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New records of *Polypedilum* Kieffer, 1912 from Ecuador, with description of a new species

(Diptera, Chironomidae)

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Polypedilum darwini sp. nov. is described from Ecuadorian Amazonia based on the adult male. The new species is similar to *P. feridae* Bidawid-Kafka, 1996 in general morphology. Additionally *Polypedilum salwiti* Bidawid-Kafka, 1996 is recorded for the first time outside of Brazil.

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Introduction

The Neotropical realm is a well-known hotspot of insect biodiversity, with Brazil alone assumed to be home for at least 500 000 species of Hexapoda (Rafael et al. 2009). The Diptera, one of the four megadiverse orders of insects, is making up large part of this diversity. For example, a single four acres patch of cloud forest in Costa Rica has yielded 4,332 species of flies and midges within a span slightly more than single year (Borkent et al. 2018). One of the largest Diptera families in the Neotropical realm and worldwide is the Chironomidae (Spies & Reiss 1996), the non-biting midges. With more than 7000 described species, Chironomidae is the most abundant and species-rich family of aquatic insects throughout the world (Ferrington 2007). Despite unprecedented rates of new chironomid taxa descriptions from the Neotropics in the last two decades, very large numbers of species are expected to have remained unknown due to the family's high diversity (Bidawid-Kafka 1996, Ferrington 2007).

Puyo, the capital of Ecuador's Pastaza Province, is a relatively small city (approximately 33,500 inhabitants) located in the western Amazon on the outer flanks of the Eastern Cordillera of the Andes, at 924 m a.s.l. The city has a rainy, tropical climate with temperature ranges between 13.7 °C and 29.2 °C and an average annual precipitation of 4524.7 mm (Palacios Tapia et al. 2014).

Here we present results of small-scale Chironomidae sampling in Puyo city that has revealed the

presence of a new chironomid species, and of another one previously known only from its type locality in Brazilian Amazonia. Both species belong to the cosmopolitan genus *Polypedilum* Kieffer, 1912, the largest genus of Chironomidae, with 501 species described (Ekrem et al. 2017). About 90 of these species have been described from the Neotropical region (see Spies & Reiss 1996, Donato & Paggi 2008, Oyewo & Sæther 2008, Vinogradova 2008, Sæther et al. 2010, Mendes et al. 2011, Pinho et al. 2013, 2015), the majority of them from Amazonia.

Material and methods

Specimens were collected in Puyo city, Ecuador, between January and February 2015; they were attracted to a light, caught using a hand-net, and placed into 1.5 ml Eppendorf tubes with 76 % ethanol. The material was mounted in Euparal using methods described by Kirk-Spriggs (2017) and studied and photographed under the Keyence BZ-9000 fluorescence microscope with either a ×10, ×20 or ×40 objective. Observations were conducted using bright field settings.

Measurements were prepared using ImageJ measurement utilities, calibrated with photographs of an object micrometer next to the measured specimen, to an accuracy of 10 µm. General morphological terminology and measurements follow Sæther (1980), and Bidawid & Fittkau (1995) for types of volsellae and tergal bands. For comparative purposes we have examined the type material of several Neotropical *Polypedilum* s. str. species, in particular *P. feridae* Bidawid-Kafka, 1996; *P. amataura* Bidawid-Kafka, 1996, *P. marauia* Bidawid-Kafka, 1996 and *P. salwiti* Bidawid-Kafka, 1996 from the collection of Section Diptera, Zoological State Collection, Munich (ZSM). Photographs of the specimens from ZSM were taken using DCM 510 ocular camera and Leitz Diaplan optical microscope. Standard abbreviations for the morphological structures used in the text are as follows: SVo, Superior volsella (of the hypopygium); IVo, inferior volsella (of the hypopygium); AR, antennal ratio; IV, inner vertical setae; OV, outer vertical setae; HV, hypopygium value; HR, hypopygium ratio as defined by Sæther (1980).

The following keys and descriptions were used for identification of the material: Bidawid-Kafka (1996), Bidawid & Fittkau (1995), Donato & Paggi (2008), Mendes et al. (2011), Pinho et al. (2015), Sæther et al. (2010). Figures were produced by line-tracing drawings made with the aid of a camera lucida (Fig. 1A–D). Tracing was done in the Inkscape freeware.The holotype of the new species and voucher of *P. salwiti* are stored in the Museo Ecuatoriano de Ciencias Naturales, Sección de Entomología (MECN) in Quito, Ecuador.

Results

Order Diptera Linnaeus, 1758
Family Chironomidae Newman, 1834
Genus *Polypedilum* Kieffer, 1912
Subgenus *Polypedilum* Kieffer, 1912

Polypedilum darwini sp. nov.

Type material. Holotype: ♂ (MECN, slide mounted in Euparal), from type locality / Ecuador, Pastaza province, Puyo city, in the apartment in the block of flats next to Manabi street, 01°28'48"S, 78°00'08"W; 926 m a.s.l. / Ł. Kaczmarek & M. Roszkowska [lgts] i–ii 2015 [red label]. Zoobank LSID urn:lsid:zoobank.org:pub:667E9319-5F4D-4D16-9EE2-8DEBD8D78A94.

