New species of the endemic Neotropical caddisfly genus *Contulma* from the Andes of Ecuador (Trichoptera: Anomalopsychidae)

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The genus *Contulma* Flint (Trichoptera: Anomalopsychidae) is composed mostly of regionally endemic species occurring above 2000 m, with a few more widespread species and some that are found at lower elevations. Adults of 3 new species of *Contulma* are described and illustrated from the Andes of Ecuador, *Contulma lina*, new species, *Contulma quito*, new species, and *Contulma sangay*, new species. These species are similar to previously described species from the region, including *C. paluguillensis*, *C. nevada*, and *C. lanceolata*. New provincial records are provided for *C. bacula*, *C. cataracta*, and *C. echinata*. *Contulma duffi* Oláh, 2016 is considered a junior, subjective synonym of *C. penai*, Holzenthal & Flint, 1995. Also, we provide an identification key to males of the 30 *Contulma* species now known.

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Abstract. The genus *Contulma* Flint (Trichoptera: Anomalopsychidae) is composed mostly of regionally endemic species occurring above 2000 m in Central and South America, with a few more widespread species and some that are found at lower elevations. Adults of 3 new species of *Contulma* are described and illustrated from the Andes of Ecuador, *Contulma lina*, new species, *Contulma quito*, new species, and *Contulma sangay*, new species. These species are similar to previously described species from the region, including *C. paluguillensis*, *C. nevada*, and *C. lancelolata*. New provincial records are provided for *C. bacula*, *C. cataracta*, and *C. echinata*. *Contulma duffi* Oláh, 2016 is considered a junior, subjective synonym of *C. penai*, Holzenthal & Flint, 1995. Also, we provide an identification key to males of the 30 *Contulma* species now known.

Introduction

Neotropical Trichoptera currently includes more than 3,200 described species representing 155 genera and 25 families (Holzenthal & Calor, 2017) occurring in Mexico, the Caribbean, Central, and South America. Remarkably, 115 genera, or ca.75% of the total, are endemic to the region, making the fauna the second most diverse in the world for endemic genera after the Australasian (de Moore & Ivanov, 2008). Moreover, several Neotropical genera are highly endemic regionally at the species level such as *Amphoropsyche* Holzenthal (Holzenthal, 1985, Holzenthal & Rázuri-Gonzales, 2011), *Atananolica* Mosely (Holzenthal, 1988, Henriques-Oliveira & Santos, 2014), and *Contulma* Flint (Holzenthal & Robertson, 2006), the latter the main subject of this paper. Nevertheless, the Neotropical caddisfly fauna is incompletely known, mainly because there are regions in the Neotropics where the aquatic ecosystems are far from being well studied (e.g., Ríos-Touma, Holzenthal, Huisman, Thomson, & Rázuri-Gonzales, 2017). There is also a lack of regional researchers studying the order, especially in the Andean countries of Venezuela, Colombia, Ecuador, Peru, and Bolivia, which undoubtedly harbor 100s of species. For example, co-authors Ríos-Touma is the first Ecuadorian to describe new species of caddisflies and Rázuri-Gonzales only the second Peruvian to do so.

A comprehensive revision of the endemic Neotropical genus *Contulma* was completed by Holzenthal & Flint (1995) and included 21 species, 18 described as new. Since then, 7 new species have been described, including 1 we synonymize here (Table 1). Species in the genus are known from Costa Rica, the Andes of Colombia to Chile, and in the mountains of southeastern Brazil (Holzenthal & Calor, 2017). This genus seems to display a high degree of local endemism among its species (Holzenthal & Robertson, 2006), and they are rarely collected using standard light trap techniques. Hand netting during the day, especially at high elevations, or the use of Malaise traps is generally more effective (Holzenthal & Ríos-Touma, 2012). The infrequency of collection does not mean the species are rare in nature, but most have been described from only 1-5 individuals. Perhaps this is a reflection of minimal collecting effort or low temperatures at high elevations that reduce adult flying activity. The habitats of these species are small waterfalls, seeps, and small streams in lush forested mountainous areas as well as high elevation *páramo* streams above the tree line in the Andes (Holzenthal & Flint, 1995).

Of the 30 species now known in the genus, including 3 new species described here, 19

occur in the tropical Andean countries (Ecuador, Colombia, Peru, Bolivia) and all occur above 2000 m, except for 2 of these species also found in lower elevations (Holzenthall & Flint, 1995, Holzenthall & Robertson, 2006). Eight species occur in Ecuador, 5 endemic and 3 are also present in Colombia. The 3 new species described here are from localities where no caddisfly collecting occurred previously.

