



Diversity and distribution of the Caddisflies (Insecta: Trichoptera) of Ecuador

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ABSTRACT

Background. Aquatic insects and other freshwater animals are some of the most threatened forms of life on Earth. Caddisflies (Trichoptera) are highly biodiverse in the Neotropics and occupy a wide variety of freshwater habitats. In Andean countries, including Ecuador, knowledge of the aquatic biota is limited, and there is a great need for baseline data on the species found in these countries. Here we present the first list of Trichoptera known from Ecuador, a country that harbors two global biodiversity “hotspots.”

Methods. We conducted a literature review of species previously reported from Ecuador and supplemented these data with material we collected during five recent field inventories from about 40 localities spanning both hotspots. Using species presence data for each Ecuadorian province, we calculated the CHAO 2 species estimator to obtain the minimum species richness for the country.

Results. We recorded 310 species, including 48 new records from our own field inventories for the country. CHAO 2 calculations showed that only 54% of the species have been found. Hydroptilidae and Hydropsychidae were the most species rich families. We report the family Xiphocentronidae for the first time from Ecuador as well as several new records of genera from different families.

Discussion. As in the neighboring Andean countries of Colombia and Peru, it is common to find undescribed species of caddisflies. There are vast areas of Ecuador and the northern Andes that are completely unexplored, and we expect that hundreds of new species are yet to be discovered.

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INTRODUCTION

Aquatic ecosystems are among the most threatened on Earth, and the biodiversity they contain, particularly insects, is still largely undiscovered in many parts of the world (Vörösmarty *et al.*, 2010). For example, according to species estimators we only know about 30% of the caddisfly species from the northern Andean region of South America

(Venezuela, Colombia, Ecuador, Peru) (RW Holzenthal & B Ríos-Touma, unpublished data). The lack of information on the diversity of species, and their distribution and functional role in aquatic ecosystems, makes predictions of the effects of climate change on these ecosystems and their biota difficult, if not impossible (*Holzenthal, Thomson & Ríos-Touma, 2015*).

Trichoptera, or caddisflies, are exclusively aquatic in the larval and pupal stages except for a very few terrestrial or semi-terrestrial and brackish-water species and one family whose members are marine (*Holzenthal, Thomson & Ríos-Touma, 2015*). The members of this order are considered to be biological indicators of good to excellent water quality and are highly sensitive to human disturbance to running waters worldwide (*Chang et al., 2014*). Currently, there are about 15,000 species described, making Trichoptera the second most diverse monophyletic group of aquatic animals, surpassed only by the clade Diptera: Culicomorpha/Psychodomorpha (*Malm, Johanson & Wahlberg, 2013*). In Trichoptera, The Neotropical region is the 3rd most species rich in the world with 2100 species recorded as of 2008 after the Oriental and Palearctic regions (*De Moor & Ivanov, 2008*). In terms of endemism of genera, the Neotropics (115 endemic genera) are second only to the Australasian region (120 endemic genera) (*De Moor & Ivanov, 2008*).

The Neotropical country of Ecuador hosts an amazing diversity of species, many of them threatened, in two biodiversity “hotspots:” the Tropical Andes and the Tumbes-Choco-Magdalena (*Myers et al., 2000*). The designation of these hotspots did not include insects or any aquatic biota other than fish. However, the diversity and endemism of aquatic insects are probably much greater in terms of species numbers than the vertebrate fauna. Considering the importance and sensitivity of aquatic invertebrate biota to changes in habitat, spanning across the watershed, increased knowledge of their taxonomy and biology is urgently needed. Trichoptera are probably one of the best known aquatic groups from the Andes of Ecuador, with some available catalogues of species and their distributions (*Flint, Holzenthal & Harris, 1999; Holzenthal & Calor, in press*). These baseline data, in addition to the wide range of trophic relationships and microhabitats caddisflies exploit, makes this group ideal for biodiversity and biogeographic studies (*Holzenthal, Thomson & Ríos-Touma, 2015*). The neighboring countries of Colombia and Peru, have full country or regional Trichoptera checklists (*Flint & Reyes, 1991; Flint, 1991; Flint, 1996a; Medellín, Ramírez & Rincón, 2004; Muñoz-Quesada, 2000; Rincón-Hernández, 1999*). However, there is no checklist or review of species or their distributions for any aquatic insect order for Ecuador. For these reasons the objectives in this study are to: (1) compile the first list of species of the caddisflies of Ecuador with in-country distribution data from the literature and from our own recent collections; and (2) estimate the total species richness of Ecuadorian caddisflies and define priority areas for future surveys.

MATERIALS & METHODS

To gather species information, we referred to the latest version of the *Catalog of Neotropical Trichoptera* (*Holzenthal & Calor, in press*). We then searched in the original sources to find more detailed locality information and, especially, the Ecuadorian provinces where

the species were recorded. Collections of specimens are recorded in the literature from as early as 1899 ([Ulmer, 1905](#)), followed by collections in the early 1900s by Paul Rivet ([Navás, 1913](#)) with a large set of collections not appearing until the 1970s by Jeffrey Cohen and Andrea Langley under the Ecuador Peace Corps-Smithsonian Institution Aquatic Insect Survey project which are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, (NMNH). The main taxonomic work on this material was done by O.S. Flint, Jr. (NMNH) during the 1980–90s.

During the period covered by the literature (1899 until present), several new provinces were created in Ecuador, including Morona Santiago (1952), Napo (1959), Orellana (1998), Santa Elena (2007), Santo Domingo (2007), Sucumbios (1989), and Zamora Chinchipe (1953). Since the historical records do not reflect these new political subdivisions, we tried to relate the locality descriptions to the current province. However, the majority of records did not have exact coordinates and others lacked sufficient locality information to allow us to be certain about the collection site. With the literature information at hand, we made a first list of species ([Table 1](#)) that we then compared with our own recent collections from Ecuador from 2010 to 2015 ([Table S1](#)). Collection methods used ranged from sweep netting (mainly in páramo locations) to collecting at black lights during the early evening (at all sites). See [Blahnik & Holzenthal \(2004\)](#) and [Blahnik, Holzenthal & Prather \(2007\)](#) for a review of collecting methods, field techniques, and genitalia preparation for adult Trichoptera. We made at least two different collections in each of Chimborazo, Imbabura, Morona Santiago, Napo, Pichincha, and Santo Domingo provinces (for exact locations refer to [Table S1](#) and [Fig. 1](#)). Specimens collected in our own research are deposited in the University of Minnesota Insect Collection, St. Paul, Minnesota, USA (UMSP), the Museo Ecuatoriano de Ciencias Naturales, Quito, Ecuador (MECN), the Museo de Ecología Acuática de la Universidad San Francisco de Quito, Ecuador (MUEA-USFQ), and the Museo de Zoología de la Universidad Tecnológica Indoamérica, Quito, Ecuador (MZUTI).

From the final list of species ([Table 1](#)), we calculated both country richness and province richness. We used the presence of the species per province to calculate an incidence based richness estimator (CHAO 2). This nonparametric species estimator allows for estimation of the potential richness based on the number of observed species, species that are found only in one location, and species that are observed in two locations. Despite its simplicity, a rigorous body of statistical theory demonstrates that CHAO 2 is a robust estimator of minimum richness ([Shen, Chao & Lin, 2003](#)) and is more rigorous and performs better in benchmark surveys than extrapolated asymptotic functions or other parametric species richness estimators ([Gotelli & Colwell, 2011](#)) with the kind of data used in this study.

RESULTS

We recorded 310 species of Trichoptera in Ecuador, belonging to 15 families and 52 genera. Literature records contained 264 species for the country ([Table 1](#)). Of these, 15 did not have specific locality data, although for nine of them we were able to collect additional specimens representing new locality records. We found 48 species that were

Table 1 Trichoptera of Ecuador. Caddisfly species found in Ecuador with their distribution, based on literature records as well as recent collections. Endemic species and new records are indicated.

Species	Province	Endemic	Altitude	Source
Anomalopsychidae				
Contulma				
<i>bacula</i> Holzenthal & Flint, 1995	Napo, Morona Santiago		2,770	<i>Holzenthal & Flint (1995)</i>
<i>cataracta</i> Holzenthal & Flint, 1995	Napo, Morona Santiago	E	1,800–3,516	<i>Holzenthal & Flint (1995)</i>
<i>echinata</i> Holzenthal & Flint, 1995	Napo		3,690	NEW RECORD
<i>ecuadorensis</i> Holzenthal & Flint, 1995	Imbabura	E	2,200	<i>Holzenthal & Flint (1995)</i>
<i>lanceolata</i> Holzenthal & Flint, 1995	Napo	E	1,260	<i>Holzenthal & Flint (1995)</i>
<i>paluguillensis</i> Holzenthal & Ríos-Touma, 2012	Pichincha	E	3,848	<i>Holzenthal & Ríos-Touma (2012)</i>
<i>papallacta</i> Holzenthal & Flint, 1995	Napo	E		<i>Holzenthal & Flint (1995)</i>
<i>penai</i> Holzenthal & Flint, 1995	Tungurahua, Zamora Chinchipe		1,539–2,000	<i>Holzenthal & Flint (1995)</i>
<i>spinosa</i> Holzenthal & Flint, in Flint, 1991	Azuay, Pichincha, Zamora Chinchipe		1,600–3,700	<i>Holzenthal & Flint (1995)</i>
Atriplectididae				
Neotriplectides				
sp. (larval record only)	Not known (probable in Ecuador)			<i>Holzenthal (1997)</i>
Calamoceratidae				
Banyallarga				
<i>loxana</i> (Navás), 1934	Azuay, Loja, Zamora Chinchipe		2,000–3,100	<i>Prather (2004)</i>
<i>penai</i> Prather, 2004	Loja		2,750	<i>Prather (2004)</i>
<i>villosa</i> (Navás), 1934	Loja	E	2,500–2,750	<i>Prather (2004)</i>
Phylloicus				
<i>cressae</i> Prather, 2003	Napo, Pichincha		950–1,250	<i>Prather (2003)</i>
<i>elegans</i> Hogue & Denning, in Denning et al., 1983	Santo Domingo		229	<i>Prather (2003)</i>
<i>ephippium</i> Prather, 2003	Tungurahua	E	15,50	<i>Prather (2003)</i>
<i>fenestratus</i> Flint, 1974	Napo, Pastaza			<i>Prather (2003)</i>
<i>lituratus</i> Banks, 1920	Napo, Pastaza, Santo Domingo		229–1,200	<i>Prather (2003)</i>
<i>llaviuco</i> Prather, 2003	Azuay		3,010	<i>Prather (2003)</i>
<i>paucartambo</i> Prather, 2003	Napo		1,750	<i>Prather (2003)</i>
<i>trichothylax</i> Prather, 2003	Cotopaxi		1,372	<i>Prather (2003)</i>
Ecnomidae				
Austrotinodes				
<i>ancylus</i> Flint & Denning, 1989	Pastaza			<i>Flint & Denning (1989b)</i>
Glossosomatidae				
Mortoniella				
<i>angulata</i> Flint, 1963	Napo, Pichincha	E	3,810	<i>Flint (1963)</i>
<i>apiculata</i> Flint, 1963	Napo, Pichincha	E	2,600	<i>Flint (1963)</i>
<i>aries</i> (Flint), 1963	Napo, Pastaza, Pichincha		2,440	<i>Flint (1963)</i> ; this paper
<i>atenuata</i> (Flint), 1963	Napo		543	NEW RECORD

