 4 anteriorly polished grading into punctate laterally and posteriorly; remaining tergites finely punctate. Abdominal petiole (T2) strong, longitudinally striate, twice as wide as long in dorsal view. T4 the largest tergite. Relative dorsal length of T3–T8: 10:14:1:1:2:1.

Xyalophora **Kieffer, 1901**

Xyalophora Kieffer, 1901: 344. Type species: *Figites clavatus* Giraud, 1860, by monotypy and original designation.

Ceraspidia Belizin, 1952: 301. Type species: *Ceraspidia japonica* Belizin, 1952, by monotypy and original designation.

Diagnosis. *Xyalophora* shares the presence of a scutellar spine with *Neralsia*, absent in *Figites* and *Lonchidia*. *Xyalophora* can be separated from *Neralsia* by the presence of transversely striate notauli (smooth in *Neralsia*), and an often slightly smaller scutellar spine; this second character, however, is often linked to adult body size and should be used with caution. As in the case of *Neralsia*, species of *Xyalophora* can be superficially similar to *Prosaspicera* (Aspicerinae), but can be separated from that taxon by the lack of a facial impression on the head, as well as the lack of a ligulate metasomal T2. All three African species have the occipital carinae directed towards the ocellar area and separated in the middle by a smooth surface as well as a smooth interocellar area.

Distribution. Probably worldwide, but no records from the Oriental region are published. Afrotropical records: Burkina Faso (Jiménez et al. 2008c); Democratic Republic of Congo, Mali, Namibia, South Africa (here).

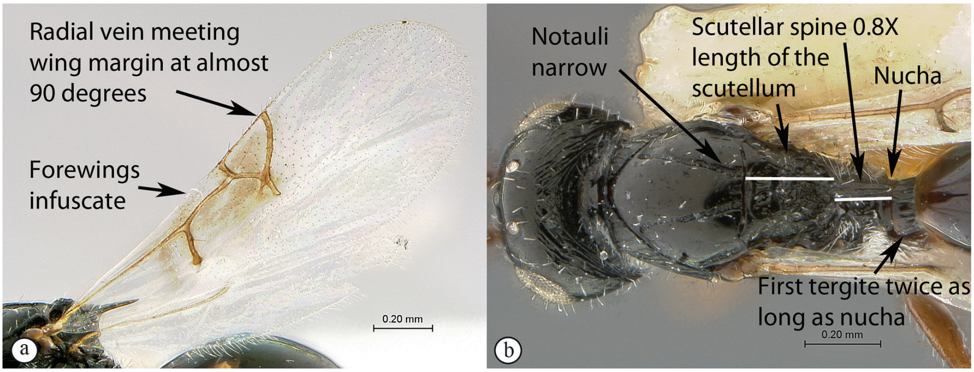
Biology. Parasitoids of calyptrate Brachycera larvae in decomposing substrates (Ionescu 1969).

Comments. A rare genus that has been recently revised by Jiménez et al. (2008c).

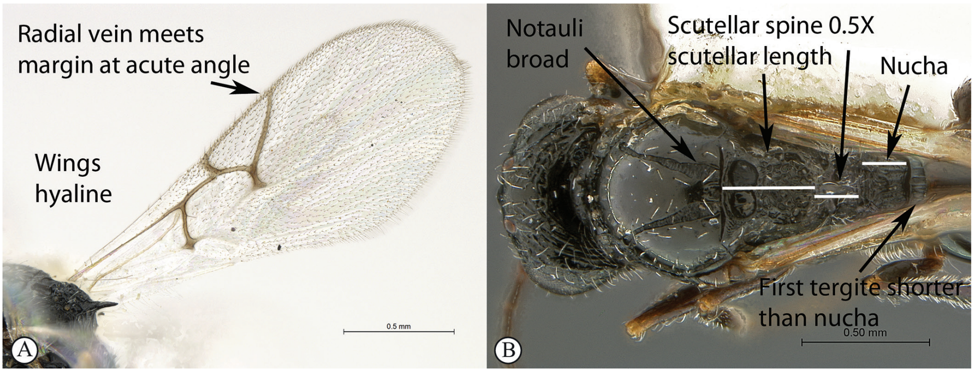
Species richness

Xyalophora provancheri Jiménez & Pujade-Villar, 2008 (Burkina Faso)
Xyalophora tedjoansi **sp. n.** (Mali)
Xyalophora tintini **sp. n.** (Democratic Republic of Congo, Namibia, South Africa)

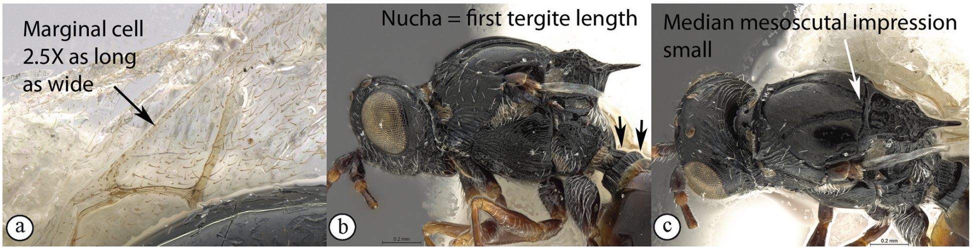
Key to Afrotropical species of *Xyalophora*



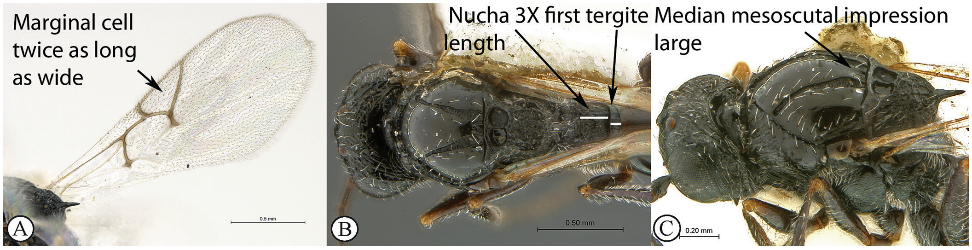
1 Forewings infuscate over area surrounding venation (a). Marginal cell 1.55× as long as wide (a), venation thick with a very thin marginal vein (a); radial vein meeting wing margin at almost 90 degrees (a). Scutellar spine long, 0.8× length of the scutellum (excluding spine) (b). Notauli narrow (maximum width 0.35× the minimum distance separating notauli towards posterior mesoscutal margin) (b). Head subquadrate, 1.1× wider than long. First tergite (petiole) long (0.6× as long as high in lateral view; twice as long as nucha in dorsal view) (b) .... ***Xyalophora tedjoansi*** **sp. n.**



– Forewings hyaline (A). Marginal cell 2–2.5× as long as wide (A), venation thinner with less contrast in thickness with marginal vein (A); radial vein meets wing margin at acute angle (A). Scutellar spine shorter, 0.5× the length of the scutellum (excluding spine) (B). Notauli widened posteriorly (maximum width 0.7–0.8× the minimum distance separating notauli towards posterior mesoscutal margin) (B). Head distinctly (1.25×) wider than long. First tergite short (0.2–0.25× as long as high in lateral view; either a third of nucha length (B) or equivalent in length to nucha in dorsal view) **2**



2 Marginal cell 2.5× as long as wide (a). Nucha short, equivalent in length to first tergite (b). First tergite 0.25× as long as high in lateral view (b). Second flagellar segment longer than first. Median mesoscutal impression small (c)..................
......................................***Xyalophora provancheri*** **Jiménez & Pujade-Villar**



– Marginal cell twice as long as wide (A). Nucha long, 3× first tergite length (B). First tergite 0.2× as long as high in lateral view. Second flagellar segment as long as first. Median mesoscutal impression large, distinct (C)................
....***Xyalophora tintini*** **sp. n.**

Xyalophora provancheri Jiménez & Pujade-Villar, 2008

Figures 7, 8

Type material. Holotype. Female: C-335, Burkina Faso, Komprenya, 1–6.VI.1988, Sanborne, Landry & Tou Sarame" (white label); "Holotype desig.-2006 Jiménez & Pujade-Villar" (red label); "*Xyalophora provancheri* sp. n. & Jiménez & Pujade-Villar, det. 2006" (white label); IMAGED WaspWeb LAS 4.4 SAMC 2014 (yellow label). Deposited in CNCI, Ottawa.

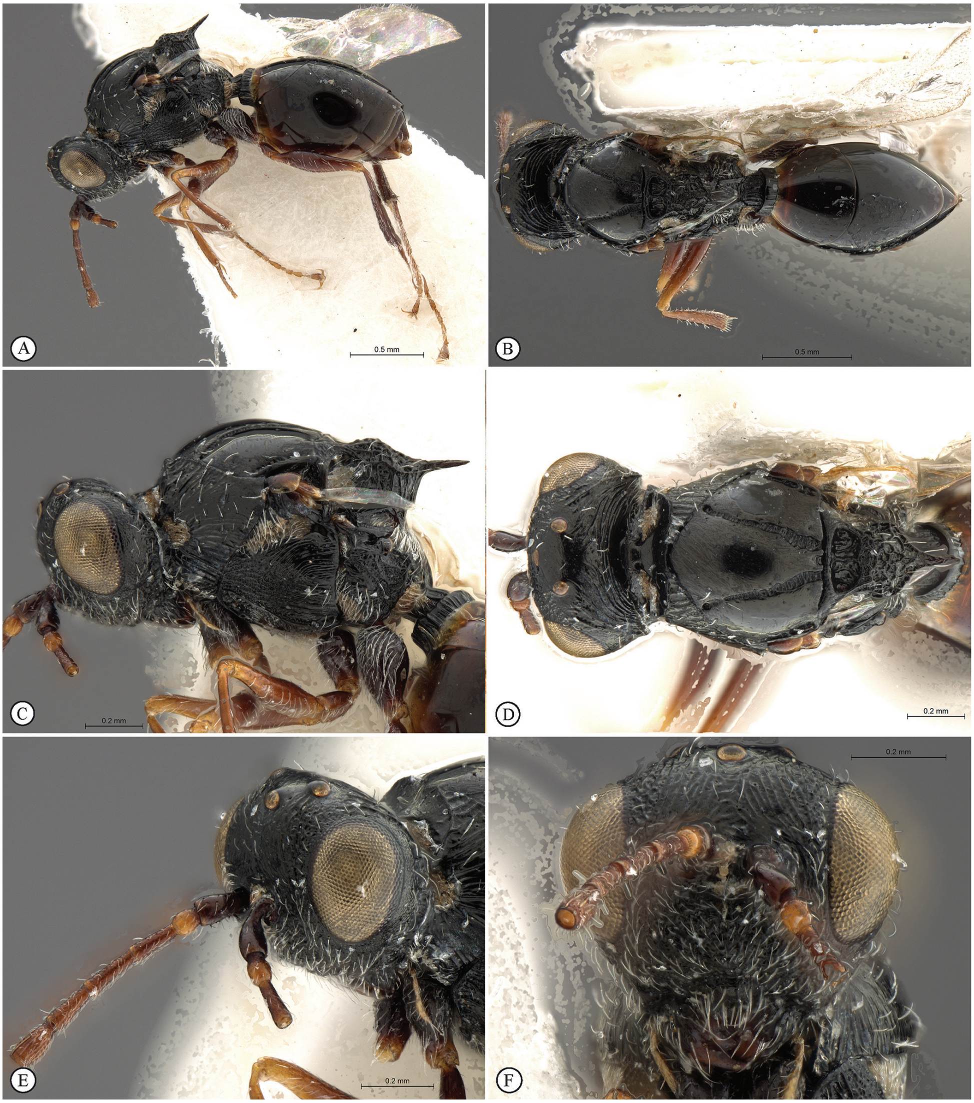


Figure 7. *Xyalophora provancheri*, holotype female. **A** lateral habitus **B** dorsal habitus **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** head and antennae, anterio-lateral view **F** head, anterior view.

Diagnosis. Occipital carinae parallel, fine. Scutellar spine long, 0.5× length of the scutellum (excluding spine). First tergite short (0.25× as long as high in lateral view; equivalent in length to nucha in dorsal view). Notauli widened posteriorly (maximum width 0.8× the minimum distance separating them towards posterior mesoscutal margin). Marginal cell 2.5× as long as wide. Second flagellar segment longer than first.

Distribution. Burkina Faso.

Figure 8. *Xyalophora provancheri*, holotype female. **A** head and mesosoma, dorso-lateral view **B** metasoma, lateral view **C** head and partial mesosoma, anterio-dorsal view **D** forewing (inset: data labels).

Xyalophora tedjoansi van Noort, Buffington & Forshage, sp. n.

http://zoobank.org/9C36B235-2E9C-4067-BCA5-05ACFA2F7710
Figures 9, 10

Type material. HOLOTYPE. Female: COLL. MUS. TERVUREN, Mali: Cinzana, 18-ix-1970, G. Pierrard, Imaged WaspWeb SAMC 2012 (yellow label), Holotype F ***Xyalophora tedjoansi*** van Noort, Buffington & Forshage (red label) [point-mounted on white card] (RMCA).

PARATYPE. 1F: COLL. MUS. TERVUREN, Mali: R.C T. – M'Pesoba, 11-vii-1970, G. Pierrard, Imaged WaspWeb, SAMC 2012 (yellow label), Paratype F ***Xyalophora tedjoansi*** van Noort, Buffington & Forshage (yellow label) (RMCA).

Distribution. Mali.

Etymology. The specific epithet *tedjoansi* is in the genitive case and is to commemorate the American-cosmopolitan poet Ted Joans (1928–2003), a surrealist, beat, black power and jazz activist who made Mali one of his several homes in the world. The *Xyalophora* spine may suggest the horn of Joans' totemic rhino.

Diagnosis. The large first tergite (petiole) and infuscate forewings surrounding the venation and radial vein meeting wing margin at almost 90 degrees immediately

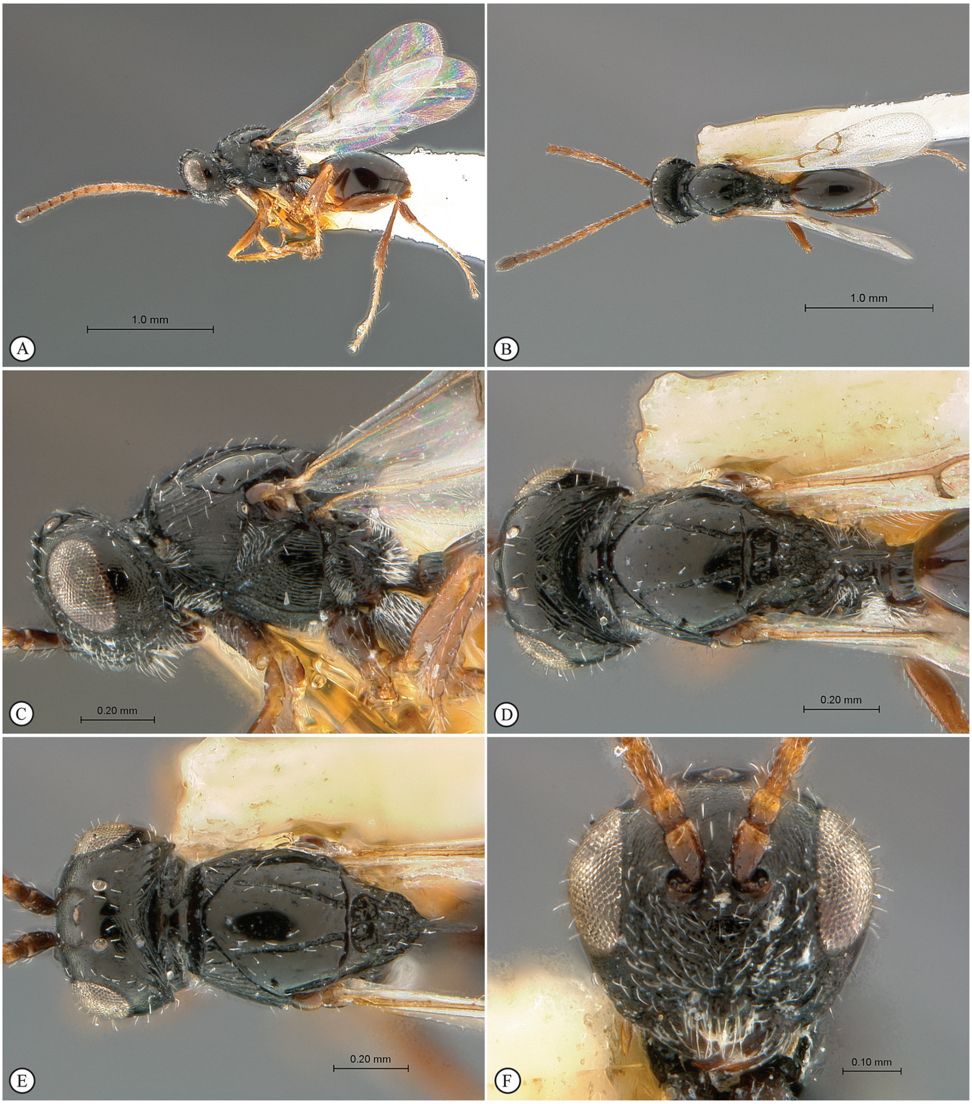


Figure 9. *Xyalophora tedjoansi* sp. n., holotype female. **A** lateral habitus **B** dorsal habitus **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** head and mesosoma, posterior-dorsal view **F** head, anterior view.

distinguish this species. Head subquadrate, 1.1× wider than long (*X. provancheri* distinctly wider than long 1.24×). Occipital carinae parallel, fine as in *X. provancheri* contrasting with the discontinuous rugose carinae of *Xyalophora tintini*. Antennae clavate as in *X. provancheri*. Scutellar spine long, 0.8× length of the scutellum (excluding spine). Scutellar spine shorter in the other two Afrotropical species (0.5× length of the scutellum). Petiole (T2) longer than in other two species:1.6× higher than long in lateral view (3.6–4× higher than long in other two species). Notauli narrow, 1/3 of the distance separating them at posterior mesoscutal margin; broader in other two species (1/2 of the distance separating them at posterior mesoscutal margin). Marginal cell venation much thicker (except for thin marginal vein) than in the other two species; Rs radial vein meeting wing margin at almost 90 degrees (Rs meets wing margin at acute angle in *X. provancheri* and *X. tintini*). Wings infuscate around venation, hyaline in *X. tintini*. First tergite (petiole) long (0.6× as long as high in lateral view; twice as long as nucha in dorsal view).

Description. FEMALE. Length 1.85 mm. Head, mesosoma black; metasoma dark brown. Antennae brownish-orange, darkening towards terminal three segments. Legs brownish-orange, except for coxae, which are darker. Wings transparent; with irregular infuscation either side of the basalis vein, and in marginal cell.

Head. Head subquadrate, 1.1× wider than long. Entire head, including eyes, with scattered pubescence, pubescence densest on lower face. Eyes not laterally extended, confluent with outer margin of gena in frontal view. Antenna 13 segmented; F1 slightly shorter than F2; flagellum widening gradually toward apex with final segment (F11) globular. Vertex polished, ocellar plate slightly raised; ocelli normal, their diameter half the distance between lateral and median ocellus (COC); POC:OOC:COC = 20:15:12. Upper face coriaceous, antennal scrobes not delimited. Occiput weakly concave in dorsal view, with numerous sub-parallel, occasionally reticulate, carinae radiating from occiptal carinae and directed medially towards ocelli, but terminating well before lateral ocelli. Lower face rugulose, weakly humped between toruli and clypeal margin, slightly protruding in lateral view. Upper clypeal margin defined by pronounced excavation containing anterior tentorial pits. Clypeus with strong medial hump dorsally, concave ventrally with strong pubescence. Gena rugulose in malar space, coriaceous medially and dorsally.

Mesosoma. With scattered pubescence. Anterior plate of pronotum polished, glabrous dorsally and medially, setose laterally on bridge; fovea closed with narrow lateral bridge; plate dorsally and laterally defined by strong pronotal carina. Lateral surface of pronotum horizontally striate, anterio-medially and ventrally with patch of dense white setae. Mesoscutum polished with lines of strong white setae each side of notauli and along lateral margins of scutum. Notauli almost complete, terminating just before anterior margin of mesoscutum; transversely striate; only slightly widening towards posterior mesoscutal margin (maximum width 0.35× the minimum distance separating them towards posterior mesoscutal margin); median mesoscutal impression very faint, weakly defined; parascutal impressions defined, sculpturing similar to notauli. Mesoscutum convex and scutellum anteriorly humped in lateral view. Scutellar fovea each with a longitudinal carina. Scutellum strongly areolate-rugose. Scutellar spine elongate, 0.8× scutellar length (excluding spine). Mesopleural triangle defined without ventral carina, strongly pubescent; posterior half (including speculum) of mesopleuron horizontally striate, anterior half rugulose-punctate; mesopleural carina defined. Metepisternum ventrally excavated with pubescence, medially longitudinally striate. Metepimeron depressed with pubescence. Dorsellum laterally strongly excavated. Lateral propodeal carina present. Lateral propodeal area densely pubescent. Rs+M of forewing

Figure 10. *Xyalophora tedjoansi* sp. n., holotype female. **A** head and mesosoma, dorso-lateral view **B** metasoma, lateral view **C** head and partial mesosoma, anterio-dorsal view **D** forewing and hind wing **E** paratype female, lateral habitus **F** data labels.

weakly defined distally at junction with 2r, but otherwise absent. Basalis vein present. M+Cu1 absent. Marginal cell closed, 1.55× as long as wide, veins thick, contrasting with thin marginal vein. Radial vein meets wing margin at almost 90 degrees. Margin with fringe of setae. Legs sparsely punctate, pubescent. Metacoxa stongly and densely pubescent. Mesotibial and metatibial outer spur shorter than inner spur. Ratio of first metatibial segment to the remaining 4 segments: 0.77×.

Metasoma. Tergites polished. First tergite longitudinally striate, 4.3× as wide as long in dorsal view; 1.6× higher than long in lateral view; twice as long as nucha in dorsal view. T4 the largest tergite. Relative dorsal length of T3–8: 75:95:15:15:20:15. Posterior margin of T7 evenly curved. T8 exposed. Ovipositor valves not extending beyond apex of metasoma, concealed within T8. Hypopygium not extending beyond T8.

Xyalophora tintini **van Noort, Buffington & Forshage, sp. n.**

http://zoobank.org/B80EB32C-A928-4F39-BD29-3E6D02EBDC1A

Figures 11, 12

Type material. HOLOTYPE Female. **DEMOCRATIC REPUBLIC OF CONGO:** Congo belge : P.N.U. Mabwe (r. E. lac Upemba), (585m) 15-viii-1947. Miss. G.F. de Witte. 678a, Holotype F ***Xyalophora tintini*** van Noort, Buffington & Forshage (red label) [point-mounted on white card] (RMCA).

PARATYPES. NAMIBIA, 1 male: South West Africa (W22), Kuiseb river canyon, 22–23.i.1972, Riverside vegetation, Southern African Exp. B.M.1972-1 (BMNH). **SOUTH AFRICA**, 1 female: Cape Province, Swellendam, ii.1932, S. Africa, R.E. Turner, Brit Mus., 1932-145 (BMNH).

Diagnosis. Occiput with parallel carinae (but with some discontinuous reticulation on left hand side of occiput in holotype female). Head distinctly (1.25×) wider than long as in *X. provancheri* (*X. tedjoansi* subquadrate 1.1×). Scutellar spine shorter, 0.5× length of the scutellum (excluding spine) as in *X. provancheri* (longer, 0.8× in *X. tedjoansi*). Notauli widened posteriorly, narrow in *X. tedjoansi*. Median mesoscutal impression distinct. Marginal cell 2.0× as long as wide (2.5× in *X. provancheri*). Wings hyaline, infuscate around venation in *X. tedjoansi*.

Distribution. Democratic Republic of Congo, Namibia, South Africa.

Etymology. The specific epithet *tintini* is in the genitive case and is for Tintin, the comic book character by Hergé, whose adventures in the Congo have done much to popularise the country in a very controversial manner in parts of the world. The *Xyalophora* spine may possibly suggest Tintin's famous tuft of hair.

Description. FEMALE. Length 2.75 mm. Head, mesosoma and metasoma black. Antennae and legs dark brown except for coxae, which are black. Wings transparent; without any infuscation.

Head. Head transverse. 1.25× wider than long. Entire head, including eyes, with scattered pubescence, pubescence densest on lower face. Eyes not laterally extended, almost confluent with outer margin of gena in frontal view. Antennae damaged in holotype, only 10 segments remaining on left antennae (right antenna missing); F1 equal in length to F2; flagellum widening toward remaining end. Vertex weakly rugulose, polished adjacent to lateral ocelli, ocellar plate slightly raised, polished, weakly laterally defined with confused carinae; lateral ocellus diameter 0.65× the distance between lateral and median ocellus (COC); POC:OOC:COC = 30:20:17.

