#### 1

## New *Cernotina* caddisflies from the Ecuadorian Amazon (Trichoptera: Polycentropodidae) (#20130)

First submission

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Dezene Huber / 21 Sep 2017

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2



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## New *Cernotina* caddisflies from the Ecuadorian Amazon (Trichoptera: Polycentropodidae)

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Two new species of the caddisfly genus *Cernotina* Ross, 1938 (Polycentropodedae) are described from the lowland Amazon basin of Ecuador, *Cernotina tiputini*, new species, and *Cernotina waorani*, new species. These represent the first new species described from this region. We also record from Ecuador for the first time *Cernotina hastilis*, previously known from Tobago, and present new Ecuadorian locality records for *C. cygnea* and *C. lobisomem*. The homology of the intermediate appendage of the male genitalia of this genus is established. The region surveyed in under severe environmental threat from logging, mining, and crude oil extraction, making the description of the biodiversity of the region imperative.

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1 2	New Cernotina caddisflies from the Ecuadorian Amazon (Trichoptera: Polycentropodidae)
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7	
8 9	Abstract
10	Two new species of the caddisfly genus Cernotina Ross, 1938 (Polycentropododae) are
11	described from the lowland Amazon basin of Ecuador, Cernotina tiputini, new species, and
12	Cernotina waorani, new species. These represent the first new species described from this
13	region. We also record from Ecuador for the first time Cernotina hastilis, previously known
14	from Tobago, and present new Ecuadorian locality records for C. cygnea and C. lobisomem. The
15	homology of the intermediate appendage of the male genitalia of this genus is established. The
16	region surveyed in under severe environmental threat from logging, mining, and crude oil
17	extraction, making the description of the biodiversity of the region imperative.
18	
19	Key words: Amazonian streams, aquatic macroinvertebrates, species description, endemism,
20	morphology, homology, Neotropics, taxonomy
21 22	*C(
23	*Corresponding author = Lucas Camargos (camar069@umn.edu)

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24	
25 26	Introduction
27	Trichoptera are an order of insects found in all faunal regions and is comprised of almost 16,000
28	described species. It is the largest insect order in which all included species live in freshwater
29	during the immature stages (except for a very few semi-terrestrial species and even fewer marine
30	species) (Holzenthal et al. 2015). The Neotropical region (Mexico, Central America, the
31	Caribbean, and South America) is especially diverse in Trichoptera, with more than 3,200
32	species currently known (Holzenthal and Calor 2017). Because of their high sensitivity to
33	pollution and environmental changes, caddisflies are considered to be biological indicators of the
34	quality of freshwater (Chang et al, 2014). Various biological indices and metrics have been
35	developed incorporating caddisfly diversity and abundance to assess and monitor water quality
36	by many national agencies around the world, including those in South American (Rios-Touma et
37	al., 2014).
38	Among the 39 extant families of Trichoptera, the cosmopolitan family Polycentropodidae
39	contains about 650 species and 15 genera (Chamorro and Holzenthal 2011). Five genera of
40	polycentropidids occur in the Neotropics: Cernotina Ross 1938, Cyrnellus Banks 1913,
41	Nyctiophylax Brauer 1865, Polycentropous Curtis 1835, and Polyplectropus Ulmer 1905
42	(Holzenthal and Calor 2017).
43	As an exclusively New World genus, Cernotina has most of its 70 extant species in the
44	Neotropical region (Holzenthal and Calor 2017), where most occur in the lowlands of the vast
45	Amazon basin (Flint 1971). One species, Cernotina pulchra Wichard, 2007, is known from
46	Dominican amber. No species occur in temperate southern South America (Chile and adjacent
47	patagonian Argentina). In the central and northern Andean countries, Cernotina is found
48	exclusively in the Amazonian lowlands (Holzenthal and Calor 2017). In spite of its diversity and
<del>49</del>	apparently wide distribution, published descriptions and records are few and include those from
<del>50</del>	Argentina (Flint 1983), Brazil (Flint 1971, 1991, Holzenthal and Almeida 2003, Santos and
51	Nessimian 2008, Dumas and Nessimian 2011, Barcelos-Silva et al. 2013), Peru (Sykora 1998),
<del>5</del> 2	and Uruguay (Angrisano 1994). The first records of the genus from Ecuador were recently
53	published for Cernotina cygnea Flint, 1971 and C. lobisomem Santos and Nessimian, 2008
54	(Rios-Touma, et al. 2017). In North America, Cernotina inhabits lotic and lentic freshwaters



habitats and the larvae are considered predators (Morse and Holzenthal 2008). However, there is no ecological information for the Neotropical species.