(continued on next page)

Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>bilineata</i> Ulmer, 1906	Chimborazo, Pichincha, Morona Santiago		550–1,370	Flint (1963)
<i>chicana</i> Sykora, 1999	Chimborazo, Pastaza, Napo, Zamora Chinchipe	E	880	Sykora (1999)
<i>hodgesi</i> Flint, 1963	Napo, Pichincha	E	4,115	Flint (1963)
<i>leei</i> (Flint) 1974	Pichincha		570	NEW RECORD
<i>paralineata</i> Sykora, 1999	Zamora Chinchipe, Morona Santiago	E	1,340–1,531	Sykora (1999)
<i>quinuas</i> Harper & Turcotte, 1985	Azuay	E	3,300	Harper & Turcotte (1985)
<i>roldani</i> Flint 1991	Pichincha		570–700	NEW RECORD
<i>santiaga</i> Sykora, 1999	Morona Santiago	E	2,200	Sykora (1999)
<i>similis</i> Sykora, 1999	Santo Domingo	E		Sykora (1999)
<i>squamata</i> Sykora, 1999	Napo	E	1,900	Sykora (1999)
<i>wygodzinskii</i> (Schmid), 1958	Zamora Chinchipe			Sykora (1999)
Protoptila				
<i>disticha</i> Flint 1971	Orellana		240–250	NEW RECORD
Helicopsychidae				
Helicopsyche				
<i>angulata</i> (<i>Feropsyche</i>) Flint, 1981	Napo			Flint (1981a)
<i>blahniki</i> (<i>Cochliopsyche</i>) Johanson, 2003	Pastaza, Napo, Sucumbíos		300	Johanson (2003)
<i>breviterga</i> (<i>Feropsyche</i>) Flint 1991	Imbabura, Pichincha		1,312–1,587	NEW RECORD
<i>clara</i> (<i>Cochliopsyche</i>) (Ulmer), 1905	Pastaza		400	Johanson (2003)
<i>cochleara</i> (<i>Feropsyche</i>) Johanson, 1999	Pastaza	E		Johanson (2003)
<i>cotopaxi</i> (<i>Feropsyche</i>) Botosaneanu & Flint, 1982	Cotopaxi	E	3,500	Johanson (2002)
<i>fistulata</i> (<i>Feropsyche</i>) Flint 1991	Morona Santiago		1,646	NEW RECORD
<i>napoa</i> (<i>Cochliopsyche</i>) Johanson, 2003	Napo (Sucumbíos), Pastaza	E		Johanson (2003)
<i>opalescens</i> (<i>Cochliopsyche</i>) Flint, 1972	Pastaza, Orellana, Sucumbíos			Johanson (2003)
<i>puyoa</i> (<i>Cochliopsyche</i>) Johanson, 2003	Pastaza, Orellana, Sucumbíos	E		Johanson (2003)
<i>vazquezae</i> (<i>Cochliopsyche</i>) Flint, 1986	Napo, Zamora Chinchipe		950–1,340	Johanson (2003)
<i>vergelana</i> (<i>Feropsyche</i>) Ross 1956	Pichincha		570	NEW RECORD
<i>woytowskii</i> (<i>Feropsyche</i>) Ross 1956	Morona Santiago. Santo Domingo		1,646	NEW RECORD
Hydrobiosidae				
Atopsyche				
<i>banksi</i> (<i>Atopsyche</i>) Ross, 1953	Chimborazo		2,800	Sykora (1991)
<i>cajas</i> (unplaced) Harper & Turcotte, 1985	Azuay	E		Harper & Turcotte (1985)
<i>callosa</i> (<i>Atopsaura</i>) (Navás), 1924	Azuay, Pichincha, Loja, Santo Domingo, Zamora Chinchipe		550–570, 1,860	Sykora (1991); this paper
<i>catherinae</i> (<i>Atopsyche</i>) Harper & Turcotte, 1985	Azuay		3,300	Harper & Turcotte (1985)
<i>chirihuana</i> (<i>Atopsyche</i>) Schmid, 1989	Pichincha	E	229	Schmid (1989)

(continued on next page)

Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>chirimachaya</i> (unplaced) Harper & Turcotte, 1985	Azuay		3,300	<i>Harper & Turcotte (1985)</i>
<i>clarkei</i> (<i>Atopsaura</i>) Flint, 1963	Morona Santiago		2,200	<i>Sykora (1991)</i>
<i>copayapu</i> (<i>Atopsyche</i>) Schmid, 1989	Pichincha, Loja	E	550–1,080	<i>Sykora (1991)</i> ; this paper
<i>davidsoni</i> (unplaced) Sykora, 1991	Bolívar	E	3,420	<i>Sykora (1991)</i>
<i>flinti</i> (unplaced) Sykora, 1991	Chimborazo	E	3,500	<i>Sykora (1991)</i>
<i>incatupac</i> (<i>Atopsyche</i>) Schmid, 1989	Cotopaxi, El Oro	E	1,780–1,860	<i>Sykora (1991)</i>
<i>janethae</i> (<i>Atopsyche</i>) Harper & Turcotte, 1985	Azuay	E	3,300	<i>Harper & Turcotte (1985)</i>
<i>lobosa</i> (<i>Atopsaura</i>) Ross & King, 1952	Pichincha		2,807	NEW RECORD
<i>maitacpac</i> (<i>Atopsyche</i>) Schmid, 1989	Napo	E		<i>Sykora (1991)</i>
<i>mancocapac</i> (<i>Atopsyche</i>) Schmid, 1989	Pastaza			<i>Sykora (1991)</i>
<i>milena</i> (unplaced) Sykora, 1991	Bolívar	E		<i>Sykora (1991)</i>
<i>neolobosa</i> (<i>Atopsaura</i>) Flint, 1963	Napo, Loja	E	3,200	<i>Flint (1963)</i>
<i>onorei</i> (unplaced) Sykora, in Flint et al., 1999	Loja	E		<i>Sykora (1991)</i>
<i>pachacutec</i> (<i>Atopsyche</i>) Schmid, 1989	Cotopaxi, El Oro	E		<i>Sykora (1991)</i>
<i>puharcocha</i> (<i>Atopsaura</i>) Schmid, 1989	Morona Santiago		2,200	<i>Sykora (1991)</i>
<i>rawlinsi</i> (<i>Atopsaura</i>) Sykora, 1991	Loja	E	3,130	<i>Sykora (1991)</i>
<i>sinchicurac</i> (<i>Atopsaura</i>) Schmid, 1989	Loja, Zamora Chinchipe	E	1,600–2,500	<i>Schmid (1989)</i>
<i>tampurima</i> (<i>Atopsyche</i>) Schmid, 1989	Napo, Zamora Chinchipe		1,420	<i>Schmid (1989)</i> and <i>Sykora (1991)</i>
<i>tlaloc</i> (<i>Atopsyche</i>) Schmid, 1989	Azuay	E	2,200–2,400	<i>Schmid (1989)</i> and <i>Sykora (1991)</i>
<i>vatucra</i> (<i>Atopsyche</i>) Ross, 1953	Morona Santiago		1,076	NEW RECORD
<i>youngi</i> (unplaced) Sykora, 1991	Azuay	E	2,600	<i>Sykora (1991)</i>
Cailloma				
<i>lucidula</i> (Ulmer), 1909	Chimborazo, Pichincha		3,500–3,850	<i>Sykora (1991)</i> ; this paper.
Hydropsychidae				
Centromacronema				
<i>excisum</i> (Ulmer), 1905	Pichincha		700	<i>Ulmer (1905)</i> ; this paper
<i>obscurum</i> (Ulmer) 1905	Imbabura		1,312	NEW RECORD
Leptonema				
<i>album</i> Mosely, 1933:49	Santo Domingo	E		<i>Oláh & Johanson (2012)</i>
<i>andrea</i> Flint, McAlpine & Ross, 1987	Pastaza	E		<i>Flint, McAlpine & Ross (1987)</i>
<i>cheesmanae</i> Mosely 1933	Pichincha		570–1,180	NEW RECORD
<i>cinctum</i> Ulmer, 1905	Bolivar			<i>Ulmer (1905)</i>
<i>coheni</i> Flint, McAlpine & Ross, 1987	Cotopaxi	E		<i>Oláh & Johanson (2012)</i>
<i>divaricatum</i> Flint, McAlpine & Ross, 1987	Pichincha			<i>Flint, McAlpine & Ross (1987)</i>
<i>forficulum</i> Mosely 1933	Pichincha		550–570	NEW RECORD

(continued on next page)

Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>intermedium</i> Mosely, 1933	Bolivar, Santo Domingo		600–2,500	<i>Oláh & Johanson (2012)</i>
<i>janolah</i> Oláh & Johanson, 2012	Pichincha	E		<i>Oláh & Johanson (2012)</i>
<i>lojaense</i> Flint, McAlpine & Ross, 1987	Loja	E		<i>Flint, McAlpine & Ross (1987)</i>
<i>m&ibulatum</i> Flint, McAlpine & Ross, 1987	Pastaza, Orellana, Sucumbíos			<i>Flint, McAlpine & Ross (1987)</i>
<i>mastigion</i> Flint, McAlpine & Ross, 1987	Los Ríos, Santo Domingo	E	229–600	<i>Flint, McAlpine & Ross (1987); Oláh & Johanson (2012)</i>
<i>olmos</i> Olah & Johanson, 2012	Morona Santiago		1,646	NEW RECORD
<i>pseudocinctum</i> Flint, McAlpine & Ross, 1987	Tungurahua	E	1,280	<i>Flint, McAlpine & Ross (1987)</i>
<i>rosenbergi</i> Mosely, 1933	Esmeraldas, Pichincha, Imbabura		600	<i>Flint, McAlpine & Ross (1987); Oláh & Johanson (2012)</i>
<i>simplex</i> Mosely, 1933	Loja	E		<i>Flint, McAlpine & Ross (1987)</i>
<i>sociale</i> Flint, 2008	Orellana		250	<i>Flint (2008)</i>
<i>sparsum</i> (Ulmer), 1905	Pichincha, Napo, Santo Domingo, Orellana, Sucumbíos, Pastaza		400–1,080	<i>Flint, McAlpine & Ross (1987)</i>
<i>spirillum</i> Flint, McAlpine & Ross, 1987	Tungurahua, Pastaza, Napo, Imbabura, Morona Santiago		1,300	<i>Flint, McAlpine & Ross (1987)</i>
<i>stigmatosum</i> Ulmer, 1905	Bolivar			<i>Ulmer (1905)</i>
<i>trifidum</i> Flint, McAlpine & Ross, 1987	Napo		510	<i>Flint, McAlpine & Ross (1987)</i>
<i>viridianum</i> Navás, 1916	Napo		300–400	<i>Oláh & Johanson (2012)</i>
Macronema				
<i>burmeisteri</i> Banks, 1924	Sucumbíos		418	<i>Flint (1978)</i>
<i>fraternum</i> Banks, 1910	unspecified locality			<i>Flint (1996a)</i>
<i>hageni</i> Banks, 1924	Sucumbíos		418	<i>Flint (1978)</i>
<i>variipenne</i> Flint & Bueno-Soria, 1979	Cotopaxi, Pichincha		320–550	<i>Flint & Bueno-Soria (1979); this paper</i>
Macrostemum				
<i>ulmeri</i> (Banks), 1913	unknown			<i>França, Paprocki & Calor (2013)</i>
Smicridea				
<i>acuminata</i> (<i>Rhyacophylax</i>) Flint, 1974	Morona Santiago, Pichincha, Napo		570–1,076	NEW RECORD
<i>andicola</i> (<i>Rhyacophylax</i>) Flint, 1991	Pastaza, Tungurahua, Napo			<i>Flint (1991)</i>
<i>begorba</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo	E	360	<i>Oláh & Johanson (2012)</i>
<i>bidactyla</i> (<i>Rhyacophylax</i>) Flint & Reyes, 1991	El Oro			<i>Flint & Reyes (1991)</i>
<i>biserrulata</i> (<i>Rhyacophylax</i>) Flint, 1991	Pichincha, Santo Domingo			<i>Flint (1991); this paper</i>
<i>bivittata</i> (<i>Smicridea</i>) (Hagen) 1861	Napo, Santo Domingo, Morona Santiago, Pichincha		600–1,100	<i>Oláh & Johanson (2012); this paper</i>
<i>curvipenis</i> (<i>Smicridea</i>) Flint, 1991	Napo		3,600	<i>Flint (1991)</i>

(continued on next page)

Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>felsa</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo	E	400	<i>Oláh & Johanson (2012)</i>
<i>fogasa</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo	E	1,660	<i>Oláh & Johanson (2012)</i>
<i>furesa</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo		1,100	<i>Oláh & Johanson (2012)</i>
<i>gemina</i> (<i>Smicridea</i>) Blahnik, 1995	Cotopaxi, Santo Domingo, Pichincha, Guayas, Esmeraldas, Los Ríos		220–600	<i>Blahnik (1995)</i> ; this paper
<i>hajla</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo	E	400	<i>Oláh & Johanson (2012)</i>
<i>homora</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo		400	<i>Oláh & Johanson (2012)</i>
<i>horga</i> (<i>Smicridea</i>) Oláh & Johanson, 2012	Pichincha, Santo Domingo	E	550–600	<i>Oláh & Johanson (2012)</i>
<i>kapara</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Morona Santiago		1,076	NEW RECORD
<i>lebena</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo		1,966	NEW RECORD
<i>medena</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Imbabura, Morona Santiago		1,312–1,587	NEW RECORD
<i>murina</i> (<i>Rhyacophylax</i>) McLachlan, 1871	Pichincha, Napo		570	<i>Flint & Denning (1989a)</i> (unspecified locality); this paper
<i>nemtomba</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo		400	<i>Oláh & Johanson (2012)</i>
<i>nigricans</i> (<i>Smicridea</i>) Flint, 1991	Tungurahua		1,780	<i>Flint (1991)</i>
<i>petasata</i> (<i>Rhyacophylax</i>) Flint, 1981	Pastaza			<i>Flint (1981a)</i>
<i>polyfasciata</i> (<i>Smicridea</i>) Martynov, 1912	unspecified locality			<i>Flint (1991)</i>
<i>probolophora</i> (<i>Rhyacophylax</i>) Flint, 1991	Morona Santiago		1,531	NEW RECORD
<i>radula</i> (<i>Rhyacophylax</i>) Flint, 1974	Imbabura		1,312	NEW RECORD
<i>sarkoska</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Pichincha, Santo Domingo		1,600	<i>Oláh & Johanson (2012)</i>
<i>sudara</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Pichincha, Santo Domingo		600	<i>Oláh & Johanson (2012)</i>
<i>tavola</i> (<i>Rhyacophylax</i>) Oláh & Johanson, 2012	Napo	E	400	<i>Oláh & Johanson (2012)</i>
<i>tina</i> Oláh & Johanson, 2012	Santo Domingo		600	<i>Oláh & Johanson (2012)</i>
<i>truncata</i> (<i>Smicridea</i>) Flint, 1974	Orellana		240–250	NEW RECORD
<i>varia</i> (<i>Smicridea</i>) (Banks), 1913	Esmeraldas, Los Ríos, Pichincha, Manabí, Santo Domingo		0–580	<i>Blahnik (1995)</i>
<i>ventridenticulata</i> (<i>Rhyacophylax</i>) Flint, 1991	Morona Santiago, Chimborazo, Cotopaxi, Imbabura		800–2,200	<i>Flint (1991)</i>
Synoestropsis				<i>Flint (1981a)</i>
<i>punctipennis</i> Ulmer, 1905	unspecified locality			

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Table 1 (continued)

Species	Province	Endemic	Altitude	Source
Hydroptilidae				
Acostatrichia				
<i>cerna</i> Oláh & Flint, 2012	Los Ríos	E	250	Oláh & Flint (2012)
<i>hosulaba</i> Oláh & Flint, 2012	Pastaza	E		Oláh & Flint (2012)
<i>kihara</i> Oláh & Flint, 2012	Napo	E	580	Oláh & Flint (2012)
<i>pika</i> Oláh & Flint, 2012	Pichincha, Santo Domingo	E		Oláh & Flint (2012)
<i>ujasa</i> Oláh & Flint, 2012	Pastaza	E		Oláh & Flint (2012)
Anchitrichia				
<i>agaboga</i> Oláh & Flint, 2012	Cotopaxi	E	1,080	Oláh & Flint (2012)
<i>holzenthali</i> Oláh & Flint, 2012	Napo	E	950	Oláh & Flint (2012)
<i>palmatiloba</i> Flint, 1991	Pichincha, Pastaza, Cotopaxi		330–575	Flint (1991); this paper
Betrichia				
<i>rovatka</i> Oláh & Johanson, 2011	Pastaza, Napo, Orellana, Sucumbíos			Oláh & Flint (2012)
Bredinia				
<i>dominicensis</i> Flint, 1968	Esmeraldas, Pichincha			Harris, Holzenthal & Flint (2002)
<i>espinosa</i> Harris, Holzenthal & Flint, 2002	Los Ríos, Pichincha, Cotopaxi, Manabí, Guayas			Harris, Holzenthal & Flint (2002)
<i>manabiensis</i> Harris, Holzenthal & Flint, 2002	Manabí	E		Harris, Holzenthal & Flint (2002)
<i>spangleri</i> Harris, Holzenthal & Flint, 2002	Pastaza, Napo, Cotopaxi	E	350–500	Harris, Holzenthal & Flint (2002)
<i>venezuelensis</i> Harris, Holzenthal & Flint, 2002	Pastaza, Napo			Harris, Holzenthal & Flint (2002)
Byrsopteryx				
<i>loja</i> Harris & Holzenthal, 1994	Zamora Chinchipe	E	2,000	Harris & Holzenthal (1994)
<i>rayada</i> Harris & Holzenthal, 1994	Cañar	E	2,910	Harris & Holzenthal (1994)
Ceratotrichia				
<i>felgorba</i> Oláh & Flint, 2012	Napo	E	580	Oláh & Flint (2012)
<i>flavicoma</i> Flint, 1992	Pastaza, Napo, El Oro, Cotopaxi		335	Flint (1992a)
<i>jobbra</i> Oláh & Flint, 2012	Manabí, Esmeraldas	E	1,100	Oláh & Flint (2012)
Costatrichia				
<i>noite</i> Angrisano, 1995	Napo, Sucumbíos			Oláh & Flint (2012)
Flintiella				
<i>astilla</i> Harris, Flint & Holzenthal, 2002	Napo			Harris, Flint & Holzenthal (2002)
<i>heredia</i> Harris, Flint & Holzenthal, 2002	Pastaza			Harris, Flint & Holzenthal (2002)
<i>pizotensis</i> Harris, Flint & Holzenthal, 2002	Esmeraldas, Cotopaxi, Napo, Los Ríos, Pichincha		340	Harris, Flint & Holzenthal (2002)
<i>tamaulipasa</i> Harris, Flint, & Holzenthal 2002	Orellana		240	NEW RECORD
Hydroptila				
<i>ditalea</i> Flint, 1968	unspecified locality			Flint & Reyes (1991)