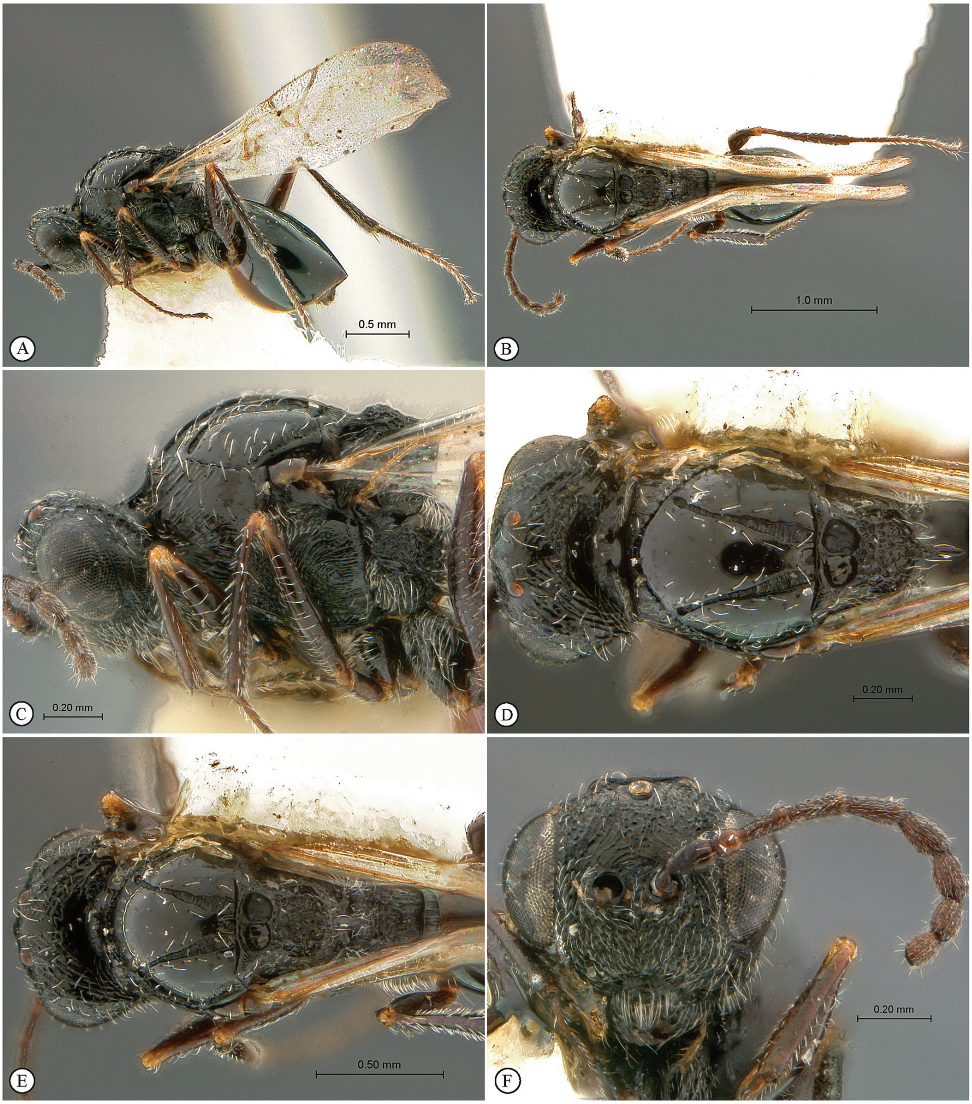


Figure 11. *Xyalophora tintini* sp. n., holotype female. **A** lateral habitus **B** dorsal habitus **C** head and mesosoma, lateral view **D** head and mesosoma, dorsal view **E** head and mesosoma, posterior-dorsal view **F** head, anterior view.

Upper face rugose, antennal scrobes not delimited, but scrobal area with parallel striations directed towards medial rugose area anterior to medial ocellus. Occiput weakly concave in dorsal view, rugulose, with some parallel carinae, medially polished. Lower face rugulose, weakly humped between toruli and clypeal margin, slightly protruding in lateral view. Upper clypeal margin defined by pronounced excavation containing anterior tentorial pits. Clypeus with strong medial longitudinal hump dorsally, concave ventrally with strong, long pubescence; clypeal margin evenly convex. Gena finely colliculate in malar space, coriaceous medially and dorsally; genal carina defined with strong linear alveolations.

Mesosoma. With scattered strong pubescence. Anterior plate of pronotum polished, glabrous dorsally and medially, setose laterally on bridge; fovea closed with broad lateral bridge; plate dorsally and laterally defined by strong pronotal carina. Lateral surface of pronotum horizontally striate, anterio-medially and ventrally with patch of white setae. Mesoscutum polished with lines of strong white setae each side of notauli and along lateral margins of scutum. Notauli almost complete, terminating just before anterior margin of mesocutum; transversely striate; posteriorly broadening abruptly prior to narrowing again at posterior mesoscutal margin; widened posteriorly (maximum width 0.7× the minimum distance separating them towards posterior mesoscutal margin); median mesoscutal impression present as small circular concavity; parascutal impressions defined, sculpturing similar to notauli. Mesoscutum convex and scutellum anteriorly humped in lateral view. Scutellar fovea each with an incomplete longitudinal carina. Scutellum strongly areolate-rugose. Scutellar spine elongate, 0.5× scutellar length (excluding spine). Mesopleural triangle defined without ventral carina, strongly pubescent; posterior half (except for polished speculum) of mesopleuron horizontally striate, anterior half rugulose-punctate; mesopleural carina defined. Metepisternum ventrally excavated with pubescence, medially rugulose. Metepimeron depressed with pubescence. Dorsellum laterally strongly excavated. Lateral propodeal carina present. Lateral propodeal area densely pubescent. Rs+M of forewing weakly defined distally at junction with 2r, but otherwise absent. Basalis vein present. M+Cu1 absent. Marginal cell 2.0× as long as wide, closed along wing margin with weak vein. Margin with fringe of setae. Legs sparsely punctate, pubescent. Metacoxa stongly and densely pubescent. Mesotibial and metatibial outer spur shorter than inner spur. Ratio of first metatibial segment to the remaining 4 segments: 0.88×.

Metasoma. Tergites polished. First tergite (petiole) short, longitudinally striate, 3.5× as wide as long in dorsal view; 5× higher than long in lateral view; a third of nucha length in dorsal view. T4 the largest tergite. Relative dorsal length of T3–T4: 7:10; T5–T8 hidden beneath T4. Ovipositor valves not extending beyond apex of metasoma, concealed within T8. Hypopygium not extending beyond T8.

MALE. Length 2 mm. Head, mesosoma and metasoma black. Antennae reddish-brown; legs brown except for coxae, which are dark brown and femur/tibial junctions which are paler. Wings transparent; without any infuscation.

Head. As in female, except for antenna with 14 segments: F1 0.85× length of F2; F3-F7 equivalent in length to F2. F8–F11 equivalent in length to F1; ultimate segment 1.65× F1; and occiput with parallel semi-reticulate carina, medially polished.

Mesosoma as in female, except for stronger forewing venation and slightly more hirsute wing surface and fringe.

Metasoma. Tergites polished. First tergite (petiole) short, polished with isolated longitudinal striae, 3× as wide as long in dorsal view; equivalent to nucha length in dorsal view. T4 the largest tergite. Relative dorsal length of T3–T5: 7:9:1; T6–T7 hidden beneath T5.

Figure 12. *Xyalophora tintini* sp. n., holotype female. **A** head and mesosoma, dorso-lateral view **B** head and partial mesosoma, anterio-dorsal view **C** forewing and hind wing **D** data labels.

Comments. The much smaller second female from South Africa has a very thin, polished second tergite, with no discernable longitudinal striations. Possibly these are hidden under the overlapping anterior margin of the third tergite. Otherwise this specimen keys to *X. tintini*. This species is very similar to *X. provancheri* only being separated by the shorter first tergite and slightly broader marginal cell. The tendency towards rugulose sculpture on the occiput of the holotype specimen is likely to be related to the larger size of the holotype and not diagnostically useful.

Conclusion

Representatives of Afrotropical Figitinae are rare in collections and the available specimens probably represent a superficial gathering of actual species richness. Very few countries are represented in the material that was available for examination and with further sampling, potentially using less commonly deployed collecting techniques such as carrion traps, fecal traps and emergence traps, many more specimens are anticipated. However, from experience with Malaise trapping projects in central, east and southern Africa, Afrotropical Figitidae may be locally abundant, and if the trap is in the wrong place at the wrong time, the wasps will be missed. These projects, which have resulted in months of Malaise trap samples, yielded precious few Figitinae. In contrast, Malaise trapping programs in North, Central and South America have yielded many specimens and species of Figitinae, but these samples emanate from traps sited in close association with areas of human disturbance and/or domesticated livestock. Since core figitines are associated with brachyceran flies, it is logical that we would find these wasps where we find the flies, and many of these flies are associated with homo-specific environments. Perhaps future collecting in the Afrotropical Region, in or near homo-specific environments, will yield hitherto unknown species of Figitinae.

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References

Ashmead WH (1887) On the cynipidous galls of Florida, with descriptions of new species and Synopses of the described species of North America. Transactions of the American Entomological Society 14: 125–158.

Belizin VI (1952) [Wasps of the subfamily Aspicerinae (Hymenoptera, Cynipidae) in the Fauna of the USSR]. Entomologicheskoye Obozreniye 32: 290–303.

Benoit PLG (1956) Figitinae nouveaux du Congo Belge (Cynip.-Figitidae). Revue de Zoologie et de Botanique Africaines 53: 377–384.

Buffington ML, van Noort S (2009) A world revision of *Anacharoides* Cameron, 1904 (Hymenoptera: Figitidae) with a description of a new species. Zookeys 20: 245–274. doi: 10.3897/zookeys.20.124

Buffington ML, Burks R, McNeil L (2005) Advanced techniques for imaging microhymenoptera. American Entomologist 51: 50–54.

Buffington ML, Gates M (2009) Advanced imaging techniques II: using a compound microscope for photographing point-mount specimens. American Entomologist 54: 222–224.

Buffington ML, Nylander JAA, Heraty J (2007) The phylogeny and evolution of Figitidae (Hymenoptera: Cynipoidea). Cladistics 23: 1–29. doi: 10.1111/j.1096-0031.2007.00153.x

Cameron P (1883) Fam. Figitidae. In: Godman FO, Salvin O (Eds) Biologia Centrali-Americana or Contributions to the knowledge of the fauna and flora of Mexico and Central America, v. I (Hymenoptera). Taylor & Francis edit, London, 73–75.

Dalla Torre KW, Kieffer JJ (1910) Cynipidae. Das Tierreich 24. Berlin, 891 pp.

Díaz NB, Gallardo F, Marchiori C, Linhares A (2000) About Cynipoidea of Brazil, parasitoids of dung-flies. II (Insecta, Hymenoptera). Anais da Sociedade Entomolológica do Brasil 29 (3): 469–474. doi: 10.1590/S0301-80592000000300009

Fontal-Cazalla FM, Buffington M, Nordlander G, Liljeblad J, Ros-Farré P, Nieves-Aldrey JL, Pujade-Villar J, Ronquist F (2002) Phylogeny of the Eucoilinae (Hymenoptera: Cynipoidea: Figitidae). Cladistics 18: 154–199. doi: 10.1111/j.1096-0031.2002.tb00147.x

Förster A (1869) Ueber die Gallwespen. Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien 19: 327–370.

Harris RA(1979) A glossary of surface sculpturing. Occasional Papers in Entomology 28: 1–31.

Hartig T (1840) Ueber die Familie der Gallwespen. Zeitschrift für die Entomologie 2: 176–209.

Hedicke H (1913) Beiträge zur Kenntnis der Cynipiden. iv. Ent. Mitt. 2: 146–148.

Hennig W (1976) 63a – Anthomyiidae, T 3. In: Lindner E (Ed.) Die Fliegen der palearktischen Region. Stuttgart, 681–974.

Ionescu MA (1969) Hymenoptera Cynipoidea. Fauna Republicii Socialiste România, Insecta vol IX, fasc 6, 292 pp.

James HC (1928) On the life-histories and economic status of certain Cynipid parasites of Dipterous larvae, with descriptions of some new larval forms. Annals of Applied Biology 15: 287–316.

Jiménez M, Díaz NB, Gallardo F, Ros-Farré P, Pujade-Villar J (2004) Las especies sudamericanas del género *Neralsia* Cameron (Hymenoptera: Cynipoidea: Figitidae: Figitinae): estudio del material tipo. Butlletí de la Institució Catalana d'Història Natural 72: 61–81.

Jiménez M, Díaz NB, Gallardo F, Ros-Farré P, Pujade-Villar J (2005a) Resultados preliminares del estudio de las especies sudamericanas del género *Neralsia* Cameron (Hymenoptera: Cynipoidea: Figitidae: Figitinae). Sessió Conjunta d'Entomologia de la Institució Catalana d'Història Natural y la Societat Catalana de Lepidopterologia 13 (2003): 73–84.

Jiménez M, Díaz NB, Gallardo F, Ros-Farré P, Pujade-Villar J (2005b) Descripción de ocho especies sudamericanas del género *Neralsia* Cameron 1883, con carena escutelar alta (Hymenoptera: Cynipoidea: Figitidae). Nouvelle Revue d'Entomologie (N.S.) 22(2): 165–179.

Jiménez M, Díaz NB, Gallardo F, Ros-Farré P, Pujade-Villar J (2006) Descripción de nueve especies sudamericanas del género *Neralsia* Cameron con carena escutelar baja (Hymenoptera: Cynipoidea: Figitidae). Neotropical Entomology 31(1): 59–69. doi: 10.1590/S1519-566X2006000100009

Jiménez M, Paretas-Martínez J, Pujade-Villar J (2007) Revision of the South American species of *Neralsia* (Hymenoptera: Figitidae) with the description of eight new species. Revista de Biologia Tropical (International Journal of Tropical Biology) 56(2): 795–828. doi: 10.15517/rbt.v56i2.5625

Jimenéz M, Paretas-Martínez J, Pujade-Villar J (2008a) Revisión de las especies de *Neralsia* de Centroamérica y las Antillas, con la descripción de once especies nuevas (Hymenoptera: Figitidae: Figitinae). Dugesiana 15(1): 45–68.

Jiménez M, Paretas-Martínez J, Pujade-Villar J (2008b) Revision of the species of *Neralsia* (Hymenoptera: Figitidae: Figitinae) from North America. Annals of the Entomological Society of America 101(6): 993–1002. doi: 10.1603/0013-8746-101.6.993

Jiménez M, Paretas-Martínez J, Pujade-Villar J (2008c) Revision of *Xyalophora* Kieffer and description of *Xyalophoroides* gen. n. (Hymenoptera: Figitidae: Figitinae). European Journal of Entomology 105: 751–769. doi: 10.14411/eje.2008.101

Jiménez M, Pujade-Villar J (2009) Descripción de nueva especie de *Neralsia* (Hymenoptera: Figitinae) de Bolivia. Boletín Sociedad Entomológica Aragonesa 45: 313–315.

Kerr PH, Fisher EM, Buffington ML (2008) Dome lighting for insect imaging under a microscope. American Entomologist 54: 198–200.

Kieffer JJ (1901) Notes sur les Cynipides (Hymén.). Bulletin de la Societe Entomologique de France 1901: 343–344.

Latreille PA (1802) Histoire Naturelle, Générale et Particulière, des Crustacés et des Insectes. 14 Vols, 3. F. Dufart, Paris.

Penev L, Sharkey M, Erwin T, van Noort S, Buffington M, Seltmann K, Johnson NF, Taylor M, Thompson FC, Dallwitz MJ (2009) Data publication and dissemination of interactive keys under the open access model. ZooKeys working example. Forum paper. ZooKeys 21: 1–17. doi: 10.3897/zookeys.21.274

Petersen-Silva R, Pujade-Villar J (2010) Descripción de dos nuevas especies del género *Neralsia* Cameron de Venezuela (Hymenoptera: Cynipoidea: Figitidae). Dugesiana 17(1): 49–52.

Petersen-Silva R, Jiménez M, García JL, Pujade-Villar J (2010) Nuevos aportes al conocimiento de las especies del género *Neralsia* Cameron (Hymenoptera: Figitidae: Figitinae) en Venezuela. Boletín de la Sociedad Entomológica Aragonesa 46: 373–376.

Pujade-Villar J, Paretas-Martínez J, Jiménez M (2006) Description of a new species of *Neralsia* Cameron with a wide distribution in the American continent: *N. incompleta* n. sp. (Hymenoptera: Figitidae: Figitinae). Annales de la Société Entomologique de France (n.s.) 42(1): 45–49.

Ronquist F (1999) Phylogeny, classification and evolution of the Cynipoidea. Zoologica Scripta 28: 139–164. doi: 10.1046/j.1463-6409.1999.00022.x

Ronquist F, Nordlander G (1989) Skeletal morphology of an archaic cynipoid, *Ibalia rufipes* (Hymenoptera, Ibaliidae). Entomologica Scandinavica, Suppl. 33: 1–60.

Thomas G, Morgan C (1972) Parasites of the horn fly in Missouri. Journal of Economic Entomology 65: 169–174.

Thomson CG (1862) Försök till uppställning och beskrifning af Sveriges Figiter. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar 18: 395–400.

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Supplementary catalogue of the Anthomyiidae (Diptera) of China

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Abstract

The present catalogue of Anthomyiidae attempts to list all species (173) described or recorded from mainland China (165) and Taiwan (8) that for various reasons are not treated in “Flies of China” from 1998. The catalogue further lists Chinese species that are presently standing in new generic combinations compared to those of “Flies of China”, species that have changed name because of synonymy or misidentification, and species upgraded from subspecies to species. Regional distribution by province is specified for all species. Literature sources to descriptions or records of anthomyiid species from China are only given for those 173 species not covered by “Flies of China”. Four new combinations are proposed: *Enneastigma fulva* (Malloch, 1934), *Enneastigma henanensis* (Ge & Fan, 1982), *Enneastigma lengshanensis* (Xue, 2001) and *Hylemya qinghaiensis* (Fan, Chen & Ma, 1989). *Eremomyia turbida* Huckett, 1951 is revived from synonymy with *Chortophila triticiperda* Stein, 1900 (current name *Eutrichota turbida*). One subspecies is upgraded to species: *Adia asiatica* Fan, 1988. The following eight new synonymies are proposed: *Delia pectinator fuscilateralis* Fan in Fan & Zheng, 1992 with *Delia pectinator* Suwa, 1984; *Eremomyia pilimana pilimarginata* Fan & Qian in Fan, Chen, Ma & Ge, 1982 with *Eremomyia turbida* Huckett, 1951 (current name *Eutrichota turbida*); *Lopesohylemya* Fan, Chen & Ma, 1989 with *Hylemya* Robineau-Desvoidy, 1830; *Deliomyia* Fan in Fan et al., 1988 with *Subhylemyia* Ringdahl, 1933; *Hydrophoria disticrassa* Xue & Bai, 2009 with *Hydrophoria pullata* Wu, Liu & Wei, 1995 (current name *Zaphne pullata*); *Heteroterma* Wei, 2006 with *Scathophaga* Meigen, 1803; *Heteroterma fanjingensis* Wei, 2006 with *Scathophaga curtipilata* Feng, 2002; *Scatomyza fansipanicola* Ozerov in Ozerov & Krivosheina, 2011 with *Scathophaga curtipilata* Feng, 2002. The genus *Heteroterma* Wei, 2006 and species *Heteroterma fanjingensis* Wei, 2006 are reassigned from Anthomyiidae to Scathophagidae.

Keywords

Nomenclature, classification, Anthomyiidae, Scathophagidae, China, Taiwan

Introduction

China is a huge country of 9.6 million square kilometres in eastern Asia supporting a rich Palaearctic biota supplemented with a smaller Oriental biota in the southern areas. The Anthomyiidae are a large and diverse family of muscoid Diptera with c. 2000 described species worldwide. Anthomyiid flies are most diverse under temperate to subarctic conditions in the Northern Hemisphere. Accordingly, the Chinese anthomyiid fauna is exceedingly rich, including about one-third of the known world fauna, but still far from exhaustively investigated despite the voluminous literature on the subject.

The first comprehensive revision of the Anthomyiidae in China is that of Fan et al. (1988) who recognized 352 named species/subspecies in 43 genera. A second, more summary treatment of the family was given by Wei et al. (1998a, b) in the monumental “Flies of China” issued in two volumes (Xue and Chao 1998a, b). They recognized 515 species/subspecies in 43 genera from mainland China (514) and Taiwan (1). This figure has presently been adjusted to 511 species because of subsequent synonymy proposals. After combining this number with the extra species from the present catalogue, the number of anthomyiid species recorded from China has now reached 684 species in 36 genera. This number includes 9 species recorded from Taiwan but not from mainland China. The lower number of genera reflects recent attempts toward a phylogeny-based classification of the family in terms of supposedly monophyletic genera.

The notable increase in number of anthomyiid species presently recognized from mainland China (675) compared to “Flies of China” (511) reflects on one hand the high activity level of taxonomic and faunistic investigation of anthomyiid flies that has taken place in China since 1992/93 (the approximate deadline for “Flies of China”). However, our catalogue includes 25 species described as new and 17 species recorded from China or Taiwan before 1992 that for unknown reasons are omitted from “Flies of China”. These aspects emphasize the strong need of the present supplementary list.

Materials and methods

The following catalogue is primarily a compilation of all anthomyiid species recorded from mainland China and Taiwan but for various reasons omitted from consideration in “Flies of China” (Wei et al. 1998a, b). These species are marked with an asterisk. The catalogue further includes species that (1) are presently recognized in a different generic combination, (2) have changed name because of synonymy or misidentification, or (3) have been upgraded from subspecies to species rank.

The arrangement of the species is alphabetical by genus and by species. The generic classification follows the most recent update of the family in "Fauna Europaea" (Michelsen 2011). Accordingly, all taxa ranked as subgenus or subspecies in "Flies of China" are either upgraded to genus or species rank or synonymized. Synonyms are only given to the extent that these are treated as valid genus or species group names in "Flies of China". A reference to the original Chinese record is given for all anthomyiid species in the catalogue that have not received treatment in "Flies of China". The known distribution in China by province given for all species included in the catalogue. An explanatory 'Taxonomic note' is added whenever the present nomenclature deviates from that of "Flies of China".

Catalogue

Genus *Adia* Robineau-Desvoidy, 1830

Adia asiatica Fan in Fan et al., 1988, STAT. REV.
Adia grisella asiatica Fan. Wei et al. 1998a: 670.
Distribution in China. Neimenggu, Qinghai, Sichuan, Yunnan.
Taxonomic note. The present taxon differs significantly from *Adia grisella* (Rondani) in the structure of the male terminalia. It also has a distribution overlapping with *A. grisella* in Central Asia (DM Ackland in litt.).

Genus *Alliopsis* Schnabl & Dziedzicki, 1911

Syn.: *Paraprosalpia* Villeneuve, 1922.
Taxonomic note. Synonymy first proposed by Michelsen (1985: 39).

Alliopsis billbergi (Zetterstedt, 1838)
Paraprosalpia billibergi [misspelling of *billbergi*] *shanghaina* Fan in Fan, Chen, Cui & Wang, 1983.
Paraprosalpia billergi [misspelling of *billbergi*] *shanghaina* Fan. Wei et al. 1998a: 760.
Distribution in China. Heilongjiang, Shanghai.
Taxonomic note. Synonymy first proposed by Michelsen (2004).

Alliopsis denticauda (Zetterstedt, 1838)
Paraprosalpia denticauda (Zetterstedt). Wei et al. 1998a: 760.
Distribution in China. Heilongjiang.

Alliopsis flavipes (Fan & Cui in Fan, Chen, Cui & Wang, 1983)
Paraprosalpia flavipes Fan & Cui. Wei et al. 1998a: 760.
Distribution. China: Heilongjiang.

Alliopsis maculifrons (Zetterstedt, 1838)
Paraprosalpia lutebasicosta Fan in Fan, Chen, Cui & Wang, 1983.
Alliopsis lutebasicosta (Fan). Wei et al. 1998a: 756.
Distribution in China. Heilongjiang.
Taxonomic note. Synonymy first proposed by Michelsen (2004)

Alliopsis magnilamella (Fan in Fan, Chen, Cui & Wang, 1983)
Paraprosalpia magnilamella Fan. Wei et al. 1998a: 760.
Distribution. China: Qinghai.

Alliopsis moerens (Zetterstedt, 1838)
Paraprosalpia moerens (Zetterstedt). Wei et al. 1998a: 760.
Distribution in China. Heilongjiang, Neimenggu.

Alliopsis pilitarsis (Stein, 1900)
Paraprosalpia pilitarsis (Stein). Wei et al. 1998a: 760.
Distribution in China. Heilongjiang, Xinjiang.

Alliopsis sepiella (Zetterstedt, 1845)
Paraprosalpia sepiella (Zetterstedt). Wei et al. 1998a: 760.
Distribution in China. Xinjiang.

Alliopsis tibialis (Fan & Wang in Fan, Chen, Ma & Ge, 1982)
Paraprosalpia tibialis Fan.
Parprosalpia [misspelling of *Paraprosalpia*] *tibialis* Fan & Wang. Wei et al. 1998a: 760.
Distribution. China: Shanxi.

Genus *Anthomyia* Meigen, 1803
Syn.: *Craspedochoeta* Macquart, 1851.
Taxonomic note. Synonymy first proposed by Michelsen (1985: 39).

**Anthomyia alishana* Ackland & Suwa in Ackland, 1987
Distribution in China. Taiwan (Ackland 1987: 46).

Anthomyia cannabina (Stein, 1916)
Craspedochoeta cannabina (Stein). Wei et al. 1998a: 651.
Distribution in China. Heilongjiang, Liaoning.

Anthomyia confusanea Michelsen in Michelsen & Báez, 1985
Craspedochoeta liturata (Robineau-Desvoidy, 1830) [misidentification]. Wei et al. 1998a: 651.
Distribution in China. Heilongjiang, Neimenggu, Shanxi, Xinjiang.
Taxonomic note. *Anthomyia liturata* (Robineau-Desvoidy, 1830) is known exclusively from Europe, whereas *A. confusanea* is a more widespread Palearctic species.

**Anthomyia hirsuticorpa* (Feng & Fan in Feng, Fan & Zeng, 1999)
Craspedochoeta hirsuticorpa Feng & Fan.
Distribution. China: Sichuan (Feng et al. 1999: 321).

**Anthomyia lasiommata* Fan & Chen, 1992
Distribution. China: Hainan (Fan and Chen 1992: 197).

**Anthomyia latifasciata* Suwa, 1987
Distribution in China. Guizhou (Wei 2006b: 525).

Anthomyia mimetica (Malloch, 1918)
Craspedochoeta angulata (Tiensuu, 1938). Wei et al. 1998a: 651.
Distribution in China. Heilongjiang, Liaoning.
Taxonomic note. Synonymy first proposed by Michelsen (2004).

Anthomyia oculifera Bigot, 1885
Anthomyia koreana Suh & Kwon, 1985. Wei et al. 1998a: 648.
Distribution in China. Liaoning.
Taxonomic note. Synonymy first proposed by Griffiths (2001: 2256).

**Anthomyia psilommata* Fan & Chen, 1992
Distribution. China: Hainan (Fan and Chen 1992: 198).

Anthomyia pullulula (Fan in Fan, Chen, Ma & Wu, 1984)
Craspedochoeta pullulula Fan. Wei et al. 1998a: 651.
Distribution in China. Shanxi, Qinghai, Xinjiang.

**Anthomyia sinensis* Zhang & Sun, 1997
Distribution. China: Liaoning (Zhang and Sun 1997: 23).

Genus *Boreophorbia* Michelsen, 1987

**Boreophorbia hirtipes* (Stein, 1907)
Chirosia hirtipes Stein.
Distribution in China. Qinghai (Stein 1907: 369; Hennig 1966: 63).