The family Polycentropodidae can be distinguished from other Neotropical caddisflies by a combination of characters (Pes et al., 2014): absence of ocelli; elongate, flexible segment 5 of the maxillary palp; segment 3 of the maxillary palp inserted subapically on segment 2; pair of distinct, oval, setal warts on the mesoscutum. *Cernotina* can be separated from other Neotropical polycentropodids by the absence of a preapical tibial spur on the foreleg.

The eastern part of the Ecuadorian Amazon includes the vast Yasuní National Park (ca. 10,000 km²) and the adjacent, much smaller and private Tiputini Biodiversity Station (6.5 km²). These conservation areas harbor a great diversity of amphibians, mammals, birds, and plants (Bass et al. 2010). In contrast, most insects, including Trichoptera have not been intensively studied in this area. However, while existing records are scarce, they suggest a diverse fauna (Rios-Touma et al., 2017). Oil concessions and logging have been threatening the biological diversity of this region for more than five decades (¬Bass et al. 2010, Sierra, 2000; Viña et al., 2004, O'Rourke and Connolly, 2003). Further, since freshwater biodiversity is among the world's least known (Dudgeon et al., 2005, Esteban and Finlay, 2010, D), and the Amazon is among the greatest global freshwater ecosystems, it is imperative to study well preserved areas like Yasuní and Tiputini. In our recent effort to record species of Trichoptera from Tiputini, we found new species and records of *Cernotina* (Rios-Touma et al, 2017) among other caddisflies. In this paper, we describe two new species of *Cernotina* from Tiputini and record a previously described species for the first time in Ecuador.

#### Methods

- 79 Collecting was accomplished at three sites in the Tiputini Biodiversity Station in October, 2011.
- 80 The station is located on the northern bank of the Río Tiputini, an easterly flowing southern
- 81 tributary of the much larger Río Napo (supplementary file 1). We sampled two small waterways
- and the Tiputini river using ultraviolet lights for approximately 2.5 hours (17:30-20:00 h). (Fig.
- 83 1). To collect dry specimens for subsequent pinning, ultraviolet and white fluorescent lights were
- 84 hung in front of a white bed sheet placed by the margin of the streams (Fig. 1D). Adult
- 85 Trichoptera attracted to the lights were captured in jars containing ammonium carbonate as the



86	killing agent. In addition, a small UV light was placed over a white tray containing 80% ethanol
87	and left for about 2.5 hours at streamside. Caddisflies collected in the tray way were sorted later
88	on the laboratory from other insects and were stored in 80% ethanol.
89	For examination and description the male genitalia were prepared using warm 85% lactic
90	acid to macerate soft tissue following the procedures of Blahnik et al. (2007). Pencil sketches
91	were rendered with the aid of a drawing tube attached to an Olympus BX 41 compound
92	microscope. Pencil sketches were imported into Adobe Illustrator CC to produce final digital
93	illustrations. Terminology for male genitalic structures follows that of Chamorro and Holzenthal
94	(2011) for Polycentropodidae.
95	The specimens examined in this work are deposited in the University of Minnesota Insect
96	Collection, St. Paul, Minnesota, USA (UMSP), the Museo Ecuatoriano de Ciencias Naturales,
97	Quito, Ecuador (MECN), and the Museo de Ecología Acuática de la Universidad San Francisco
98	de Quito, Ecuador (USFQ) as indicated below. All collections were performed under the
99	Environmental Ministry of Ecuador study permit No 0032 MAE-DPO-PNY -2011.
100	The electronic version of this article in Portable Document Format (PDF) will represent a
101	published work according to the International Commission on Zoological Nomenclature (ICZN),
102	and hence the new names contained in the electronic version are effectively published under that
103	Code from the electronic edition alone. This published work and the nomenclatural acts it
104	contains have been registered in ZooBank, the online registration system for the ICZN. The
105	ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information viewed
106	through any standard web browser by appending the LSID to the prefix <a href="http://zoobank.org/">http://zoobank.org/</a> . The
107	LSID for this publication is: urn:lsid:zoobank.org:pub:5CE7AFEF-5077-4930-96BA-
108	5B746FF12250. The online version of this work is archived and available from the following
109	digital repositories: PeerJ, PubMed Central and CLOCKSS.
110	
111	
112	Results
113	
114	Species descriptions
115	
116	Cernotina tiputini, new species