Materials and Methods

We used the methods described by Blahnik & Holzenthall (2004) to prepare adult specimens for taxonomic study. Genitalia were cleared in 85% lactic acid heated to 125°C for 20 min (Blahnik, Holzenthall, & Prather, 2007). An Olympus BX41 compound microscope outfitted with a drawing tube was used to observe specimens. Genital structures were drawn with pencil on paper and final illustrations were rendered in Adobe Illustrator. Morphological terminology follows that of Holzenthall & Flint (1995). Descriptions of species and generation of the identification key were accomplished using the software packages DELTA and INTKEY (Dallwitz, 1980, Dallwitz, Paine, & Zurcher, 1999).

Types of the new species are deposited in the collections of the Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador (MECN) and the University of Minnesota Insect Collection, St. Paul, Minnesota, USA (UMSP). All specimens examined in this study were affixed with a barcode label containing a unique 9 digit numeric code starting with the prefix UMSP. These codes are provided here for holotypes only. All associated specimen data are stored in the UMSP database. This study was performed under the Environmental Ministry of Ecuador study permits 36-2010-IC-FLO/FAU-DPA-MA and 005-15-IC-FAU-FLO-DNB/MA.

The electronic version of this article in Portable Document Format (PDF) will represent a published work according to the International Commission on Zoological Nomenclature (ICZN), and hence the new names contained in the electronic version are effectively published under that Code from the electronic edition alone. This published work and the nomenclatural acts it contains have been registered in ZooBank, the online registration system for the ICZN. The ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information viewed through any standard web browser by appending the LSID to the prefix <http://zoobank.org/>. The LSID for this publication is: urn:lsid:zoobank.org:pub:54BC56DC-5CC1-4DA0-82E4-

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Results

Species descriptions

Contulma lina, new species, Holzenthal, Ríos-Touma, Rázuri-Gonzales

LSID urn:lsid:zoobank.org:act:310DDC54-0008-4535-A385-BD71BB630F21

Figures 1A-E, 2

Diagnosis: *Contulma lina*, n. sp., as well as *C. quito*, n. sp., and the recently described *C. paluguillensis* Holzenthal & Ríos-Touma, 2012, in addition to *C. echinata*, *C. nevada*, and *C. papallacta*, all described by Holzenthal & Flint (1995), and all from either Ecuador or Colombia, share several features. All have some degree of development of a dorsolateral process on segment IX in the male genitalia and a development of setae or a setose process on the mesal face of the same segment below the dorsolateral process. These 3 species formed a clade within the *cranifer*-group of Holzenthal & Flint (1995) to which *C. lina*, n. sp., *C. quito*, n. sp., and *C. paluguillensis* also belong. In some species, one or the other of these characters may be more or less developed, but the combination of characters shared by these species indicate that they may have a common origin. The phallic structures seem to be unique to each species and attest to their distinctiveness. All are known from only a handful of specimens, most from only the type and a few paratypes, and the species each occur from only one or a few high altitude localities spread across a vast expanse of the northern Andes. We predict that additional collecting will discover yet more new species in this radiation of Andean Trichoptera biodiversity. *Contulma lina* is distinguished from the above mentioned species, all illustrated by Holzenthal & Flint (1995) and Holzenthal & Ríos-Touma (2012), by the following combination of characters: mesal surface of segment IX bearing a sinuous band of setae from below dorsolateral process and continuing to near sternum IX; mesal process of sternum IX with prominent posteromesal, heavily sclerotized, spatulate projection, without excavation; and phallus without spine-like

117 setae, but instead with the apex bearing a lightly sclerotized scale-like structure, shallowly
118 excavate at apex.

119 **Description:** *Male:* Forewing length 5.5 mm (n=1). Forewing color gray brown, immaculate,
120 vestiture rubbed (specimen was netted during the day in light rain and mist). Male genitalia:
121 Segment IX very short dorsally, narrow, deeply excavate mesally; in lateral view, IX quadrate,
122 extended anterolaterally; posteriorly with short, broad, dorsolateral, spatulate process; posterior
123 margin of IX produced medially to form broad, prominent, quadrate, heavily setose, paired
124 lateral lobes; lobes widely separated ventrally; mesal face of segment IX bearing sinuous band of
125 setae from below spatulate process continuing to near sternum IX; sternum IX with prominent
126 posteromesal, heavily sclerotized, spatulate projection. Inferior appendages short, subtriangular,
127 apices broadly rounded and bearing apical setae; inferior appendages apparently fused to base of
128 IXth sternal projection, together forming highly complex structure as in Figs. 1A, C. Processes of
129 subphallic membranes present, membranous, mound-like, setose. Segment X entirely
130 membranous, apex entire, extending beyond apices of dorsolateral processes. Phallus complex;
131 phallobase tubular, elongate, slender, sclerotized; phallicata very lightly sclerotized, dorsally
132 with paired, very lightly sclerotized, semi-membranous lobes; apicoventral phallic membranes
133 with paired, broad, lightly sclerotized, dorsolateral plates, membranes inflated anteroventrally,
134 apically with lightly sclerotized scale-like structure, shallowly excavate at apex; phallotremal
135 sclerite present, tubular, curved.