Genus *Botanophila* Lioy, 1864

Syn.: *Monochrotogaster* Ringdahl, 1932; *Pseudomyopina* Ringdahl, 1933.
Taxonomic note. Synonymy first proposed by Michelsen (2004) for *Monochrotogaster* and by Michelsen (1985: 39) for *Pseudomyopina*.

**Botanophila alcaecerca* (Deng, 1997)
Pegohylemyia alcaecerca Deng.
Distribution. China: Shandong, Sichuan (Deng 1997: 201).

**Botanophila alishana* Suwa, 1996
Distribution. China: Taiwan (Suwa 1996: 147).

**Botanophila angulisurstyla* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 168).

**Botanophila angustisilva* Xue & Yang, 2002
Distribution. China: Shaanxi, Gansu (Xue and Yang 2002: 73).

Botanophila atricornis (Fan & Wu, 1981)
Monochrotogaster atricornis Fan & Wu. Wei et al. 1998a: 702.
Distribution. China: Qinghai, Sichuan.

**Botanophila bicoloripennis* Xue & Zhang, 1996
Distribution. China: Hebei, Sichuan (Xue and Zhang 1996b: 169).

**Botanophila caligotypa* (Zheng & Fan, 1990)
Pegohylemyia caligotypa Zheng & Fan.
Distribution. China: Qinghai (Zheng and Fan 1990: 181).

Botanophila cercodiscoides (Fan, Zhong & Deng in Fan et al., 1988)
Pegohylemyia okai cercodiscoides Fan, Zhong & Deng.
Botanophila okai cercodiscoides (Fan, Zhong & Deng). Wei et al. 1998a: 693.
Distribution. China: Sichuan.
Taxonomic note. First ranked as species by Xue and Song (2007: 22).

**Botanophila chelonocerca* Xue & Yang, 2002
Distribution. China: Gansu (Xue and Yang 2002: 74).

**Botanophila choui* (Fan, Chen & Ma, 2000)
Pegohylemyia choui Fan, Chen & Ma.
Distribution. China: Qinghai (Fan et al. 2000: 130).

**Botanophila chui* Suwa, 1996
Distribution. China: Taiwan (Suwa 1996: 140).

**Botanophila clavata* (Hennig, 1970)
Distribution in China. Qinghai, Yunnan (Wang et al. 2006: 158).

**Botanophila convexifrons* (Fan, Chen & Chen 1993)
Pegohylemyia convexifrons Fan, Chen & Chen.
Distribution. China: Henan, Xinjiang (Fan et al. 1993: 59).

**Botanophila cornuta* (Deng, 1997)
Pegohylemyia cornuta Deng.
Distribution. China: Sichuan (Deng 1997: 202).

**Botanophila cuneata* (Deng, Li & Liu, 1996)
Pegohylemyia cuneata Deng, Li & liu.
Distribution. China: Jiangxi, Sichuan (Deng et al. 1996: 427).

**Botanophila curvimargo* (Zheng & Fan, 1990)
Pegohylemyia curvimargo Zheng & Fan.
Distribution. China: Qinghai (Zheng and Fan 1990: 181).

**Botanophila densispinula* Xue & Song, 2007
Distribution. China: Sichuan (Xue and Song 2007: 25).

Botanophila depressa (Stein, 1907)
Chortophila depressa Stein.
Botanophila oraria (Collin, 1967). Wei et al. 1998a: 693.
Distribution in China. Qinghai, Gansu, Xizang (Stein 1907: 365; Wang et al. 2006: 158).
Taxonomic note. Synonymy first suggested by Hennig (1970: 392).

**Botanophila dianisenecio* Xue & Wang, 2010
Distribution. China: Yunnan (Xue and Wang 2010: 457).

**Botanophila dolichocerca* (Zheng & Fan, 1990)
Pegohylemyia dolichocerca Zheng & Fan.
Distribution. China: Heilongjiang, Qinghai (Zheng and Fan 1990: 182).

**Botanophila endotylata* (Deng, Li & Liu, 1996)
Pegohylemyia endotylata Deng, Li & Liu.
Distribution. China: Henan, Sichuan (Deng et al. 1996: 426).

**Botanophila euryisurstyla* (Deng, Liu & Li, 1995)
Pegohylemyia euryisurstyla Deng, Liu & Li.
Distribution. China: Sichuan (Deng et al. 1995: 375).

**Botanophila fanjingensis* Wei, 2006
Distribution. China: Guizhou (Wei 2006b: 528).

**Botanophila flavibellula* (Deng, Geng, Liu & Li, 1995)
Pegohylemyia flavibellula Deng Geng, Liu & Li.
Distribution. China: Jilin, Sichuan (Deng et al. 1995: 58).

**Botanophila fulgicauda* (Deng, Liu & Li, 1995)
Pegohylemyia fulgicauda Deng, Liu & Li.
Distribution. China: Sichuan (Deng et al. 1995: 375).

Botanophila fumidorsis (Ackland, 1967)
Pseudomyopina fumidorsis probola Fan in Ye, Ni & Fan, 1982. Wei et al. 1998a: 702.
Distribution in China. Shandong, Gansu, Xinjiang.
Taxonomic note. Synonymy first proposed by Zhang and Zhu (2014: 23).

**Botanophila gnava* (Meigen, 1826)
Distribution in China. Heilongjiang, Xinjiang (Wang et al. 2006: 159).

**Botanophila gnavoides* (Hennig, 1970)
Distribution in China. Gansu, Xinjiang (Wang et al. 2006: 159).

**Botanophila guizhouensis* Wei, 2006
Distribution. China: Guizhou (Wei 2006b: 529).

**Botanophila higuchii* (Suwa, 1974)
Pegohylemyia higuchii Suwa.
Distribution in China. Shaanxi, Gansu (Wu and Zhang 1988: 348).

**Botanophila hohxiliensis* Xue & Zhang, 1996
Distribution. China: Jilin, Qinghai (Xue and Zhang 1996b: 170).

**Botanophila kanmiyai* Suwa, 1996
Distribution. China: Taiwan (Suwa 1996: 144).

**Botanophila latigena* (Stein, 1907)
Chortophila latigena Stein.
Pegohylemyia latigena (Stein). Hennig 1970: 382.
Botanophila latigena (Stein). Wang et al. 2006: 159.
Distribution in China. Qinghai, Gansu, Hebei (Stein 1907: 359; Wang et al. 2006: 159).

**Botanophila latispinisternata* Xue & Wang, 2010
Distribution. China: Yunnan (Xue and Wang 2010: 461).

**Botanophila ligoniformis* (Deng, 1993)
Pegohylemyia ligoniformis Deng.
Distribution. China: Sichuan, Xizang (Deng 1993: 58).

**Botanophila longibarbata* Xue & Wang, 2010
Distribution. China: Yunnan (Xue and Wang 2010: 455).

Botanophila maculipes (Zetterstedt, 1845)
Botanophila pseudomaculipes (Strobl, 1893). Wei et al. 1998a: 693.
Distribution in China. Sichuan, Xizang (Wang et al. 2006: 159).
Taxonomic note. Synonymy first proposed by Michelsen (1985: 51).

**Botanophila mediotubera* (Deng, Li & Liu, 1996)
Pegohylemyia mediotubera Deng, Li & Liu.
Distribution. China: Jiangxi, Sichuan (Deng et al. 1996: 428).

Botanophila melametopa (Fan in Fan & Zheng, 1992)
Pegohylemyia melametopa Fan.
Pegohylemyia nigrifrontata Fan & Zheng, 1992.
Botanophila melametopa (Fan). Wei et al. 1998b: 2274.
Botanophila nigrifrontata (Fan & Zheng). Wei et al. 1998b: 2274.
Distribution. China: Sichuan.
Taxonomic note. Synonymy first proposed by Xue and Song (2007: 30).

**Botanophila menyuanensis* (Zheng & Fan, 1990)
Pegohylemyia menyuanensis Zheng & Fan.
Distribution. China: Qinghai (Zheng and Fan 1990: 182).

**Botanophila monacensis* (Hennig, 1970)
Pegohylemyia monacensis Hennig.
Distribution in China. Hebei (Zhao 1983: 24).

**Botanophila monoconica* (Chen & Fan, 1995)
Pegohylemyia monoconica Chen & Fan.
Distribution. China: Qinghai (Chen and Fan 1995: 492).

**Botanophila nigribella* (Deng, Geng, Liu & Li, 1995)
Pegohylemyia nigribella Deng, Geng, Liu & Li.
Distribution. China: Henan, Sichuan (Deng et al. 1995: 58).

Botanophila pamirensis (Ackland, 1967)
Pseudomyopina pamirensis Ackland. Wei et al. 1998a: 702.
Distribution in China. Henan, Xinjiang.

**Botanophila papiliocerca* (Deng, 1997)
Pegohylemyia papiliocerca Deng.
Distribution. China: Shanxi, Sichuan (Deng 1997: 201).
Taxonomic note. *Pegohylemyia papiliocera* is an incorrect original spelling in the English summary (p. 204) by Deng (1997).

**Botanophila peltophora* (Li, Cui & Fan, 1993)
Pegohylemyia peltophora Li, Cui & Fan.
Distribution. China: Neimenggu, Henan (Li et al. 1993: 129).

**Botanophila peninsularis* Suh & Kwon, 1986
Distribution in China. Liaoning (Wang et al. 2006: 160).

**Botanophila pilicoronata* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 171).

**Botanophila platysurstyla* Xue & Song, 2007
Distribution. China: Sichuan (Xue and Song 2007: 26).

**Botanophila prenochirella* (Zheng & Fan, 1990)
Pegohylemyia prenochirella Zheng & Fan.
Distribution. China: Qinghai (Zheng and Fan 1990: 182).

**Botanophila rotundivalva* (Ringdahl, 1937)
Distribution in China. Shandong, Shaanxi (Xue and Yang 2002: 77; Wang et al. 2006: 160).

**Botanophila rubrigena* (Schnabl, 1915)
Distribution in China. Qinghai, (Wang et al. 2006: 160).

Botanophila rufifrons (Fan & Chen, 1981)
Monochrotogaster rufifrons Fan & Chen. Wei et al. 1998a: 702.
Distribution. China: Qinghai.

**Botanophila sanctiforceps* Xue & Yang, 2002
Distribution. China: Gansu (Xue and Yang 2002: 76).

**Botanophila sericea* (Malloch, 1920)
Botanophila sericea (Malloch). Xue and Song (2007: 14).
Distribution in China. Not given.

**Botanophila spinisternatodea* Xue & Wang, 2010
Distribution. China: Yunnan (Xue and Wang 2010: 460).

**Botanophila stenocerca* (Zheng & Fan, 1990)
Pegohylemyia stenocerca Zheng & Fan.
Distribution. China: Qinghai (Zheng and Fan 1990: 182).

**Botanophila strictistriolata* Xue & Zhang, 2005
Distribution. China: Gansu (Xue and Zhang 2005: 789).

**Botanophila submontivaga* Xue & Zhang, 1996
Distribution. China: Gansu, Xinjiang (Xue and Zhang 1996a: 199).

**Botanophila subobscura* Xue & Yang, 2002
Distribution. China: Gansu (Xue and Yang 2002: 77).

**Botanophila subspinulibasis* Xue & Song, 2007
Distribution. China: Sichuan (Xue and Song 2007: 28).

**Botanophila tetracrula* (Deng, 1997)
Pegohylemyia tetracrula Deng.
Distribution. China: Sichuan (Deng 1997: 203).

**Botanophila tortiforceps* (Deng, 1993)
Pegohylemyia tortiforceps Deng.
Distribution. China: Sichuan (Deng 1993: 58).

**Botanophila trifurcata* (Huckett, 1947)
Distribution in China. Qinghai, Sichuan (Wang et al. 2006: 161).

**Botanophila trifurcatoides* Xue & Song, 1992
Pegohylemyia trifurcata Hennig, 1976 [preoccupied in *Botanophila*].
Distribution. China: Heilongjiang (Hennig 1976: 953).

**Botanophila trinivittata* (Zheng & Fan, 1990)
Pegohylemyia trinivittata Zheng & Fan.
Distribution. China: Qinghai (Zheng and Fan 1990: 182).

Botanophila unicolor (Ringdahl, 1932)
Monochrotogaster unicolor Ringdahl. Wei et al. 1998a: 702.
Distribution in China. Xinjiang.

**Botanophila unicrucianella* (Xue & Zhang, 1996)
Pseudomyopina unicrucianella Xue & Zhang.
Distribution. China: Qinghai (Xue and Zhang 1996b: 186).

**Botanophila unimacula* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 172).

**Botanophila vicariola* (Fan in Fan, Chen & Fang, 1987)
Pegohylemyia vicariola Fan.
Distribution. China: Xizang (Fan et al. 1987: 300).

Botanophila zhuoniensis (Jin, 1983)
Pegohylemyia zhuoniensis Jin.
Botanophila zhuouniensis [misspelling of *zhuoniensis*] (Jin). Wei et al. 1998a: 698.
Distribution. China: Gansu.

Genus *Chirosia* Rondani, 1856
Syn.: *Meliniella* Suwa, 1974; *Shakshainia* Suwa, 1974.
Taxonomic note. Synonymy first proposed by Michelsen (1988: 277).

Chirosia bisinuata (Tiensuu, 1939)
Meliniella bisinuata (Tiensuu). Wei et al. 1998a: 666.
Distribution in China. Heilongjiang.

**Chirosia forcipispatula* Xue, 2001
Distribution. China: Yunnan (Xue 2001a: 307).

Chirosia griseifrons (Séguy, 1923)
Meliniella griseifrons (Séguy). Wei et al. 1998a: 666.
Distribution in China. Heilongjiang, Liaoning.

Chirosia grossicauda Strobl, 1899
Chirosia parvicornis (Zetterstedt, 1845) [misidentification]. Wei et al. 1998a: 656.
Distribution in China. Liaoning, Fujian.
Taxonomic note. The valid name for the present species first proposed by Michelsen (1985: 54).

**Chirosia nodula* (Li, Cui & Fan, 1993)
Meliniella nodula Li, Cui & Fan.
Distribution. China: Henan (Li et al. 1993: 129).

Chirosia rametoka (Suwa, 1974)
Shakshainia rametoka Suwa. Wei et al. 1998a: 666.
Distribution in China. Heilongjiang, Liaoning.

Chirosia spatuliforceps (Fan & Chu in Fan, Chen, Ma & Ge, 1982)
Meliniella spatuliforceps Fan & Chu. Wei et al. 1998a: 666.
Distribution. China: Fujian, Sichuan, Yunnan.

Chirosia strigilliformis (Deng & Li, 1986)
Meliniella strigilliformis Deng & Li. Wei et al. 1998a: 666.
Distribution. China: Sichuan.

**Chirosia styloplasis* (Zheng & Fan, 1990)
Meliniella styloplasis Zheng & Fan.
Distribution. China: Xizang (Zheng and Fan 1990: 181).

Genus *Delia* Robineau-Desvoidy, 1830

**Delia absidata* Xue & Du, 2008
Distribution. China: Yunnan (Xue and Du 2008: 114).

**Delia ancylosurstyla* Xue, 2002
Distribution. China: Gansu (Xue 2002: 73).

**Delia angustaeformis* (Ringdahl, 1933)
Distribution in China. Xinjiang (Qian et al. 1998: 75).

**Delia apicifloralis* Xue, 2002
Distribution. China: Gansu (Xue 2002: 74).

**Delia brevipalpis* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 174).

**Delia conjugata* Deng & Li, 1994
Distribution. China: Sichuan (Deng and Li 1994: 20).

**Delia conversatoides* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 175).

Delia diluta (Stein, 1916)
Delia diluta (Stein). Fan et al. 1988: 178.
Delia segmentata (Wulp, 1896) [misidentification]. Wei et al. 1998a: 714.
Distribution in China. Qinghai.
Taxonomic note. Dely-Draskovits (1993: 49) listed by mistake *Delia diluta* as a junior synonym of the Nearctic *D. segmentata*.

**Delia dovreensis* Ringdahl, 1953
Distribution in China. Shanxi (Wang 1983: 412).

**Delia falciforceps* Xue & Zhang, 1996
Distribution. China: Xinjiang (Xue and Zhang 1996a: 204).

**Delia fimbrifascia* Xue & Du, 2009
Distribution. China: Yunnan (Xue and Du 2009: 155).

**Delia flavicommixta* Xue & Zhang, 1996
Distribution. China: Xinjiang (Xue and Zhang 1996a: 206).

**Delia flavipes* Tian & Ma, 1999
Distribution. China: Neimenggu (Tian and Ma 1999: 217).

**Delia flavogrisea* (Ringdahl, 1926)
Distribution in China. Heilongjiang (Hennig 1974: 814).

Delia floricola Robineau-Desvoidy, 1830
Delia floricola Robineau-Desvoidy. Fan et al. 1988: 158.
Delia cardui (Meigen, 1826) [misidentification]. Wei et al. 1998a: 718.
Distribution in China. Xinjiang.
Taxonomic note. Dely-Draskovits (1993: 41) listed by mistake *Delia floricola* as a junior synonym of *D. cardui*.

**Delia formosana* Suwa, 1994
Distribution. China: Taiwan (Suwa 1994a: 63)

**Delia hohxiliensis* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 176).

Delia linearis (Stein, 1898)
Delia flabellifera (Pandellé, 1900). Wei et al. 1998a: 718.
Distribution in China. Heilongjiang, Jilin, Neimenggu, Hebei, Shanxi, Gansu, Xinjiang.
Taxonomic note. Synonymy first proposed by Barták et al. (1990: 443) on advice from GCD Griffiths.

**Delia longiarista* Xue, 2002
Distribution. China: Gansu (Xue 2002: 77).

**Delia longimastica* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 177).

Delia madoensis Fan in Fan et al., 1988.
Delia rondanii madoensis Fan in Fan et al. Wei et al. 1998a: 723.
Distribution in China. Gansu, Qinghai.
Taxonomic note. First ranked as species by Zhang and Zhu (2014: 48).

**Delia mastigella* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 178).

**Delia minutigrisea* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 179).

**Delia nigriabdominis* Xue, 2001
Distribution. China: Yunnan (Xue 2001a: 306).

**Delia parvicanalis* Fan in Fan, Chen, Ma & Wu, 1984
Distribution. China: Qinghai, Sichuan (Fan et al. 1984: 243).

Delia pectinator Suwa, 1984
Delia pectinator fuscilateralis Fan in Fan & Zheng, 1992, syn. n. Wei et al. 1998b: 2269.
Distribution in China. Sichuan.
Taxonomic note. Griffiths (1993: 1444) showed that *Delia pectinator* described from Japan is widely distributed in northern North America. His redescription suggests that ssp. *fuscilateralis* Fan falls within the variation of *D. pectinator*.

Delia penicilliventris Ackland, 2010
Delia penicillaris (Rondani, 1866) [misidentification]. Wei et al. 1998a: 722.
Distribution in China. Heilongjiang.
Taxonomic note. Ackland (2010: 80) showed that *Delia penicillaris* auct. consists of two different species of which true *D. penicillaris* (Rondani) is only found in Central and South Europe.

**Delia persica* Hennig, 1974
Distribution in China. Hebei (Zhao 1983: 24).

**Delia podagricicauda* Xue, 1997
Distribution. China: Sichuan (Xue 1997: 1493).

**Delia scrofifacialis* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 180).

**Delia stenostyla* Deng & Li, 1994
Distribution. China: Sichuan (Deng and Li 1994: 20).

**Delia subatrifrons* Xue & Du, 2009
Distribution. China: Sichuan, Yunnan (Xue and Du 2009: 157).

**Delia subinterflua* Xue & Du, 2008
Distribution. China: Sichuan, Yunnan (Xue and Du 2008: 116).

**Delia taonura* Deng & Li, 1994
Distribution. China: Sichuan (Deng and Li 1994: 18).

Delia tenuiventris (Zetterstedt, 1860)
Delia conversata (Tiensuu, 1936). Wei et al. 1998a: 714.
Distribution in China. Heilongjiang, Xinjiang.
Taxonomic note. Synonymy first proposed by Michelsen (1985: 58).

**Delia turcmenica* Hennig, 1974
Distribution in China. Qinghai (Xue and Zhang 1996a: 201).

**Delia unguitigris* Xue, 1997
Distribution. China: Sichuan (Xue 1997: 1494)

**Delia uralensis* Hennig, 1974
Distribution in China. Heilongjiang, Jilin, Liaoning, Qinghai (Fan et al. 1988: 166).

Genus *Egle* Robineau-Desvoidy, 1830

Egle ciliata (Walker, 1849)
Egle muscaria (Fabricius, 1777) [misidentification]. Wei et al. 1998a: 660.
Distribution in China. Liaoning, Neimenggu.
Taxonomic note. The valid name for the present species was first proposed by Michelsen (1979: 193).

Egle inermis Ackland, 1970
Egle steini Schnabl, 1911 [misidentification]. Wei et al. 1998a: 661.
Distribution in China. Liaoning.
Taxonomic note. Misidentification first noted by Michelsen (2009: 42).

**Egle longirostris* (Stein, 1907)
Chortophila longirostris Stein.
Lasiomma longirostris (Stein). Hennig 1972: 430.
Egle longirostris (Stein). Michelsen 1988: 277; Michelsen 2009: 20.
Distribution. China: Qinghai (Stein 1907: 366).

Egle minuta (Meigen, 1826)
Egle korpokkur Suwa, 1974. Wei et al. 1998a: 660.
Egle gracilior Zheng & Fan, 1990. Zheng and Fan 1990: 181.
Distribution in China. Liaoning, Shanxi, Gansu, Sichuan.
Taxonomic note. Synonymy first proposed by Michelsen (2004) for *Egle korpokkur* and by Griffiths (2003: 2350) for *E. gracilior*.

Egle subarctica (Huckett, 1965)
Egle cyrtacra Fan & Wang in Fan, Chen, Ma & Ge, 1982. Wei et al. 1998a: 660.
Distribution in China. Shanxi.
Taxonomic note. Synonymy first proposed by Michelsen (2004).

Genus *Emmesomyia* Malloch, 1917

**Emmesomyia dorsalis* (Stein, 1915)
Chortophila dorsalis Stein.
Distribution in China. Taiwan (Stein 1915: 47; Pont and Ackland 2009: 16, 55).

**Emmesomyia ovata* (Stein, 1915)
Chortophila ovata Stein.
Distribution in China. Taiwan (Stein 1915: 47; Pont and Ackland 2009: 29, 56).

**Emmesomyia roborospinosa* Cui, Li & Fan, 1993
Distribution. China: Heilongjiang (Cui et al. 1993: 137).

**Emmesomyia similata* Suwa, 1991
Distribution in China. Guizhou (Wei 2006b: 533).

Emmesomyia suwai Ge & Fan, 1988
Emmesomyia socia suwai Ge & Fan. Wei et al. 1998a: 770.
Distribution in China. Heilongjiang, Henan, Sichuan, Guizhou, Yunnan.
Taxonomic note. First ranked as species by Suwa (1991: 20).

Genus *Enneastigma* Stein, 1916

Taxonomic note. The following two species are presently referred to *Enneastigma* rather than *Pegoplata*, because the male cerci that are not forming a projecting lobe between the surstyli, a derived character state only defining the genera *Pegoplata* and *Myopina* within the *Myopina* group of genera. In that respect *Enneastigma* agrees with *Calythea* Schnabl & Dziedzicki.

Enneastigma fulva (Malloch, 1934), COMB. NOV.
Nupedia fulva (Malloch). Wei et al. 1998a: 767.
Distribution in China. Zhejiang, Guangdong, Hainan, Sichuan, Guizhou, Yunnan.

Enneastigma henanensis (Ge & Fan, 1982), COMB. NOV.
Nupedia henanensis Ge & Fan. Wei et al. 1998a: 767.
Distribution. China: Henan, Sichuan, Guizhou, Yunnan.

Enneastigma lengshanensis Xue, 2001, COMB. NOV.
Pegoplata lengshanensis Xue, 2001.
Distribution. China: Yunnan (Xue 2001b: 486).

Genus *Eutrichota* Kowarz, 1893

Syn.: *Eremomyia* Stein, 1898; *Pegomyza* Schnabl & Dziedzicki, 1911; *Arctopegomyia* Ringdahl, 1938; *Parapegomyia* Griffiths, 1984.
Taxonomic note. Synonymy first proposed by Griffiths (1984: 415) for *Eremomyia*, by Suwa (1974: 231) for *Pegomyza* and *Arctopegomyia*, and by Barták et al. (1990) for *Parapegomyia*.

Eutrichota apiciserpenta Xue & Dong in Xue, Dong & Bai, 2012
Distribution. China: Yunnan (Xue et al. 2012: 81).

Eutrichota breviungula Xue & Dong in Xue, Dong & Bai, 2012
Distribution. China: Sichuan, Yunnan, Xizang (Xue et al. 2012: 83).

Eutrichota fanjingensis Wei, 2006
Distribution. China: Guizhou (Wei 2006b: 531).

Eutrichota gansuensis (Xue & Zhang, 2005)
Parapegomyia gansuensis Xue & Zhang.
Distribution. China: Gansu (Xue and Zhang 2005: 796).

Eutrichota latimana Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 181).

Eutrichota minutiungula Xue & Bai in Xue, Dong & Bai, 2012
Distribution. China: Sichuan (Xue et al. 2012: 84).

Eutrichota nigriceps Xue & Zhang, 1996
Distribution. China: Qinghai (Xue & Zhang 1996b: 182).

Eutrichota palaestinensis (Hennig, 1973)
Distribution in China. Shaanxi (Wu and Zhang 1988: 348).

Eutrichota praepotens (Wiedemann, 1817)
Distribution in China. Only record from northern China (Hennig 1972: 472) in need of verification.

Eutrichota ruficeps Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 183).

Eutrichota turbida (Huckett, 1951), SP. REV.
Eremomyia triticiperda (Stein, 1900) [misidentification]. Hennig 1972: 462 (in part: Kyrgyzstan).
Eutrichota triticiperda (Stein) [misidentification]. Griffiths 1984: 441.
Eremomyia pilimana pilimarginata Fan & Qian in Fan, Chen, Ma & Ge, 1982, syn. n.
Eutrichota pilimarginata (Fan & Qian). Wei et al. 1998a: 749.
Distribution in China. Xinjiang.
Taxonomic note. Comparative study has convinced one of us (VM) that *Eutrichota triticiperda* (Stein) from Central Europe is different from the species identified by that name from Central Asia (Hennig 1972: 462) and North America (Griffiths 1984: 446). The valid name for the Holarctic species is *E. turbida* (Huckett). It differs from *E. triticiperda* by the absence of a shiny area on the antenna and, in males only, by a different shape of sternite V and presence of a broad, shiny black median field on sternites II–IV.