117	urn:lsid:zoobank.org:act:E254D21B-7FA0-47CA-AF34-BE437CEE71CE
118	
119	Figure 2
120	
121	This species is very similar to C. chelifera Flint, 1972 from Argentina in the 2 apical spines of
122	the dorsolateral lobe of the preanal appendage and the general shape of the appendage. It differs
123	from the Argentinian species by the overall shape of tergum X and the intermediate appendage,
124	its relative size shorter than the inferior appendage, a broader dorsolateral lobe in dorsal aspect, a
125	narrower inferior appendage, and by having 2 internal spines instead of only 1 long spine in the
126	phallus.
127	
128	Forewing length 3.5 mm male (n=2). Forewing very light brown, apex with small patch of dark
129	setae, white hairs along anal margin; head and thorax with white hair dorsally; antennae
130	stramineous. Forewing with fork V petiolate; hindwing with cross vein Cu2-1A absent, vein 3A
131	absent.
132	Male genitalia: Sternum IX with height 3/4ths of entire male genital complex, quadrate,
133	anteroventral margin with deep, broad concavity. Tergum X semi-membranous, divided mid-
134	dorsally; intermediate appendages slightly curved ventrad, thumb-like, ca. as long as inferior
135	appendage, setose, with 2 stronger apical setae, surface with microsetae. Preanal appendages
136	each composed of 2 lobes; dorsolateral lobe oblong, shorter than inferior appendage, with 2
137	apical spines; ventromesal lobe produced dorsolaterally, fused on midline, shorter than inferior
138	appendage, bearing a row of stout setae on posterior margin. Inferior appendages in lateral view
139	slightly fusiform, straight, apex rounded; sclerotized apicomesally, pointed in ventral view;
140	basodorsal lobe elongate, ca. as long as body of appendage, oriented posteriad, bearing a row of
141	setae. Phallus slightly bent at mid-length, narrow, with 2 spines; phallotremal sclerite large,
142	ovate, with 2 apparent lateral processes.
143	
144	Holotype male: ECUADOR: Orellana, Reserva de Biodiversidad Tiputini, river slough, Numa
145	trail, 00.63954°S, 76.14836°W, el. 260 m, 23.x.2011, Holzenthal and Ríos [pinned] (UMSP).
146	Paratype: same as holotype, except: 1 male [alcohol] (MECN).
147	



148	<b>Etymology:</b> The species is named for the Tiputini River and the adjacent biodiversity research
149	station.
150	
151	Cernotina waorani, new species
152	
153	urn:lsid:zoobank.org:act:15FD59A3-69F2-4152-B7B8-EE5E34051603
154	
155	Figure 3
156	
157	This species has similarities with C. fallaciosa Flint 1983 from Argentina in the bulbous apex of
158	the inferior appendage in lateral aspect and the presence of multiple internal spines in the
159	phallus. However, the absence of apical spines on the dorsolateral lobe of the preanal appendage,
160	its shape, and the presence of a flap-like mesal process renders this species distinct.
161	
162	Forewing length 4 mm (n=2). Forewing stramineous, with slightly darker hairs at apex; head and
163	thorax with lighter hair dorsally; antennae stramineous. Forewing with fork V sessile; hindwing
164	with crossvein Cu2-1A present, vein 3A absent.
165	Male genitalia: Sternum IX with height ca. half of entire male genital complex, trapezoidal;
166	anteroventral margin with deep, narrow concavity. Tergum X semi-membranous, divided mid-
167	dorsally; intermediate appendages straight, finger-like, ca. as long as inferior appendage, setose,
168	without spines, surface with microsetae. Preanal appendages each composed of 2 lobes:
169	dorsolateral lobe elongate, longer than inferior appendage, with flap-like mesal process;
170	ventromesal lobe oblong, not fused on midline, shorter than inferior appendage, bearing a row of
171	stout setae on posterior margin. Inferior appendage subtriangular in lateral view, lateral apex
172	narrow; apex complex, directed mesad, with apicomesal lobe-like processes, mesal process with
173	sclerotized apex; basodorsal lobe absent. Phallus straight, narrow, with 2 spines and membranous
174	pouch of 8 small spines; phallotremal sclerite anterodorsal, large, hourglass-shaped.
175	
176	Holotype male: ECUADOR: Orellana, Reserva de Biodiversidad Tiputini, small stream, Harpia
177	trail, 00.63496°S, 76.14602°W, el. 240 m, 22.x.2011, Holzenthal and Ríos [pinned] (UMSP).