Diagnosis. The new species can be easily distinguished from all other Neotropical *Polypedilum* s. str., except for *P.* (s. str.) *feridae* Bidawid-Kafka, 1996, based on the following combination of characters: anal point long, parallel sided; superior volsella (SVo) base with lateral fold, inferior volsella (IVo) of type C_3 (Bidawid-Kafka 1996) (Fig. 1C,D) wing bare, with distinct brown marks (Fig. 1A). The species is distinguished from *P. feridae* based on the Ti_1 scale being rectangular and bearing very long subapical setae together with the short apical setae (Fig. 1B), on the weaker wing pigmentation, fewer strong setae on the SVo base, and on absence of the prominent hooked seta on the apex of the IVo.

Description

Total length 2.53 mm. Wing length 1.56 mm. Total length/wing length 1.62.

Coloration. In Euparal: head, thorax and abdomen yellow-brown; legs banded, with dark brown rings at distal ends of femora and proximal ends of tibiae; wing membrane light brownish with five distinct, light brown fields (see Figs 2A–C, 3A–B).

Head. Antenna with 13 flagellomeres. Lengths of flagellomeres 1–12 (in µm): 50, 22, 24, 25, 25, 21, 24, 28, 27, 27, 23, 24. Terminal flagellomere 456 µm long, AR 1.4. Plume well developed (Fig. 2C). Pedicel bare, 89 µm long. Eye bean-shaped, dorsomedial extension weak (Fig. 2A,B). Clypeus with 16 setae (Fig. 2A). Head with 6 IV, 4 OV (Fig. 2A). Palps lost, except for the palpomeres 1 and 2 of the right palp (Fig. 2B). Tentorium well-developed, with anterior pit behind the scape, posterior pit on the top of the posterior arm of tentorium. Frontal tubercles absent (Fig. 2A,B).

Thorax. Thorax brown. Antepronotum normally developed. Scutal tubercle absent. Acrostichal setae not visible. Dorsocentral setae 7. Prealar setae 4. Scutellum with 6 weak setae (Fig. 2B).