Genus *Hydrophoria* Robineau-Desvoidy, 1830
Taxonomic note. *Hydrophoria* in the present narrow sense follows upon the recognition of *Zaphne* (q.v.) as a separate genus.

**Hydrophoria aberrans* Stein, 1918
Distribution. China: Taiwan (Stein 1918: 159; Suwa 1985: 6)

**Hydrophoria fanjingensis* Wei, 2006
Distribution. China: Guizhou (Wei 2006b: 525).

**Hydrophoria lushiensis* Ge & Li, 1985
Distribution. China: Henan (Ge and Li 1985: 242).

**Hydrophoria nigrinitida* Feng, 2006
Distribution. China: Sichuan (Feng 2006: 1).

**Hydrophoria robustisurstylus* Feng, 2006
Distribution. China: Sichuan (Feng 2006: 1).

Hydrophoria silvicola (Robineau-Desvoidy, 1830)
Hydrophoria annulata (Pandellé, 1899) [misidentification]. Wei et al. 1998a: 672.
Hydrophoria silvicola (Robineau-Desvoidy). Xue et al. 2009: 421.
Distribution in China. Xinjiang, Liaoning, Jilin, Heilongjiang.
Taxonomic note. The valid name for the present species was first proposed by Barták et al. (1990: 443).

Genus *Hylemya* Robineau-Desvoidy, 1830

Syn.: *Lopesohylemya* Fan, Chen & Ma, 1989, syn. n.

Taxonomic note. Fan et al. (1989) established a new genus *Lopesohylemya* with the new species *L. qinghaiensis* (see below) as type species. They further suggested that their new genus should also accommodate the *histrio* species group of the genus *Eustalomyia* Kowarz. As noted in the discussion by Griffiths (1996: 1754), we disagree that *Lopeshylemyia* and *Eustalomyia* are closely related taxa. Instead, we propose that *L. qinghaiensis* is closely related to *Hylemya flavicruralis* Suwa, 1989 described from Nepal. The distal articles of both antennae are missing in the holotype and only known specimen of *Lopesohylemya qinghaiensis*. Accordingly, the authors were unable to observe the plumose condition of the arista, a prime characteristic of the genus *Hylemya*.

**Hylemya teinosurstylia* Xue & Zhang, 2004
Distribution. China: Guangxi, Yunnan (Xue and Zhang 2004: 546).

Hylemya qinghaiensis (Fan, Chen & Ma, 1989), COMB. NOV.
Lopesohylemya qinghaiensis Fan, Chen & Ma. Wei et al. 1998a: 732.
Distribution. China: Qinghai.

Hylemya urbica Wulp, 1896
Hylemya latifrons Schnabl. Wei et al. 1998a: 736.
Distribution in China. Heilongjiang.
Taxonomic note. Synonymy first published in Barták et al. (1990: 443) on advice from GCD Griffiths.

Genus *Hylemyza* Schnabl & Dziedzicki, 1911

Taxonomic note. First revived from synonymy with *Hylemya* Robineau-Desvoidy, 1830 by Michelsen (1985: 39).

Hylemyza partita (Meigen, 1826)
Hylemya partita (Meigen). Wei et al. 1998a: 736.
Distribution in China. Heilongjiang, Qinghai.

Genus *Hyporites* Pokorny, 1893

Syn.: *Engyneura* Stein, 1907

Taxonomic note. Species of *Engyneura* agree closely with those of *Hyporites*, and together they constitute a well defined, clearly monophyletic entity of anthomyiid flies. This was realized by Hennig (1966: 77), but he desisted from formally synonymizing these genera because no material of *Engyneura* was available to him. This synonymy was first proposed by Michelsen (2004).

Hyporites curvostylata (Fan & Chen in Fan, Chen, Fan, Ma & Zhong, 1980)
Engyneura curvostylata Fan & Chen. Wei et al. 1998a: 744.
Distribution. China: Qinghai.

Hyporites gracilior (Fan & Zhong in Fan, Chen, Fan, Ma & Zhong, 1980)
Engyneura gracilior Fan & Zhong. Wei et al. 1998a: 744.
Distribution. China: Qinghai, Xizang.

Hyporites leptinostylata (Fan, Van & Ma in Fan, Chen, Fan, Ma & Zhong, 1980)
Engyneura leptinostylata Fan, Van & Ma. Wei et al. 1998a: 744.
Distribution. China: Qinghai.

Hyporites pilipes (Stein, 1907)
Engyneura pilipes Stein. Wei et al. 1998a: 744.
Distribution. China: Gansu, Qinghai.

Hyporites setigera (Stein, 1907)
Engyneura setigera Stein. Wei et al. 1998a: 744.
Distribution in China. Gansu, Qinghai.

Hyporites setifemorata (Fan in Fan & Zheng, 1992)
Engyneura setifemorata Fan. Wei et al. 1998b: 2270.
Distribution. China: Sichuan.

**Hyporites yuanyea* (Xue & Liu, 2013)
Engyneura yuanyea Xue & Liu.
Distribution. China: Yunnan (Xue and Liu 2013: 147).

Genus *Lasiomma* Stein, 1916
Syn.: *Acrostilpna* Ringdahl, 1929; *Sinohylemya* Hsue, 1980.
Taxonomic note. Synonymy first established by Griffiths (2003: 2380) for *Acrostilpna* and by Michelsen (1988: 276) for *Sinohylemya*.

Lasiomma craspedodontum (Hsue, 1980)
Sinohylemya craspedodonta Hsue. Wei et al. 1998a: 743.
Distribution in China. Jilin, Liaoning, Sichuan.

Lasiomma latipenne (Zetterstedt, 1838)
Acrostilpna latipennis (Zetterstedt). Wei et al. 1998a: 653.
Distribution in China. Heilongjiang.

Lasiomma monticola Suh & Kwon, 1985
Sinohylemya ctenocnema Hsue, 1980 [preoccupied in *Lasiomma*]. Wei et al. 1998a: 743.
Distribution in China. Heilongjiang, Liaoning.
Taxonomic note. Synonymy first proposed by Michelsen (2004), valid name by Suwa (2005: 100).

Lasiomma picipes (Meigen, 1826)
Lasiomma octoguttatum (Zetterstedt, 1845). Wei et al. 1998a: 662.
Distribution in China. Xizang.
Taxonomic note. Synonymy first proposed by Barták et al. (1990: 443).

Lasiomma replicatum (Huckett, 1929)
Acrostilpna montana Ma, 1988. Wei et al. 1998a: 653.
Distribution in China. Heilongjiang, Liaoning, Shanxi.
Taxonomic note. Synonymy first proposed by Griffiths (2003: 2406).

Genus *Leucophora* Robineau-Desvoidy, 1830

Leucophora dasyprosterna Fan & Qian in Fan et al. 1988
Leucophora brevifrons dasyprosterna Fan & Qian. Wei et al. 1998a: 728.
Distribution. China: Xinjiang.
Taxonomic note. First ranked as species by Zhang and Zhu (2014: 10).

**Leucophora liaoningensis* Zhang & Zhang, 1998
Distribution. China: Liaoning (Zhang and Zhang 1998: 103).

**Leucophora obtusa* (Zetterstedt, 1838)
Distribution in China. Liaoning (Fan and Zheng 1992: 1140).

**Leucophora xinjiangensis* Xue & Zhang, 1996
Distribution. China: Xinjiang (Xue and Zhang 1996a: 209).

Genus *Mycophaga* Rondani, 1856

**Mycophaga testacea* (Gimmerthal, 1834)
Distribution in China. Sichuan (Feng et al. 2010: 35).

Genus *Myopina* Robineau-Desvoidy, 1830

**Myopina myopina* (Fallén, 1824)
Distribution in China. Shanxi (Wang 1995: 94).

Genus *Paradelia* Ringdahl, 1933

Syn.: *Pseudonupedia* Ringdahl, 1959.

Taxonomic note. Synonymy first proposed by Barták et al. (1990: 443). Incidentally, *Pseudonupedia* Ringdahl is unavailable, as no type species was designated. The name was first made available by Huckett (1971: 76) who proposed *Anthomyia intersecta* Meigen, 1826 as type species.

**Paradelia brunneonigra* (Schnabl in Schnabl & Dziedzicki, 1911)
Pseudonupedia brunneonigra (Schnabl). Wu and Zhang 1988: 348.
Distribution in China. Shaanxi, Gansu.

Paradelia intersecta (Meigen, 1826)
Pseudonupedia intersecta (Meigen). Wei et al. 1998a: 761.
Distribution in China. Jilin, Shanxi, Gansu.

**Paradelia lundbeckii* (Ringdahl, 1918)
Distribution in China. Sichuan (Deng and Li 1993: 9).

Paradelia palpata (Stein, 1906)
Pseudonupedia trigonalis (Karl). Wei et al. 1998a: 761.
Distribution in China. Qinghai.
Taxonomic note. Synonymy first proposed by Griffiths (1987: 766).

Genus *Paregle* Schnabl, 1911

Syn.: *Chionomyia* Ringdahl, 1933.
Taxonomic note. Synonymy first proposed by Suwa (1974: 92).

Paregle vetula (Zetterstedt, 1838)
Chionomyia vetula (Zetterstedt). Wei et al. 1998a: 703.
Distribution in China. Heilongjiang, Jilin, Liaoning, Neimenggu, Beijing, Hebei, Shanxi, Shandong, Henan.

Genus *Pegomya* Robineau-Desvoidy, 1830

**Pegomya acisophalla* Xue, 2003
Distribution. China: Yunnan (Xue 2003: 80).

**Pegomya agilis* Wei, 2006
Distribution. China: Guizhou (Wei 2006a: 286).

**Pegomya basichaeta* Li, Liu & Fan in Li, Liu, Fan & Cui, 1999
Distribution. China: Henan (Li et al. 1999: 244).

**Pegomya calyptrata* (Zetterstedt, 1846)
Distribution in China. Qinghai (Ci and Yang 1986: 26).

**Pegomya chaetostigmata* Zheng & Fan, 1990
Distribution. China: Xizang (Zheng and Fan 1990: 182).

**Pegomya cricophalla* Xue, 2003
Distribution. China: Yunnan (Xue 2003: 81).

**Pegomya deprimata* (Zetterstedt, 1845)
Distribution in China. Jiangxi (Wu and Zhang 1988: 349).

**Pegomya diplothrixa* Li, Liu & Fan in Li, Liu, Fan & Cui, 1999
Distribution. China: Henan (Li et al. 1999: 243).

**Pegomya flavifrons* (Walker, 1849)
Distribution in China. Shanxi, Qinghai, Xinjiang (Song et al. 2007: 230)

**Pegomya heteroparamera* Zheng & Fan, 1990
Distribution. China: Sichuan (Zheng and Fan 1990: 184).

**Pegomya hohxiliensis* Xue & Zhang, 1996
Distribution. China: Qinghai (Xue and Zhang 1996b: 185).

**Pegomya huanglongensis* Deng & Li, 1993
Distribution. China: Sichuan (Deng and Li 1993: 8).

**Pegomya incrassata* Stein, 1907
Pegomyia incrassata Stein.
Distribution in China. Guangdong, Qinghai (Stein 1907: 356; Song et al. 2007: 230).

Pegomya japonica Suwa, 1974
Pegomya japonica japonica Suwa. Wei et al. 1998a: 789.
Pegomya japonica mokanensis Fan, 1982. Wei et al. 1998a: 789.
Distribution in China. Zhejiang, Fujian, Sichuan.
Taxonomic note. Synonymy first proposed by Zhang and Zhu (2014: 30).

**Pegomya lageniforceps* Xue, 2003
Distribution. China: Yunnan (Xue 2003: 82).

Pegomya lurida (Zetterstedt, 1846)
Pegomya valgenovensis Hennig. Wei et al. 1998a: 798.
Distribution in China. Heilongjiang, Jilin, Liaoning, Sichuan.
Taxonomic note. Synonomy first proposed by Michelsen (2004).

**Pegomya mediarmata* Zheng & Xue, 2002
Distribution. China: Liaoning (Zheng and Xue 2002: 159).

**Pegomya mirabifurca* Cui, Li & Fan, 1993
Distribution. China: Heilongjiang, Henan, Neimenggu (Cui et al. 1993: 137; Song et al. 2007: 230).

**Pegomya nigripraepeda* Feng, 2006
Distribution. China: Sichuan (Feng 2006: 2).

Pegomya nudapicalis Li & Deng in Fan et al., 1988
Pegomya dichaetomyiola nudapicalis Li & Deng. Wei et al. 1998a: 784.
Distribution. China: Sichuan.
Taxonomic note. *Pegomya dichaetomyiola nudicpiculis* and *P. dichaetomyiola nudiapicalis* are incorrect original spellings in the Index (p. 391) and in the English summary (p. 396) by Fan et al. (1988). Ranked as species by Zhang and Zhu (2014: 19).

**Pegomya pulchripes* (Loew, 1857)
Distribution in China. Hebei, Sichuan (Zhao 1983: 24).

**Pegomya revolutiloba* Zheng & Fan, 1990
Distribution. China: Xizang (Zheng and Fan 1990: 184).

Pegomya rhagolobos Li, Deng, Zhu & Sun, 1984
Pegomya rhagolobs [misspelling of *rhagolobos*] Li, Deng, Zhu & Sun. Wei et al. 1998a: 788.
Distribution. China: Sichuan.

**Pegomya rufina* (Fallén, 1825)
Distribution in China. Shaanxi (Wu and Zhang 1988: 349).

**Pegomya semicircula* Li, Liu & Fan, 1999
Distribution. China: Henan (Li et al. 1999: 243).

**Pegomya setaria* (Meigen, 1826)
Distribution in China. Shanghai (Hennig 1973: 635).

**Pegomya spiraculata* Suwa, 1974
Distribution in China. Liaoning (Song et al. 2007: 230).

**Pegomya sublurida* Hsue, 1981
Distribution. China: Liaoning (Hsue 1981: 89).

**Pegomya tabida* (Meigen, 1826)
Distribution in China. Shaanxi (Wu and Zhang 1988: 349).

**Pegomya unilongiseta* Fan & Huang in Fan, Huang, Zou & Wu, 1984
Distribution. China: Fujian (Fan et al. 1984: 220).

**Pegomya yunnanensis* Xue, 2001
Distribution. China: Yunnan (Xue 2001b: 487).

Genus *Pegoplata* Schnabl & Dziedzicki, 1911

Syn.: *Nupedia* Karl, 1930.
Taxonomic note. Griffiths (1986: 610) first proposed a wider concept of *Pegoplata* to include species previously recognized in *Nupedia*.

Pegoplata aestiva (Meigen, 1826)
Nupedia aestiva (Meigen). Wei et al. 1998a: 765.
Distribution in China. Shanxi, Qinghai, Xinjiang, Sichuan, Yunnan, Xizang.

Pegoplata annulata (Pandellé, 1899)
Pegoplata juvenilis (Stein, 1898) [misidentification]. Wei et al. 1998a: 768.
Distribution in China. Heilongjiang.
Taxonomic note. Griffiths (1986: 622) recognized two subspecies under *Pegoplata juvenilis* (Stein, 1898), of which the nominal subspecies is Nearctic in distribution and its Palearctic counterpart was named as *P. juvenilis nitidicauda* (Schnabl, 1911). Barták et al. (1990: 448) and subsequent European authors treat the Palearctic taxon as a distinct species by the name *Pegoplata annulata* (Pandellé, 1899).

Pegoplata infirma (Meigen, 1826)
Nupedia infirma (Meigen). Wei et al. 1998a: 765.
Distribution in China. Heilongjiang, Hebei, Shanxi, Gansu, Xinjiang.

**Pegoplata laotudingga* Zheng & Xue, 2002
Distribution. China: Liaoning (Zheng and Xue 2002: 158).

Pegoplata linotaenia (Ma, 1986)
Nupedia linotaenia Ma. Wei et al. 1998a: 767.
Distribution. China: Heilongjiang, Liaoning, Neimenggu.

Pegoplata nigroscutellata (Stein, 1920)
Nupedia nigroscutellata (Stein). Wei et al. 1998a: 767.
Distribution in China. Heilongjiang, Qinghai.

Pegoplata patellans (Pandellé, 1900)
Nupedia patellans (Pandellé). Wei et al. 1998a: 767.
Distribution in China. Gansu, Qinghai, Xinjiang, Sichuan.

Pegoplata plicatura (Hsue, 1981)
Nupedia plicatura Hsue. Wei et al. 1998a: 767.
Distribution. China: Liaoning.

**Pegoplata qiandianensis* Wei, 2006
Distribution. China: Guizhou (Wei 2006b: 534).

Genus *Phorbia* Robineau-Desvoidy, 1830

**Phorbia fani* Xue, 2001
Distribution. China: Sichuan, Yunnan (Xue 2001b: 485).

Phorbia genitalis (Schnabl, 1911)
Phorbia securis xibeina Wu, Zhang & Fan in Fan et al., 1988. Wei et al. 1998a: 742.
Distribution in China. Shaanxi, Gansu, Qinghai.
Taxonomic note. Synonymy first proposed by Ackland (1993: 213).

Phorbia lobata (Huckett, 1929)
Phorbia perssoni Hennig, 1976. Wei et al. 1998a: 742.
Distribution in China. Xinjiang.
Taxonomic note. Synonymy first proposed by Ackland (1993: 220) on advice from GCD Griffiths.

**Phorbia longipilis* (Pandellé, 1900)
Distribution in China. Heilongjiang (Hennig 1976: 950).

**Phorbia morulella* Fan, Li & Cui, 1993
Distribution. China: Henan (Fan et al. 1993: 133).

**Phorbia polystrepsis* Fan, Chen & Ma, 2000
Distribution. China: Qinghai (Fan et al. 2000: 130).

**Phorbia simplisternita* Fan, Li & Cui, 1993
Distribution. China: Henan (Fan et al. 1993: 133).

**Phorbia sinosingularis* Zhang, Fan & Zhu, 2011
Distribution. China: Shanxi (Zhang et al. 2011: 298).

**Phorbia subcurvifolia* Zhang, Fan & Zhu, 2011
Distribution. China: Heilongjiang (Zhang et al. 2011: 297).

Phorbia subfascicularis Suwa, 1994
Phorbia fascicularis Tiensuu, 1936 [misidentification]. Wei et al. 1998a: 740.
Distribution in China. Heilongjiang.
Taxonomic note. Misidentification first noted by Suwa (1994b: 535).

Genus *Ringdahlia* Michelsen, 2014

Ringdahlia curtigena (Ringdahl, 1935)
Lasiomma curtigena (Ringdahl). Wei et al. 1998a: 662.
Distribution in China. Gansu.
Taxonomic note. The genus *Ringdahlia* was established by Michelsen (2014: 12) for the present species previously referred to either *Lasiomma* Stein or *Chirosiomima* Hennig.

Genus *Sinophorbia* Xue, 1997

Syn.: *Sinophorbia* Xue in Wei et al., 1998
Sinophorbia tergiprotuberans Xue, 1997
Sinophorbia tergiprotuberans Xue in Wei et al., 1998b: 2301.
Distribution. China: Sichuan (Xue 1997: 1496).
Note. The present genus and species, intended for publication in "Flies of China" (Xue in Wei et al., 1998b), were accidentally published by Xue (1997: 1495–1497).

Genus *Strobilomyia* Michelsen, 1988

**Strobilomyia lijiangensis* Roques & Sun in Roques, Sun, Zhang, Pan, Xu & Delplanque, 1996
Distribution. China: Yunnan (Roques et al. 1996: 421).

**Strobilomyia oriens* (Suwa, 1983)
Lasiomma abietes [misspelling of *abietis*] (Huckett, 1953) [misidentification].
Distribution in China. Liaoning (Hsue 1983: 52).
Taxonomic note. Michelsen (1988: 312) noted that *Strobilomyia abietis* is a Nearctic species and replaced by *S. oriens* in East Asia.

[*Strobilomyia sanyangi* Roques & Sun in Sun, Roques, Zhang & Xu, 1996]
Unavailable *nomen nudum* (Sun et al. 1996: 146).

**Strobilomyia sibirica* Michelsen, 1988
Distribution in China. Heilongjiang (Roques et al. 2003: 365).

**Strobilomyia svenssoni* Michelsen, 1988
Distribution in China. Heilongjiang (Sun et al. 1995: 10).

Genus *Subhylemyia* Ringdahl, 1933

Syn.: *Deliomyia* Fan in Fan et al., 1988, syn. n.
Taxonomic note. *Deliomyia* was proposed as a subgenus of *Subhylemyia* Ringdahl. The genus *Subhylemyia* is reasonably well defined and includes only two known species. Thus we see no reason to split this taxon any further.

Subhylemyia dorsilinea (Stein, 1920)
Subhylemyia (*Deliomyia*) *lineola* (Collin). Wei et al. 1998a: 734.
Distribution in China. Neimenggu, Qinghai.
Taxonomic note. Synonymy first proposed by Griffiths (1998: 1880).

Genus *Zaphne* Robineau-Desvoidy, 1830

Taxonomic note. First proposed by Michelsen (1985: 40) as valid generic name for a species group split off from *Hydrophoria* s. lat.

Zaphne ambigua (Fallén, 1823)
Hydrophoria ambigua (Fallén). Wei et al. 1998a: 672.
Zaphne ambigua (Fallén). Xue et al. 2009: 423.
Distribution in China. Heilongjiang.

Zaphne divisa (Meigen, 1826)
Hydrophoria divisa (Meigen). Wei et al. 1998a: 672.
Zaphne divisa (Meigen). Xue et al. 2009: 423.
Distribution in China. Heilongjiang, Neimenggu, Tianjin.

Zaphne fasciculata (Schnabl, 1915)
Hydrophoria fasciculata (Schnabl). Wei et al. 1998a: 672.
Zaphne fasciculata (Schnabl). Xue et al. 2009: 423.
Distribution in China. Heilongjiang.

Zaphne ignobilis (Zetterstedt, 1845)
Hydrophoria ignobilis (Zetterstedt). Wei et al. 1998a: 672.
Zaphne ignobilis (Zetterstedt). Xue et al. 2009: 424.
Distribution in China. Heilongjiang, Jinlin, Yunnan.

Zaphne inuncta (Zetterstedt, 1838)
Hydrophoria hyalipennis (Zetterstedt, 1855). Wei et al. 1998a: 672.
Zaphne inuncta (Zetterstedt). Xue et al. 2009: 424.
Distribution in China. Heilongjiang, Jilin.
Taxonomic note. Synonymy established by Michelsen (1985: 48, 49).

**Zaphne laxibarbiventris* Xue & Dong in Xue, Bai & Dong, 2009
Distribution. China: Yunnan (Xue et al. 2009: 425).

Zaphne lineatocollis (Zetterstedt, 1838)
Hydrophoria lineatocollis (Zetterstedt). Wei et al. 1998a: 673.
Zaphne lineatocollis (Zetterstedt). Xue et al. 2009: 425.
Distribution in China. Heilongjiang.

Zaphne maculipennis (Stein, 1907)
Hydrophoria maculipennis Stein. Wei et al. 1998a: 673.
Zaphne maculipennis (Stein). Xue et al. 2009: 425.
Distribution in China. Neimenggu, Qinghai, Shanxi, Xizang.

Zaphne melaena (Stein, 1907)
Hydrophoria melaena Stein. Wei et al. 1998a: 673.
Zaphne melaena (Stein). Xue et al. 2009: 426.
Distribution in China. Heilongjiang, Liaoning, Qinghai, Neimenggu, Shanxi, Sichuan, Xinjiang.

Zaphne nuda (Schnabl in Schnabl & Dziedzicki, 1911)
Hydrophoria nuda (Schnabl). Wei et al. 1998a: 673.
Zaphne nuda (Schnabl). Xue et al. 2009: 427.
Distribution in China. Heilongjiang.

**Zaphne pullata* (Wu, Liu & Wei, 1995)
Hydrophoria pullata Wu, Liu & Wei.
Zaphne pullata (Wu, Liu & Wei). Xue et al. 2009: 427.
Hydrophoria disticrassa Xue & Bai in Xue, Bai & Dong, 2009, syn. n.
Distribution. China: Guizhou, Yunnan (Wu et al. 1995: 290; Xue et al. 2009: 418).
Taxonomic note. Present synonymy based on comparison of the original illustrations of the male terminalia of the two nominal species.

Zaphne tundrica Schnabl in Schnabl & Dziedzicki, 1911
Hydrophoria verticina (Zetterstedt, 1838) [misidentification]. Wei et al. 1998a: 676.
Zaphne verticina (Zetterstedt) [misidentification]. Xue et al. 2009: 427.
Distribution in China. Xinjiang.
Taxonomic note. Misidentification first noted by Griffiths (1998: 1982).

Zaphne venatifurca (Zhong, 1985)
Hydrophoria venatifurca Zhong. Wei et al. 1998a: 676.
Zaphne venatifurca (Zhong). Xue et al. 2009: 427.
Distribution. Xizang.

Zaphne ventribarbata (Hsue, 1981)
Hydrophoria ventribarbata Hsue. Wei et al. 1998a: 676.
Zaphne ventribarbata (Hsue). Xue et al. 2009: 427.
Distribution. Jilin.

Zaphne wierzejskii (Mik, 1867)
Hydrophoria wierzejskii (Mik). Wei et al. 1998a: 676.
Zaphne wierzejskii (Mik). Xue et al. 2009: 427.
Distribution in China. Heilongjiang, Liaoning, Neimenggu, Shanxi, Qinghai, Xinjiang.

Zaphne zetterstedtii (Ringdahl, 1918)
Hydrophoria zetterstedti [misspelling of *zetterstedtii*] (Ringdahl). Wei et al. 1998a: 676.
Zaphne zetterstedti [misspelling of *zetterstedtii*] (Ringdahl). Xue et al. 2009: 428.
Distribution in China. Heilongjiang, Sichuan.

Valid species removed from the list of Chinese Anthomyiidae

Eutrichota schineri (Schnabl, 1910)
A record from NE China by Suwa (1999: 224) is mistaken and refers to *E. socculata* (Zetterstedt).