136 *Female:* Forewing length 6.5 mm (n=1). Color and vestiture as in male. Vaginal apparatus in
137 ventral view elongate, hourglass shaped, narrowest in middle; base widely emarginate,
138 subtriangular; apex trident shaped with wide, paired, sclerotized, slightly sinuate midlateral
139 processes, their apices truncate; single medial process elongate, narrow, sclerotized, about same
140 length as midlateral processes; medial membranes highly convoluted, as approximated in Fig. 2;
141 apical membranes highly convoluted, with heavily sclerotized, rounded, beaklike apical sclerite.

142 **Holotype male: ECUADOR: Napo:** Reserva Ecológica Cayambe-Coca, waterfall, rd. to
143 Oyacachi, 0.32621°S, 78.15049°W, el. 3690 m, 16.x.2011, Holzenthal, Ríos-Touma, Pita
144 (UMSP000098532) (UMSP). **Paratype:** same data as holotype, 1 female (MECN).

145 **Etymology:** This species is named for Lina Pita, lifelong friend of Blanca Ríos-Touma and

one of the collectors of this species.

***Contulma quito*, new species, Holzenthal, Ríos-Touma, Rázuri-Gonzales**

LSID urn:lsid:zoobank.org:act:97969526-CF58-48A8-8548-8817326D04A0

Figures 3A-F

Diagnosis: This new species is very similar to *C. nevada* of the group of species mentioned above (*C. echinata*, *C. lina*, *C. nevada*, *C. paluguillensis*, and *C. papallacta*). *Contulma quito*, n. sp., and *C. nevada* have similar short dorsolateral processes on segment IX, a small setal patch or setal bearing process below the dorsolateral process, emarginate sternal projection of sternum IX, and short spines in the phallus. The major differences between *C. quito* and *C. nevada* are the broader excavation of the IXth sternal projection and the many more spine-like setae in the phallus of *C. quito*.

Description: *Male*: Forewing length 5.5 mm (n=3). Forewing color brown, with small patch of cream colored hairs at apex of subcosta and arculus, vestiture intact. Male genitalia: Segment IX very short dorsally, narrow, deeply excavate mesally; in lateral view, IX quadrate, slightly extended anterolaterally; posteriorly with very short, narrow, dorsolateral, spatulate process; posterior margin of IX produced medially to form broad, prominent, broadly rounded, heavily setose, paired lateral lobes; lobes widely separated ventrally; mesal face of segment IX with short, sclerotized, setose process below spatulate process. [*Variation*: in male paratype UMSP000148995, the spatulate processes and the short setose processes below them are each fused on both sides of the specimen to form a thin, crecentic shelf (Fig. 3F). In male paratype UMSP000148996, the spatulate processes and the setose processes below them are variously slightly longer or shorter on either the right or left sides than they are in the holotype]. Sternum IX with prominent posteromesal, heavily sclerotized, strongly emarginate projection. Inferior appendages short, crescentic, apices rounded and bearing apical setae; inferior appendages apparently fused to base of IXth sternal projection, together forming highly complex structure as in Figs. 3A, C. Processes of subphallic membranes present, membranous, mound-like, setose. Segment X entirely membranous, apex divided, with lightly sclerotized lateral flanges. Phallus complex; phallobase tubular, elongate, slender, sclerotized; phallicata very lightly sclerotized,

dorsally with paired, very lightly sclerotized, semi-membranous lobes; apicoventral phallic membranes with paired, broad, lightly sclerotized, dorsolateral plates forming broadly rounded trough, apicoventrally with paired patches of numerous (ca. 50) very short spine-like setae; phallotremal sclerite very lightly sclerotized, difficult to discern.

Female: Unknown.

Holotype male: ECUADOR: Pichincha: Distrito Metropolitano de Quito, Quebrada Guapalito, 0.40113°S, 78.38378°W, el. 2807 m, 26.vii.2015, Rázuri, Ríos-Touma, Amigo (UMSP000148997) (UMSP). **Paratypes: ECUADOR: Pichincha:** Distrito Metropolitano de Quito, Quebrada Convalecencia, 0.40060°S, 78.38256°W, el. 2813 m, 26.vii.2015, Morabowen, Hernández, 2 males (UMSP, MECN).

Etymology: Named for Quito, the capital of Ecuador, where the species was collected and where the surrounding Andes seem to harbor a multitude of species in the genus.