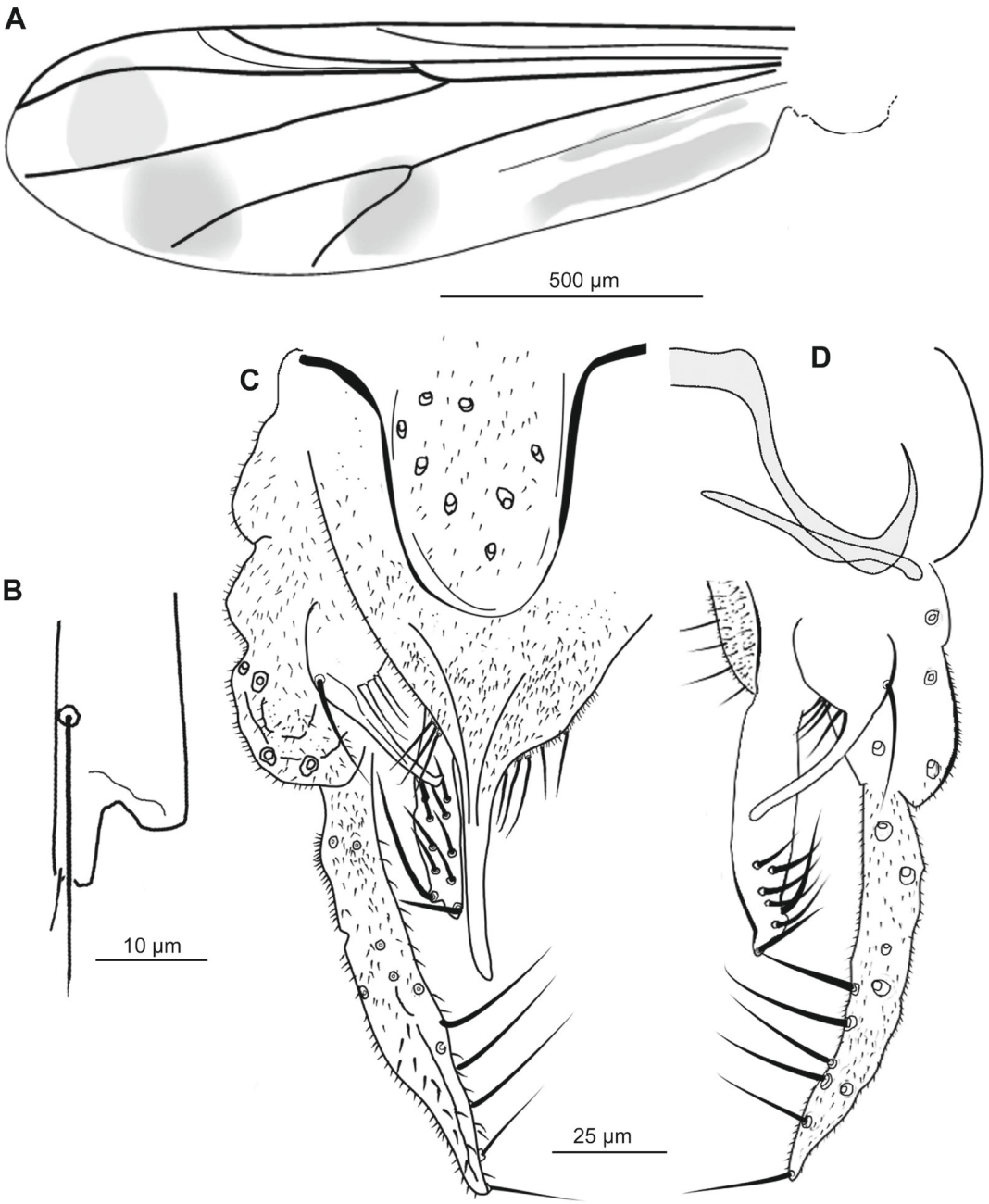

Fig. 1. Morphological details of *Polypedilum darwini* sp. nov., adult male, holotype. **A.** Wing. **B.** Distal end of fore tibia. **C.** Hypopygium, dorsal view. **D.** Hypopygium with tergite IX removed.

Wings. Membranes without macrotrichia, with moderate punctation and 4–5 brown fields (Figs 1A, 3A).

Legs. Fore femur 298 µm long; fore tibia 80 µm long, with prominent rectangular scale (27 µm long) bearing very long subapical setae and short apical setae (Figs 1B, 3C). Mid femur 310 µm long; mid tibia

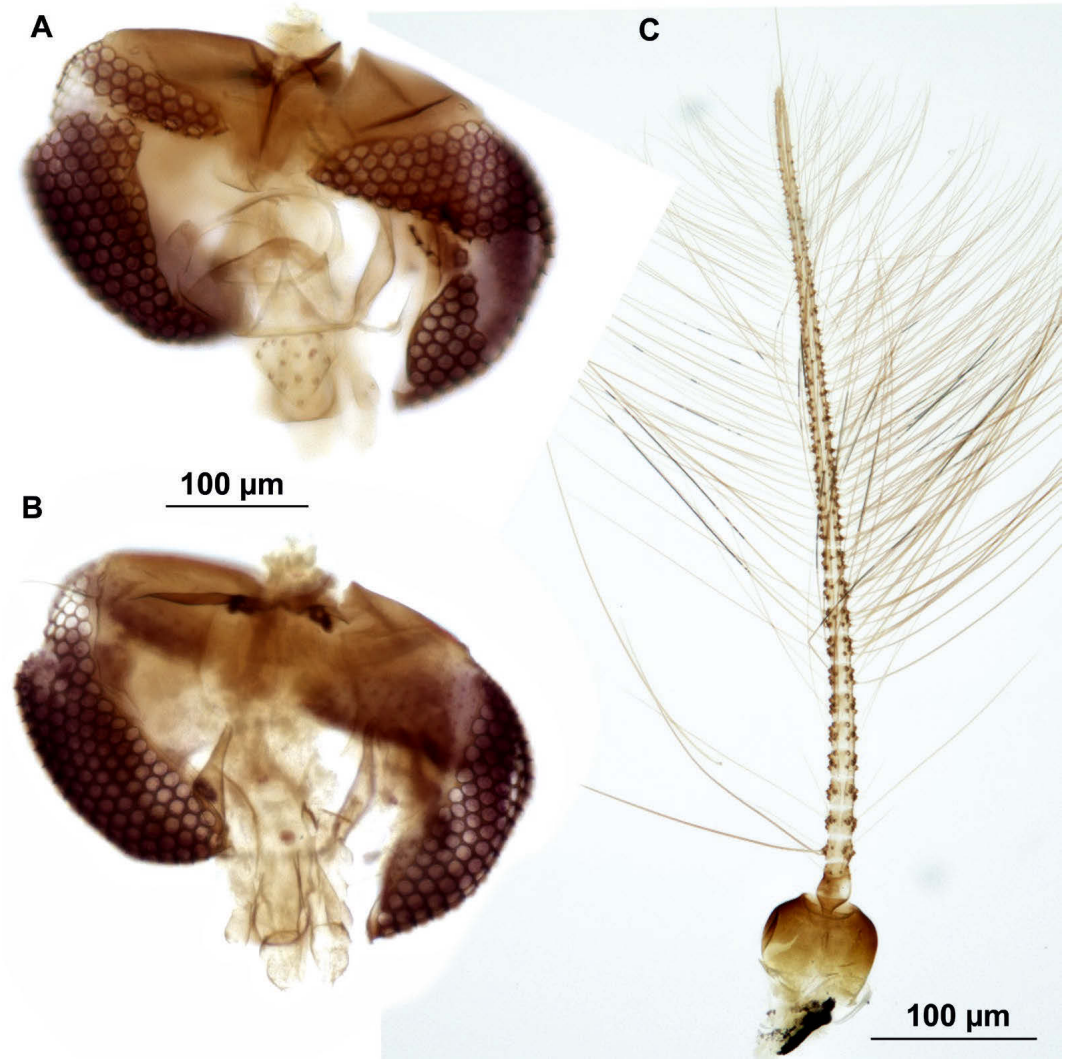

Fig. 2. Morphological details of *Polypedilum darwini* sp. nov., adult male, holotype. **A.** Head, anterior view. **B.** Head, posterior view. **C.** Antennae.