Lasiomma seminitidum (Zetterstedt, 1845)
Recorded from NE China by Suwa (1999: 224), but this refers to *L. craspedodontum* (Xue) as clarified by Suwa (2005: 93).

Identity of *Heteroterma fanjingensis* Wei

Wei (2006b: 531) proposed in the family Anthomyiidae a new genus *Heteroterma* for a new species *fanjingensis* based on 1 male, 1 female from Guizhou, China. On inspection of the original illustrations of the male and female terminalia it occurred to one of us (VM) that they might belong to a species of Scathophagidae rather than Anthomyiidae. Dr AL Ozerov, Zoological Museum, Moscow State University, was consulted and he immediately identified this nominal species that he did not know about beforehand. The nomenclatorial implications are summarized below.

Genus *Scathophaga* Meigen, 1803

Syn.: *Heteroterma* Wei, 2006, syn. n.
[name preoccupied by *Heteroterma* Gabb, 1869 in Tudiclidae, a fossil gastropod family]

Scathophaga curtipilata Feng, 2002
Heteroterma fanjingensis Wei, 2006, syn. n.
Scatomyza fansipanicola Ozerov in Ozerov & Krivosheina, 2011, syn. n.
Distribution. China: Sichuan, Guizhou; Vietnam (Feng 2002: 365; Wei 2006b: 531; Ozerov and Krivosheina 2011: 5).
Taxonomic note. Ozerov and Krivosheina (2011: 3) proposed a revival of the genus *Scatomyza* Fallén for a group of species previously recognized in *Scathophaga* Meigen. This is not followed here, as this may well result in a paraphyletic *Scatophaga* s. str.

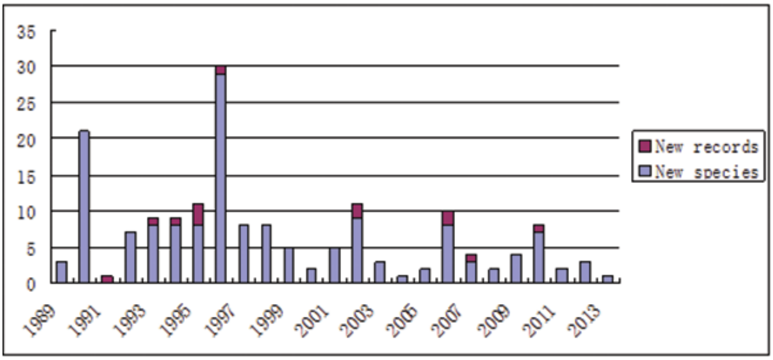

Figure 1. Number of anthomyiid species described or newly recorded from China and Taiwan all years from 1989 to 2013, a time span of 25 years.

Discussion

We have attempted to consult all relevant publications on Chinese Anthomyiidae in the preparation of the above supplementary catalogue of Anthomyiidae covering both mainland China and Taiwan. The anthomyiid fauna of mainland China comprises 675 species in 37 genera which corresponds to more than one-third of the known world fauna and 84% of the currently recognized anthomyiid genera. One genus (*Sinophorbia* Xue, 1997) and c. 425 species of Anthomyiidae are presently regarded as endemic to mainland China; other 6 species are endemic to Taiwan. However, a revisional study of the difficult and species rich genus *Botanophila* in North America is still pending and may expectedly show that a substantial number of the species currently listed as endemic to China in reality are more widespread, northern Holarctic species.

As shown in the bar graph (Fig. 1), species have been described or newly recorded from mainland China all years since the publication of the regional monograph by Fan et al. (1988). The bar graph suggests that the knowledge about anthomyiid species diversity in China is still far from exhaustive. Predictably, many new species await discovery and description, especially from inaccessible high altitude regions such as the Tibetan Plateau.

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References

Ackland DM (1987) The genus *Anthomyia* in the Oriental region. Insecta Matsumurana (N.S.) 36: 39–60.

Ackland DM (1993) Revisionary notes on the genus *Phorbia* (Diptera: Anthomyiidae) with descriptions of three new species from the Czech Republic and Georgia (Palaearctic Region). European Journal of Entomology 90: 209–226.

Ackland DM (2010) Additions and changes to the British List of Anthomyiidae (Diptera). Dipterists Digest 17: 79–82.

Barták M, Michelsen V, Rozkošný R (1990) New records of Anthomyiidae from Czechoslovakia, with a revised check list of Czechoslovak species (Diptera). Scripta Facultatis Scientiarum Naturalium Universitatis Purkyniensis Brunensis 20(9–10): 439–450.

Chen ZZ, Fan ZD (1995) A new species of Anthomyiidae from Qinghai, China (Diptera). Acta Zootaxonomica Sinica 20(4): 492–494. [in Chinese with English summary]

Ci YL, Yang C (1986) A preliminary investigation of flies in Xining Region. Journal of Qinghai Medical College 2: 24–29. [in Chinese with English summary]

Cui CY, Li SJ, Fan ZD (1993) Two new species of Anthomyiidae (Diptera) from Northeast China. Contributions from Shanghai Institute of Entomology 11: 137–140. [in Chinese with English summary]

Dely-Draskovits Á (1993) Family Anthomyiidae. In: Soós Á, Papp L (Eds) Catalogue of Palaearctic Diptera 13. Hungarian Natural History Museum, Budapest, 11–112.

Deng AX (1993) Two new species belonging to *tibetana* Group of genus *Pegohylemyia* in China (Diptera: Anthomyiidae). Journal of West China University of Medical Sciences 24(1): 58–61. [in Chinese with English summary]

Deng AX (1997) Note on four new species of genus *Pegohylemyia* of Anthomyiidae in Minshan Mountain Region of Sichuan (Diptera: Anthomyiidae). Acta Zootaxonomica Sinica 22 (2): 201–205. [in Chinese with English summary]

Deng AX, Geng L, Liu Y, Li L (1995) Reports on two species of *Pegohylemyia tibetana* Group in Xiling Snow Mountain of Dayi County, Sichuan, China (Anthomyiidae, Diptera). Journal of West China University of Medical Sciences 26(1): 58–60. [in Chinese with English summary]

Deng AX, Li L (1993) Note on a new species of genus *Pegomya* and a new record of genus *Paradelia* in Northwest Sichuan (Anthomyiidae: Diptera). Sichuan Journal of Zoology 12 (4): 8–10. [in Chinese with English summary]

Deng AX, Li L (1994) Descriptions of three new species of the genus *Delia*, Anthomyiidae, Diptera in Sichuan, China. Journal of West China University of Medical Sciences 25(1): 18–21. [in Chinese with English summary]

Deng AX, Li L, Liu Y (1996) Notes on three new species of the genus *Pegohylemyia* from Northwestern Sichuan (Diptera: Anthomyiidae). Acta Entomologica Sinica 39(4): 426–429. [in Chinese with English summary]

Deng AX, Liu Y, Li L (1995) Two new species of *Pegohylemyia tibetana* Group in Xiling Snow Mountain of Dayi County in Sichuan, China (Diptera, Anthomyiidae). Journal of West China University of Medical Sciences 26(4): 375–377. [in Chinese with English summary]

Fan ZD, Chen ZZ (1992) Two new species of the genus *Anthomyia* from Hainan, China. Chinese Journal of Vector Biology and Control 3(4): 197–199. [in Chinese with English summary]

Fan ZD, Chen ZZ, Chen HL (1993) A new species of the genus *Pegohylemyia* (Diptera: Anthomyiidae) from Henan, China. Entomotaxonomia 15(1): 59–61. [in Chinese with English summary]

Fan ZD, Chen ZZ, Fang JM (1987) Diptera: Anthomyiidae, Muscidae, Calliphoridae, Sarcophagidae. In: Zhang SM (Ed.) Agricultural insects, spiders, plant diseases and weeds of Xizang 1. Tibet People's Press, Lhasa, 299–306. [in Chinese with English summary]

Fan ZD, Chen ZZ, Ma SY (1989) *Lopesohylemya*, a new genus of Anthomyiidae (Diptera) from Qinghai, China. Memórias do Instituto Oswaldo Cruz 84 (Suppl. 4): 567–568. doi: 10.1590/S0074-02761989000800097

Fan ZD, Chen ZZ, Ma SY (2000) Two new species of Anthomyiidae (Diptera) from Qinghai, China. Entomotaxonomia 22(2): 129–133. [in Chinese with English summary]

Fan ZD, Chen ZZ, Ma ZY, Ge FX (1982) On some new species of Anthomyiidae from China (Diptera). Contributions from Shanghai Institute of Entomology 2 [1981]: 221–239. [in Chinese with English summary]

Fan ZD, Chen ZZ, Ma SY, Wu Y (1984) New species of the family Anthomyiidae (Diptera) from Qinghai Province, China, I. Contributions from Shanghai Institute of Entomology 4: 239–253. [in Chinese with English summary]

Fan ZD, Huang JC, Zou MQ, Wu JY (1984) A preliminary report on Anthomyiidae from Wuyi Mountain, with descriptions of two new species of the genus *Pegomya* (Diptera: Anthomyiidae). Wuyi Science Journal 4: 219–223. [in Chinese with English summary]

Fan ZD, Li SJ, Cui CY (1993) Two new species of the genus *Phorbia* from Henan, China. Contributions from Shanghai Institute of Entomology 11: 133–136. [in Chinese with English summary]

Fan ZD, Sun CH, Chen ZZ, Ma SY, Wu L, Ge FX, Xue WQ, Cui CY, Wang CS, Ma CY, Wang CJ, Jin ZY, Jiang TJ, Qian JQ, Li R (1988) Diptera: Anthomyiidae. Economic Insect Fauna of China 37. Science Press, Beijing, China, 396 pp., 10 pls. [in Chinese with English summary]

Fan ZD, Zheng SS (1992) Anthomyiidae. In: Chen SX (Ed.) Insects of the Hengduan Mountains Region 2. Science Press, Beijing, 1127–1165. [in Chinese with English summary]

Feng Y (2002) One new species of *Scathophaga* from Western Sichuan, China (Diptera: Scathophagidae). Chinese Journal of Vector Biology and Control 13(5): 365–366. [in Chinese with English summary]

Feng Y (2006) Three new species and a new record of the Anthomyiidae from Sichuan, China (Diptera: Muscoidea). Entomological Journal of East China 15(1): 1–6. [in Chinese with English summary]

Feng Y, Fan ZD, Zeng WZ (1999) Three new species of Calyptratae from Sichuan, China (Diptera: Anthomyiidae, Muscidae). Chinese Journal of Vector Biology and Control 10 (5): 321–324. [in Chinese with English summary]

Feng Y, Qian WP, He JH (2010) Anthomyiidae from Sichuan. Sichuan Science and Technology Press, Chengdu, 65 pp. [in Chinese with English summary]

Ge FX, Li SJ (1985) Two new species of Anthomyiidae from Henan Province (Diptera). Zoological Research 6(3): 232–242. [in Chinese with English summary]

Griffiths GCD (1984) Anthomyiidae [part]. In: Lindner E (Ed.) Flies of the Nearctic Region 8 (2) 4. E. Schweizerbart, Stuttgart, 409–600.

Griffiths GCD (1987) Anthomyiidae [part]. In: Lindner E (Ed.) Flies of the Nearctic Region 8 (2) 6. E. Schweizerbart, Stuttgart, 729–952.

Griffiths GCD (1993) Anthomyiidae [part]. In: Lindner E (Ed.) Flies of the Nearctic Region 8 (2) 10. E. Schweizerbart, Stuttgart, 1417–1632.

Griffiths GCD (1996) Anthomyiidae [part]. In: Lindner E (Ed.) Flies of the Nearctic Region 8 (2) 11. E. Schweizerbart, Stuttgart, 1633–1872.

Griffiths GCD (1998) Anthomyiidae [part]. In: Lindner E (Ed.) Flies of the Nearctic Region 8 (2) 12. E. Schweizerbart, Stuttgart, 1873–2120.

Griffiths GCD (2001) Flies of the Nearctic Region, Cyclorrpha II (Schizophora: Calyptratae) Anthomyiidae 8 (2) 13. Schweizerbart, Stuttgart, 2121–2288.

Griffiths GCD (2003) Flies of the Nearctic Region, Cyclorrpha II (Schizophora: Calyptratae) Anthomyiidae 8 (2) 14. Schweizerbart, Stuttgart, 2289–2484.

Hennig W (1966) Anthomyiidae [part]. In: Lindner E (Ed.) Die Fliegen der palaearktischen Region 7 (1) Lief. 268. E. Schweizerbart, Stuttgart, 49–96.

Hennig W (1970) Anthomyiidae [part]. In: Lindner E (Ed) Die Fliegen der palaearktischen Region 7 (1) Lief. 283. E. Schweizerbart, Stuttgart, 377–424.

Hennig W (1972) Anthomyiidae [part]. In: Lindner E (Ed.) Die Fliegen der palaearktischen Region 7 (1) Lief. 294. E. Schweizerbart, Stuttgart, 425–472.

Hennig W (1973) Anthomyiidae [part]. In: Lindner E (Ed.) Die Fliegen der palaearktischen Region 7 (1) Lief.297. E. Schweizerbart, Stuttgart, 593–680.

Hennig W (1976) Anthomyiidae [part]. In: Lindner E (Ed.) Die Fliegen der palaearktischen Region 7 (1) Lief. 314. E. Schweizerbart, Stuttgart, 921–974.

Hsue WC (1981) Four new species of the Anthomyiidae from Liaoning and Kirin, China (Diptera: Anthomyiidae). Acta Entomologica Sinica 24(1): 89–96. [in Chinese with English summary]

Hsue WC (1983) A catalog of Anthomyiidae from Liaoning Province. Transactions of Liaoning Zoological Society 4(2): 45–60. [in Chinese with English summary]

Huckett HC (1971) The Anthomyiidae of California exclusive of the subfamily Scatophaginae (Diptera). Bulletin of the California Insect Survey 12: 1–121.

Li SJ, Cui CY, Fan ZD (1993) Descriptions of two Anthomyiidae species from Henan Province (Diptera). Contributions from Shanghai Institute of Entomology 11: 129–132. [in Chinese with English summary]

Li SJ, Liu CL, Fan ZD, Cui CY (1999) Descriptions of three new *Pegomya* species from Henan, China (Diptera: Anthomyiidae). Chinese Journal of Vector Biology and Control 10(4): 241–245. [in Chinese with English summary]

Michelsen V (1979) Notes on the identity and type-material of the Anthomyiidae, Fanniidae, and Muscidae (Diptera) described by J.C. Fabricius. Steenstrupia 5: 181–196.

Michelsen V (1985) A revision of the Anthomyiidae (Diptera) described by J.W. Zetterstedt. Steenstrupia 11(2): 37–65.

Michelsen V (1988) A world revision of *Strobilomyia* gen. n.: the anthomyiid seed pests of conifers (Diptera: Anthomyiidae). Systematic Entomology 13: 271–314. doi: 10.1111/j.1365-3113.1988.tb00244.x

Michelsen V (2004) Anthomyiidae. In: Pape T (Ed.) Diptera Brachycera. Fauna Europaea ver. 1.0. [Ver. 2.6.2 available from http://www.faunaeur.org]

Michelsen V (2009) Revision of the willow catkin flies, genus *Egle* Robineau-Desvoidy (Diptera: Anthomyiidae), in Europe and neighbouring areas. Zootaxa 2043: 1–76.

Michelsen V (2011) Anthomyiidae. In: Pape T (Ed.) Diptera Brachycera. Fauna Europaea ver. 2.4. [Ver. 2.6.2 available from http://www.faunaeur.org]

Michelsen V (2014) Taxonomic assessment of *Chirosiomima* Hennig (Diptera: Anthomyiidae), with proposal of a new genus for *Hylemyia curtigena* Ringdahl. Zootaxa 3790: 86–102. doi: 10.11646/zootaxa.3790.1.4

Ozerov AL, Krivosheina MG (2011) To the knowledge of dung flies (Diptera, Scathophagidae) of Vietnam, with the description of a new species. Far Eastern Entomologist 228: 1–10.

Pont AC, Ackland DM (2009) The types of Anthomyiidae (Diptera) in the Museum für Naturkunde Berlin, Germany. Zoosystematics and Evolution 85(1): 5–56. doi: 10.1002/zoos.200800015

Pont AC, Xue WQ (2007) The publication date of "Flies of China". Studia Dipterologica 14 (1): 159–160.

Qian JQ, Ma DX, Fan ZD, Xue WQ, Zhao JM, Ni T, Yao ZX, Xiang CQ, Xu TS (1998) Studies on flies in Xinjiang: I. Anthomyiidae. Endemic Diseases Bulletin 13(2): 74–77. [in Chinese with English summary]

Roques A, Sun JH, Zhang XD, Pan YZ, Xu YB, Delplanque A (1996) Cone flies, *Strobilomyia* spp. (Diptera: Anthomyiidae), attacking larch cones in China, with description of a new species. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 69(3–4): 417–429.

Roques A, Sun JH, Sachet J-M, Pan YZ (2003) Review of cone fly species, *Strobilomyia* spp. (Diptera: Anthomyiidae), affecting conifer natural regeneration in the Far East. Acta Entomologica Sinica 46(3): 363–381.

Song WH, Xue WQ, Wang MF (2007) Study on faunistic distribution of genus *Pegomya* in China. Journal of Shenyang Normal University (Natural Science) 25(2): 229–232. [in Chinese with English summary]

Stein P (1907) Zur Kenntnis der Dipteren von Central-Asien. II. Cyclorrhapha schizophora schizometopa. Die von Roborowsky und Kozlov in der Mongolei und Tibet gesammelten Anthomyiiden. Ezhegodnik Zoologicheskogo Muzeya Imperatorskoi Akademii Nauk, St. Petersburg 12: 318–372.

Stein P (1915) H. Sauter's Formosa Ausbeute. Anthomyidae (Dipt.). Supplementa Entomologica 4: 13–56.

Stein P (1918) Zur weitern Kenntnis aussereuropäischer Anthomyiden. Annales Historico-Naturales Musei Nationalis Hungarici 16: 147–244.

Sun JH, Roques A, Zhang XD, Li H (1995) New larch cone and seed insect pest – *Strobilomyia svenssoni* Michelsen. Journal of Northeast Forestry University 23(4): 10–13. [in Chinese with English summary]

Sun JH, Roques A, Zhang XD, Xu YB (1996) Egg morphology and oviposition patterns of the *Strobilomyia* spp. (Diptera: Anthomyiidae) flies damaging Siberian larch cones in northeastern China. Entomologica Sinica 3(2): 145–152.

Suwa M (1974) Anthomyiidae of Japan (Diptera). Insecta Matsumurana (N.S.) 4: 1–247.

Suwa M (1985) Redescription of *Hydrophoria aberrans* Stein from Taiwan (Diptera: Anthomyiidae). Akitu (N.S.) 74: 1–10.

Suwa M (1991) A revision of the genus *Emmesomyia* Malloch in Japan (Diptera: Anthomyiidae). Insecta Matsumurana (N.S.) 45: 1–48.

Suwa M (1994a) Some species of the genus *Delia* from Taiwan, with description of a new species (Diptera: Anthomyiidae). Procedings of the Japanese Society of Systematic Zoology 51: 63–68.

Suwa M (1994b) A new species closely related to *Phorbia fascicularis* Tiensuu (Diptera, Anthomyiidae). Japanese Journal of Entomology 62(3): 529–536.

Suwa M (1996) Some species of the genus *Botanophila* from Taiwan, with descriptions of three new species (Diptera: Anthomyiidae). Oriental Insects 30: 137–153. doi: 10.1080/00305316.1996.10433834

Suwa M (1999) Japanese records of anthomyiid flies (Diptera: Anthomyiidae). Insecta Matsumurana (N.S.) 55: 203–244.

Suwa M (2005) Supplementary notes on the family Anthomyiidae of Japan (Diptera), VI. Insecta Matsumurana (N.S.) 61: 87–106.

Tian ZF, Ma ZY (1999) A new species of the genus *Delia* Robineau-Desvoidy from China (Diptera: Anthomyiidae). Acta Zootaxonomica Sinica 24(2): 217–218.

Wang DD, Du J, Xue WQ (2006) Research of genus *Botanophila* from China (Diptera: Anthomyiidae). Journal of Medical Pest Control 22(3): 157–162. [in Chinese with English summary]

Wang MF (1983) New records of Anthomyiidae and Fanniidae from China. Acta Zootaxonomica Sinica 8(4): 412. [in Chinese with English summary]

Wang MF (1995) Two new records of Anthomyiidae from China. Acta Zootaxonomica Sinica 20(1): 94. [in Chinese with English summary]

Wei LM (2006a) Anthomyiidae. In: Jin DC, Li ZZ (Eds) Insects from Chishui spinulose tree fern landscape. Guizhou Science and Technology Publishing House, Guiyang, 286–289. [in Chinese with English summary]

Wei LM (2006b) Anthomyiidae. In: Li ZZ, Jin, DC (Eds) Insects from Fanjingshan landscape. Guizhou Science and Technology Publishing House, Guiyang, 525–541. [in Chinese with English summary]

Wei LM, Xue WQ, Cui CY (1998a) The family Anthomyiidae of China (Diptera). In: Xue WQ, Chao CM (Eds) Flies of China. Volume 1 [1996]. Liaoning Science and Technology Press, Shenyang, 634–808. [in Chinese with English summary]

Wei LM, Xue WQ, Cui CY (1998b) The family Anthomyiidae of China (Diptera). In: Xue WQ, Chao CM (Eds) Flies of China. Volume 2 [1996]. Liaoning Science and Technology Press, Shenyang, 2266–2278, 2301–2307. [in Chinese with English summary]

Wu CG, Liu GB, Wei LM (1995) A new species of *Hydrophoria* (Diptera: Anthomyiidae) from Guizhou, China. Entomotaxonomia 17(4): 290–292. [in Chinese with English summary]

Wu YQ, Zhang GQ (1988) Eight new records of species of family Anthomyiidae from China. Journal of the Fourth Military Medical University 9(5): 348–349. [in Chinese with English summary]

Xue WQ (1997) Diptera: Anthomyiidae. In: Yang XK (Ed.) Insects of the Three Gorge Reservoir Area of Yangtze River. Chongqing Publishing House, Chongqing, 1491–1497. [in Chinese with English summary]

Xue WQ (2001a) Two new species of the Anthomyiidae from Yunnan Province, China (Diptera: Anthomyiidae). Zoological Research 22(4): 306–309.

Xue WQ (2001b) Three new species of the Anthomyiidae from Yunnan Province, China (Diptera: Anthomyiidae). Zoological Research 22(6): 485–489. [in Chinese with English summary]

Xue WQ (2002) Three new species of the genus *Delia* (Diptera: Anthomyiidae) from Gansu Province, China. Entomologia Sinica 9(1): 73–78

Xue WQ (2003) Three new species of the genus *Pegomya* from Yunnan Province, China (Diptera: Anthomyiidae). Acta Entomologica Sinica 46(1): 80–84.

Xue WQ, Bai SC, Dong WX (2009) A review of the genera *Hydrophoria* and *Zaphne* from China, with the descriptions of two new species (Diptera: Anthomyiidae). Entomological News 120(4): 415–429. doi: 10.3157/021.120.0411

Xue WQ, Chao CM (Eds) (1998a) Flies of China. Volume 1 [1996]. Liaoning Science and Technology Press, Shenyang, 1–1365. [in Chinese with English summary] [Note: The two-volume set "Flies of China" bears a date of December 1996, but the actual date of publication was May 1998 (Pont et Xue 2007).]

Xue WQ, Chao CM (Eds) (1998b) Flies of China. Volume 2 [1996]. Liaoning Science and Technology Press, Shenyang, 1–17, 1366–2425, 32 colour plates. [in Chinese with English summary]

Xue WQ, Dong WX, Bai SC (2012) A study on the genus *Eutrichota* (Diptera: Anthomyiidae), with descriptions of three new species from China. Oriental Insects 44(1): 77–90. doi: 10.1080/00305316.2010.10417608

Xue WQ, Du J (2008) Two new species of *Delia*, with a key to the males of the world species of the *interflua* group (Diptera: Anthomyiidae). Entomological News 119(2): 113–122. doi: 10.3157/0013-872X(2008)119[113:TNSODW]2.0.CO;2

Xue WQ, Du J (2009) The Holarctic species of the *Delia alaba* subsection, with descriptions of two new species (Diptera: Anthomyiidae). Entomologica Americana 115(2): 154–159. doi: 10.1664/07-RA-003.1

Xue WQ, Liu YN (2013) A new species of *Engyneura* Stein (Diptera: Anthomyiidae) from China with key to species. Oriental Insects 47(2–3): 144–149. doi: 10.1080/00305316.2013.811012

Xue WQ, Song WH (2007) A review of the genus *Botanophila* Lioy (Diptera: Anthomyiidae) from China, with descriptions of three new species. Zootaxa 1633: 1–38.

Xue WQ, Wang DD (2010) Four new species of the genus *Botanophila* Lioy (Diptera: Anthomyiidae) from China. Annales de la Société entomologique de France (N.S.) 46(3–4): 453–463.

Xue WQ, Yang M (2002) Four new species and two new record species of the genus *Botanophila* (Diptera: Anthomyiidae) from China. Entomologia Sinica 9(2): 73–79.

Xue WQ, Zhang XZ (1996a) Anthomyiidae. In: Fan SQ, Guan G (Eds) Insects of the Karakorum–Kunlun Mountains. Science Press, Beijing, 195–212. [in Chinese with English summary]

Xue WQ, Zhang XZ (1996b) Anthomyiidae. In: Wu SG, Feng ZJ (Eds) The Biology and Human Physiology in the Hoh Xil Region. Science Press, Beijing, 167–191. [in Chinese with English summary]

Xue WQ, Zhang XZ (2004) Anthomyiidae. In: Yang XK (Ed.) Insect from Mountain Shiwandashan Area of Guangxi. China Forestry Publishing House, Beijing, 546–547. [in Chinese with English summary]

Xue WQ, Zhang XZ (2005) Anthomyiidae. In: Yang XK (Ed.) Insect Fauna of Middle–West Qingling Range and South Mountains of Gansu Province. Science Press, Beijing, 787–797. [in Chinese with English summary]

Zhang LF, Sun JZ (1997) A new species of the genus *Anthomyia* from Liaoning, China (Diptera: Anthomyiidae). Zoological Research 18(1): 23–25. [in Chinese with English summary]

Zhang LF, Zhang DL (1998) A new species of *Leucophora* from Liaoning, China (Diptera: Anthomyiidae). Acta Entomologica Sinica 41(1): 103–105. [in Chinese with English summary]

Zhang XF, Fan ZD, Zhu WB (2011) Two new species of the genus *Phorbia* (Diptera: Anthomyiidae) from China. Acta Zootaxonomica Sinica 36(2): 297–300.