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Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>grenadensis</i> Flint, 1968	Napo		400	<i>Oláh & Johanson (2011)</i>
<i>paschia</i> Mosely, 1937	Pichincha			NEW RECORD
<i>spada</i> Flint, 1991	Morona Santiago, Pichincha		1,646	NEW RECORD
<i>venezuelensis</i> Flint, 1981	Napo, Morona Santiago		400	<i>Oláh & Johanson (2011)</i>
<i>Leucotrichia</i>				
<i>fairchildi</i> Flint, 1970	Los Rios		250	<i>Thomson & Holzenthal (2015)</i>
<i>forrota</i> Oláh & Johanson, 2011	Napo, Pastaza			<i>Thomson & Holzenthal (2015)</i>
<i>fulminea</i> Thomson & Holzenthal, 2015	Cañar	E	2,910	<i>Thomson & Holzenthal (2015)</i>
<i>inops</i> Flint, 1991	Pichincha		1,800	<i>Thomson & Holzenthal (2015)</i>
<i>pectinata</i> Thomson & Holzenthal, 2015	Tungurahua	E	1,550	<i>Thomson & Holzenthal (2015)</i>
<i>riostoumae</i> Thomson & Holzenthal, 2015	Imbabura	E	1,587	<i>Thomson & Holzenthal (2015)</i>
<i>Mayatrichia</i>				
<i>illobia</i> Harris & Holzenthal, 1990	Pastaza			<i>Harris & Holzenthal (1990)</i>
<i>Metrichia</i>				
<i>argentinica</i> (Schmid, 1958)	Pichincha		2,807	NEW RECORD
<i>cuena</i> (Harper & Turcotte), 1985	Azuay	E	3,300	<i>Harper & Turcotte (1985)</i>
<i>patagonica</i> (Flint), 1983	Pichincha, Morona Santiago		3,848	NEW RECORD
<i>spica</i> Bueno-Soria & Holzenthal, 2003	Pichincha			NEW RECORD
<i>Neotrichia</i>				
<i>biuncifera</i> Flint, 1974	Morona Santiago		1,076	NEW RECORD
<i>delgadeza</i> Harris, in Harris & Davenport, 1992	Pastaza	E		<i>Harris & Davenport (1992)</i>
<i>napoensis</i> Harris, in Harris & Davenport, 1992	Napo	E		<i>Harris & Davenport (1992)</i>
<i>Ochrotrichia</i>				
<i>ecuatoriana</i> Bueno-Soria & Santiago-Fragoso, 1992	Pastaza			<i>Bueno-Soria & Santiago-Fragoso (1992)</i>
<i>puyana</i> Bueno-Soria & Santiago-Fragoso, 1992	Pastaza	E		<i>Bueno-Soria & Santiago-Fragoso (1992)</i>
<i>raposa</i> Bueno-Soria & Santiago-Fragoso, 1992	Esmeraldas, Los Ríos			<i>Bueno-Soria & Santiago-Fragoso (1992)</i>
<i>yanayacuana</i> Bueno-Soria & Santiago-Fragoso, 1992	Tungurahua	E	300	<i>Bueno-Soria & Santiago-Fragoso (1992)</i>
<i>Oxyethira</i>				
<i>azteca</i> (<i>Loxotrichia</i>) (Mosely), 1937	unspecified locality			<i>Flint (1996b)</i>
<i>apinolada</i> (<i>Oxytrichia</i>) Holzenthal & Harris, 1992	Pichincha		700	NEW RECORD
<i>circaverna</i> (<i>Dampftrichia</i>) Kelley, 1983	Napo			<i>Kelley (1983)</i>

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Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>colombiensis</i> (<i>Tanytrichia</i>) Kelley, 1983	Los Ríos			Kelley (1983)
<i>matadero</i> (<i>Dactylotrichia</i>) Harper & Turcotte, 1985	Azuay	E	3,300	Harper & Turcotte (1985)
<i>parazteca</i> (<i>Loxotrichia</i>) Kelley, 1983	Cotopaxi			Kelley (1983)
<i>parce</i> (<i>Loxotrichia</i>) (Edwards & Arnold), 1961	Pichincha, Morona Santiago			Flint (1996b); this paper
<i>quincuaginta</i> (<i>incertae sedis</i>) Kelley, 1983	Pastaza	E		Kelley (1983)
<i>scaedactyla</i> (<i>Dactylotrichia</i>) Kelley, 1983	Pastaza	E		Kelley (1983)
<i>simanka</i> (unplaced) Oláh & Johanson, 2011	Napo	E		Oláh & Johanson (2011)
<i>tica</i> (<i>Loxotrichia</i>) Holzenthal & Harris, 1992	unknown			Flint (1996b)
Rhyacopsyche				
<i>benwa</i> Wasmund & Holzenthal, 2007	Napo		580	Wasmund & Holzenthal (2007)
<i>bunkotala</i> Oláh & Johanson, 2011	Napo	E		Oláh & Johanson (2011)
<i>colubrinosa</i> Wasmund & Holzenthal, 2007	Cotopaxi, Pastaza, Pichincha, Zamora Chinchipe		330–1,250	Wasmund & Holzenthal (2007)
<i>hajtoka</i> Oláh & Johanson, 2011	Pichincha	E		Oláh & Johanson (2011)
<i>peruviana</i> Flint, 1975	Pastaza, Zamora Chinchipe			Wasmund & Holzenthal (2007)
<i>tanylobosa</i> Wasmund & Holzenthal, 2007	Morona Santiago, Napo, Pastaza, Pichincha, Santo Domingo, Zamora Chinchipe		950–1,531	Wasmund & Holzenthal (2007); this paper
Zumatrichia				
<i>antilliensis</i> Flint, 1968	Napo		600	Oláh & Flint (2012)
<i>bevagota</i> Oláh & Flint, 2012	Cotopaxi	E	1,100	Oláh & Flint (2012)
<i>corosa</i> Oláh & Flint, 2012	Cotopaxi	E	1,101	Oláh & Flint (2012)
<i>fesuka</i> Oláh & Flint, 2012	Napo	E	580	Oláh & Flint (2012)
<i>gorba</i> Oláh & Flint, 2012	Zamora Chinchipe	E	880	Oláh & Flint (2012)
<i>kerekeda</i> Oláh & Flint, 2012	Santo Domingo, Pichincha, Cotopaxi, Napo, Manabí, Loja, El Oro, Los Ríos		300–425	Oláh & Flint (2012); this paper
<i>kisgula</i> Oláh & Flint, 2012	Napo	E		Oláh & Flint (2012)
<i>kislaba</i> Oláh & Flint, 2012	Pastaza	E		Oláh & Flint (2012)
<i>lapa</i> Oláh & Flint, 2012	Pastaza	E		Oláh & Flint (2012)
<i>masa</i> Oláh & Flint, 2012	Pastaza	E		Oláh & Flint (2012)
<i>palmara</i> Flint, 1970	unknown			Flint & Reyes (1991)
<i>picigula</i> Oláh & Flint, 2012	Napo, Cotopaxi	E	330–950	Oláh & Flint (2012)
<i>sima</i> Oláh & Flint, 2012	Pichincha	E		Oláh & Flint (2012)

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Table 1 (continued)

Species	Province	Endemic	Altitude	Source
Leptoceridae				
<i>Achoropsyche</i>				
<i>duodecimpunctata</i> (Navás), 1916	Orellana		250	This paper, locality previously unspecified
<i>Amphoropsyche</i>				
<i>napo</i> Holzenthal, 1985	Napo	E		Holzenthal (1985)
<i>téayapa</i> Holzenthal & Rázuri-Gonzales, 2011	Pichincha	E	1,800	Holzenthal & Rázuri-Gonzales (2011)
<i>Atanatolica</i>				
<i>acuminata</i> Holzenthal, 1988	Zamora Chinchipe	E		Holzenthal (1988b)
<i>cotopaxi</i> Holzenthal, 1988	Cotopaxi, Morona Santiago, Pichincha	E	2,500–3,650	Holzenthal (1988b)
<i>manabi</i> Holzenthal, 1988	Manabí, Pichincha	E		Holzenthal (1988b)
<i>Grumichella</i>				
<i>flaveola</i> (Ulmer), 1911	Loja, Napo, Pastaza, Morona Santiago, Zamora Chinchipe		820–1,800	Holzenthal (1988b)
<i>trujilloi</i> Calor & Holzenthal, 2015	Morona Santiago		2,772	NEW RECORD
<i>Nectopsyche</i>				
<i>argentata</i> Flint, 1991	Imbabura, Pichincha		1,180–1,587	Flint (1991)
<i>gemma</i> (Müller), 1880	Loja			Navás (1913)
<i>gemmoides</i> Flint, 1981	Morona Santiago		1,076	This paper, locality previously unspecified
<i>maculipennis</i> Flint 1983	Orellana		240–250	NEW RECORD
<i>muhni</i> (Navás), 1916	unspecified locality			Flint (1974)
<i>onyx</i> Holzenthal 1995	Pichincha		570–700	NEW RECORD
<i>pavida</i> (Hagen) 1861	Morona Santiago		1,076	NEW RECORD
<i>punctata</i> (Ulmer), 1905	Pichincha, Napo		570	This paper, locality previously unspecified
<i>quatuorguttata</i> (Navas) 1922	Orellana		240–250	NEW RECORD
<i>spiloma</i> (Ross), 1944	unspecified locality			Flint & Reyes (1991)
<i>splendida</i> (Navás), 1917	Orellana		240	Flint (1992b) (unspecified locality); this paper
<i>Oecetis</i>				
<i>acciptrina</i> Blahnik & Holzenthal, 2014	Los Ríos, Pichincha		550–750	Blahnik & Holzenthal (2014)
<i>angularis</i> Blahnik & Holzenthal, 2014	Cotopaxi, Loja, Pichincha, Santo Domingo		300–1,080	Blahnik & Holzenthal (2014)
<i>campana</i> Blahnik & Holzenthal, 2014	Zamora Chinchipe, Napo, Pastaza		580–980	Blahnik & Holzenthal (2014)
<i>constricta</i> Blahnik & Holzenthal, 2014	Cotopaxi, Guayas, Napo		305–580	Blahnik & Holzenthal (2014)
<i>excisa</i> Ulmer, 1907	Orellana, Morona Santiago		240–1,076	NEW RECORD
<i>mexicana</i> Blahnik & Holzenthal, 2014	Los Ríos		250	Blahnik & Holzenthal (2014)