178	<i>Paratypes:</i> same as holotype, except – 4 males [alcohol] (USFQ, MECN); same except: Reserva
179	de Biodiversidade Tiputini, river slough, Numa trail, 00.63954°S, 76.14836°W, el. 260 m,
180	23.x.2011, Holzenthal and Ríos – 1 male [pinned] (UMSP).
181	
182	Etymology: The new species in named for the Waorani people in whose territory, now under
183	severe environmental threat, this species occurs.
184	
185	Additional species records
186	
187	Cernotina hastilis Flint 1996, NEW RECORD
188	
189	Flint, 1996a:75 [original designation]. —Botosaneanu, 2002:95 [checklist]. —Holzenthal and
190	Calor, 2017:415 [catalog].
191	
192	This species was previously recorded from Tobago.
193	
194	Material examined: ECUADOR: Orellana, Reserva de Biodiversidad Tiputini, small stream,
195	Harpia trail, 00.63496°S, 76.14602°W, el. 240 m, 22.x.2011, Holzenthal and Ríos – 2 males
196	[pinned] (UMSP); same except: 27 males [alcohol] (UMSP, MECN, USFQ).
197	
198	Cernotina cygnea Flint 1971
199	
200	Cernotina cygnea Flint, 1971:37 [original description]. —Sykora, 1998:120 [distribution]. —
201	Paprocki et al., 2004:15 [checklist]. —Ríos-Touma et al., 2017:14 [distribution]. —
202	Holzenthal and Calor, 2017:413 [catalog].
203	
204	This species was previously reported from Brazil, Ecuador, and Peru
205	
206	Material examined: ECUADOR: Orellana, Reserva de Biodiversidad Tiputini, river slough,
207	Numa trail, 00.63954°S, 76.14836°W, el. 260 m, 23.x.2011, Holzenthal and Ríos - 1 male
208	[pinned] (UMSP).



209	
210	Cernotina lobisomem Santos and Nessimian 2008
211	
212	Cernotina lobisomem Santos and Nessimian, 2008:27 [original description]. —Paprocki and
213	França, 2015:82 [checklist]. —Ríos-Touma et al., 2017:14 [distribution]. —Holzenthal and
214	Calor, 2017:415 [catalog].
215	
216	Material examined: ECUADOR: Orellana, Reserva de Biodiversidade Tiputini, river slough,
217	Numa trail, $00.63954^{\circ}$ S, $76.14836^{\circ}$ W, el. $260$ m, $23.x.2011$ , Holzenthal and Ríos - $1$ male
218	[alcohol] (UMSP).
219	
220	This species was previously reported from Brazil,
221	
222	
223	Discussion
224	
225	As discussed by Chamorro and Holzenthal (2010), the intermediate appendage in
226	Polycentropodidae is difficult to distinguish in taxa where this structure is fused with tergum X
227	along its mesal margin, a characteristic commonly found in Cernotina. This confusion has led to
228	difficulty in determining the homology of the intermediate appendage versus the dorsolateral
229	appendage in previous species descriptions (e.g., Holzenthal and Almeida, 2003). Some species
230	such as C. perpendicularis Flint, 1971 has an appendage very distinct from the membranous
231	tergum X, similar to that of some <i>Polyplectropus</i> . In those cases, the intermediate appendages
232	are lateral to tergum X, mesal to the dorsolateral lobe of the preanal appendages, and always
233	setose.
234	In this paper, we used the term "intermediate appendage" to refer to the lateral, setose,
235	lightly sclerotized lobes of tergum X, following the morphological discussions of Chamorro and
236	Holzenthal (2010) for <i>Polyplectropus</i> and the character coding from Chamorro and Holzenthal
237	(2011).
238	
239	Conclusions