Zhang XF, Zhu WB (2014) The types of Anthomyiidae (Diptera) in the Shanghai Entomological Museum, Chinese Academy of Science, China. Zootaxa 3756(1): 1–67. doi: 10.11646/zootaxa.3756.1.1

Zhao BG (1983) New records of Muscoidea from China. Zoological Research 5: 24. [in Chinese]

Zheng LJ, Xue WQ (2002) Two new species of the Anthomyiidae from Liaoning Province, China (Diptera: Anthomyiidae). Acta Zootaxonomica Sinica 27(1): 158–161. [in Chinese with English summary]

Zheng SS, Fan ZD (1990) Descriptions of some new species of family Anthomyiidae from Western China (Diptera). Contributions from Shanghai Institute of Entomology 9: 181–187. [in Chinese and English]

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A new species of *Cyphomyia* Wiedemann from the Dominican Republic with a key to Caribbean species of the genus (Diptera, Stratiomyidae, Clitellariinae)

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Abstract

A new species of *Cyphomyia* Wiedemann, *C. baoruco* **sp. n.**, is described from the Dominican Republic. A key to the species of *Cyphomyia* known from the Caribbean islands is provided.

Keywords

Neotropical Region, Caribbean, Dominican Republic, taxonomy, new species

Introduction

The genus *Cyphomyia* Wiedemann is a fairly large genus of Stratiomyidae with 83 species. A large majority of the species are found in the Neotropical Region where 72 species are known (Woodley 2001). Eight species have been described from Caribbean islands. Only *C. marginata* Loew, described from Cuba, is also known to occur on a mainland area, southern Florida. The Caribbean species have never been systematically revised and have remained difficult to identify without comparative material. Seven of the eight species are quite similar in general appearance, being bluish to bluish black in color with three more or less distinct silvery pilose vittae on the scutum, silvery pilose spots on the abdomen, and nearly hyaline wings. Males have conspicuously, densely pilose eyes, and females of some of the species have shorter pilosity on the eyes or have it very reduced. This is an unusual character state in the genus as most mainland species have bare eyes.

The purpose of this paper is to describe a new species of *Cyphomyia* from the Dominican Republic that differs in general appearance from the described Caribbean species, having a bluish black body with a weakly vittate scutum, no silvery spots on the abdomen, and particularly by having dark wings. This appearance is similar to many mainland species of *Cyphomyia*. In addition, a key is presented that includes all of the described Caribbean species of *Cyphomyia*.

Methods

Specimens examined in this study are all housed in the Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (USNM). Images of the primary types of *Cyphomyia acuminata* James, *Cyphomyia brevis* James, *Cyphomyia marginata* Loew, and *Cyphomyia rubra* Loew were examined on the Museum of Comparative Zoology, Harvard University, type database internet site (Museum of Comparative Zoology 2014).

Specimens were examined using a Zeiss Stemi SV 11 stereomicroscope. Male terminalia were dissected and cleared using hot KOH, neutralized with acetic acid, rinsed in water, and are stored in a microvial with glycerin on the specimen pin.

Results

Cyphomyia baoruco Woodley, sp. n.

http://zoobank.org/E5019831-62C9-4150-AD82-44E98F71B60C
Figs 1–6

Diagnosis. *Cyphomyia baoruco* can be separated from all other Caribbean species of *Cyphomyia* by its bluish black body, the abdomen without silvery pilose spots dorsally, and its darkly infuscated wings. The male (female unknown) can be separated from New World mainland species by its eyes that have very long pilosity that appears slightly crinkly. Mainland species with pilose eyes generally have hairs that are shorter and denser, and none have crinkly pilosity.

Description. Male. (Figs 1–2). *Head:* Black, frontal triangle vaguely more brownish; eyes large, holoptic on upper frons, ommatidia nearly uniform in size without abrupt transition, with moderately dense, black pilosity that is about the length of scape and slightly crinkly (Figs 3–4); face very slightly convex, evenly receding to oral margin; postocular orbit, only narrowly visible in lower half in profile; head largely devoid of tomentum, present only along lower part of postocular orbit and extremely narrow strip along eye margin on gena, face, and frons, where it is grayish; head with very long

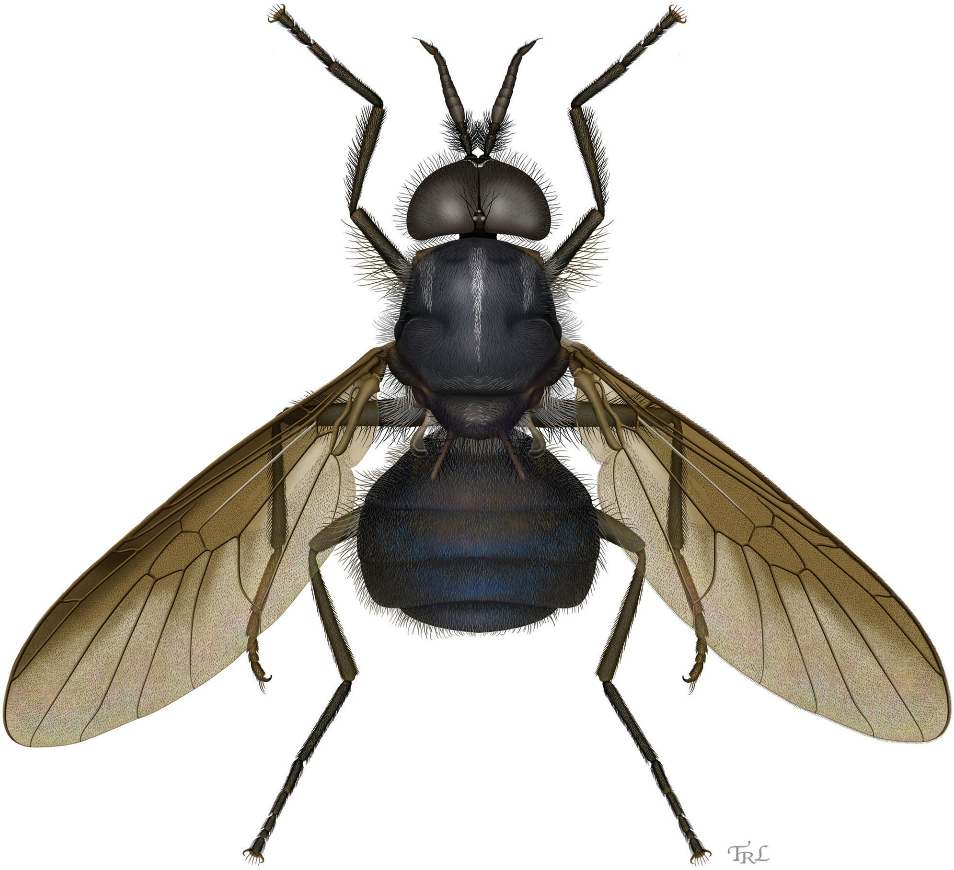
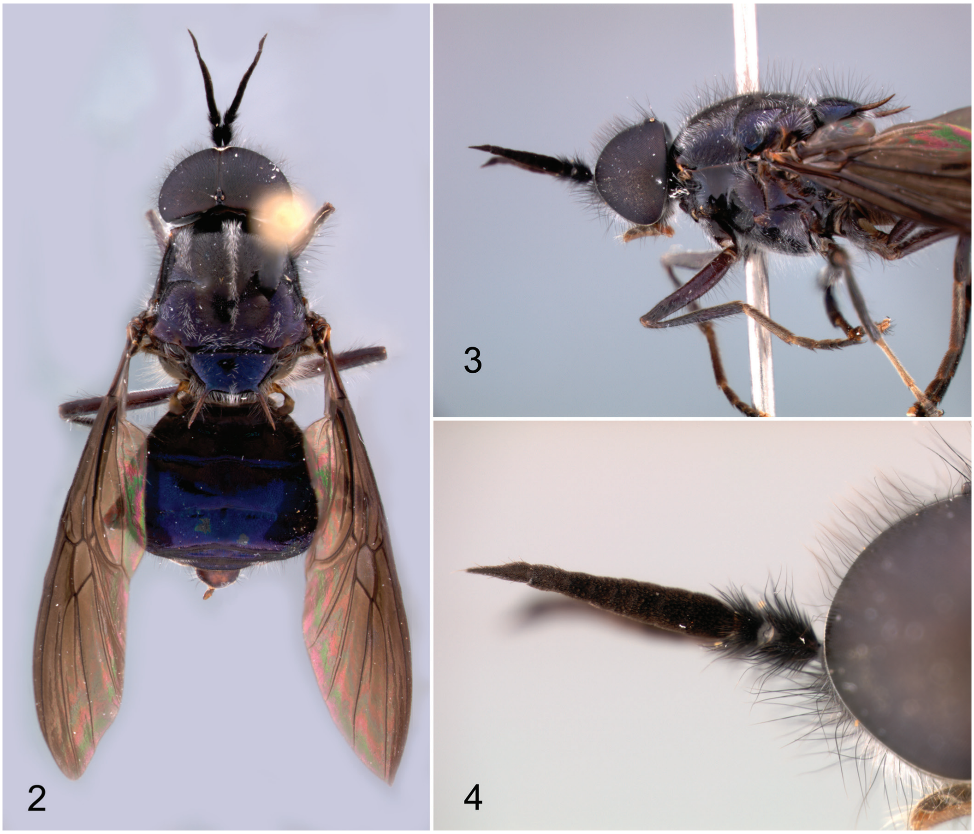


Figure 1. Dorsal habitus of *Cyphomyia baoruco* Woodley, sp. n..

pilosity, about length of scape+pedicel, of moderate density, black on ocellar triangle, face, and gena, with some whitish hairs intermixed on lower part of face and entirely whitish on lower gena and postgena; antenna (Fig. 4) black, 1.71 times length of head, gradually tapering from base to apex, ratio of segments 19:9:91[16:10:7:6:8:10:12:22], last flagellomere acuminate, scape and pedicel very densely set with bushy black pilosity, some hairs almost as long as scape+pedicel, flagellum velvety tomentose, a few short hairs present on apical flagellomere; palpus black, small, two-segmented (mostly obscured by labellum); proboscis dark yellowish, brownish laterally on labellum.

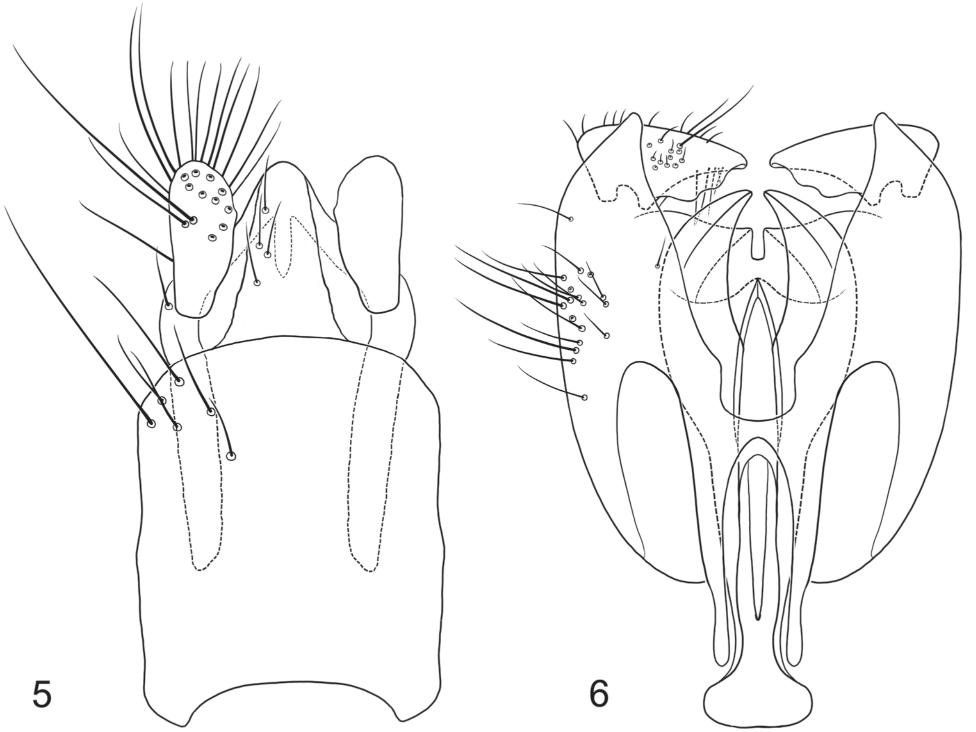
Thorax: Black, vaguely browner under wing base, postpronotal lobe, lateral part of postalar callus, and scutellar spines brownish yellow; scutellum with spines a little longer than scutellum, almost in same plane as scutellum, curving very slightly upward; prosternum and medial part of laterotergite with yellowish white tomentum, small areas on meron with sparser, inconspicuous tomentum; pilosity of thorax primarily silvery white, partly semi-appressed on scutum where it forms a narrow medial vitta that decreases in width posteriorly so that it is only a few hairs wide near scutellum, and



Figures 2–4. Photographic images of the holotype male of *Cyphomyia baoruco* Woodley, sp. n. **2** Dorsal habitus **3** Head and thorax, left lateral view **4** Anterior part of head and antenna, left lateral view.

sublateral patches forming wider, more poorly developed vittae anterior to transverse suture; other areas of scutum with semi-appressed dark hairs, and both scutum and scutellum including spines with very long, erect, slightly wavy black hairs (Fig. 3); central part of anepisternum, most of meron, and medial part of subscutellum bare and shiny; legs dark brown to brownish black, front and middle tarsi with basal two tarsomeres paler, dark yellowish; legs mostly pilose, a mixture of pale and dark hairs, mostly short and semi-appressed, longer erect hairs present on posterior and ventral surfaces of front and middle femora, most of hind femur, and posterior surfaces of front and middle tibiae; wing with dark brown infuscation over entire surface that gradually gets paler posteriorly, entirely set with microtrichia except for strip along anterior portion of cell cup and most of alula; halter with stem yellowish, knob brown.

Abdomen: Dark brownish with slight bronzy reflections, subshiny on tergites 1 and 2 and basal part of tergite 3, remainder black with distinct metallic blue reflections, shiny; sternite 1 brown, uniformly set with brownish tomentum, 2–5 black with metallic blue reflections, shiny, segments beyond 5 brownish; tergites with dark, semi-



Figures 5–6. Male terminalia of *Cyphomyia baoruco* Woodley, sp. n. **5** Epandrium and postgenital segments, dorsal view **6** Genital capsule and phallic complex, dorsal view.

appressed pilosity, with longer erect hairs laterally, some of which are whitish on basal two tergites, becoming progressively shorter posteriorly; first two sternites with erect, whitish hairs medially, otherwise sternites with short, semi-appressed pilosity.

Male terminalia: With gonocoxites (Fig. 6) slightly longer than wide with lateral triangular processes covering gonostylar articulation, gonocoxal apodemes extending anteriorly beyond anterior margin of genital capsule; hypandrium completely fused, posterior portion of ventral bridge grooved medially, sharply bilobed; gonostylus with weakly developed rounded process posterolaterally, dorsal edge sharp, slightly produced; phallic complex complicatedly fused with gonocoxites, apparently trifid, medial lobe sharply pointed, apparent lateral lobes longer than medial lobe, flattened and with medial curvature posteriorly; epandrium (Fig. 5) simple, more or less quadrate, a little longer than wide, posterior margin evenly rounded; cercus short, slightly widened and rounded posteriorly.

Measurements: Length exclusive of antennae, 9.1 mm; antennal length, 2.5 mm; wing length, 9.5 mm.

Female. Unknown.

Distribution. Known only from the Dominican Republic on the island of Hispaniola.

Type material. Holotype male (USNM), **DOMINICAN REPUBLIC:** Pedernales Province, Parque Nacional Sierra de Baoruco, Las Abejas, 18°09.011'N, 71°37.342'W, 1150 meters, 17 July 2006, N.E. Woodley. A Smithsonian Institution barcode label is attached to the specimen: USNMENT 01028720. The holotype is in excellent condition.

Etymology. The species epithet, *baoruco*, is a noun in apposition from the name of the mountain range, Sierra de Baoruco, where the holotype specimen was collected.

Remarks. As noted in the introduction, this species differs from all other Caribbean species of *Cyphomyia* in general appearance. It looks more like many Central and South American species that have a dark bluish black body and dark brown wings. The females of these mainland species often have a bright yellow head, and it will be interesting to see if the female of *C. baoruco* also has this feature when it is discovered.

The type locality of *C. baoruco*, Las Abejas, is at the southwestern end of the Sierra de Baoruco range, which is more or less continuous with the Massif de la Selle in eastern Haiti. The habitat at this site is classified as premontane wet forest (Fisher-Meerow and Judd 1989), an epiphyte-rich diverse hardwood forest which occurs in a thin strip along the southern part of the mountain range mostly between 1100–1200 meters. Las Abejas has been a fairly well-known collecting site since at least the early 1980s, and has produced some remarkable new species (e.g., Woodley 1993, Konstantinov and Chamorro-Lacayo 2006). This habitat in this region is critically endangered (León et al. 2013). Even though this habitat type is now largely within Parque Nacional Sierra de Baoruco, it has suffered extensive deforestation primarily for subsistence farming, and this is probably more intense at its western end near Haiti. I first visited Las Abejas in 1984 and last in 2006 and the extent of deforestation at the site during that time span was significant.

I have composed a key to the described species of *Cyphomyia* found on Caribbean islands that is provided below. It should be noted, however, that due to the paucity of collecting on many islands in the region, it is likely that additional undescribed species will be found. After the key a few brief notes on the included species are given.

Key to Caribbean species of *Cyphomyia*

1 Entire body including legs yellowish to brownish; antenna black; only known from Cuba .... ***C. rubra* Loew**

– Body predominantly blackish with metallic bluish reflections; antenna variable, but usually with some reddish to yellowish coloration especially basally; Cuba and elsewhere **2**

2(1) Scutellum entirely yellowish to brownish red, occasionally vaguely darker at extreme base **3**

– Scutellum black, usually with metallic bluish reflections, at most narrow apical margin and spines yellowish **4**

3(2) Posterior margin of fifth abdominal tergite with broad yellowish margin, in females this tergite can be mostly yellowish; femora usually yellowish, if brownish the darker coloration is not sharply delimited and is basal, grading into broadly yellowish apex; USA: Florida, Bahamas, Cuba, Puerto Rico .... ***C. marginata* Loew**

– Posterior margin of fifth abdominal tergite dark; femora and tibiae dark brown to blackish, with joint between them narrowly pale yellow that is sharply delimited; Hispaniola, ?Jamaica .... ***C. albomaculata*** **(Macquart)**

4(2) Wing darkly infuscated over entire surface; abdominal tergites without silvery pilosity; Dominican Republic .... ***C. baoruco*** **sp. n.**

– Wing hyaline; abdominal tergites with silvery pilosity moderately developed into spots, at least on fifth tergite **5**

5(4) Apex of scutellum yellow, visible in dorsal view; Jamaica ... ***C. acuminata*** **James**

– Apex of scutellum dark, concolorous with disc, margin may be yellowish brown to brown but this color not visible in dorsal view............................ **6**

6(5) All femora yellowish to brownish yellow; Cuba.................. ***C. brevis*** **James**

– All femora dark brown to black.. **7**

7(6) Scutum above notopleural suture with dark hairs, contrasting with the pale hairs that form the sublateral vittae, so that the anterior end of each vitta is more or less distinct and does not appear to coalesce with lateral pilosity; St. Vincent, Grenada .... ***C. lasiophthalma*** **Williston**

– Scutum above notopleural suture with pale hairs, concolorous with those that form the sublateral vitta, so that the anterior end of each vitta is not distinct as it coalesces with lateral pilosity.. **8**

8(7) Basal three flagellomeres uniformly orange, sharply contrasting with darker, more distal flagellomeres, rarely the basal three with a small amount of brownish infuscation; lateral silvery hair patches on tergites 4 and 5 moderately well developed, more or less evident to the naked eye; Puerto Rico, Virgin Islands, St. Kitts, Antigua, St. Lucia......... ***C. chalybea*** **(Wiedemann)**

– Basal three flagellomeres more brownish, not sharply contrasting with more distal flagellomeres, if some orangish color present, color evenly grades toward darker apex; lateral silvery hair patches on tergites 4 and 5 poorly developed, not readily evident to naked eye; Dominica...... ***C. dominicana*** **James**

Identification notes on Caribbean *Cyphomyia* species

In this section a few brief notes are given concerning identifications and distributions of Caribbean *Cyphomyia*. Full nomenclatural details and synonymy are presented in Woodley (2001) so are not repeated here.

Cyphomyia acuminata **James.** This species is only known from Jamaica, and I am not aware of any specimen records beyond the original type series. Although some Caribbean *Cyphomyia* have a scutellar margin that is lighter in color than the disc, this is the only species that has yellowish color between the spines that extends onto the disc and can be seen in dorsal view.

Cyphomyia albomaculata **(Macquart).** This species was described from Haiti. It is widespread and common at lower elevations in the Dominican Republic. Lindner

(1949) recorded the species from Jamaica. The few specimens I have seen from Jamaica seem to be this species but have a paler basitarsus on the hind leg that is not apically blackish as found in Hispaniolan specimens.

Cyphomyia brevis **James.** This species is known only from Cuba. Because it has pale femora, this species is incorrectly placed by James (1940: 128) in his key. In order to get to couplet 22 where it keys out, you have to chose "anterior femora black, brown, or blue; yellow at apex or not at all" at couplet 11, which is incorrect.

Cyphomyia chalybea **(Wiedemann).** This species is quite similar to *C. dominicana*, but is almost always readily distinguishable by the orange color of the basal three antennal flagellomeres. The antennal flagellum is shorter than in *C. dominicana*, but this is difficult to appreciate without having both species at hand. Also, *C. chalybea* has more conspicuous pilose spots on the abdomen. James (1967: 4) noted these differences when describing *C. dominicana*. Additionally, the pilose vittae on the scutum are more conspicuous in *C. chalybea*. In USNM there are specimens of this species from the Virgin Islands (St. Thomas, St. Croix, Guana), St. Kitts, Antigua, and St. Lucia. Records from Cuba, Dominican Republic, and Jamaica require confirmation before they can be considered part of the distribution of this species.

Cyphomyia dominicana **James.** This species is quite similar to *C. chalybea*; comparisons are noted above under that species. Part of the type series of this species, as well as a few additional specimens, were reared but unfortunately the larval host was not recorded.

Cyphomyia lasiophthalma **Williston.** I am basing my concept of this species on the specimens that James (1967: 4) examined from Grenada, which are present in the USNM collection. More material is necessary from the Lesser Antilles to get a more precise idea of species concepts in this region.

Cyphomyia marginata **Loew.** This species was described from Cuba. I have examined specimens from USA: Florida, the Bahamas, and Puerto Rico that I consider conspecific, although specimens from Puerto Rico generally have darker legs. This species has also been recorded from Jamaica and Hispaniola, but I think that these records almost certainly refer to *C. albomaculata*. James (1940) synonymized *Cyphomyia scutellata* (Cresson), described from Costa Rica, with *C. marginata*. James noted that the abdomen of *C. scutellata* was entirely black so that synonymy must be incorrect.

Cyphomyia rubra **Loew.** This unusual species is only known from Cuba. Only three other described species of *Cyphomyia*, all from Central or South America, out of 72 Neotropical species, are extensively pale in coloration. The male of this species has not been described and remains unknown.

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References

Fisher-Meerow LL, Judd WS (1989) A floristic study of five sites along an elevational transect in the Sierra de Baoruco, Prov. Pedernales, Dominican Republic. Moscosoa 5: 159–185.

Konstantinov AS, Chamorro-Lacayo ML (2006) A new genus of moss-inhabiting flea beetles (Coleoptera: Chrysomelidae) from the Dominican Republic. The Coleopterists Bulletin 60(4): 275–290. doi: 10.1649/0010-065X(2006)60[275:ANGOMF]2.0.CO;2

James MT (1940) Studies in Neotropical Stratiomyidae (Diptera). IV. The genera related to *Cyphomyia* Wiedemann. Revista de Entomologia (Rio de Janeiro) 11(1–2): 119–149.

James MT (1967) Bredin-Archbold-Smithsonian biological survey of Dominica. 5. Family Stratiomyidae (Diptera). Proceedings of the United States National Museum 123(3622): 1–23. doi: 10.5479/si.00963801.123-3622.1

León YM, Garrido E, Almonte J (2013) Monitoring and mapping broadleaf mountain forests of southern Sierra de Bahoruco, Dominican Republic. Grupo Jaragua, Santo Domingo, 36 pp. http://www.bicknellsthrush.org/pdf/GJBITHFundreport_English.pdf [accessed 20 August 2014]

Lindner E (1949) Neotropische Stratiomyiiden des Britischen Museums in London. - Theil II. Annals and Magazine of Natural History, Series 12 1(12): 851–891.

Museum of Comparative Zoology (2014) MCZ Type Database @ Harvard Entomology. Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts. http://insects.oeb.harvard.edu/mcz/index.php [accessed 18 August 2014]

Woodley NE (1993) A remarkable new species of *Paradejeania* from the Dominican Republic (Diptera: Tachinidae). Proceedings of the Entomological Society of Washington 95: 182–188.

Woodley NE (2001) A world catalog of Stratiomyidae (Insecta: Diptera). Myia 11: (8) + 1–475.

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RESEARCH ARTICLE

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A new species of redfin (Teleostei, Cyprinidae, *Pseudobarbus*) from the Verlorenvlei River system, South Africa

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Abstract

Pseudobarbus verloreni, a new species, is described from material collected in the Verlorenvlei River system on the west coast of South Africa. It differs from its congeners (except *P. skeltoni*, *P. burchelli,* and *P. burgi*) by the presence of two pairs of oral barbels. *Pseudobarbus verloreni* **sp. n.** can be distinguished from the three currently described double barbeled *Pseudobarbus* species by the following combination of characters: pigment pattern, generally deeper body relative to standard length, a longer intestine associated with the deeper body form, shorter snout relative to head length, and much shorter anterior barbels relative to head length. The new species is distinguished from *P. burgi* in the neighbouring Berg River system by its longer head and longer pre-dorsal length. It seems as if *Pseudobarbus verloreni* **sp. n.** has been extirpated from the Langvlei River system and face several threats to its survival in the Verlorenvlei River system.