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Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>protrusa</i> Blahnik & Holzenthal, 2014	Loja, Pichincha		300–570	<i>Blahnik & Holzenthal (2014)</i> ; this paper
<i>pseudoinconspicua</i> Bueno 1981	Orellana		240–250	NEW RECORD
<i>punctata</i> (Navás) 1924	Pichincha		570–700	NEW RECORD
<i>punctipennis</i> (Ulmer), 1905	Orellana		240–250	<i>Quinteiro & Calor (2015)</i> (unspecified locality); this paper
<i>tumida</i> Blahnik & Holzenthal 2014	Pichincha		550–575	NEW RECORD
Triaenodes				
<i>hodgesi</i> Holzenthal & Andersen, 2004	Pichincha, Esmeraldas	E	152	<i>Holzenthal & Andersen (2004)</i>
<i>peruanus</i> Flint & Reyes, 1991	Santo Domingo		229	<i>Holzenthal & Andersen (2004)</i>
Triplectides				
<i>flintorum</i> Holzenthal, 1988	Loja		2,000	<i>Holzenthal (1988a)</i>
Limnephilidae				
Anomalocosmoecus				
<i>illiesi</i> (Marlier), 1962	Pichincha		3,848	<i>Flint (1991)</i> (unspecified locality); this paper
Odontoceridae				
Marilia				
<i>gigas</i> Flint, 1991	Pastaza			<i>Flint (1991)</i>
Philopotamidae				
Chimarra				
<i>acinaciformis</i> (<i>Curgia</i>) Flint, 1998	Pastaza	E		<i>Flint (1998)</i>
<i>centralis</i> (<i>Curgia</i>) Ross, 1959	Pichincha			<i>Flint (1998)</i>
<i>coheni</i> (<i>Chimarra</i>) Blahnik, 1998	Pichincha	E	335	<i>Blahnik (1998)</i>
<i>creagra</i> (<i>Chimarra</i>) Flint, 1981	Morona Santiago, Napo		1,076	<i>Flint (1998)</i>
<i>decimlobata</i> (<i>Chimarra</i>) Flint, 1991	Imbabura		1,312–1,587	NEW RECORD
<i>didyma</i> (<i>Curgia</i>) Flint, 1998	Pichincha, Cotopaxi		335–1,100	<i>Flint (1998)</i>
<i>dolabrifera</i> (<i>Chimarra</i>) Flint & Reyes, 1991	Pichincha, Cotopaxi, Esmeraldas, Los Ríos		335	<i>Blahnik (1998)</i>
<i>duckworthi</i> (<i>Chimarra</i>) Flint, 1967	Pastaza			<i>Blahnik (1998)</i>
<i>emima</i> (<i>Chimarra</i>) Ross, 1959	Pichincha, Cotopaxi, Loja, Los Ríos, Santo Domingo		220–550	<i>Blahnik (1998)</i> ; this paper
<i>geranoides</i> (<i>Curgia</i>) Flint, 1998	Pichincha, Pastaza, Tungurahua, Zamora Chinchipe		980–4,200	<i>Flint (1998)</i>
<i>immaculata</i> (<i>Curgia</i>) Ulmer, 1911	Napo, Pastaza, Sucumbíos			<i>Flint (1998)</i>
<i>inflata</i> (<i>Chimarra</i>) Blahnik, 1998	Napo (Sucumbíos)	E		<i>Blahnik (1998)</i>
<i>langleyae</i> (<i>Chimarra</i>) Blahnik, 1998	Napo (Sucumbíos)	E		<i>Blahnik (1998)</i>
<i>lojaensis</i> (<i>Curgia</i>) Flint, 1998	Zamora Chinchipe	E	2,000	<i>Blahnik (1998)</i>
<i>longiterga</i> (<i>Chimarra</i>) Blahnik & Holzenthal, 1992	Manabí, Pichincha (Santo Domingo)		220	<i>Blahnik (1998)</i>
<i>macara</i> (<i>Curgia</i>) Flint, 1998	Loja	E	650	<i>Flint (1998)</i>
<i>margaritae</i> (<i>Curgia</i>) Flint, 1991:26	Tungurahua		1,550	<i>Flint (1998)</i>

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Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>munozii</i> (Chimarra) Blahnik & Holzenthal 1992	Pichincha		570–700	NEW RECORD
<i>onima</i> (Chimarra) Flint 1991	Pichincha, Santo Domingo		700	NEW RECORD
<i>otuzcoensis</i> (Curgia) Flint & Reyes, 1991	Pichincha		2,000	Flint (1998)
<i>pablito</i> (Curgia) Flint, 1998	Pichincha		570	Flint (1998)
<i>paracreagra</i> (Chimarra) Blahnik, 1998	Pastaza, Morona Santiago, Tungurahua		1,280–1,531	Flint (1998)
<i>peineta</i> (Chimarra) Blahnik & Holzenthal, 1992	Los Ríos, Santo Domingo, Pichincha		220–550	Blahnik (1998); this paper
<i>persimilis</i> (Curgia) Banks, 1920	Los Ríos, Esmeraldas, Pichincha, Loja, Cotopaxi, Manabí		225–600	Flint (1998)
<i>peruviana</i> (Curgia) Flint, 1998	Napo, Pastaza		950	Flint (1998)
<i>prolata</i> (Chimarrita) Blahnik, 1997	Pastaza	E		Blahnik (1997)
<i>pumila</i> (Chimarra) (Banks), 1920	Los Ríos	E		Flint (1998)
<i>puya</i> (Curgia) Flint, 1998	Pastaza	E		Flint (1998)
<i>quadraterga</i> (Chimarra) Blahnik, 1998	Zamora Chinchipe	E	980–1,340	Blahnik (1998)
<i>rafita</i> (Chimarra) Blahnik, 1998	Pastaza	E	1,000	Blahnik (1998)
<i>strongyla</i> (Chimarra) Blahnik, 1998	Pichincha	E	1,100	Blahnik (1998)
<i>utra</i> (Chimarra) Blahnik, 1998	Pastaza, Morona Santiago	E	1,076	Blahnik (1998); this paper
<i>xus</i> (Chimarra) Blahnik, 1998	Pastaza, Napo			Blahnik (1998)
<i>zamora</i> (Chimarra) Blahnik, 1998	Zamora Chinchipe,		980	Blahnik (1998)
Chimarrhodella				
<i>aequatoria</i> (Navás), 1934	Loja	E		Navás (1934)
<i>ornata</i> Blahnik, 2004	Tungurahua	E	1,600	Blahnik (2004)
<i>ulmeri</i> (Ross), 1956	Morona Santiago, Pastaza, Tungurahua	E	1,076–1,280	Blahnik (2004)
Wormaldia				
<i>andrea</i> Muñoz-Quesada & Holzenthal, 2015	Tungurahua	E	1,550	Muñoz-Quesada & Holzenthal (2015)
<i>araujoii</i> Muñoz-Quesada & Holzenthal, 2015	Napo	E	640	Muñoz-Quesada & Holzenthal (2015)
<i>planae</i> Ross & King, in Ross, 1956	Los Ríos, Pichincha, Santo Domingo		250–1,250	Muñoz-Quesada & Holzenthal (2015); this paper
Polycentropodidae				
Cernotina				
<i>cygnea</i> Flint 1971	Orellana		240–250	NEW RECORD
<i>lobisomem</i> Santos & Nessimian 2008	Orellana		240–250	NEW RECORD
Cyrnellus				
<i>fraternus</i> (Banks), 1905	unspecified locality			Flint (1982)
<i>mammillatus</i> Flint, 1971	Orellana		240–250	Flint (1982) (unspecified locality); this paper
Polycentropus				
<i>altmani</i> Yamamoto, 1967	unspecified locality			Flint (1981a)

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Table 1 (continued)

Species	Province	Endemic	Altitude	Source
<i>ceciliae</i> Flint 1991	Imbabura, Pichincha		1,180–1,587	NEW RECORD
<i>cuspidatus</i> Flint, 1981	Pastaza			Flint (1981b)
<i>exsertus</i> Flint, 1981	Pastaza	E		Flint (1981b)
<i>joergenseni</i> Ulmer, 1909b:75	Napo, Morona Santiago		1,646–2,772	Flint & Reyes (1991) (un-specified locality); this paper
<i>quadricuspidis</i> Hamilton & Holzenthal, 2005	Zamora Chinchipe	E	2,000	Hamilton & Holzenthal (2005)
<i>silex</i> Hamilton & Holzenthal, 2005	Pichincha	E	1,400	Hamilton & Holzenthal (2005)
<i>Polyplectropus</i>				
<i>brborichorum</i> Chamorro & Holzenthal, 2010	Pastaza	E		Chamorro & Holzenthal (2010)
<i>buchwaldi</i> (Ulmer), 1911	unspecified locality	E		Chamorro & Holzenthal (2010)
<i>ecuadoriensis</i> Chamorro & Holzenthal, 2010	Sucumbíos, Napo, Pastaza, Cotopaxi			Chamorro & Holzenthal (2010)
<i>inarmatus</i> Flint, 1971	Pastaza, Sucumbíos, Orellana		240–1,200	Chamorro & Holzenthal (2010)
<i>laminatus</i> (Yamamoto), 1966	El Oro, Pichincha		250–570	Chamorro & Holzenthal (2010)
<i>puyoensis</i> Chamorro & Holzenthal, 2010	Pastaza	E		Chamorro & Holzenthal (2010)
<i>recurvatus</i> (Yamamoto), 1966	Cotopaxi, Los Ríos		250–330	Chamorro & Holzenthal (2010)
Xiphocentronidae				
<i>Machairocentron</i>				
<i>echinatum</i> (Flint) 1981	Orellana		240–250	NEW RECORD
<i>Xiphocentron</i>				
sp. (undetermined females only)	Napo		1,966	NEW RECORD

not previously reported (Table 1 and Table S1). Pichincha ($n = 78$), Napo ($n = 75$), and Pastaza ($n = 70$) were the provinces with the most species recorded in total. However, since these provinces have been divided into new provinces (see Methods), we could not update all records accurately by province because of incomplete locality descriptions in the historical literature. Accordingly, records for Santo Domingo, Sucumbíos, and Orellana provinces could be diminished. On the other hand, Cañar, Guayas, Bolivar, Chimborazo, El Oro, Manabí, and Esmeraldas provinces have less than 10 species recorded (Fig. 1). Carchi, Santa Elena (which was previously part of Guayas) and Galápagos have no species recorded.

A total of 188 species are only known from one province, and 66 species from three or more provinces. According to the species estimator CHAO 2, the estimated caddisfly richness for the country is 578 species, indicating that only 54% of the Ecuadorian caddisfly fauna is known.

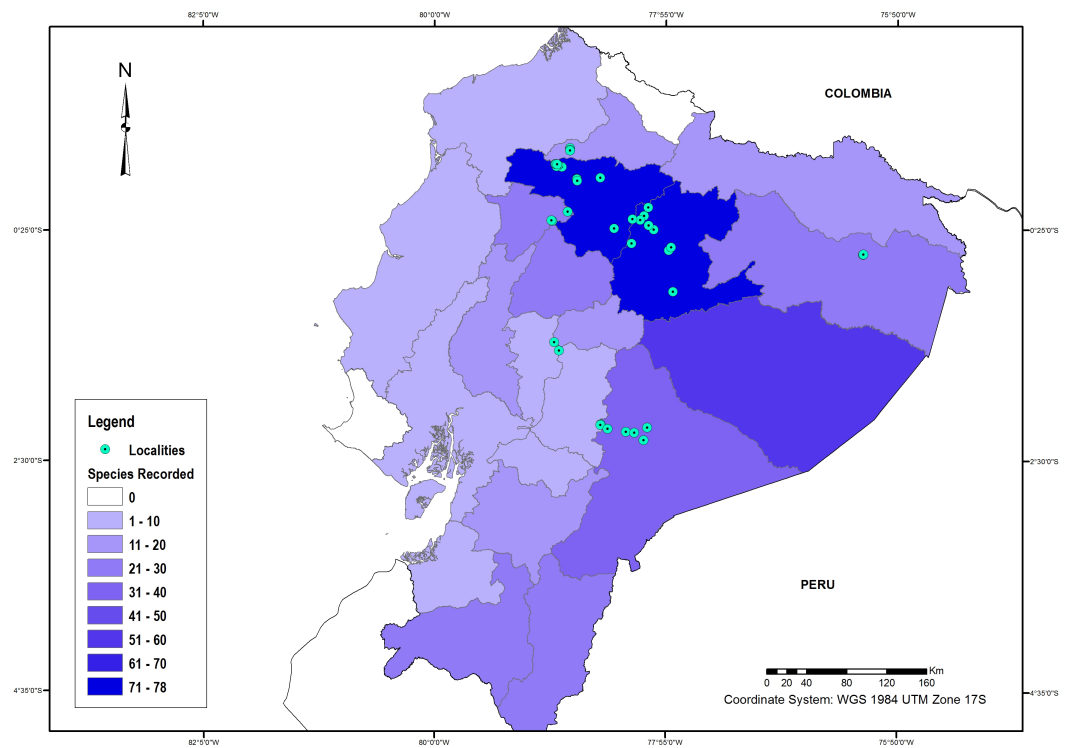


Figure 1 Trichoptera species richness in Ecuador. Caddisfly species per province. Number of species indicated by color intensity. Localities for recent collections indicated by circles.