***Contulma sangay*, new species, Holzenthal, Ríos-Touma, Rázuri-Gonzales**

LSID urn:lsid:zoobank.org:act:38C17810-F31C-45A5-BFAC-3D3C5E68AD47

Figures 4A-D, 5

Diagnosis: This new species is similar to *C. lanceolata*, Holzenthal & Flint, 1995, also from Ecuador. Both share a similar shape of segment IX, which is strongly extended anterolaterally and with the posterior portion excavated medially in both species. In addition, both have an elongate dorsolateral setose lanceolate process on segment IX, but in *C. sangay* the process is divided apically into a pair of narrow, terete lobes. Most distinctively, the new species lacks the ventrolateral process of segment IX seen in *C. lanceolata* (Holzenthal & Flint, 1995, fig. 70).

Description: *Male*: Forewing length 4.5 mm (n=1). Forewing color brown, immaculate, vestiture intact. Male genitalia: Segment IX short dorsally, narrow; in lateral view, IX trapezoidal, strongly extended anterolaterally; posteriorly with elongate, dorsolateral, lanceolate process, apically divided into pair of terete, narrow, closely appressed lobes; process bearing

minute setae dorsally along length; posterior margin of IX excavated medially, produced ventrally, to form prominent, semiquadrate, setose, paired lateral lobes; lobes close together ventrally, forming acute separation; mesal face of segment IX without setae or processes; sternum IX short, subquadrate projection, its surface rugose and with very small, mesal sclerotized spur. Inferior appendages very short, crescentric, apices subacute, directed ventrally, and bearing apical setae; inferior appendages apparently fused to base of IXth sternal projection, together forming highly complex structure as in Figs. 4A, C. Processes of subphallic membranes absent (or not apparent). Segment X entirely membranous, apex cleft, extending to apices of dorsolateral processes. Phallus complex; phallobase tubular, elongate, slender, sclerotized; phallicata very lightly sclerotized, dorsally with prominent membranous lobe; apicoventral phallic membranes with paired, broad, lightly sclerotized, ventrolateral plates, fused ventrally and forming apparent pore, apex with pair of small papillate lobes; phallotremal sclerite present, small, subquadrate.

Female: Forewing length 4.5 mm (n=1). Color as in male, but vestiture rubbed. Vaginal apparatus in ventral view short, oval, widest in middle; base rounded, urn-shaped; apex trident shaped with narrow, paired, lightly sclerotized, indistinct midlateral processes, their apices acute; single medial process elongate, narrow, sclerotized, longer than midlateral processes; medial membranes highly convoluted, as approximated in Fig. 5; apical membranes highly convoluted, with lightly sclerotized, broad, thin, shelf-like apical sclerite.

Holotype male: ECUADOR: Morona-Santiago: Río Salado, Highway E46 (via Riobamba-Macas), 2.24253°S, 78.27791°W, el. 1646 m, 26.i.2015, Holzenthal, Huisman, Ríos-Touma, Amigo (UMSP000147014) (UMSP). **Paratype:** same data as holotype, 1 female (MECN).

Etymology: Named for the type locality, Sangay National Park, where the species was collected from the Río Salado.

New Provincial Records

Contulma bacula Holzenthal & Flint, 1995:11 [Type locality: Ecuador, Napo, 1 mi E of Pa-pallacta; type depository: NMNH; holotype male]. —Medellín, Ramírez, & Rincón,

235 2004:201 [distribution; biology]. —Holzenthal & Calor, 2017:21 [catalog].

236 **Distribution.** Colombia, Ecuador.

237 **New provincial record: ECUADOR: Morona-Santiago:** Río Tinguichaca; Highway E46 (via
238 Riobamba-Macas), 02.21474°S, 078.44218°W, el. 2772 m, 25.i.2015, Holzenthal, Huisman,
239 Ríos-Touma, Amigo, 1 male, 2 females (UMSP).

240

241 ***Contulma cataracta*** Holzenthal & Flint, 1995:12 [Type locality: Ecuador, Napo, Río Maspá
242 Chico, 2 km W Cuyuja; type depository: NMNH; holotype male]. —Holzenthal & Calor,
243 2017:22 [catalog].

244 **Distribution.** Ecuador.

245 **New provincial record: ECUADOR: Morona-Santiago:** Sangay National Park, waterfall 2,
246 2.18111°S, 78.5062°W, el. 3516 m, 12.xi.2015, Ríos-Touma, Thomson, Amigo, 3 males, 1
247 female (UMSP).

248

249 ***Contulma echinata*** Holzenthal & Flint, 1995:15 [Type locality: Colombia, Caldas, 5 km W
250 Termales de Ruíz; type depository: NMNH; holotype male; female]. —Muñoz-Quesada,
251 2000:274 [checklist]. —Holzenthal & Calor, 2017:22 [catalog].

252 **Distribution.** Colombia, Ecuador.