Keywords

Freshwater fish, endemic hotspot, threatened, double barbeled redfins

Introduction

Species of the cyprinid genus *Pseudobarbus* (commonly referred to as “redfins”) are distinctly pigmented small-to-medium sized riverine fishes endemic to southern Africa (Skelton 1988). *Pseudobarbus* was described by Smith (1841) as a subgenus of *Barbus*.

Nearly 150 years later, the subgenus was raised to a full generic status (Skelton 1988). The monophyly of *Pseudobarbus* is supported by molecular data and morphological characters (Swartz et al. 2009). The most prominent diagnostic characters for members of this tetraploid genus (Naran et al. 2006) are the presence of bright red fins, a soft or flexible primary dorsal spine, and males develop prominent head and body tubercles during the breeding season. During his taxonomic revision of *Pseudobarbus*, Skelton (1988) recognised seven species, namely *P. afer* (Peters, 1864), *P. asper* (Boulenger, 1911), *P. burchelli* (Smith, 1841), *P. phlegethon* (Barnard, 1938), *P. quathlambae* (Barnard, 1938), and *P. tenuis* (Barnard, 1938). Two decades later, following genetic studies and a resurgence of field surveys in the Cape Floristic Region, a new redfin species *P. skeltoni* was described from the Breede River system (Chakona and Swartz 2013), bringing the number of nominal species to eight. Based on insights from molecular studies, several other taxa of this genus remain to be described (Bloomer and Impson 2000, Swartz et al. 2007, 2009, 2014, Chakona et al. 2013). Herein, we describe a ninth species of *Pseudobarbus* from the Verlorenvlei River system, which was identified as a unique genetic lineage of *P. burgi* following a phylogeographic study by Bloomer and Impson (2000).

The Verlorenvlei and Berg lineages of *Pseudobarbus burgi*, three lineages of *P. burchelli* (see Chakona et al. 2013 and Swartz et al. 2014), and *P. skeltoni* have two pairs of oral barbels and form a monophyletic group within *Pseudobarbus* (Swartz et al. 2009). The taxonomic history of the double barbeled redfins has been complex and confusing. The first double barbeled redfin was described by Smith (1841) as *Barbus* (*Pseudobarbus*) *burchelli*. This was followed by descriptions of *Gnathendalia vulnerata* Castelnau, 1861 and *Barbus multimaculatus* Steindachner, 1870, both from the Breede River system. Valenciennes (Cuvier and Valenciennes 1842) described *Barbus gobionides* but this species was later synonymised with *Gnathendalia vulnerata* by Günther (1868). Barnard (1943) subsequently declared *Barbus gobionides* Valenciennes, 1842 a nomen dubium, while Boulenger (1905) placed *Barbus multimaculatus* Steindachner, 1870 in synonymy with *Gnathendalia vulnerata*. This decision was subsequently accepted by Barnard (1943), Jubb (1965), and Skelton (1988). Boulenger (1911) described *Barbus* (*Pseudobarbus*) *burgi* from the Berg River system, but Barnard (1943) placed this species in synonymy with *Barbus* (*Pseudobarbus*) *burchelli*, and recognised *Barbus vulneratus* for the Breede River system. Jubb (1965) later reversed this decision and considered *Gnathendalia vulnerata* to be a synonym of *Barbus* (*Pseudobarbus*) *burchelli*. Skelton (1988) accepted Jubb's (1965) nomenclatural changes to maintain taxonomic stability in his taxonomic revision of redfin minnows.

Thus, *Pseudobarbus burchelli*, *P. burgi,* and the recently described *P. skeltoni* are the only double barbeled *Pseudobarbus* species that are presently recognised. The known distribution of *P. burchelli* sensu lato spans four river systems (Heuningnes, Breede, Duiwenhoks, and Goukou) on the south coast of South Africa (Skelton 1988), while *P. skeltoni* is restricted to the Breede River system (Chakona and Swartz 2013). The historical distribution of *P. burgi* sensu lato included the Langvlei, Verlorenvlei, Berg, and Eerste river systems on the west coast of South Africa (Skelton 1988). The Eerste population is thought to be extinct due to a combination of impacts including introduction of non-native species (Gaigher et al. 1980). Recent surveys suggest that the

Langvlei population has also been lost. Skelton (1988) noted that specimens of *P. burgi* from the Verlorenvlei River system had a longer intestine and longer predorsal length compared to specimens from the Berg River system. Bloomer and Impson (2000) discovered high levels of genetic differentiation (5.3–7.0% for the mitochondrial control region) between populations of *P. burgi* from the Verlorenvlei and Berg river systems, indicating a long history of isolation. The differentiation between these two lineages was confirmed by Swartz et al. (2009) and Chakona and Swartz (2013). The purpose of the present study is to describe the Verlorenvlei *Pseudobarbus* population as a new species, *Pseudobarbus verloreni* sp. n.

Materials and methods

Institutional abbreviations follow Sabaj (2013) and are listed at http://www.asih.org/node/204. Description of the new *Pseudobarbus* species is based on 47 specimens (holotype and paratypes) that were collected from the Verlorenvlei River system during surveys conducted in January 1999 and March 2012. The type material has been deposited at the South African Institute for Aquatic Biodiversity (SAIAB), MRAC, USNM and BMNH.

Molecular data

Two *Pseudobarbus* individuals from the Verlorenvlei River system were sequenced to assign a hologenetype and a paragenetype following Chakrabarty (2010) for the mitochondrial cytochrome *b* gene. The sequences were added to the genetic analysis done by Chakona and Swartz (2013) to show the phylogenetic position of the hologenetype and the paragenetype in relation to all known lineages and species of *Pseudobarbus*. Methods of DNA extraction, amplification, sequencing and analysis follow Swartz et al. (2009) and Chakona and Swartz (2013). The hologenetype and paragenetype sequences were deposited in GenBank for future reference (GenBank numbers are given below) following the definitions of Chakrabarty (2010).

Morphological data

Meristic and morphological characters were examined following Hubbs and Lagler (1958), Skelton (1988), and Chakona and Swartz (2013). The characters considered for each specimen in the present study (22 morphometric measurements) and (12 meristic counts) are presented in Table 1. In addition, entire branchial baskets were dissected from three specimens to examine and count pharyngeal teeth.

We compared morphological and meristic differences among all double barbeled redfins using raw data from Skelton (1980, 1988) and Chakona and Swartz (2013).

Table 1. Morphological characters of *Pseudobarbus* species used in the present study.

Character	Description	Acronym
Morphometric measurements		
Standard length	Tip of the snout to the point of flecture of the caudal fin	SL
Pre-dorsal length	Tip of the snout to the origin of the dorsal fin	PDL
Head length	Tip of the snout to the posterior bony margin of the operculum	HL
Snout length	Tip of the snout to the anterior bony edge of the orbit	S
Orbit diameter	The greatest bony diameter of the orbit	OD
Inter-orbit width	Shortest distance between bony edges of the orbits	IO
Post-orbit length	Distance between the posterior bony edge of orbit to the posterior bony edge of operculum	PO
Head depth	Maximum depth measured from the nape	HD
Body depth	Maximum depth measured from the anterior base of the dorsal fin	BD
Anterior barbel length	From base to tip of anterior barbel	AB
Posterior barbel length	From base to tip of posterior barbel	PB
Dorsal fin base	Distance between origin of dorsal fin and base of last dorsal fin ray	DB
Dorsal fin height	From anterior base to tip of dorsal fin	DH
Pectoral fin length	From anterior base to tip of pectoral fin	PtL
Pelvic fin length	From anterior base to tip of pelvic fin	PvL
Anal fin base	Distance between origin of anal fin and base of last anal fin	AfB
Anal fin height	From anterior base to tip of anal fin	AfH
Caudal peduncle length	Distance from posterior base of anal fin the point of flecture of the caudal fin	CPL
Caudal peduncle depth	The least depth of the caudal peduncle	CPD
Pectoral to pelvic fin length	Distance between the posterior margins of the fin bases	PP
Pelvic to anal fin length	Distance between posterior base of the pelvic fin to anterior base of the anal fin	PA
Body width	The greatest width just anterior to the origin of the dorsal fin	BW
Meristic counts		
Lateral line scales	Number of scale rows along the lateral line	LL
Lateral line to dorsal fin origin	Number of scale rows between lateral line scale row (does not include lateral line scale) and anterior base of the dorsal fin	LD
Lateral line to pelvic fin origin	Number of scale rows between lateral line scale row (does not include lateral line scale) and anterior base of pelvic fin	LP
Lateral line to anal fin origin	Number of scale rows between lateral line scale row (does not include lateral line scale) and anterior base of the anal fin	LA
Circumpeduncular scales	Number of scale rows around the caudal peduncle at narrowest portion of caudal peduncle	CP
Predorsal scales	Number of scale rows between the supraoccipital and the anterior base (origin) of the dorsal fin	PDS
Unbranched dorsal fin rays	Number of unbranched primary dorsal rays	UdR
Branched dorsal fin rays	Number of branched dorsal rays; two last branched rays counted as one	BdR
Anal fin rays	Includes both simple and branched rays; two last rays counted as one	
Pectoral fin rays	Includes both simple and branched rays	
Pelvic fin rays	Includes both simple and branched rays	
Total vertebrae	Total number of vertebrae in vertebral column (including four Weberian vertebrae and a single ural centrum)	TV
Pre-dorsal vertebrae	Total number of vertebrae in advance of the leading dorsal fin pterigiophore (including the four Weberian vertebrae)	PdV
Pre-caudal vertebrae	Total number of vertebrae in advance of the vertebrae with haemal arch opposite the leading anal pterygiophore plus the four Weberian vertebrae	PcV
Pre-anal vertebrae	Total number of vertebrae in advance of the leading anal pterygiophore (including the four Weberian vertebrae)	PaV
Caudal vertebrae	Total number of vertebrae posterior to (and including) the vertebra with haemal arch opposite the leading anal pterygiophore plus a single ural centrum	CV

Specimens were assigned to four groups based on geographic origin and previous genetic results (Bloomer and Impson 2000; Swartz et al. 2009, 2014; Chakona and Swartz 2013; Chakona et al. 2013): *P. skeltoni* (*n*=25), *P. burchelli* (*n*=128), *P. burgi* (specimens from the Berg River system only; *n*=66) and Verlorenvlei *Pseudobarbus* (specimens from the Verlorenvlei River system only; *n*=47). A total of 47 specimens of Verlorenvlei *Pseudobarbus* were radiographed to count skeletal features.

Statistical analyses were performed with the programs InfoStat (Di Rienzo et al. 2012), PAST and STATISTICA 12. Prior to analyses, morphometric data were normalised using procedures described by Lleonart et al. (2000). Analyses of meristic characters were performed using the raw data.

Principal component analysis (PCA) was performed using the correlation matrix to explore the separation of the specimens based on the normalised morphometric data (Lleonart et al. 2000) and raw meristic characters. Invariant characters (such as the number of pelvic fin rays) were excluded from analysis. All scores (including PC1) were considered, because the normalisation approach allows for size free comparisons (Lleonart et al. 2000).

Discriminant Function Analysis (DFA) was performed to visualise the degree of morphological separation among the species and to identify the most important characters that contribute to the differentiation. DFA also provides jacknifed measurements of re-classification success of individuals to their original group, as well as identifying the group to which individuals were assigned if misclassified. Separate DFAs were performed for the morphometric and meristic characters, as well as for these two data sets combined.

Results

Figure 1 is a re-analysis of the phylogeny done by Chakona and Swartz (2013) to include the genetypes of *Pseudobarbus verloreni* sp. n. sequenced in the present study. It shows the phylogenetic relationships among double barbeled redfins based on the mitochondrial cytochrome *b* data, and shows the position of the new species that is distinct from the three described double barbeled redfin species, including the three previously identified lineages of *P. burchelli* (Swartz et al. 2009, 2014). The model corrected genetic distances show deep divergences (6.6–12.3%) between the new species and the other members of the double barbeled redfin group.

Principal components analysis (PCA) of normalised morphometric and raw meristic characters shows *Pseudobarbus* specimens from the Verlorenvlei River system, herein described as the new species *P. verloreni* sp. n., form a cluster that is clearly separated from *P. skeltoni* and marginally overlaps with *P. burchelli* and *P. burgi* (Figure 2). The most important factor loadings are presented in Table 2. PCI was mainly defined by differences in head length, head depth, predorsal length, number of lateral line scales, number of scale rows between lateral line and dorsal fin, number of scale rows around the caudal peduncle and the number of predorsal scale rows

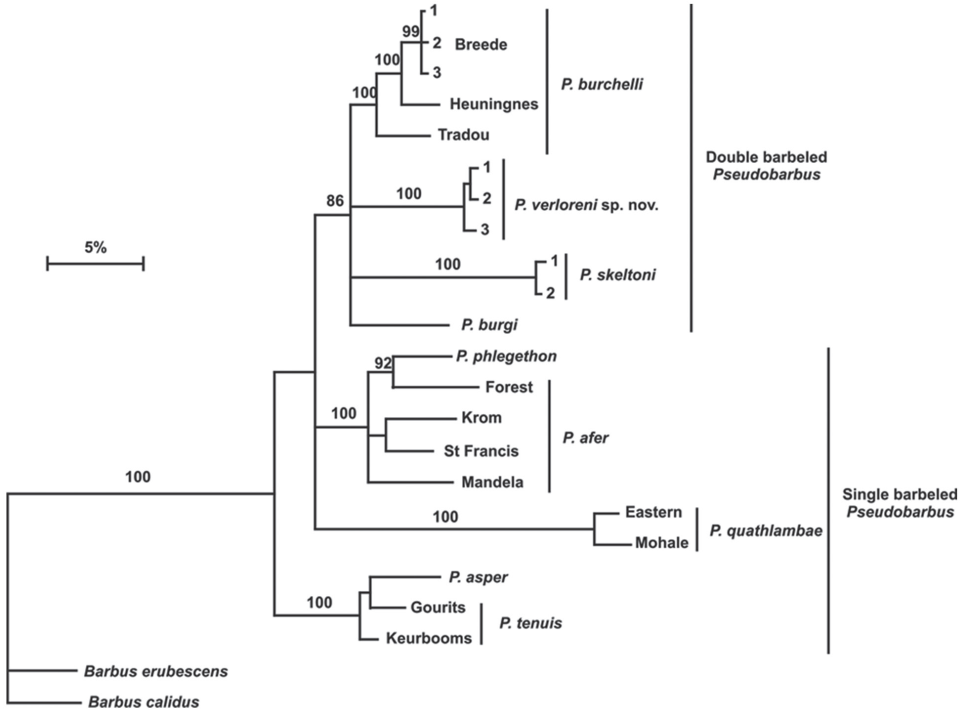

Figure 1. Bayesian phylogenetic tree showing genetic distances between *Pseudobarbus verloreni* sp. n. compared to all other *Pseudobarbus* species/lineages. Bayesian posterior probabilities are shown on the branches.

(Table 2). PCII primarily contrasted differences in body depth, length of anterior barbel, and snout length. PCIII was mainly defined by caudal peduncle depth and body width. Specimens of *P. verloreni* sp. n. were associated positively with PCII, describing individuals characterised by deeper bodies relative to standard length. Specimens of the new species are separated from those of *P. burgi*, which were associated positively with PCI, describing individuals characterised by deeper heads relative to head length. Note also that the syntypes of *P. burgi* are clearly not conspecific with specimens of *P. verloreni* (Figure 2).

The Discriminant Function Analysis (DFA) performed using combined morphometric and meristic characters correctly classified all individuals of the new species (Table 3). Similar to PCA results, the discriminant scores showed that the new species was clearly separated from the three previously described species of *Pseudobarbus* with two pairs of oral barbels (results not shown).

The DFA using morphometric measurements revealed morphological shape differences between the new species and the other previously described species of *Pseudobarbus* with two pairs of oral barbels. This analysis correctly classified all individuals of the new species, *P. verloreni* sp. n., as well as *P. burgi* sensu stricto while three individuals of *P. skeltoni* and four individuals of *P. burchelli* were misclassified (Table 3).

Table 2. Factor loadings for the first three principal component (PC) axes of a PCA carried out on morphometric and meristic characters of double barbeled *Pseudobarbus* specimens (*n*=266) from the Cape Floristic Region of South Africa.

Character	PCI	PCII	PCIII
Head length	-0.769	0.408	-0.077
Head depth	0.669	0.194	-0.276
Inter orbit	0.514	0.297	-0.421
Snout length	0.205	-0.727	0.040
Post orbit	0.325	-0.387	-0.067
Predorsal length	-0.721	0.418	0.218
Dorsal fin base	0.507	-0.115	0.296
Body depth	0.148	0.796	0.269
Body width	-0.463	0.153	0.620
Caudal peduncle length	0.478	-0.431	0.107
Caudal peduncle depth	-0.335	0.178	0.752
Anterior barbel	-0.405	-0.729	0.418
Posterior barbel	-0.250	-0.477	0.520
Unbranched dorsal fin rays	-0.215	-0.477	0.111
Lateral line scales	-0.650	-0.340	-0.153
Scale rows between lateral line and dorsal fin	-0.853	0.024	-0.100
Scale rows between lateral line and pelvic fin	-0.575	0.248	-0.191
Scale rows between lateral line and anal fin	-0.180	0.165	0.114
Scale rows around caudal peduncle	-0.687	-0.103	-0.194
Predorsal scale rows	-0.758	-0.352	0.095

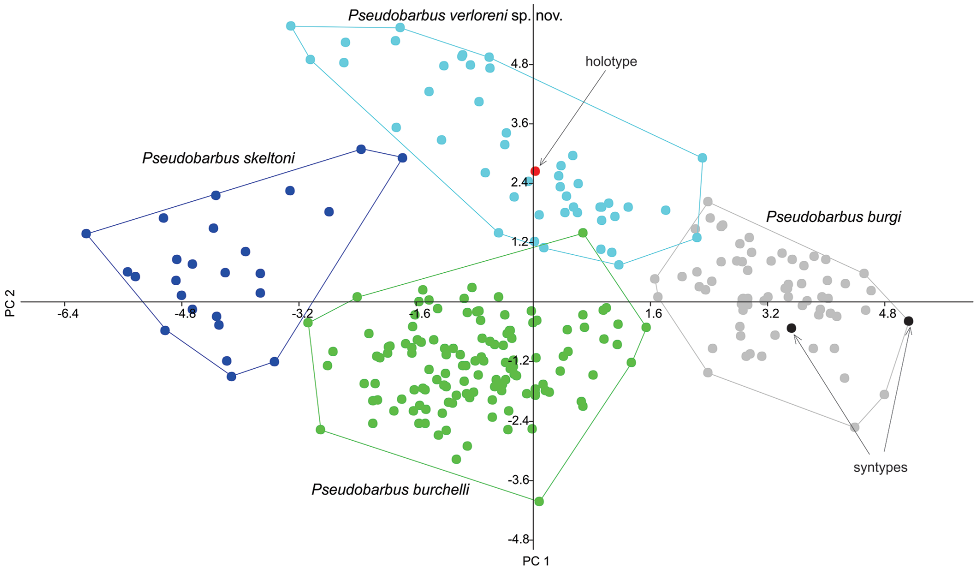

Figure 2. Scatter plot of PC1 against PC2 for a PCA carried out on 15 normalised morphometric and seven raw meristic characters for all examined specimens (*n*=266) of double barbeled redfins from the Cape Floristic Region of South Africa. The figure shows clear separation of *Pseudobarbus verloreni* sp. n. from to all the other *Pseudobarbus* species/lineages.

Table 3. Classification results of discriminant function analysis using (a) combined morphometric and meristic characters, (b) morphometric characters and (c) meristic characters of double barbeled *Pseudobarbus* species from the Cape Floristic Region of South Africa.

	Species	Predicted count				Total	Error (%)
		1	2	3	4		
Combined data	1. *P. burchelli*	128	0	0	0	128	0.00
	2. *P. burgi*	0	66	0	0	66	0.00
	3. *P. skeltoni*	0	0	24	1	25	4.00
	4. *P. verloreni* sp. n.	0	0	0	47	47	0.00
Morphometrics	1. *P. burchelli*	124	1	3	0	128	3.13
	2. *P. burgi*	0	66	0	0	66	0.00
	3. *P. skeltoni*	1	0	22	2	25	12.00
	4. *P. verloreni* sp. n.	0	0	0	47	47	0.00
Meristics	1. *P. burchelli*	99	9	5	15	128	22.66
	2. *P. burgi*	0	65	0	1	66	1.52
	3. *P. skeltoni*	0	0	25	0	25	0.00
	4. *P. verloreni* sp. n.	1	2	0	44	47	12.41

In contrast, the DFA using meristic characters showed poor classification of individuals of the four species, with three individuals of the new species, 29 individuals of *P. burchelli* and one individual of *P. burgi* being misclassified (Table 3).

Based on the deep genetic and significant morphological divergence between individuals from the Verlorenvlei River system and other members of the double barbeled redfin group, the Verlorenvlei population represents a new species.

Pseudobarbus verloreni **sp. n.**

http://zoobank.org/A98AABCD-73D2-425B-877A-22C7364A57B3
Figure 3, Table 4

Proposed common names. Verlorenvlei redfin (English), Verlorenvlei rooivlerkie (Afrikaans).

Holotype. South Africa: Western Cape Province: SAIAB186092, mature male, 70.8 mm standard length (SL), collected from the Verlorenvlei River, 20 m upstream from railway at the Het Kruis bridge on R365 (32.60179000 S, 18.75039000 E) on 13 March 2012 by E. Swartz and W. Bronaugh, using a seine net. Hologenetype: GenBank number KM366106.

Paratypes (*n*=46). South Africa: Western Cape Province: SAIAB192542 (*n*=3, 53.3–70.8 mm SL), same data as for holotype; SAIAB59808 (*n*=10, 40.1–46.9 mm SL), collected from the Verlorenvlei River (32.74560165 S, 18.81780052 E) on 22 January 1999 by R. Bills and D. Naran using a seine net and D-net; BMNH2014.2.26.1-2 (*n*=2, 52.8–58.2 mm SL), USNM427302 (*n*=2, 53.4–56.8 mm SL), MRAC-B4-03-P-1-2 (*n*=2, 53.0–54.5 mm SL), same data and collectors as SAIAB59808, SAIAB121038 (*n*=10, 34.0–68.0 mm SL) collected from the Verlorenvlei River in

1973 by P. Skelton, C. Gaigher and D. Heard; SAIAB121039 (*n*=17, 41–57 mm SL) collected from the Kruis River, Verlorenvlei, in 1973 by P. Skelton, C. Gaigher and D. Heard. Paragenetype: SAIAB192542, GenBank number: KM366107.

Diagnosis. The new species can be distinguished from its congeners by distinct linear speckles above and below the lateral line, anterior barbels minute and much smaller than eye diameter, lips unretracted, and a cartilaginous plate absent.

Description. Proportional measurements and meristic characters are presented in Table 4. The body is fusiform, more or less laterally compressed, with a conspicuous lateral stripe from the posterior edge of the head terminating in a dark spot at the base of the caudal peduncle. The lateral band is more pronounced in juveniles and sub-adults, but is less conspicuous in adults. Distinct linear speckles are present on the abdomen. The head is relatively small and slightly depressed; head length is almost equal to body depth. Two pairs of barbels, rostral (anterior) barbels minute and much smaller than eye diameter; maxillary barbels are rooted at the corner of the mouth are longer than rostral barbels and are equal or smaller than eye diameter. Eyes are relatively large, located dorsolaterally, closer to the tip of the snout than the caudal margin of the operculum, interorbital space is flat. Mouth is sub-terminal, lower lip is unretracted and lacks a cartilaginous plate. Snout is relatively short, only few nuptial tubercles present (observed in only one individual; Figure 4) or tubercles are completely lacking.

Counts for the holotype are given in a separate column in Table 4. Dorsal fin of the new species has 3 unbranched and 7 or 8 branched rays, distal margin almost straight, anterior base of dorsal fin inserted directly above or slightly in front of the origin of pelvic fins. Origin of dorsal fin inserted almost midway between tip of snout and base of caudal fin. Pectoral fins with 13 to 16 rays, shorter than head length, reaching beyond halfway to pelvic fin origin. Pelvic fin with 7 to 9 rays, shorter than head, posterior edge gently rounded, reaching the anus in males and within one or two scale rows to the anus in females. Anal fin with 3 or 4 unbranched and 5 branched rays, distal margin almost straight or gently rounded, origin inserted closer to origin of pelvic fin than base of caudal fin. Caudal fin forked, shorter than head length. Genital opening situated adjacent to anterior base of anal fin.

Scales moderately large; lateral line complete, majority of specimens have 32 scales along lateral line (range 29–36); 5–6 (mode 6) scale rows between dorsal fin origin and lateral line; 4–5 (mode 5) scale rows between pelvic fin origin and lateral line; 4–5 (mode 4) scale rows between lateral line and anal fin origin; 12–16 (mode 12) circumpeduncular scale rows. Predorsal scale rows 13–18 (mode 16), embedded in skin, smaller than flank scales. Patch between head and posterior base of pectoral fins naked; scales between posterior base of pectoral fins and anterior base of pelvic fins smaller than flank scales and embedded. Pelvic fins lack prominent or elongate axillary scales. Scales radiately striated.