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240	
241	The species of <i>Cernotina</i> described and recorded here were collected only adjacent to two small
242	waterways, one a permanent small stream, the other an inundated, separated channel of the
243	Tiputini River. We did not collect any specimen from lights set adjacent to the Tiputuni River.
244	Even though the study consisted of only 3 nights of sampling (one on the Tiputini, two on the
245	small water bodies), we collected 5 species, 3 recorded here and 2 species previously reported
246	from Ecuador by Ríos-Touma et al. (2017). Considering the amount of similar freshwater
247	habitats, the potential diversity of this genus in northern Amazonia is enormous. However,
248	several species could become locally extinct due to the effects of environmental degradation
249	from crude oil extraction, mining, and deforestation if current conservation efforts are not
250	maintained. Loss of species diversity could be even greater, especially if regional endemism is
251	also high as might occur with some Cernotina (Flint 1971). The importance of areas such as
252	Tiputini and Yasuní cannot be overstated for the conservation of the largely unknown freshwater
253	insect fauna of the Amazon.
254	
255	Acknowledgements
256	
257	Dr. David Romo and Dr. Andrea Encalada, Universidad San Francisco de Quito, provided
258	transportation, lodging, and access to services at the Tiputini station. This study was also
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261	Trichoptera de Ecuador." LC is funded by CAPES "Programa Ciências Sem Fronteiras" (Science
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263	The funders had no role in the study design, data collection and analysis, decision to publish, or
264	preparation of the manuscript.
265	
266	



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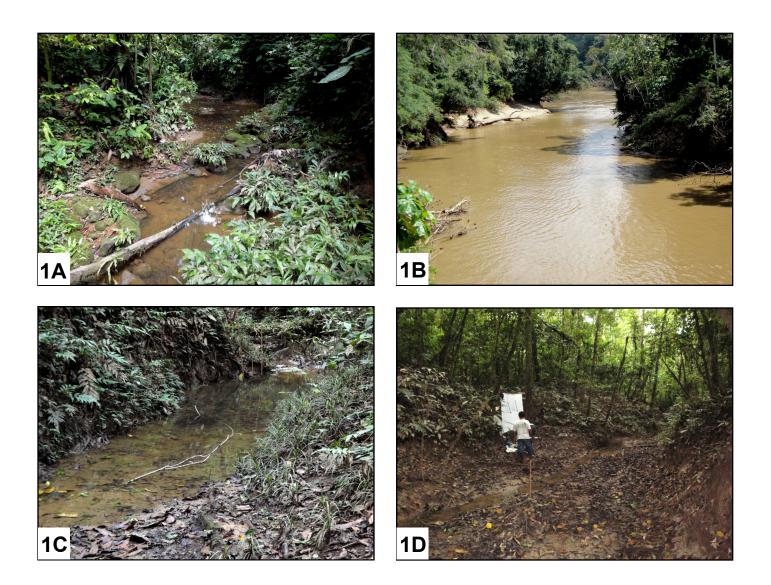
359	Figure Legends
360 361 362 363	Figure 1. <b>Collecting localities, Tiputini Biodiversity Station, Ecuador.</b> (A) small stream, Harpia trail, type locality for <i>Cernotina waorani</i> , new species. (B) Río Tiputini. (C) river slough, Numa trail, type locality for <i>Cernotina tiputini</i> , new species. (D) same, showing UV light collecting method.
364 365 366	Figure 2. <b>Male genitalia of</b> <i>Cernotina tiputini</i> , <b>new species.</b> (A) segment IX and X, lateral. (B) segment X and preanal appendages, dorsal. (C) segment IX and inferior appendages, ventral. (D) phallus, lateral. (E) phallus, dorsal. (F) ventromesal lobes of preanal appendages, ventral.
367 368 369	Figure 3. <b>Male genitalia of</b> <i>Cernotina waorani</i> , <b>new species.</b> (A) segment IX and X, lateral. (B) segment X and preanal appendages, dorsal. (C) segment IX and inferior appendages, ventral. (D) phallus, lateral. (E) phallus, dorsal.
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### Figure 1(on next page)