253 **New provincial record: ECUADOR: Napo:** Reserva Ecológica Cayambe-Coca, waterfall, rd.
254 to Oyacachi, 0.32621°S, 78.15049°W, el. 3690 m, 16.x.2011, Holzenthal, Ríos-Touma, Pita, 1
255 male (UMSP); same, except 26.ii.2012, Ríos-Touma and Pita, 1 male (UMSP).

256

257 **New synonymy**

258

259 ***Contulma penai*** Holzenthal & Flint, 1995:18 [Type locality: Ecuador, Zamora-Chinchipe, 30
260 km E Loja; type depository: NMNH; holotype male; female; larva]. —Muñoz-Quesada,
261 2000:274 [checklist]. —Holzenthal & Calor, 2017:23 [catalog].

262 —*Contulma duffi* Oláh, 2016:169 [Type locality: Colombia, Antioquia, Dusky Starfrontlet Bird
263 Reserve, Cordillera Occidental, Urrao, 6°25'N, 75°05'W, 9.ii.2014, caught by hand, leg. A.G.
264 Duff; type depository: private collection of J. Oláh; holotype male] **NEW SYNONYM**

265 **Distribution.** Colombia, Ecuador.

266

267 *Contulma duffi*, described from Antioquia, Colombia, fits clearly within the variation we have
 268 seen in the species *C. penai*, which also occurs in Antioquia, Colombia, and Ecuador, where it is
 269 rather common compared to other species in the genus. There are no features illustrated or
 270 diagnosed in the original description that distinguish the species from *C. penai*. Most of the
 271 characters discussed by Oláh (2016) are those common to the genus as a whole. The
 272 membranous structure of tergum X is identical in both species. The dorsolateral processes of
 273 segment IX are illustrated as slightly curved in *C. duffi* compared to those illustrated for *C.*
 274 *penai*, but this slight difference is variable, and the inferior appendages are identical in the 2
 275 species. In Oláh's diagnosis, the species is said to be most similar to *C. bacula*, but it shares little
 276 in common with that species. The inferior appendages, the posteromesal process of sternum IX,
 277 and the phallus are completely different between the 2 species.

278

279 **Key to Males of *Contulma* Species¹**

- 280 1. Posterior margin of segment IX with dorsolateral processes (HF 24, 44, 58, 79, 90,
 281 107) (these processes may be short, but present, as in *C. quito*, Fig. 3A, B) 2
- 282 Posterior margin of segment IX without dorsolateral processes, although there may be
 283 small setose projections or patches of setae (HF 40, 48, 49, 86, 95, 112) 21
- 284 2(1). Dorsolateral processes of segment IX very long, slender, strongly down curved, their
 285 apices rugose (HF 107, HR 2A, 4A) 3
- 286 Dorsolateral processes of segment IX shorter and/or differently shaped, their apices
 287 not rugose 6
- 288 3(2). Phallus with pair of large, highly membranous convoluted dorsolateral lobes (in some
 289 specimens these lobes may not evert during the clearing process) (HR 2D-F, 4D-E)
- 290 4

¹ Citations of previously published illustrations referenced in the key are abbreviated as follows: HF=Holzenthal & Flint, 1995, HR= Holzenthal & Robertson, 2006, JN=Jardim & Nessimian, 2011, HRT=Holzenthal & Ríos-Touma, 2012.

291		Phallus without highly membranous convoluted lobes or with much smaller, less	
292		well-developed lobes (HF 110, JN 5)	5
293	4(3).	Segment IX extended anterodorsally (HR 4A); setose lobe of posterior margin of	
294		segment IX situated close to middle of segment (HR 4A).....	<i>Contulma tripui</i>
295		Segment IX only slightly extended anterodorsally, if at all (HR 2A); setose lobe of	
296		posterior margin of segment IX situated close to ventral margin of segment (HR 2A) ..	
297		.....	<i>Contulma fluminensis</i>
298	5(3).	Posterior margin of segment IX extended into a long, narrow, acute, setose lobe (JN	
299		1)	<i>Contulma sana</i>
300		Posterior margin of segment IX extended into a much shorter, subtriangular, setose	
301		lobe (HF 107)	<i>Contulma tijuca</i>
302	6(2).	Phallus with pair of large, highly membranous convoluted dorsolateral lobes (in some	
303		specimens these lobes may not evert during the clearing process) (HF 28, 33, 56, 93) ..	
304		.....	7
305		Phallus without highly membranous convoluted lobes or with much smaller, less	
306		well-developed lobes (HF 81)	10
307	7(6).	Segment IX with pair of elongate, heavily setose, ventrolateral lobes (HF 24, 26)	
308		.....	<i>Contulma adamsae</i>
309		Segment IX without such lobes	8
310	8(7).	Dorsolateral processes of segment IX, in lateral view, long, linear, directed ventrad	
311		along entire length (sinuous and crossing apically in dorsal view) (HF 52-53);	
312		segment IX very short dorsolaterally (HF 52); segment X membranous, almost	
313		obliterated (HF 53)	<i>Contulma cranifer</i>
314		Dorsolateral processes of segment IX, in lateral view, much shorter, linear to lorate,	
315		directed posteriad, apex only slightly to strongly directed ventrad (straight and not	