Family overview

Anomalopsychidae

This Neotropical endemic family contains two genera, *Anomalopsyche* and *Contulma*, the latter with 27 species distributed from Costa Rica to Chile and southeastern Brazil. Only *Contulma* is found in Ecuador, where nine species occur (Table 1), of which one is newly recorded from the country.

Atriplectididae

This is a very rare family known from only a few widely separated regions (Holzenthal, 1997). The genus is known from Ecuador, but only from one published larval record (Table 1, Holzenthal, 1997) The larvae are unique among all Trichoptera. The head and pronotum are very small and narrow and the anterior portions of the mesothorax are narrow, very elongate, and retractile. Like the adults, they are very rarely collected.

Calamoceratidae

This family is cosmopolitan, but most of its 180 species distributed in six genera occur in tropical regions. Two genera, *Banyallarga* and *Phylloicus*, are known for Ecuador with three and eight species respectively (Table 1).

Ecnomidae

Only a single genus, *Austrotinodes*, occurs in Ecuador with one recorded species found only in one province (Table 1). In the New World *Austrotinodes* species occur from southern Texas to Chile, with 43 species recorded in the Neotropics (Holzenthal & Calor, in press).

Glossosomatidae

The family is cosmopolitan, but only members of the New World, subfamily Protoptilinae occur in the Neotropics. Only the genus *Mortoniella*, with 15 species (Table 1), has been recorded from Ecuador (Holzenthal & Calor, in press). Here we are adding *Protoptila* to the country list with one species (Table 1).

Helicopsychidae

All of the species in this cosmopolitan family except one are placed in the genus *Helicopsyche*. Johanson (1998) placed all the Neotropical species in two subgenera, *Feropsyche* and *Cochliopsyche*, both present in Ecuador. Thirteen species of *Helicopsyche* are recorded in Ecuador (with four new records provided in the present study), seven belonging to *Feropsyche* and six to *Cochliopsyche*.

Hydrobiosidae

Most of the 52 genera placed in this family occur in the Australian and southern Neotropical regions (Chile and Argentina), a few species are found in the Oriental, Nearctic, and Palearctic regions. Two genera occur in Ecuador (Table 1), *Atopsyche* with 26 species (two new records) and *Cailloma* with 1 species. The genus *Cailloma* occurs only at high altitudes (Sykora, 1991).

Hydropsychidae

This is a taxonomically diverse, cosmopolitan family. Five of the six genera known from Ecuador belong to the subfamily Macronematinae (*Centromacronema*, *Leptonema*, *Macronema*, *Macrostemum*, and *Synoestropsis*). *Smicridea* is in the subfamily Smicridiinae. There are 61 species in the family in Ecuador (Table 1) of which we are providing 11 new records. *Smicridea* is by far the most diverse, with 31 species, followed by *Leptonema* with 22. On the other hand, *Macrostemum* and *Synoestropsis* are only known from one species each, both from records with unspecified localities. Adult males of many of the Ecuador species of *Centromacronema*, *Macronema*, and *Macrostemum* swarm during the daytime and do not readily come to lights. After Hydroptilidae, this is the second most species rich family in the country.

Hydroptilidae

Microtrichoptera are found around the world and appear to be very diverse in the Neotropics. It is the most diverse family of Trichoptera found in Ecuador, and the most diverse family in the Neotropics. Seven genera and 78 species are recorded for the country, but certainly many more genera and species are yet to be collected. *Zumatrichia* and *Oxyethira* are the most species rich genera in Ecuador. *Betrichia*, *Costatrichia*, and *Mayatrichia* are only known from one species each in the country.

Leptoceridae

This is a large, cosmopolitan family of about 50 genera and more than 2,000 species. Eight genera and 33 species are known from Ecuador. The genera present in the country include *Achoropsyche*, *Amphoropsyche*, *Atanatolica*, *Grumichella*, *Nectopsyche*, *Oecetis*, *Triaenodes*, and *Triplectides*. *Nectopsyche* and *Oecetis* are the most species rich genera in the country and *Achoropsyche* and *Triplectides* are each only known from one species.

Limnephilidae

This is a large and taxonomically diverse family. Most of its 100 genera and almost 900 species occur in cool lakes and rivers of the northern hemisphere. In the Neotropics they are known only from the higher elevations of Mexico and Central America, the northern and central Andes, and from temperate, southern South America. In Ecuador, the family is known from one species in the genus *Anomalocosmoecus*, from small streams in the high páramo (Table 1).

Odontoceridae

About 160 species in 18 genera occur in all faunal regions except the Afrotropical. There are 3 genera in the Neotropics, *Anastomoneura*, *Barypenthus*, and *Marilia*. Only *Marilia* occurs in Ecuador, with one recorded species (Table 1) in the Amazonian region.

Philopotamidae

Philopotamids occur in all faunal regions. The Ecuadorian fauna is dominated, both in terms of species diversity and abundance of individuals appearing at lights, by the genus *Chimarra*. Thirty-four *Chimarra* species are known from Ecuador (only 23 have been reported from all of North America). *Chimarrhodella* and *Wormaldia*, with three species each, are also known from Ecuador.

Polycentropodidae

Approximately 900 species are known from all faunal regions. Only three genera *Cyrnellus*, *Polycentropus*, and *Polyplectropus* were previously recorded from Ecuador. We are adding the genus *Cernotina* to the species list with two new records from the Tiputini Biological Research Station. Currently, 18 species in the family are known from Ecuador.

Xiphocentronidae

About 170 species are known from the Oriental, Ethiopian, and Neotropical regions (one species extends northward into southern Texas in North America). In the current catalog of Neotropical caddisflies (*Holzenthal & Calor, in press*) none of the species in this family are recorded from Ecuador. We have collected only three specimens in this family in Ecuador, one of *Machairocentron echinatum* and two unidentifiable female specimens of *Xiphocentron*. This may be because many species are day active and do not come to lights; nevertheless, they are not at all common in the field or in collections.

DISCUSSION

Hydroptilidae, Hydropsychidae, and Philopotamidae accounted for 58% of the diversity of all Ecuadorian caddisfly species. This pattern is similar to other neotropical countries

(Muñoz-Quesada, 2000; Armitage & Cornejo, 2016). Forty-eight new records were added to those that are listed for the country in the current *Catalog of Neotropical Caddisflies* (Holzenthal & Calor, *in press*), yet the species estimator suggests that 46% of the species present in the country are yet to be discovered. This does not seem far from reality since, for example, Costa Rica has around 460 species recorded (Holzenthal & Calor, *in press*). Colombia, a country 22 times as large as Costa Rica and four times the size of Ecuador has only 210 species known (Muñoz-Quesada, 2000). Panama, on the other hand has 300 species recorded (Armitage & Cornejo, 2016). The differences between the published records are clearly related to the number of studies and surveys performed in these countries, with Costa Rica and Panama having a long tradition of biodiversity surveys. Considering the diversity of Ecuadorian ecosystems and the fact that some provinces have less than ten records, we are confident that future surveys will find more species. Most of the coastal provinces, including the Ecuadorian Chocó, are understudied and probably harbor species not known from the Amazon or the Andes. These unexplored provinces are priority areas to conduct future collections and surveys. It is important to emphasize that most of the species recorded and added through our own surveys are represented by one or a few individuals.

The land cover loss in the country is high (Sarmiento, 2002; Eva *et al.*, 2004), especially in the Andean and coastal regions. Since several groups of Trichoptera are known to be highly regionally endemic (Previsic *et al.*, 2009), probably some undescribed species are already lost. Also, climate change might play an important role affecting specialist species, such as those found in glacier-fed streams (Jacobsen *et al.*, 2012). Many protected areas in the Andean and coastal regions are located in mountainous areas, protecting only certain species. We have seen that there is an altitudinal segregation for several groups (Helicopsychidae, *Mortoniella*), and altitudinal stratification of caddisfly assemblages has been noted (Rincón-Hernández, 1999; Blinn & Ruiter, 2009). This is also a consideration to take into account for future surveys, and the establishment of protected areas should also address altitudinal zonation.

Many new species of Neotropical caddisflies have been described in recent decades. For example, the number of described species increased from 2,214 in 1999 (Flint *et al.* 1999) to almost 3,260 species today (Holzenthal & Calor, *in press*) or an increase of more than 1,000 species in 16 years. Currently, in the material we have collected since 2010 we have tentatively identified around 80 new species and some dozens of species known from unidentifiable females. The description of these new species and the identification of others will increase the number of Ecuadorian species to around 400 with material already in hand.

A list of species is a first step in the chain of knowledge of this diverse and sensitive group of insects. However, other important factors in the protection of species diversity is an understanding of their life history and habitat requirements. Currently, we only have these data for one Ecuadorian caddisfly species, *Contulma paluguillensis* (Holzenthal & Ríos-Touma, 2012). Worldwide, there is a tremendous lack of information on natural history of the world's biota (Able, 2016). Even in Europe, where almost all the species are described, life-cycle duration, reproduction, and distribution are known for <10% of

caddisfly species (*Hering et al., 2009*). However, this information is crucial to protect and to forecast the effects of climate and land use change on populations and their distributions of this fascinating group of aquatic insects.

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Competing Interests

The authors declare there are no competing interests.

Author Contributions

- Blanca Ríos-Touma conceived and designed the study, performed the study, analyzed the data, contributed reagents/materials/analysis tools, wrote the paper, prepared figures and/or tables, reviewed drafts of the paper, was also in charge of all the collecting permits.
- Ralph W. Holzenthal conceived and designed the study, performed the study, analyzed the data, contributed reagents/materials/analysis tools, wrote the paper, prepared figures and/or tables, reviewed drafts of the paper.

- Jolanda Huisman, Robin Thomson and Ernesto Rázuri-Gonzales performed the study, analyzed the data, contributed reagents/materials/analysis tools, wrote the paper, reviewed drafts of the paper.

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The following information was supplied relating to field study approvals (i.e., approving body and any reference numbers):

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Data Availability

The following information was supplied regarding data availability:

The raw data has been supplied as a [Table S1](#).

Supplemental Information

Supplemental information for this article can be found online at <http://dx.doi.org/10.7717/peerj.2851#supplemental-information>.