233 µm long, with well-developed comb consisting of 20 denticles and bearing two spurs (35 µm, 45 µm long) (Fig. 3D). Hind femur 306 µm long; hind tibia 235 µm long, with well-developed comb consisting of 21 denticles and bearing two spurs (51 µm, 13 µm long) (Fig. 3E). Each femur has light-brown rings on the proximal and distal apicies, mid and hind tibia with light-brown ring at the mid-length (Fig. 3B). All tarsi lost.

Hypopygium (Figs 1C,D, 4A,B). Tergal bands of type C_2 (Figs 1C, 4A), between them 8 dorsomedial setae. Anal point 54 µm long, hyaline and parallel-sided (Figs 1C, 4A). Gonocoxite 105 µm long. Superior volsella (SVo) of type F_3, with lateral fold (Figs 1C–D, 4B). Fold starting at the apex of the basal part of the SVo and running along the distal, digitiform parts of volsella. No setae present in the fold. Digitiform part of volsella angling from the base at 45°. Digitiform apical part of SVo 50 µm long; base 24 µm long, bearing 1 outer and 4 inner strong setae (Figs 1D, 4B). Inferior volsella of type C_3, without long caudally projecting seta (Figs 1D, 4B). Total length of the IVo 84 µm. Gonostylus tapering, with single apical setae (Figs 1C,D, 4A,B). Total length of Gonostylus 112 µm. HR 0.93, HV 1.39.