316		crossing apically in dorsal view); segment IX long dorsolaterally; segment X	
317		membranous, but well developed (HF 30, 31, 90).....	9
318	9(8).	Dorsolateral processes of segment IX, narrow, terete, apex slightly directed ventrad	
319		(HF 30-31).....	<i>Contulma bacula</i>
320		Dorsolateral processes of segment IX lorate (strap-shaped with apex flexed), apex	
321		strongly directed ventrad (HF 90).....	<i>Contulma spinosa</i>
322	10(6).	Segment IX with mesolateral patch of long or short spine-like setae or with	
323		mesolateral setose protuberances (HF 57, 75, 79; HRT 1B; Figs. 1A, B, 3B).....	11
324		Segment IX without mesolateral setae or setose protuberances	15
325	11(10).	Apex of phallus with pair of large, tooth-like structures and/or with smaller	
326		apicoventral spines (HF 60, 81; Fig. 3D).....	12
327		Apex of phallus without such spines, although small setae or papillae may be present .	
328		.....	14
329	12(11).	Apex of phallus with pair of large, tooth-like structures and smaller apicoventral	
330		spines (HF 60).....	<i>Contulma echinata</i>
331		Apex of phallus with pair of large, tooth-like structures only (HF 81)	
332		.....	<i>Contulma papallacta</i>
333		Apex of phallus with smaller apicoventral spines only (HF 77; Figs. 3D, E).....	13
334	13(12).	Projection of sternum IX subtriangular in ventral view, with broad, angulate mesal	
335		excavation (Fig. 3C).....	<i>Contulma quito, new species</i>
336		Projection of sternum IX quadrate in ventral view, with narrow mesal excavation (HF	
337		76).....	<i>Contulma nevada</i>
338	14(11).	Mesolateral setae of segment IX forming sinuous band from below dorsolateral	
339		process continuing to near sternum IX (Figs. 1A, B); projection of sternum IX	

340		rounded (entire) apically (Fig. 1C).....	<i>Contulma lina</i>, new species
341		Mesolateral setae of segment IX restricted to patch below dorsolateral process (HRT	
342		1A, B); projection of sternum IX emarginate apically (HRT 1C)	
343		.....	<i>Contulma paluguillensis</i>
344	15(10).	Segment IX extended anterodorsally (HF 44, 61, 70, 82; HR 1A; Fig. 4A); inferior	
345		appendage, in lateral view, crescentic.....	16
346		Segment IX only slightly extended anterodorsally, if at all (HF 66); inferior	
347		appendage, in lateral view, subtriangular or quadrate (HF 66).....	<i>Contulma inornata</i>
348	16(15).	Apex of phallus with pair of large, tooth-like structures (HF 64, 65); tergum IX with	
349		prominent, posteromesal extension (HF 61, 62).....	<i>Contulma ecuadorensis</i>
350		Apex of phallus without such spines, although small setae or papillae may be present;	
351		tergum IX without posteromesal extension	17
352	17(16).	Dorsolateral processes of segment IX clothed with short, fine setae (HF 44, 71, 82;	
353		Figs. 4A, B).....	18
354		Dorsolateral processes of segment IX lacking vestiture of fine setae (HR 1A, B).....	
355		.....	<i>Contulma boliviensis</i>
356	18(17).	Dorsolateral processes of segment IX curved mesally, widely separated, subtriangular	
357		(HF 44-46).....	<i>Contulma colombiensis</i>
358		Dorsolateral processes of segment IX straight, parallel, directed downward, close	
359		together, lanceolate	19
360	19(18).	Segment IX posteriorly with only single long dorsolateral or lateral setose process or	
361		none at all.....	20
362		Segment IX posteriorly with both long dorsolateral setose process and long, slender,	
363		sharply pointed, ventrolateral process (HF 70-72).....	<i>Contulma lanceolata</i>