Nuptial tubercles have only been observed in one individual of *P. verloreni* (Figure 4). The bilateral placement of tubercles on the snout is typical for *Pseudobarbus*, but the low number (only 4 tubercles in total) of the *P. verloreni* individual in Figure 4 is unusual. The other members of the double barbeled redfin group develop multiple prominent

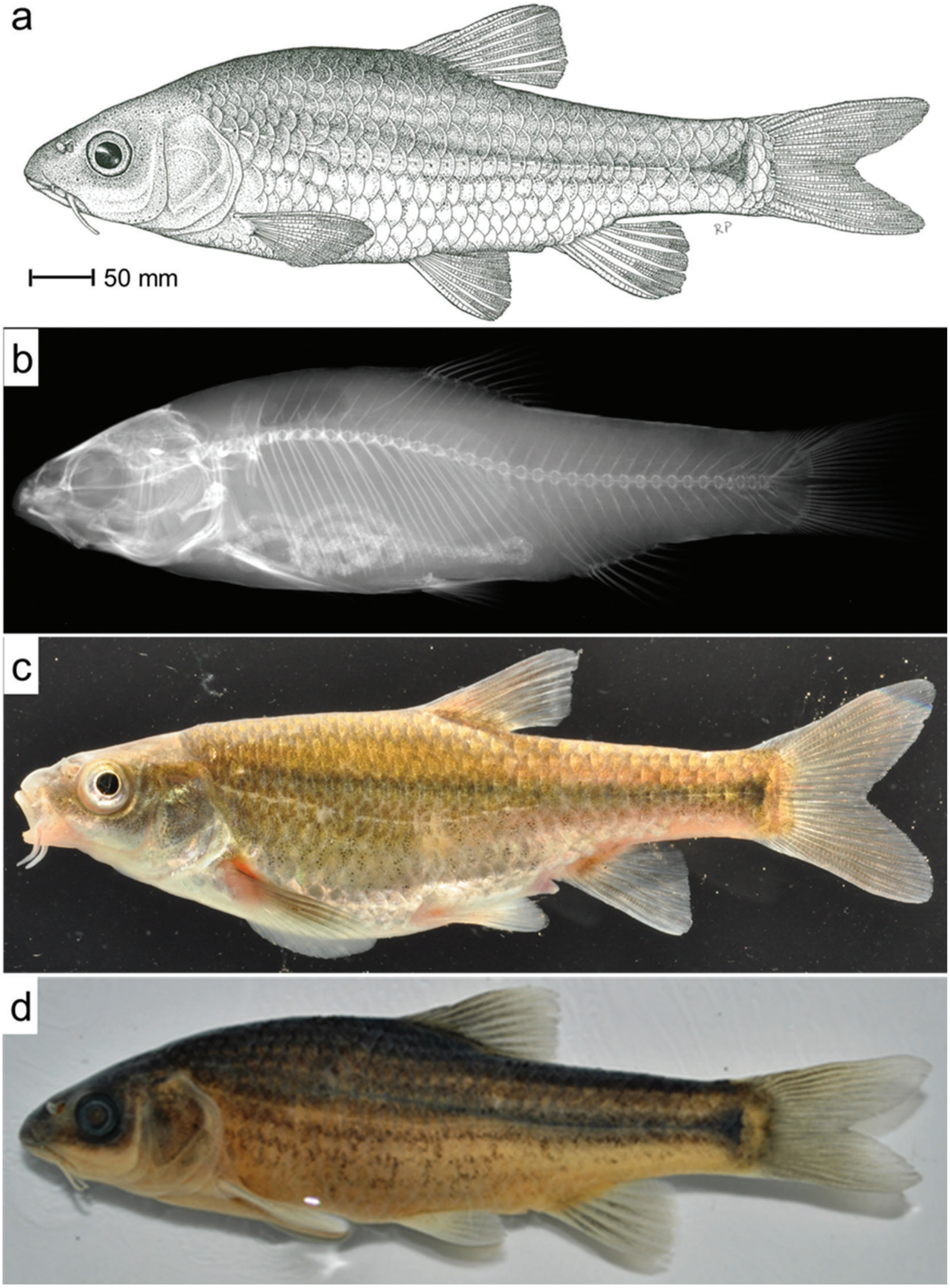

Figure 3. a Habitus of *Pseudobarbus verloreni* sp. n. (holotype, SAIAB186092). Drawing by R. Palmer **b** Radiograph of *Pseudobarbus verloreni* sp. n. (holotype, SAIAB186092) **c** Live colours of *Pseudobarbus verloreni* sp. n. (SAIAB186108). Picture by W. Bronaugh **d** Preserved colours of *Pseudobarbus verloreni* sp. n. (holotype, SAIAB186092).

Table 4. Comparisons of the morphometric measurements and meristic counts of *Pseudobarbus* species with two pairs of barbels. For meristics, the mode is given first, with the range in parentheses. Values are expressed as mean ± SE.

	***P. verloreni* sp. n.**		***P. burgi***	***P. skeltoni***	***P. burchelli***
	Holotype	**Paratypes**			
No. of specimens	1	46	66	25	128
Standard length (SL) (mm)	70.0	34.0–70.8	42.0–109.0	28.5–163.4	30.0–151.7
Head length (HL) (mm)	18.9	10.0–19.6	10.9–25.0	8.6–51.7	8.1–45.8
Percentage of SL (%)					
Head length	27.0	28.1±0.2	24.9±0.1	30.5±1.5	26.8± 1.0
Predorsal length	54.0	53.1±0.4	47.6±0.1	53.3± 1.7	51.2± 1.4
Dorsal fin base	12.9	13.2±0.1	13.7±0.1	12.0± 0.8	13.4± 0.7
Dorsal fin height	25.3	25.6±0.3	24.2±0.1	21.2± 1.8	22.9± 1.4
Body depth	27.6	29.1±0.2	26.9±0.3	25.6± 1.3	25.6± 1.6
Body width	16.1	16.4±0.2	15.2±0.3	17.9± 1.5	17.1± 1.6
Caudal peduncle length	20.9	23.5±0.2	25.7±0.1	22.4± 0.8	25.0± 1.2
Percentage of HL (%)					
Head depth	72.5	73.0±0.4	74.1± 0.3	64.2± 3.1	70.1± 2.6
Inter-obit	36.0	34.4±0.3	33.1±0.3	28.1± 2.1	31.3± 2.1
Snout length	31.2	31.0±0.4	36.6±0.4	38.0± 2.2	36.5± 1.9
Post orbit	46.0	47.6±0.5	46.4±0.3	45.4± 1.8	45.2± 1.9
Anterior barbel length	6.3	3.3±0.3	5.1±0.2	20.3± 9.5	16.5± 4.3
Posterior barbel length	30.7	20.8±0.8	19.3±0.3	27.5± 11.9	28.4± 5.6
Orbit diameter	31.2	31.5±0.4	28.8±0.4	21.5± 4.4	27.7± 2.8
Percentage of caudal peduncle length (%)					
Caudal peduncle depth	61.0	52.6±0.8	46.9± 4.0	53.4± 3.6	49.4± 3.5
Unbranched dorsal fin rays	iv	iii (iii-v)	iii (iii–iv)	iii (iii–iv)	iv (iii–iv)
Branched dorsal fin rays	7	7 (7–8)	7 (6–7)	7 (7–8)	7 (6–8)
Unbranched anal fin rays	iii	iii (iii-iv)	iii (ii-iv)	iii (iii-iv)	iii (iii-iv)
Branched anal fin rays	5	5	5 (5–6)	5 (4–5)	5 (4–6)
Pectoral fin rays	14	15 (13–16)	14 (13–16)	13 (13–16)	14 (13–16)
Pelvic fin rays	8	8 (7–9)	8 (8–9)	8 (7–8)	8 (7–8)
Lateral line scales	33	32 (29–36)	32 (28–37)	38 (36–39)	35 (29–37)
Scale rows between lateral line and dorsal fin	6	6 (5–6)	5 (4–6)	7 (6–7)	6 (5–7)
Scale rows between lateral line and pelvic fin	4	5 (4–5)	4 (3–5)	5 (5–7)	4 (4–5)
Scale rows between lateral line and anal fin	4	4 (4–5)	4 (3–4)	5 (4–6)	4 (4–6)
Caudal peduncle scale rows	12	12 (12–16)	12 (12–13)	16 (15–18)	12 (12–16)
Predorsal scale rows	16	16 (13–18)	15 (12–16)	19 (17–21)	17 (14–22)
Total vertebrae	36	36 (34–37)	37 (35–38)	37 (36–38)	36 (35–37)
Pre-caudal vertebrae	19	19 (18–21)	19 (18–20)	20 (19–21)	19 (17–20)
Caudal vertebrae	17	17 (16–19)	18 (16–19)	17 (16–18)	18 (17–20)
Predorsal vertebrae	11	11 (10–13)	11 (10–12)	12	12 (11–13)
Pre-anal vertebrae	20	20 (19–21)	20 (19–22)	21 (20–22)	19 (18–21)

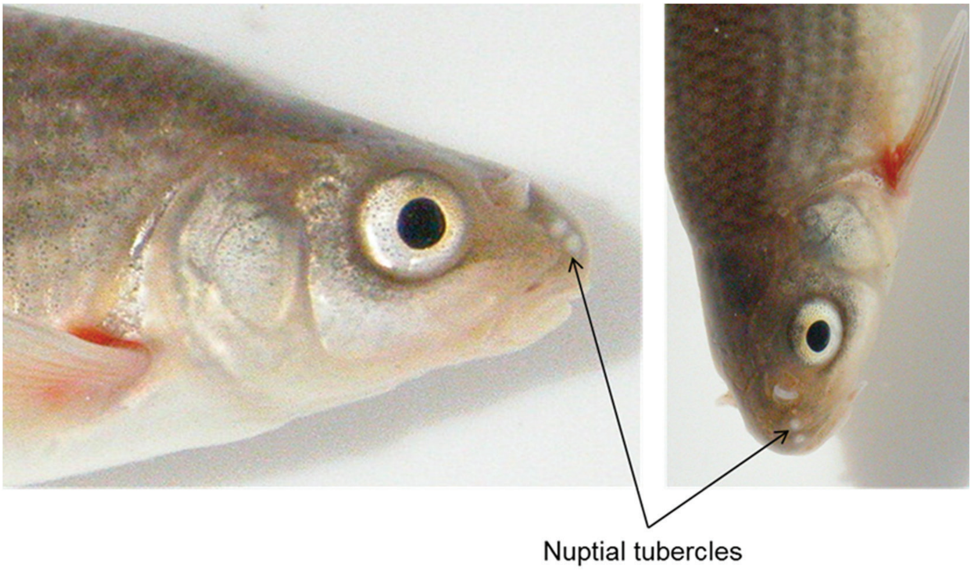

Figure 4. Lateral and dorsal view of *Pseudobarbus verloreni* sp. n. from site 4 in Figure 5. The figure shows a different pattern of tubercule expression compared to other members of the double barbeled redfin group (see Chakona and Swartz 2013).

conical tubercles on the snout and head dorsum during the breeding season (see Chakona and Swartz 2013). Additional sampling during the breeding season is required to determine whether this is a consistent development pattern for *P. verloreni*.

Colouration. Live colouration is golden-tan dorsally and laterally, becoming lighter and more silver ventrally (Figure 3c). In adults (above 40 mm SL), base of fins is pale red or yellowish-orange in some specimens. Alcohol preserved specimens have conspicuous linear speckles above and below the lateral line.

Osteology. Radiographs of the holotype (SAIAB 186092) and paratypes show that the species has osteology typical of all *Pseudobarbus* species. Compared to other cyprinids, particularly those within the genus *Barbus*, supraneural bones are less developed or extremely vestigial in all members of the genus *Pseudobarbus* (Skelton, 1988). Skelton (1988) did not record any supraneural bones in *Pseudobarbus* specimens (*n*=53) from the Verlorenvlei River system (herein described as *Pseudobarbus verloreni* sp. n.). Vertebrae counts for the holotype are given in a separate column in Table 4. Total number of vertebrae in 47- specimens investigated in the present study ranged from 34–37: 34 (*n*=1), 35 (*n*=3), 36 (*n*=31) or 37 (*n*=12) comprising 18–21 (mode 19) precaudal, 19–22 (mode 20) pre-anal, 10–13 (mode 11) predorsal and 16–19 (mode 17) caudal vertebrae (Table 4).

Additional information. SAIAB59813, juveniles (n=68, 13.5–28.4 mm SL) and adults (n=3, 59.3–64.6 mm SL), collected from the Verlorenvlei River, near Grootfontein farm (32.39830017 S, 18.47419930 E) on 23 January 1999 by R. Bills and

D. Naran using a seine net and D-net. Juveniles and sub-adults of *P. verloreni* have a conspicuous lateral band, while the lateral band is either less prominent or interrupted by linear spots in juveniles and sub-adults of the other double barbeled *Pseudobarbus* species. The new species has three rows of pharyngeal teeth, teeth pattern 2.3.5–5.3.2 (observed in 3 adults; SAIAB59813); teeth with asymmetrical crowns and hooked at their tips. *Pseudobarbus verloreni* sp. n. has the longest intestine relative to standard length compared to all the *Pseudobarbus* species (Skelton 1988: Figure 25Bc).

Comparisons. *Pseudobarbus verloreni* sp. n. is distinguished from all other species of *Pseudobarbus* (except *P. skeltoni*, *P. burchelli* and *P. burgi*) by the presence of two pairs of oral barbels. The new species is distinguished from *P. skeltoni*, *P. burchelli* and *P. burgi* by having a deeper body relative to standard length, smaller anterior barbels and shorter snout relative to head length (Table 4). The new species is distinguished from *P. skeltoni* by having a sub-terminal mouth (versus terminal in adults of the latter species) and a smaller head relative to standard length (Table 4). *Pseudobarbus verloreni* is distinguished from *P. burchelli* and *P. skeltoni* by a deeper head, wider distance between the eyes (inter-orbit), larger eye relative to head length, shorter posterior barbel relative to head length, wider post-orbit distance, shallower caudal peduncle and generally fewer scales along the lateral line. *Pseudobarbus verloreni* is distinguished from *P. burchelli* and *P. burgi* by lack of cartilaginous plate on lower lip and having unretracted lips. The new species is distinguished from *P. burgi* by its longer head, longer predorsal length, shorter caudal peduncle and larger eye (Table 4).

Reproduction. Unknown, but spawning possibly occurs around October-December, based on the general patterns of congeners.

Distribution and habitat. *Pseudobarbus verloreni* is a lowland species that is restricted to the Verlorenvlei River system on the west coast of South Africa (Figure 5). The morphological features of two juvenile specimens of *Pseudobarbus* collected from the Langvlei River by Thorne and Cambray in 1986 (SAIAB 130464) are consistent with juveniles of the new species, and are thus assigned to *P. verloreni*. The Langvlei River population is likely to have been extirpated, as no specimens of *Pseudobarbus* have been collected during more recent surveys (2001–2012). The major impact on this river is excessive water extraction that causes the river to dry up completely during the dry season. The Verlorenvlei River system has a gentle gradient and slow to moderate flow for much of the year. The water is highly turbid during the rain season (winter months) when water volume and flow velocity is high, but it becomes less turbid during low flow periods. Most sections of the river system recede into a series of isolated pools during the dry season, especially during late summer and autumn. The bottom substratum is predominantly sand, silt and mud. This is in contrast with the majority of the streams in the CFR that are associated with the Cape Fold Mountains with steeper gradients, clear water, moderate to fast flow throughout the year and rocky substratum. The species was possibly widespread throughout the Verlorenvlei and Langvlei River systems in the past, but numbers likely declined during the last century due to predation and competition from introduced fish species and habitat degradation (see below).

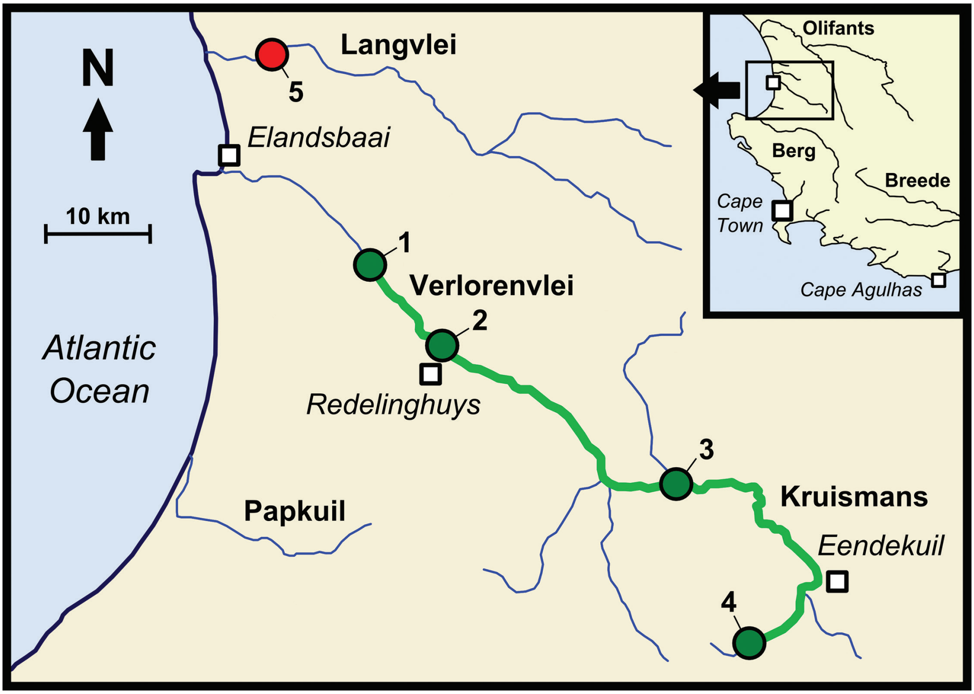

Figure 5. Map of a part of the west coast of South Africa. The map shows the likely present distribution of *Pseudobarbus verloreni* in the Verlorenvlei River system (green line), based on available accurate museum data (green circles; site 1=59813; site 2=SAIAB 59804, 130461 and 186108; site 3=SAIAB 121039, 128824, 186092 and 192542; site 4=SAIAB 130453 and 59808). Also shown is site 5 where the species was collected in the Langvlei River system in 1986 (red circle; site 5=SAIAB 130464), but have not been found in subsequent surveys. The insert map shows the study area in relation to Cape Town, Cape Agulhas (most southern point in Africa) and neighbouring major river systems.

Etymology. The species is named after the Verlorenvlei River system to which it is now confined.

Conservation. The Verlorenvlei redfin was listed as Endangered during the most recent IUCN assessment by Tweddle et al. (2009). The presence of non-native predatory black bass *Micropterus* spp and potential competitors, banded tilapia *Tilapia sparrmanii*, Mozambique tilapia *Oreochromis mossambicus* and common carp *Cyprinus carpio*, habitat degradation and excessive water withdrawal for agricultural purposes pose the greatest threat to the survival of this species. Protection of critical habitats and establishment of sanctuaries are some of the most immediate conservation measures required to prevent further decline. The effectiveness of current protected areas in conserving *Pseudobarbus verloreni* is limited because they largely encompass upland areas where this species does not occur. Long-term measures to protect and prevent extinction of this species may have to include eradication of alien fishes and the construction of barriers to prevent re-invasion where feasible and restoration of existing habitats to facilitate recovery.

Key to double barbeled redfin species of the genus *Pseudobarbus*

1 Mouth terminal, 36–39 lateral scale series ....***Pseudobarbus skeltoni***
– Mouth sub-terminal **2**
2 Lower lip unretractable, cartilaginous plate absent, conspicuous linear speckles above and below lateral line ....***P. verloreni* sp. n.**
– Lower lip retractable, cartilaginous plate present...**3**
3 Anterior barbels less than 30% of orbit diameter ....***P. burgi***
– Anterior barbels more than 30% of orbit diameter.....................***P. burchelli***

Discussion

Specimens of *Pseudobarbus* from the Verlorenvlei River system show clear genetic and morphological differences when compared with the three currently described double barbeled *Pseudobarbus* species (*P. burchelli*, *P. burgi*, and *P. skeltoni*) and are thus described as a new species. The morphological differentiation between *P. verloreni* sp. n. and *P. burgi* reported here is consistent with the findings of Skelton (1988) who reported considerable 'intraspecific' morphological variation between Verlorenvlei and Berg populations. The most informative characters that distinguish *P. verloreni* sp. n. from *P. burgi* are body depth, head length, predorsal length, snout length and anterior barbel length. However, *P. verloreni* sp. n. and *P. burgi* cannot be distinguished based on meristic characters because considerable overlap exists between the two species.

Phylogenetic results from the present study, Swartz et al. (2009) and Chakona and Swartz (2013) show that the relationships among *P. verloreni* sp. n. (referred to as Verlorenvlei lineage in latter two studies), *P. burgi* sensu stricto, *P. burchelli* sensu lato and *P. skeltoni* are not well resolved, with a polytomy linking the new species and the other taxa. This is further evidence that the *Pseudobarbus* from Verlorenvlei represents a separate species as it does not clearly group with one of the other species or lineages. Our review of available material of double barbeled redfins confirmed that *P. verloreni* sp. n. is restricted to the Verlorenvlei River system and likely have been extirpated from the adjacent Langvlei River system.

Reduced tubercle occurrence in *P. verloreni* could represent a different breeding strategy or behaviour compared to other redfins. Further research is required to better describe the ecology, biology, population size, distribution and conservation status of this species. There are serious conservation concerns, because this species is associated with pool habitats, which are also favourable habitats for non-native fish predators and competitors. This species is also threatened by proposed mining activities and excessive water withdrawal in the Verlorenvlei catchment. Improved understanding of the conservation status, distribution and ecology is a critical requirement for developing effective conservation measures to prevent extinction of this species. The current protected areas are unlikely to be effective for the conservation of *Pseudobarbus verloreni* as the known distribution range of this species falls outside protected areas. Expansion of protected areas and education of landowners may be necessary to ensure survival of this species.

Acknowledgements

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References

Barnard KH (1938) Notes on the species of Barbus from the Cape Province, with descriptions of new species. Annals and Magazine of Natural History (Series 11) 2(7): 80–88.

Barnard KH (1943) Revision of the indigenous freshwater fishes of the S.W. Cape Region. Annals of the South African Museum 36: 101–263.

Bloomer P, Impson ND (2000) Mitochondrial DNA differentiation in the Critically Endangered Berg River Redfin (*Pseudobarbus burgi*). The Journal of Heredity 91: 122–127. doi: 10.1093/jhered/91.2.122

Boulenger GA (1905) A list of freshwater fishes of Africa. Annals and Magazine of Natural History 7: 36–60. doi: 10.1080/03745480509443651

Boulenger GA (1911) Catalogue of freshwater fishes of Africa in the British Museum (Natural History). British Museum (Natural History) 2: 1–529.

Castelnau FL (1861) Mémoire sur les poissons de l’Afrique australe. Baillière et Fils, Paris. doi: 10.5962/bhl.title.3819

Cambray JA (1994) Seasonal occurrence and distribution of nuptial tubercles in two African minnows, *Pseudobarbus afer* (Peters, 1864) inhabiting clear water, and *Pseudobarbus asper* (Boulenger, 1911) inhabiting turbid water (Cypriniformes, Cyprinidae). Annals of the Cape Provincial Museums (Natural History) 19: 149–170.

Chakona A, Swartz ER (2013) A new redfin species, *Pseudobarbus skeltoni* (Cyprinidae, Teleostei), from the Cape Floristic Region, South Africa. Zootaxa 3686: 565–577. doi: 10.11646/zootaxa.3686.5.5

Chakona A, Swartz ER, Gouws G (2013) Evolutionary drivers of diversification and distribution of a southern temperate stream fish assemblage: testing the role of historical isolation and spatial range expansion. PLoS ONE 8(8): e70953. doi: 10.1371/journal.pone.0070953

Chakrabarty P (2010) Genetypes: a concept to help integrate molecular phylogenetics and taxonomy. Zootaxa 2632: 67–68.

Cuvier G, Valenciennes A (1842) Histoire naturelle des poissons. Tome seizième. Livre dix-huitième. Les Cyprinoïdes. v. 16: i-xx + 1–472, Pls. 456–487.

Gaigher IG, Hamman KCD, Thorne SC (1980) The distribution, conservation status and factors affecting the survival of indigenous freshwater fishes in the Cape Province. Koedoe 23: 57–88. doi: 10.4102/koedoe.v23i1.636

Jubb RA (1965) Freshwater fishes of the Cape Province. Annals of the Cape Provincial Museum 4: 1–72.

Lleonart J, Salat J, Torres GJ (2000) Removing allometric effects of body size in morphological analysis. Journal of Theoretical Biology 205: 85–93. doi: 10.1006/jtbi.2000.2043

Peters WCH (1864) Über eine neue Percoidengattung, Plectroperca, aus Japan und eine neue Art von Haifischen, Crossorhinus tentaculatus, aus Neuholland. Monatsberichte der Königlichen Preussische Akademie der Wissenschaft zu Berlin 1864: 121–126.

Sabaj PMH (2013) Standard symbolic codes for institutional resource collections in herpetology and ichthyology: an Online Reference. Version 4.0 (28 June 2013). Electronically accessible at http://www.asih.org/, American Society of Ichthyologists and Herpetologists, Washington, D.C.

Skelton PH (1980) Systematics and biogeography of the redfin *Barbus* species (Pisces, Cyprinidae) from southern Africa. PhD thesis, Rhodes University, Grahamstown.

Skelton PH (1988) A taxonomic revision of the redfin minnows (Pisces, Cyprinidae) from southern Africa. Annals of the Cape Provincial Museum (Natural History) 16: 201–307.

Smith A (1841) Pisces. Illustrations of the Zoology of South Africa. Smith, Elder and Col., London.

Steindachner F (1870) Ichthyologiesche Notizen (X). Sitzungsberichte Der Akademie Der Wissenschaften Wien 61: 623–642.

Swartz ER, Skelton PH, Bloomer P (2007) Sea-level changes, river capture and the evolution of populations of the Eastern Cape and fiery redfins (*Pseudobarbus afer* and *Pseudobarbus phlegethon*, Cyprinidae) across multiple river systems in South Africa. Journal of Biogeography 34: 2086–2099. doi: 10.1111/j.1365-2699.2007.01768.x

Swartz ER, Skelton PH, Bloomer P (2009) Phylogeny and biogeography of the genus *Pseudobarbus* (Cyprinidae): Shedding light on the drainage history of rivers associated with the Cape Floristic Region. Molecular Phylogenetics and Evolution 51: 75–84. doi: 10.1016/j.ympev.2008.10.017

Swartz ER, Chakona A, Skelton PH, Bloomer P (2014) The genetic legacy of lower sea-levels: does the confluence of rivers during the last glacial maximum explain the contemporary distribution of a primary freshwater fish (*Pseudobarbus burchelli*, Cyprinidae) across isolated river systems? Hydrobiologia 726: 109–121. doi: 10.1007/s10750-013-1755-7

Tweddle D, Bills R, Swartz E, Coetzer W, Da Costa L, Engelbrecht J, Cambray J, Marshall B, Impson D, Skelton PH (2009) The status and distribution of freshwater fishes. In: Darwall WRT, Smith KG, Tweddle D, Skelton PH (Eds) The Status and Distribution of Freshwater Biodiversity in Southern Africa. IUCN, Gland, Switzerland and SAIAB, Grahamstown, South Africa, 21–37.