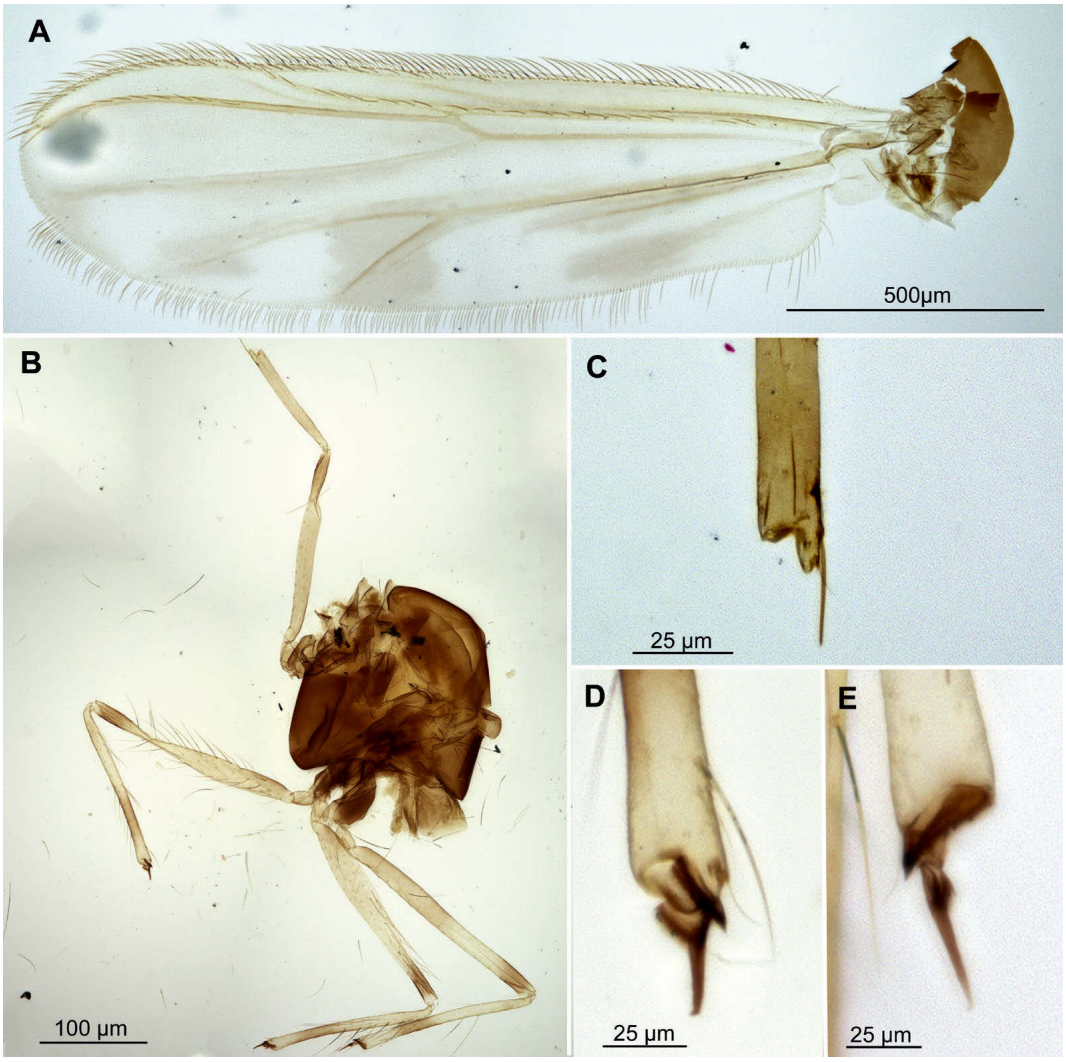

Fig. 3. Morphological details of *Polypedilum darwini* sp. nov., adult male, holotype. **A.** Wing. **B.** Thorax. **C.** Tip of the tibia, foreleg. **D.** Tip of the tibia with tibia spurs, mid leg. **E.** Tip of the tibia with tibia spurs, hind leg.

Etymology. The species is named after Charles Robert Darwin, the famous English naturalist, geologist and biologist who studied evolutionary processes on the tropical Galapagos Islands (Ecuador).

Taxonomic notes. *Polypedilum darwini* resembles in its general the morphology of the *P. feridae* (Fig. 5A–D) but differs drastically in the relative length of the digitiform part of the SVo (it is much longer in *P. darwini*) (Figs 4B, 5B). Coloration of the wing also differs in this two species.

Wing of the *P. feridae* is covered with much longer light-brown fields, rather than smaller brown fields found on the wing of the *P. darwini* (Figs 3A, 5A). The superior volsellae of the *P. darwini* are, in fact, more similar to one of the *P. amataura* Bidawid-Kafka, 1996 or *P. marauia* Bidawid-Kafka, 1996, than that of *P. feridae* (Figs 4A–B, 5B–D, 6A,D). The main difference between volsellae of the *P. darwini* on the one hand and *P. amataura* and *P. marauia*, on the other hand, is in the presence of the lateral fold running between the basal and digitiform parts of the superior volsellae (Fig. 6A,C). Superior volsellae of the *P. darwini* bears 4 strong setae on the basal part, while both *P. amataura* and *P. marauia* only have three setae in these area of the SVo (Figs 4B, 6A,C).

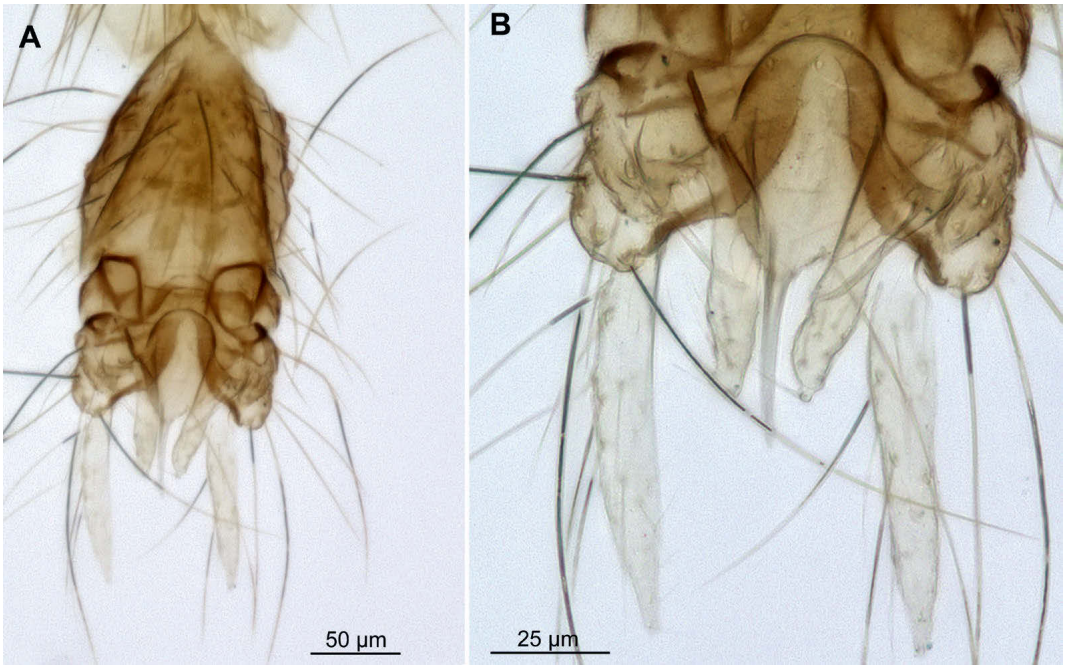

Fig. 4. Morphological details of *Polypedilum darwini* sp. nov., adult male, holotype. **A.** Hypopygium, dorsally, ×200; **B.** Hypopygium, dorsally, ×400.

Polypedilum darwini is also differing drastically from the *P. amataura* and *P. marauia* in the structure of its inferior volsellae (IVo). *P. darwini* has IVo of type F_3 (Bidawid &Fittkau 1995, Bidawid-Kafka 1996), while *P. amataura* has and A-type IVo and *P. marauia* has an IVo of the B_2 type (Figs 1D, 4B, 5B, 6B,D) (Bidawid-Kafka 1996). It is quite possible that lateral fold on the transition of the basal part of the SVo into digitiform one is actually a synapomorphy of the *P. darwini* and *P. feridae*.