364	20(19).	Apex of dorsolateral processes of segment IX entire (HF 82, 83).....	<i>Contulma penai</i>
365		Apex of dorsolateral processes of segment IX divided into pair of terete, narrow,	
366		closely appressed lobes (Figs. 4A, B)	<i>Contulma sangay, new species</i>
367	21(1).	Segment X with lightly sclerotized lateral regions that apparently articulate basally	
368		with sclerotized projections of dorsolateral corners of segment IX (HF 48-49, 103-	
369		104)	22
370		Segment X without lightly sclerotized lateral regions that apparently articulate basally	
371		with sclerotized projections of dorsolateral corners of segment IX	23
372	22(21).	Segment IX with mesolateral patch of short spine-like setae (HF 48-49); projection of	
373		sternum IX truncate (HF 50); parameres long, slender (HF 51).....	
374		.....	<i>Contulma costaricensis</i>
375		Segment IX without mesolateral setae (HF 104); projection of sternum IX acute	
376		apically (HF105); parameres short (HF 106)	<i>Contulma tica</i>
377	23(21).	Phallus with pair of large, highly membranous convoluted dorsolateral lobes (in some	
378		specimens these lobes may not evert during the clearing process) (HF 42-43, 89, 114-	
379		115)	24
380		Phallus without highly membranous convoluted lobes or with much smaller, less	
381		well-developed lobes	26
382	24(23).	Segment IX with mesolateral patch of long (HF 39-40) or short (HF 86) spine-like	
383		setae.....	25
384		Segment IX without mesolateral setae or setose protuberances (HF 111-112)	
385		.....	<i>Contulma valverdei</i>
386	25(24).	Dorsolateral membranous lobes of phallus each ending in sclerotized, scale-like	
387		process (HF 42-43); projection of sternum IX long, rounded (entire) apically (HF 41) .	
388		.....	<i>Contulma cataracta</i>

389		Dorsolateral membranous lobes of phallus entirely membranous (HF 89); projection	
390		of sternum IX short, slightly emarginate apically.....	<i>Contulma sancta</i>
391	26(23).	Segment IX with mesolateral patch of long or shorter spine-like setae (HF 95, 100) or	
392		with mesolateral setose protuberances (HF 36); inferior appendage, in lateral view,	
393		crescentic	27
394		Segment IX without mesolateral setae or setose protuberances (HR 3A, B); inferior	
395		appendage, in lateral view, subtriangular (HR 3A)	<i>Contulma meloi</i> ²
396	27(26).	Apex of phallus with large, apicoventral spines (HF 97-98); parameres absent	
397		.....	<i>Contulma talamanca</i>
398		Apex of phallus without such spines; parameres present, long, slender (HF 38, 102)....	
399		.....	28
400	28(27).	Segment IX with patch of long, stout, spine-like mesolateral setae (HF 100);	
401		phallicata with parameres and lateral flanges (HF 102)	<i>Contulma tapanti</i>
402		Segment IX without patch of long, stout, spine-like mesolateral setae, although	
403		smaller setae may be present (HF 36); phallicata with parameres only, lateral flanges	
404		absent (HF 38).....	<i>Contulma caldensis</i>
405	Discussion		

² *Contulma meloi* is a member of the group of species including *C. fluminensis*, *C. sana*, *C. tijuca*, and *C. tripui* from southeastern Brazil. However, it lacks the very long, slender, strongly downcurved, apically rugose dorsolateral processes of segment IX. The species is known only from the male holotype and a male paratype. In the holotype, there are no dorsolateral processes (HR 3A), but in the paratype, a rudimentary process occurs (HR 3G). However, it shares all other diagnostic features of this group, including the posterior, setose extension of segment IX, the broad, shelf-like structure of sternum IX, including the flat, tooth-like, apical setae, and the complex, membranous lobes of the phallus. It appears artificially in couplet 26, separated from related species because it lacks the strongly downcurved, apically rugose dorsolateral processes indicated in couplet 2. The collection of additional specimens may prove that the absence of the dorsolateral process is an aberration; if so, the specimens would lead to *C. fluminensis* in the key presented above.

Contulma species appear to be highly regionally endemic (Holzenthal & Flint, 1995, Holzenthal & Robertson, 2006). We observed this pattern in our collections in Ecuador. Patterns of high endemicity in macroinvertebrate benthic larvae are well known in high altitude glacial streams; these habitats are highly threatened by climate change (Jacobsen, Milner, Brown, & Dangles, 2012). On the other hand, we added records to the Ecuadorian fauna of species that were previously known only from Colombia, demonstrating that some species may have spread across the Andes. Despite this distribution pattern, aquatic insect species, especially mayflies, have shown genetic isolation in the various ranges of the Ecuadorian Andes, even with relatively short distances between populations and with recent volcanic eruption history (Finn, Encalada, & Hampel, 2016). No similar study has yet been performed with any Andean caddisfly species, but we expect a similar pattern of isolation among populations. This isolation could increase by the intense land use changes and water pollution occurring throughout the inter-Andean valleys (Ríos-Touma, Acosta, & Prat, 2014) potentially preventing dispersal among mountain populations and also local extinctions.

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Figure 1(on next page)

Contulma lina, new species, male genitalia.