REFERENCES

- Able KW. 2016.** Natural history: an approach whose time has come, passed, and needs to be resurrected. *ICES Journal of Marine Science: Journal Du Conseil* **73(9)**:2150–2155 DOI [10.1093/icesjms/fsw049](https://doi.org/10.1093/icesjms/fsw049).
- Armitage BJ, Cornejo A. 2016.** Orden Trichoptera (Insecta) en Panamá: Listas de especies y su distribución por cuencas y unidades administrativas. *Puente Biológico* **7**:175–199.
- Blahnik RJ. 1995.** New species of *Smicridea* (subgenus *Smicridea*) from Costa Rica, with a revision of the *fasciatella* complex (Trichoptera: Hydropsychidae). *Journal of the North American Benthological Society* **14**:84–107 DOI [10.2307/1467726](https://doi.org/10.2307/1467726).
- Blahnik RJ. 1997.** Systematics of *Chimarrita*, a new subgenus of *Chimarra* (Trichoptera: Philopotamidae). *Systematic Entomology* **22**:199–243 DOI [10.1046/j.1365-3113.1997.d01-39.x](https://doi.org/10.1046/j.1365-3113.1997.d01-39.x).
- Blahnik RJ. 1998.** A revision of the Neotropical species of the genus *Chimarra*, subgenus *Chimarra* (Trichoptera: Philopotamidae). *Memoirs of the American Entomological Institute* **59**: vi+1-318.
- Blahnik RJ. 2004.** New species of *Chimarrhodella* from Venezuela and Ecuador (Trichoptera: Philopotamidae). *Zootaxa* **552**:1–7 DOI [10.11646/zootaxa.552.1.1](https://doi.org/10.11646/zootaxa.552.1.1).
- Blahnik RJ, Holzenthal RW. 2004.** Collection and curation of Trichoptera, with an emphasis on pinned material. *Nectopsyche, Neotropical Trichoptera Newsletter* **1**:8–20.
- Blahnik RJ, Holzenthal RW. 2014.** Review and redescription of species in the *Oecetis avara* group, with the description of 15 new species (Trichoptera, Leptoceridae). *ZooKeys* **376**:1–83 DOI [10.3897/zookeys.376.6047](https://doi.org/10.3897/zookeys.376.6047).

- Blahnik RJ, Holzenthal RW, Prather AL. 2007.** The lactic acid method for clearing Trichoptera genitalia. In: Bueno-Soria J, Barba-Álvarez R, Armitage BJ, eds. *Proceedings of the 12th international symposium on Trichoptera*. Columbus: The Caddis Press, 9–14.
- Blinn DW, Ruiter DE. 2009.** Caddisfly (Trichoptera) assemblages along major river drainages in Arizona. *Western North American Naturalist* **69**:299–308 DOI [10.3398/064.069.0303](https://doi.org/10.3398/064.069.0303).
- Bueno-Soria J, Santiago-Fragoso S. 1992.** Studies in aquatic insects, XI: seven new species of the genus *Ochrotrichia* (*Ochrotrichia*) from South America (Trichoptera: Hydroptilidae). *Proceedings of the Entomological Society of Washington* **94**:439–446.
- Chamorro ML, Holzenthal RW. 2010.** Taxonomy and phylogeny of New World *Polyplectropus* Ulmer, 1905 (Trichoptera: Psychomyioidea: Polycentropodidae) with the description of 39 new species. *Zootaxa* **2582**:1–252.
- Chang FH, Lawrence JE, Rios-Touma B, Resh VH. 2014.** Tolerance values of benthic macroinvertebrates for stream biomonitoring: assessment of assumptions underlying scoring systems worldwide. *Environmental Monitoring and Assessment* **186**(4):2135–2149 DOI [10.1007/s10661-013-3523-6](https://doi.org/10.1007/s10661-013-3523-6).
- De Moor FC, Ivanov VD. 2008.** Global diversity of caddisflies (Trichoptera: Insecta) in freshwater. *Hydrobiologia* **595**:393–407 DOI [10.1007/s10750-007-9113-2](https://doi.org/10.1007/s10750-007-9113-2).
- Eva HD, Belward AS, De Miranda EE, Di Bella CM, Gond V, Huber O, Jones S, Sgrenzaroli M, Fritz S. 2004.** A land cover map of South America. *Global Change Biology* **10**(5):731–744 DOI [10.1111/j.1529-8817.2003.00774.x](https://doi.org/10.1111/j.1529-8817.2003.00774.x).
- Flint Jr OS. 1963.** Studies of Neotropical caddis flies, I: Rhyacophilidae and Glososomatidae (Trichoptera). *Proceedings of the United States National Museum* **114**:453–478 DOI [10.5479/si.00963801.114-3473.453](https://doi.org/10.5479/si.00963801.114-3473.453).
- Flint Jr OS. 1974.** The Trichoptera of Surinam. Studies of Neotropical caddisflies, XV. *Studies on the Fauna of Suriname and other Guyanas* **14**:1–151.
- Flint Jr OS. 1978.** Studies of Neotropical Caddisflies, XXII: Hydroptilidae of the Amazon Basin (Trichoptera). *Amazoniana* **6**:373–421.
- Flint Jr OS. 1981a.** Studies of Neotropical caddisflies, XXVIII: the Trichoptera of the Río Limón Basin, Venezuela. *Smithsonian Contributions to Zoology* **330**:1–61.
- Flint Jr OS. 1981b.** Studies of Neotropical caddisflies, XXIX: the genus *Polycentropus* (Trichoptera: Psychomyiidae). *Journal of the Washington Academy of Sciences* **70**(1980):148–160.
- Flint Jr OS. 1982.** Trichoptera of the area platense. *Biologia Acuatica* **2**:1–70.
- Flint Jr OS. 1991.** Studies of Neotropical caddisflies, XLV: the taxonomy, phenology, and faunistics of the Trichoptera of Antioquia, Colombia. *Smithsonian Contributions to Zoology* **520**:1–113.
- Flint Jr OS. 1992a.** Studies of Neotropical caddisflies, XXXVIII: a review of the classification and biology of the Neotropical microcaddisflies, with the description of a new genus (Trichoptera: Hydroptilidae: Leucotrichiini). In: Quintero D, Aiello A, eds. *Insects of Panama and Mesoamerica: selected studies*. Oxford: Oxford University Press, 525–531.

- Flint Jr OS. 1992b.** Studies of Neotropical caddisflies, XLIV: on a collection from Ilha de Maraca, Brazil. *Acta Amazonica* **21**(1991):63–83.
- Flint Jr OS. 1996a.** The Trichoptera collected on the expeditions to Parque Manu, Madre de Dios, Peru. In: *MANU: the biodiversity of Southeastern Peru*. Washington, D.C.: Smithsonian Institution Press, 369–430.
- Flint Jr OS. 1996b.** Studies of Neotropical caddisflies LV: Trichoptera of Trinidad and Tobago. *Transactions of the American Entomological Society* **122**:67–113.
- Flint Jr OS. 1998.** Studies of Neotropical caddisflies, LIII: a taxonomic revision of the subgenus *Curgia* of the genus *Chimarra* (Trichoptera: Philopotamidae). *Smithsonian Contributions to Zoology* **594**:1–131.
- Flint Jr OS. 2008.** Studies of Neotropical caddisflies, LXI: new species of *Leptonema* Guerin (Trichoptera: Hydropsychidae). *Proceedings of the Entomological Society of Washington* **110**:456–469 DOI [10.4289/07-042.1](https://doi.org/10.4289/07-042.1).
- Flint Jr OS, Bueno-Soria J. 1979.** Studies of Neotropical caddisflies, XXIV: the genus *Macronema* in Mesoamerica (Trichoptera: Hydropsychidae). *Proceedings of the Entomological Society of Washington* **81**:522–535.
- Flint Jr OS, Denning DG. 1989a.** Studies of Neotropical caddisflies, XL: new species of *Smicridea* (*Smicridea*) from Middle America and the West Indies (Trichoptera: Hydropsychidae). *Proceedings of the Biological Society of Washington* **102**:418–433.
- Flint Jr OS, Denning DG. 1989b.** Studies of Neotropical caddisflies, XLI: new species and records of *Austrotinodes* (Trichoptera: Psychomyiidae). *Pan-Pacific Entomologist* **65**:108–122.
- Flint Jr OS, Holzenthal RW, Harris SC. 1999.** *Catalog of the Neotropical caddisflies (Trichoptera)*. Columbus: Special Publication, Ohio Biological Survey.
- Flint Jr OS, McAlpine JF, Ross HH. 1987.** A revision of the genus *Leptonema* Guerin (Trichoptera: Hydropsychidae: Macronematinae). *Smithsonian Contributions to Zoology* **450**:1–193.
- Flint Jr OS, Reyes L. 1991.** Studies of Neotropical caddisflies, XLVI: the Trichoptera of the Río Moche Basin, Department of La Libertad, Peru. *Proceedings of the Biological Society of Washington* **104**:474–492.
- França D, Paprocki H, Calor AR. 2013.** The genus *Macrostemum* Kolenati 1859 (Trichoptera: Hydropsychidae) in the Neotropical Region: description of two new species, taxonomic notes, distributional records and key to males. *Zootaxa* **3716**:301–335 DOI [10.11646/zootaxa.3716.3.1](https://doi.org/10.11646/zootaxa.3716.3.1).
- Gotelli NJ, Colwell RK. 2011.** Estimating species richness. *Biological Diversity: Frontiers in Measurement and Assessment* **12**:39–54.
- Hamilton SW, Holzenthal RW. 2005.** Five new species of Polycentropodidae (Trichoptera) from Ecuador and Venezuela. *Zootaxa* **810**:1–14.
- Harper PP, Turcotte P. 1985.** New Ecuadorian Trichoptera. *Aquatic Insects* **7**:133–140 DOI [10.1080/01650428509361212](https://doi.org/10.1080/01650428509361212).
- Harris SC, Davenport LJ. 1992.** New species of microcaddisflies from the Amazon region, with especial reference to northeastern Peru (Trichoptera: Hydroptilidae). *Proceedings of the Entomological Society of Washington* **94**:454–470.