Polypedilum salwiti Bidawid-Kafka, 1996

Material examined. One ♂ (MECN, one specimen slide mounted in Euparal) / Ecuador, Pastaza province, Puyo city, in the apartment in the block of flats next to Manabi street, 01°28'48"S, 78°00'08"W; 926 m a.s.l. / Ł. Kaczmarek & M. Roszkowska [lgts] i–ii 2015.

Remarks. *Polypedilum salwiti* was previously known from four localities in Pará and Amazonas states in the Brazilian Amazon (Bidawid-Kafka 1996). We have attributed our specimens to *P. salwiti* based on hypopygium structure (Fig. 7A–B) and on the coloration: wing with six brown spots, abdomen dark brown, femora with light rings (Bidawid–Kafka 1996). Specimen was collected at the same locality as *P. darwini* sp. nov.

Discussion

Sæther et al. (2010) proposed a division of *Polypedilum* into nine subgenera (no longer including *Asheum* Sublette & Sublette, 1983), but failed to provide complete and workable diagnoses (Ekrem et al. 2017), and several critical elements of their proposal violated the International Code of Zoological Nomenclature (ICZN 1999); see Cranston et al. (2016). Since then, Yamamoto et al. (2016) have added *P.* (*Atopipedilum*) as a new subgenus, the removal of *P.* (*Asheum*) has remained debatable, and the validity of several other traditional subgenera has been questioned (e.g., Cranston et al. 2016). Despite these open issues, however, both species treated in the present paper can be assigned without problems to *Polypedilum* (*Polypedilum*) in the sense reaffirmed by Cranston et al. (2016).

Taking into account that Ecuador is one of the 17 megadiverse countries (Paknia et al. 2015), it is no wonder that it has an extremely diverse fauna of the aquatic insects (Jacobsen & Encalada 1998, Jacobsen et al. 2010). Concerning the Ecuadorian Chironomidae fauna, most studies have been conducted in the framework of ecological research (Jacobsen & Encalada 1998, Jacobsen et al. 2010, Prat et al. 2014, Matthews-Bird et al. 2016), but there also are a few species descriptions (Roback 1970, Borkent 1984,