Figure 1. **Male genitalia of *Contulma lina*, new species.** (A) segments IX and X, lateral (base of phallus indicated in crosshatch). (B) segments IX and X, dorsal. (C) segment IX, ventral. (D) phallus, lateral. (E) phallus apex, dorsal. Abbreviations: IX = abdominal segment IX; X = abdominal segment X.

Figure 2(on next page)

Contulma lina, new species, female vaginal apparatus.

Figures 2. **Female vaginal apparatus of *Contulma lina*, new species, ventral.**

Figure 3_(on next page)

Contulma sangay, figure 3

Figure 3. **Male genitalia of *Contulma quito*, new species.** (A) segments IX and X, lateral (base of phallus indicated in crosshatch). (B) segments XI and X, dorsal. (C) segment IX, ventral. (D) phallus, lateral. (E) phallus apex, dorsal. (F) segments IX and X, dorsal, variation in paratype specimen UMSP000148995.

Figure 4(on next page)

Contulma sangay, new species, male genitalia.

Figure 3. **Male genitalia of *Contulma sangay*, new species.** (A) segments IX and X, lateral (base of phallus indicated in crosshatch); inset: apex of inferior appendage, caudal. (B) segments XI and X, dorsal. (C) segment IX, ventral. (D) phallus, lateral; insets: details of phallic structures.

Figure 5(on next page)

Contulma sangay, new species, female vaginal apparatus.

Figures 5. **Female vaginal apparatus of *Contulma sangay*, new species, ventral.**

Table 1(on next page)

Described species in the genus *Contulma* with geographic distribution and known life stages.

Table 1. Described species in the genus *Contulma* with geographic distribution and known life stages.

Species	Author	Distribution	Known stages
<i>Contulma adamsae</i>	Holzenthal & Flint, 1995	Peru	male, female
<i>Contulma bacula</i>	Holzenthal & Flint, 1995	Colombia, Ecuador	male
<i>Contulma boliviensis</i>	Holzenthal & Roberson, 2006	Bolivia	male
<i>Contulma caldensis</i>	Holzenthal & Flint, 1995	Colombia	male
<i>Contulma cataracta</i>	Holzenthal & Flint, 1995	Ecuador	male
<i>Contulma colombiensis</i>	Holzenthal & Flint, 1995	Colombia	male, female
<i>Contulma costaricensis</i>	Holzenthal & Flint, 1995	Costa Rica	male
<i>Contulma cranifer</i>	Flint, 1969	Chile	male, female
<i>Contulma echinata</i>	Holzenthal & Flint, 1995	Colombia	male, female
<i>Contulma ecuadorensis</i>	Holzenthal & Flint, 1995	Ecuador	male, female
<i>Contulma fluminensis</i>	Holzenthal & Roberson, 2006	Brazil	male
<i>Contulma inornata</i>	Holzenthal & Flint, 1995	Colombia	male
<i>Contulma lanceolata</i>	Holzenthal & Flint, 1995	Ecuador	male
<i>Contulma lina</i> , n. sp.	Holzenthal, Ríos-Touma, & Rázuri-Gonzales, 2017	Ecuador	
<i>Contulma meloi</i>	Holzenthal & Roberson, 2006	Brazil	male
<i>Contulma nevada</i>	Holzenthal & Flint, 1995	Colombia	male, female, larva
<i>Contulma palaguillensis</i>	Holzenthal & Ríos-Touma, 2012	Ecuador	male, female, larva, pupa
<i>Contulma papallacta</i>	Holzenthal & Flint, 1995	Ecuador	male
<i>Contulma penai</i>	Holzenthal & Flint, 1995	Colombia, Ecuador	male, female, larva
<i>Contulma duffi</i> Oláh, 2016, n. syn.			male
<i>Contulma quito</i> , n. sp.	Holzenthal, Ríos-Touma, & Rázuri-Gonzales, 2017	Ecuador	
<i>Contulma sana</i>	Jardim & Nessimian, 2011	Brazil	male
<i>Contulma sancta</i>	Holzenthal & Flint, 1995	Costa Rica	male
<i>Contulma sangay</i> , n. sp.	Holzenthal, Ríos-Touma, & Rázuri-Gonzales, 2017	Ecuador	
<i>Contulma spinosa</i>	Holzenthal & Flint, 1995	Colombia, Ecuador	male, female, larva
<i>Contulma talamanca</i>	Holzenthal & Flint, 1995	Costa Rica	male, female
<i>Contulma tapanti</i>	Holzenthal & Flint, 1995	Costa Rica	male, female
<i>Contulma tica</i>	Holzenthal & Flint, 1995	Costa Rica	male
<i>Contulma tijuca</i>	Holzenthal & Flint, 1995	Brazil	male, female, probable larva
<i>Contulma tripui</i>	Holzenthal & Roberson, 2006	Brazil	male
<i>Contulma valverdei</i>	Holzenthal & Flint, 1995	Costa Rica	male, female, larva