Figure 1, Camargos et al

Catalog of the Neotropical Trichoptera (Caddisflies) Figure 1. Collecting localities, Tiputini Biodiversity Station, Ecuador. (A) small stream, Harpia trail, type locality for *Cernotina waorani*, new species. (B) Río Tiputini. (C) river slough, Numa trail, type locality for *Cernotina tiputini*, new species. (D) same, showing UV light collecting method.

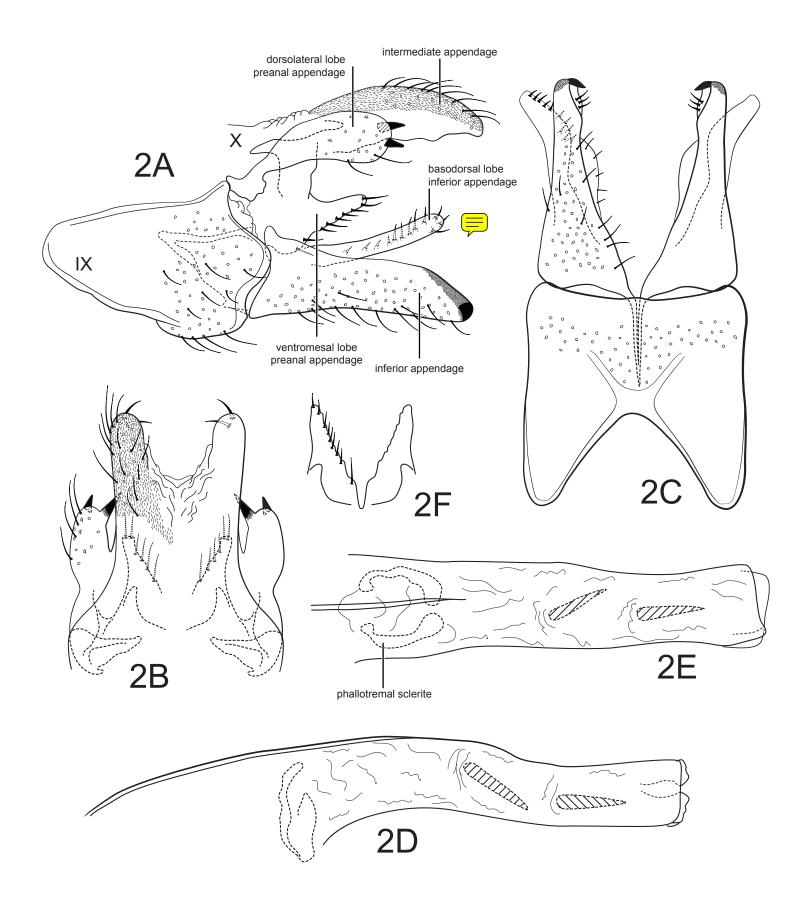




### Figure 2(on next page)

Figure 2 Camargos et al.

Catalog of the Neotropical Trichoptera (Caddisflies) Figure 2. **Male genitalia of** *Cernotina tiputini*, **new species.** (A) segment IX and X, lateral. (B) segment X and preanal appendages, dorsal. (C) segment IX and inferior appendages, ventral. (D) phallus, lateral. (E) phallus, dorsal. (F) ventromesal lobes of preanal appendages, ventral.





### Figure 3(on next page)

Figure 3 Camargos et al.

Catalog of the Neotropical Trichoptera (Caddisflies) Figure 3. **Male genitalia of** *Cernotina waorani*, **new species.** (A) segment IX and X, lateral. (B) segment X and preanal appendages, dorsal. (C) segment IX and inferior appendages, ventral. (D) phallus, lateral. (E) phallus, dorsal.