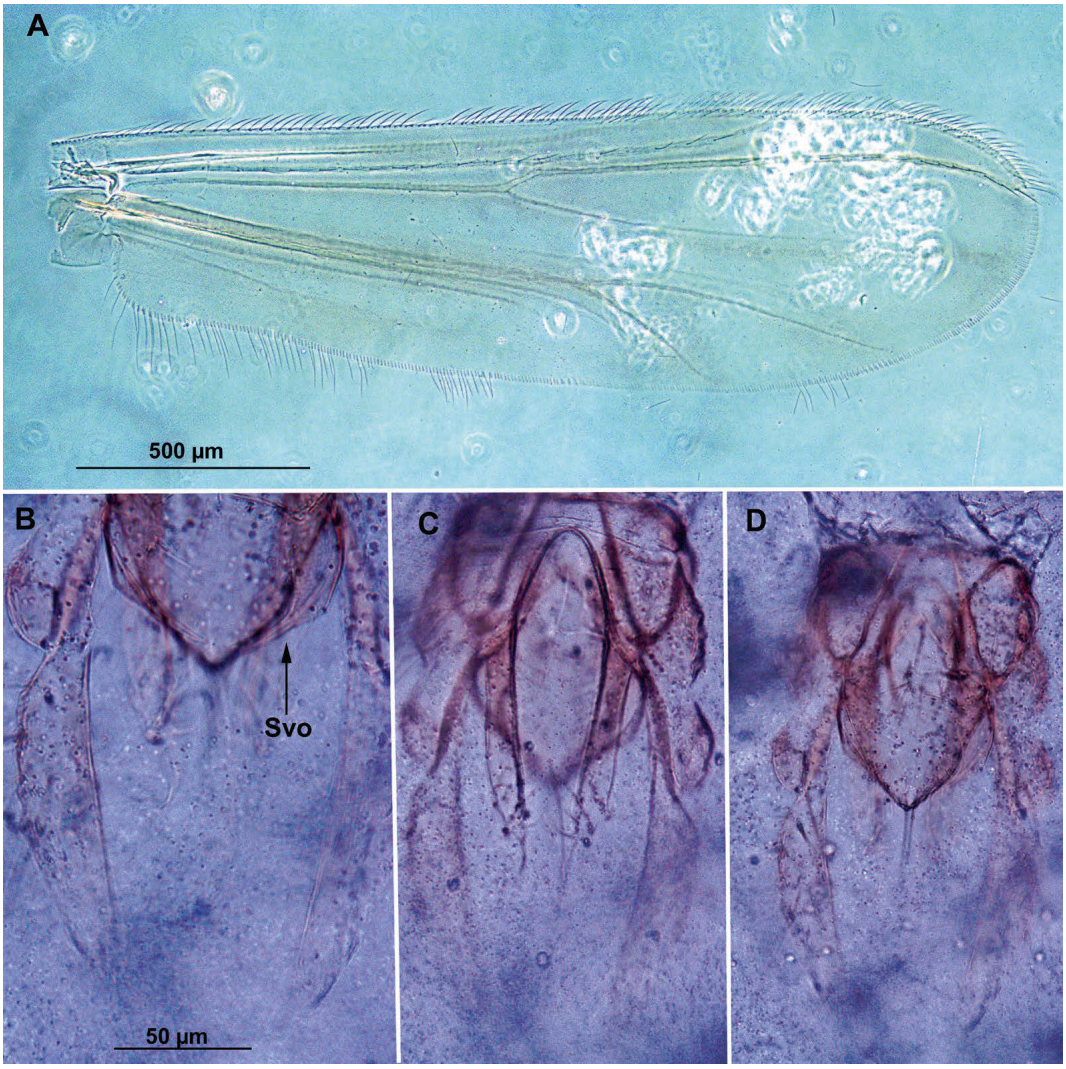

Fig. 5. Morphological details of *Polypedilum feridae* Bidawid-Kafka, 1996, adult male, holotype (ZSM collection). **A.** Wing. **B.** Hypopygium, dorsally, ×400. **C.** Hypopygium, ventrally, ×400. **D.** Hypopygium, ×200.

Stur & Andersen 2000, Giłka & Zakrzewska 2013, Prat et al. 2018). Therefore, the present new records of *Polypedilum* from Ecuador are important from both, biomonitoring and faunistic perspectives. The new record of *P. salwiti*, previously known only from Brazil (Bidawid & Fittkau 1995), suggests a wide distribution of this species along the Amazon river basin.

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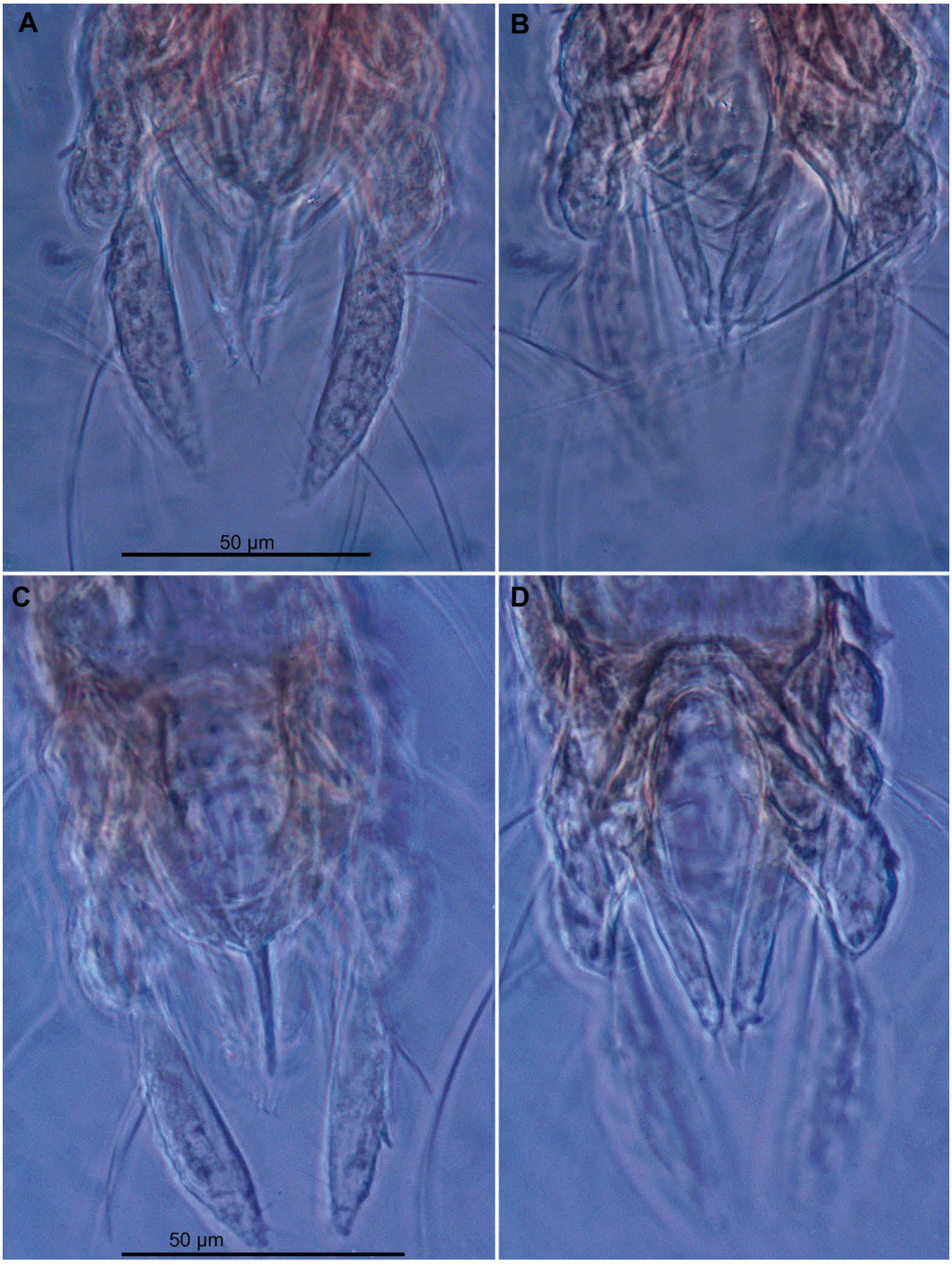