- Harris SC, Flint Jr OS, Holzenthal RW. 2002.** Review of the Neotropical genus *Flintiella* (Trichoptera: Hydroptilidae: Stactobiini). *Journal of the New York Entomological Society* **110**:65–90 DOI [10.1664/0028-7199\(2002\)110\[0065:ROTNGF\]2.0.CO;2](https://doi.org/10.1664/0028-7199(2002)110[0065:ROTNGF]2.0.CO;2).
- Harris SC, Holzenthal RW. 1990.** Hydroptilidae (Trichoptera) from Costa Rica: the genus *Mayatrichia* Mosely. *Journal of the New York Entomological Society* **98**:453–460.
- Harris SC, Holzenthal RW. 1994.** Hydroptilidae (Trichoptera) of Costa Rica and the Neotropics: systematics of the genus *Byrsopteryx* Flint (Stactobiini). *Journal of the New York Entomological Society* **102**:154–192.
- Harris SC, Holzenthal RW, Flint Jr OS. 2002.** Review of the Neotropical genus *Bredinia* (Trichoptera: Hydroptilidae: Stactobiini). *Annals of Carnegie Museum* **71**:13–45.
- Hering D, Schmidt-Kloiber A, Murphy J, Luecke S, Zamora-Munoz C, Lopez-Rodriguez MJ, Huber T, Graf W. 2009.** Potential impact of climate change on aquatic insects: a sensitivity analysis for European caddisflies (Trichoptera) based on distribution patterns and ecological preferences. *Aquatic Sciences* **71**:3–14 DOI [10.1007/s00027-009-9159-5](https://doi.org/10.1007/s00027-009-9159-5).
- Holzenthal RW. 1985.** Studies in Neotropical Leptoceridae (Trichoptera) II: *Amphoropsyche*, a new genus and species of Leptocerinae from northern South America. *International Journal of Entomology* **27**:255–269.
- Holzenthal RW. 1988a.** Systematics of Neotropical *Triplectides* (Trichoptera: Leptoceridae). *Annals of the Entomological Society of America* **81**:187–208 DOI [10.1093/aesa/81.2.187](https://doi.org/10.1093/aesa/81.2.187).
- Holzenthal RW. 1988b.** Studies in Neotropical Leptoceridae (Trichoptera), VIII: the genera *Atanatolica* Mosely and *Grumichella* Müller (Triplectidinae: Grumichellini). *Transactions of the American Entomological Society* **114**:71–128.
- Holzenthal RW. 1997.** The caddisfly (Trichoptera) family Atriplectididae in the Neotropics. In: Holzenthal RW, Flint Jr OS, eds. *Proceedings of the 8th international symposium on Trichoptera*. Columbus: Ohio Biological Survey, 157–165.
- Holzenthal RW, Andersen T. 2004.** The caddisfly genus *Triaenodes* in the Neotropics (Trichoptera: Leptoceridae). *Zootaxa* **511**:1–80 DOI [10.11646/zootaxa.511.1.1](https://doi.org/10.11646/zootaxa.511.1.1).
- Holzenthal RW, Calor A.** Catalog of the Neotropical Trichoptera (Caddisflies). *Zookeys* In Press.
- Holzenthal RW, Flint Jr OS. 1995.** Studies of Neotropical caddisflies, LI: systematics of the Neotropical caddisfly genus *Contulma* (Trichoptera: Anomalopsychidae). *Smithsonian Contributions to Zoology* **575**:1–59.
- Holzenthal RW, Rázuri-Gonzales LE. 2011.** A new species of *Amphoropsyche* (Trichoptera, Leptoceridae) from Ecuador, with a key to the species in the genus. *ZooKeys* **211**:59–65.
- Holzenthal RW, Ríos-Touma B. 2012.** *Contulma paluguillensis* (Trichoptera: Anomalopsychidae), a new caddisfly from the high Andes of Ecuador, and its natural history. *Freshwater Science* **31**:442–450 DOI [10.1899/11-067.1](https://doi.org/10.1899/11-067.1).
- Holzenthal RW, Thomson RE, Ríos-Touma B. 2015.** Order Trichoptera. In: Thorp JH, Rogers DC, eds. *Ecology and general biology, vol I: Thorp and Covich's Freshwater Invertebrates*. 4th edition. Amsterdam: Academic Press, 965–1002.

- Jacobsen D, Milner AM, Brown LE, Dangles O. 2012. Biodiversity under threat in glacier-fed river systems. *Nature Climate Change* 2(5):361–364 DOI 10.1038/nclimate1435.
- Johanson KA. 1998. Phylogenetic and biogeographic analysis of the family Helicopsychidae (Insecta: Trichoptera). *Entomologica Scandinavica* 53(Supplement):1–172.
- Johanson KA. 2002. Systematic revision of American *Helicopsyche* of the subgenus *Feropsyche* (Trichoptera, Helicopsychidae). *Insect Systematics & Evolution* 60(Supplement):1–147.
- Johanson KA. 2003. The *Helicopsyche* (*Feropsyche*) (Insecta, Trichoptera, Helicopsychidae) from Barro Colorado Island, Panama. *Zootaxa* 283:1–12 DOI 10.11646/zootaxa.283.1.1.
- Kelley RW. 1983. New Neotropical species of *Oxyethira* (Trichoptera: Hydroptilidae). *Proceedings of the Entomological Society of Washington* 85:41–54.
- Malm T, Johanson KA, Wahlberg N. 2013. The evolutionary history of Trichoptera (Insecta): a case of successful adaptation to life in freshwater. *Systematic Entomology* 38:459–473 DOI 10.1111/syen.12016.
- Medellín F, Ramírez M, Rincón ME. 2004. Trichoptera del Santuario de Iguaque (Boyacá, Colombia) y su relación con la calidad del agua. *Revista Colombiana de Entomología* 30:197–203.
- Muñoz-Quesada F. 2000. Especies del orden Trichoptera (Insecta) en Colombia. *Biota Colombiana* 1:267–288.
- Muñoz-Quesada FJ, Holzenthal RW. 2015. Revision of the Neotropical species of the caddisfly genus *Wormaldia* McLachlan (Trichoptera: Philopotamidae). *Zootaxa* 3998:1–138 DOI 10.11646/zootaxa.3998.1.1.
- Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GA, Kent J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403(6772):853–858 DOI 10.1038/35002501.
- Navás L. 1913. Névroptères. In: *Mission du Service Geographique de l'Armée par la mesure d'un arc de meridien equatorial en Amerique de Sud (1899–1910) vol 10*. Paris: Gauthier-Villars, 69–77.
- Navás L. 1934. Insectos Suramericanos. Novena serie. *Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid* 31:155–184.
- Oláh J, Flint Jr OS. 2012. Description of new species in the Leucotrichiini tribe (Trichoptera: Hydroptilidae). *Annales Historico-Naturales Musei Nationalis Hungarici* 104:131–213.
- Oláh J, Johanson KA. 2011. New Neotropical Hydroptilidae (Trichoptera). *Annales Historico-Naturales Musei Nationalis Hungarici* 103:117–255.
- Oláh J, Johanson KA. 2012. New species and records of Neotropical Macronematinae and Smicrideinae (Trichoptera: Hydropsychidae). *Annales Historico-Naturales Musei Nationalis Hungarici* 104:215–297.
- Prather AL. 2003. Revision of the Neotropical caddisfly genus *Phylloicus* (Trichoptera: Calamoceratidae). *Zootaxa* 275:1–214 DOI 10.11646/zootaxa.275.1.1.

- Prather AL. 2004.** Revision of the Neotropical caddisfly genus *Banyallarga* (Trichoptera: Calamoceratidae). *Zootaxa* **435**:1–76 DOI [10.11646/zootaxa.435.1.1](https://doi.org/10.11646/zootaxa.435.1.1).
- Previsic A, Walton C, Kucinic M, Mitrikeski PT, Kerovec M. 2009.** Pleistocene divergence of Dinaric *Drusus* endemics (Trichoptera, Limnephilidae) in multiple microrefugia within the Balkan Peninsula. *Molecular Ecology* **18**:634–647 DOI [10.1111/j.1365-294X.2008.04046.x](https://doi.org/10.1111/j.1365-294X.2008.04046.x).
- Quinteiro FB, Calor AR. 2015.** A review of the genus *Oecetis* (Trichoptera: Leptoceridae) in the Northeastern Region of Brazil with the description of 5 new species. *PLOS ONE* **10**(6):e0127357 DOI [10.1371/journal.pone.0127357](https://doi.org/10.1371/journal.pone.0127357).
- Rincón-Hernández ME. 1999.** Estudio preliminar de la distribución altitudinal y espacial de los Tricópteros en la Cordillera Oriental (Colombia). In: Amat G, Andrade M, Fernández F, eds. *Insectos de Colombia*. Santa Fe de Bogota, Colombia: Academia Colombiana de Ciencias Exactas, Físicas Y Naturales, 267–284.
- Sarmiento FO. 2002.** Anthropogenic change in the landscapes of highland Ecuador. *Geographical Review* **92**(2):213–234 DOI [10.2307/4140971](https://doi.org/10.2307/4140971).
- Schmid F. 1989.** Les Hydrobiosides (Trichoptera, Annulipalpia). *Bulletin de l'institut Royal des Sciences Naturelles de Belgique, Entomologie* **59**(Supplement):1–154.
- Shen TJ, Chao A, Lin CF. 2003.** Predicting the number of new species in further taxonomic sampling. *Ecology* **84**(3):798–804 DOI [10.1890/0012-9658\(2003\)084\[0798:PTNONS\]2.0.CO;2](https://doi.org/10.1890/0012-9658(2003)084[0798:PTNONS]2.0.CO;2).
- Sykora JL. 1991.** New species of Hydrobiosidae from Ecuador (Insecta: Trichoptera: Hydrobiosidae). *Annals of Carnegie Museum* **60**:243–251.
- Sykora JL. 1999.** Genus *Mortoniella* and its distribution in South America (Trichoptera, Glossosomatidae, Protoptilinae). In: Malicky H, Chantaramongkol P, eds. *Proceedings of the 9th international symposium on Trichoptera*. Chiang Mai: Faculty of Science, Chiang Mai University, 377–387.
- Thomson RE, Holzenthal RW. 2015.** A revision of the Neotropical caddisfly genus *Leucotrichia* Mosely, 1934 (Hydroptilidae, Leucotrichiinae). *ZooKeys* **499**:1–100 DOI [10.3897/zookeys.499.8360](https://doi.org/10.3897/zookeys.499.8360).
- Ulmer G. 1905.** Zur Kenntniss aussereuropäischer Trichopteren. (Neue Trichoptern des Hamburger und Stettiner Museums und des Zoologischen Instituts in Halle, nebst Beschreibungen einiger Typen Kolenati's und Burmeister's.). *Stettiner Entomologische Zeitung* **66**:1–119.
- Vörösmarty CJ, McIntyre PB, Gessner MO, Dudgeon D, Prusevich A, Green P, Glidden S, Bunn SE, Sullivan CA, Liermann CR, Davies PM. 2010.** Global threats to human water security and river biodiversity. *Nature* **467**(7315):555–561 DOI [10.1038/nature09440](https://doi.org/10.1038/nature09440).
- Wasmund AM, Holzenthal RW. 2007.** A revision of the Neotropical caddisfly genus *Rhyacopsyche*, with the description of 13 new species (Trichoptera: Hydroptilidae). *Zootaxa* **1634**:1–59.