Fig. 6. Morphological details of *Polypedilum amataura* (**A**, **B**) and *P. marauia* (**C**, **D**) (ZSM collection). Hypopygium, dorsally, ×400 (**A**, **C**). Hypopygium, ventrally, ×400 (**B**, **D**).

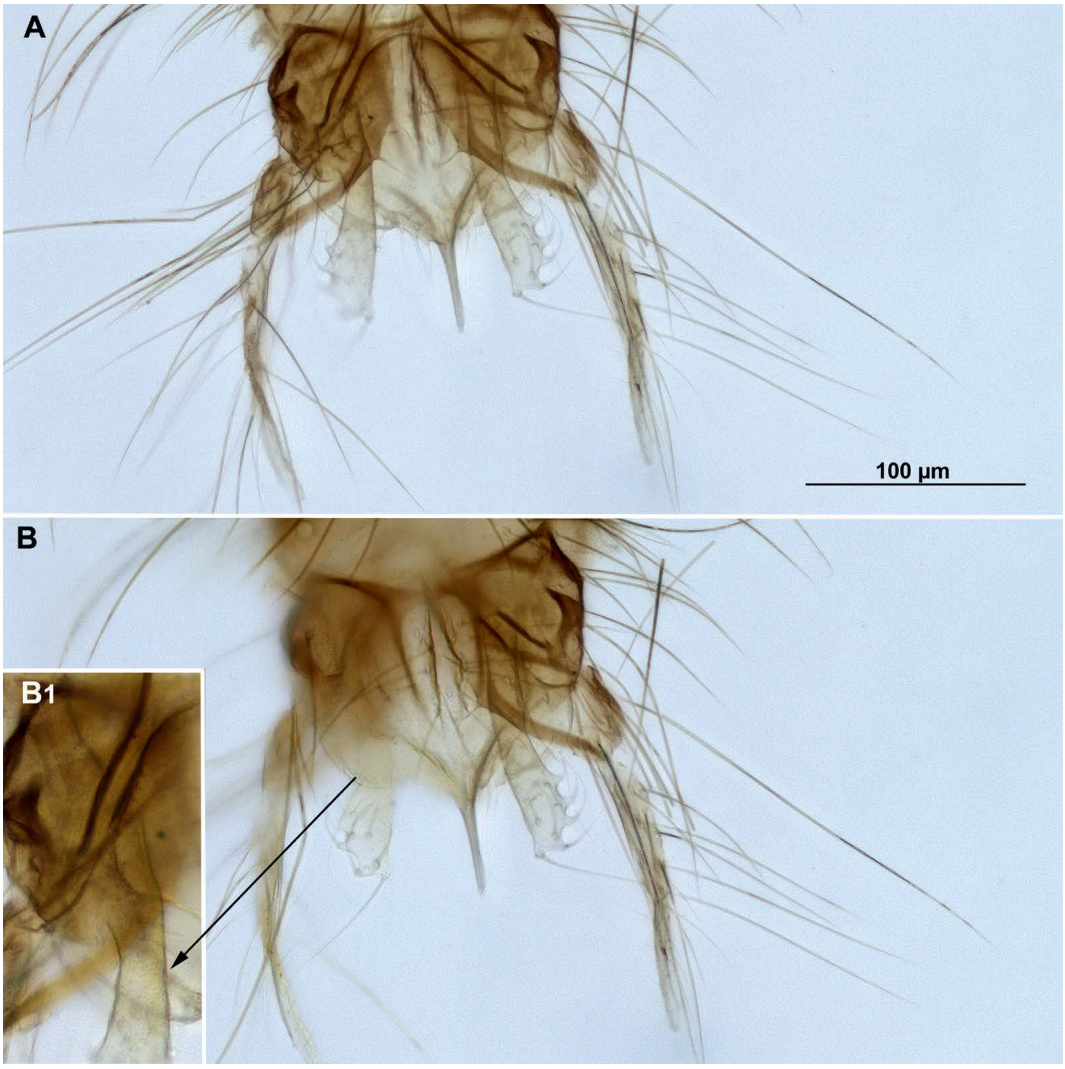

Fig. 7. Morphological details of *Polypedilum salwiti* Bidawid-Kafka, 1996. **A.** Hypopygium, ×200. **B.** Hypopygium ventrally, ×400. **B_1.** Superior volsella.

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