

NEW DISTRIBUTIONAL RECORDS AND BIOGEOGRAPHIC CONSIDERATIONS ON *PAMPACLADIUS GAUCHO* DONATO, ZANOTTO ARPELLINO AND SIRI (CHIRONOMIDAE: ORTHOCLADIINAE)

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Abstract

New records of the recently established genus *Pampacladius*, together with the confirmation that Roback and Coffman's Genus 2 sp. is conspecific with *P. gaucho*, extend its range to the Austral region and South American transition zone. Specimens from Patagonia were measured and are presented in a comparative table. Intraspecific variation of *P. gaucho* is described and biogeographic considerations based on the new records are discussed.

Introduction

Donato et al. (2024) described a new genus of Orthoclaadiinae from Argentina. The genus *Pampacladius* Donato, Zanotto Arpellino and Siri was based on one species from Pampean biogeographic province in Central Argentina. Molecular analysis places the new genus closely related to genera distributed in Austral areas, mainly Australia and New Zealand.

In a personal communication, our colleague Martin Spies kindly reported us that a specimen he collected on January 18, 1986 in Tierra del Fuego (Argentina) from Rio Ewan Sur at the bridge of Ruta Nacional 3 just south of Puente Justicia, using a Brundin-driftnet, was a pharate adult male with pupal exuviae belonging to *Pampacladius*, quite likely even to the same species. In addition, Dr. Spies suggested that the pupal morphotype of the Orthoclaadiinae "Genus 2" from Bolivia and Peru of Roback and Coffman (1983) resembles *Pampacladius*.

Following Dr. Spies' comments, collection material from La Plata Museum (MLP) and the Instituto de Limnología 'Dr. Raúl A. Ringuelet' (ILPLA) was examined for additional specimens. Adult males previously labelled as *Botryocladus*

sp. were found and, upon examination, identified as *Pampacladius gaucho*.

This study establishes the pupa of *P. gaucho* and Genus 2 sp. of Roback and Coffman (1983) as the same entity, provides measurements of specimens from new localities, and presents biogeographic considerations.

Material and methods

Specimens of *P. gaucho* deposited in MLP and ILPLA were measured. All measurements are given in μm unless otherwise stated, and values are rounded to the nearest 5 μm unless specified otherwise. Measurements are presented as ranges and summarized in Tables 1 and 2, which include data from the original description as well as new measurements of male specimens collected in the Río Negro and Tierra del Fuego provinces, Argentina. Morphological terminology and measurement standards follow Sæther (1980).

Results

Pampacladius gaucho Donato, Zanotto Arpellino and Siri, 2024

Material examined. ARGENTINA: 3 ♂; slide mounted in Canada Balsam, Río Negro, General Roca, in the shores of Negro River; -39.1105556 -67.6136111, 230 m asl; 19.07.2005; sweep net; leg. M. Donato. 3 ♂; slide mounted in Canada Balsam; Tierra del Fuego; A° s/n en R Comp. B; -53.90166667 -67.93230556; 03.21.2005; 03.12.2005; sweep net; leg. M. Donato and G. Spinelli.

The males of *P. gaucho* from the new localities did not show differences in qualitative characters such as the head, hypopygium, and thorax. However, quantitative characters of body parts (Table 1) and leg measurements (Table 2) showed slight

differences with respect to the original description, being those of the Patagonian specimens bigger and larger than those of the Pampean specimens. The mean annual temperature is 4.5°C in the Tierra del Fuego locality, 16°C in General Roca (Río Negro), and 18.4°C at the type locality of the genus. No clear increase in the measurements of meristic characters along a latitudinal gradient was observed, and thus, no clinal variation from North to South could be established. Pampean specimens are smaller than the Patagonian ones, but among the latter, those belonging to Río Negro province tend to be larger than those from Tierra del Fuego.

It is well known that temperature significantly affects chironomid developmental and growth rate, and therefore their adult body size (Pinder 1986). Some studies have documented a negative correlation between adult body size and temperature (Oliver 1971, Pinder 1986, Maier et al. 1990, Sæther and Andersen 1996, Kobayashi 1998, Frouz et al. 2002, McKie and Cranston 2005, Baek et al. 2012). However, this is not a general rule, as another study has found species in which this correlation does not hold (Wonglersak et al. 2021). Although the number of specimens analysed in this study is limited, the findings are consistent with most papers on this subject.

As was mentioned above, the specimens from MLP and ILPLA collections were labelled as *Botryocladius* sp. The genus *Botryocladius* Cranston and Edwards is a transantarctic element distributed in Australia, Argentina, and Chile. The male adult of this genus shares with *Pampacladius* the bare eyes; wings fully developed, with weakly

extended costa, finely punctate and lacking macrotrichia on membrane, with setose squama; legs with strong lateral spines on spur, with comb; and thorax with few hooked/scalpellate acrostichals in mid-thorax, without pleural setae. Of the four South American species described of *Botryocladius*, the male is known in only one (Cranston & Edward 1999). The identification of the specimens as *Botryocladius* was based on the presence of many shared characteristics, while those that differed were interpreted as representing one of the males of the three known species of the genus at the pupal stage. Although the male of *Botryocladius edwardsi* has a highly developed virga and an inferior volsella that is less pronounced than in *P. gaucho*, the Australian species exhibit variation in virga development, with the possibility of its absence. Therefore, it is crucial to consider this issue when identifying future male specimens, particularly those of unknown *Botryocladius* males.

Based on the available evidence, the two genera can be distinguished as follows: South American *Botryocladius* has a weak dorsomedial extension of the eye, a sinuate Cu_1 vein, hypopygium with a strong virga, and a weak, bare anal point. In contrast, *Pampacladius* lacks a dorsomedial extension, has an almost straight Cu_1 vein, hypopygium without a virga, and the anal point with a short apical part, reduced to a hump with a posterior elongation.

From the description and illustrations provided by Roback and Coffman (1983), the pupa of Genus 2 sp. belongs to this species.

Table 1. Comparison of measurements from the original description and specimens from the new localities in *Pampacladius gaucho* Donato, Zanotto Arpellino and Siri, male, $n = 3$ for each new locality, except when otherwise stated.

Character	Original description	Río Negro specimens	Tierra del Fuego specimens
Total length	2.22–2.95	3.35–3.62 (2)	2.92–3.06 (2)
Wing length	1.40–1.70	1.86–2.20	1.86–1.90
Total length/wing length	1.52–1.84	1.65–1.68 (2)	1.57–1.61 (2)
Wing length/length of profemur	2.83–3.09	3.1–3.14	3.14–3.30
Ultimate flagellomere	371–442	544 (1)	477–497
AR	0.88–1.03	1.15 (1)	1.04–1.16
Inner verticals	0	1–2 (2)	0
Outer verticals	0–1	1–2	1–2 (2)
Postorbitals	2–3	2	2–3 (2)
Clypeus setae	7–11	4–6	8–11 (2)
Tentorium length	130–148	146–178	142–160 (2)
Tentorium wide	24–30	30–48	28 (2)

Character	Original description	Río Negro specimens	Tierra del Fuego specimens
Stipes length	110–134	124–185	120–124 (2)
Palpomere length I	22–36	30–44	28–32
Palpomere length II	34–48	50	40–44
Palpomere length III	68–74	80–90	74–76
Palpomere length IV	70–90	96–102	86–94
Palpomere length V	80–96	100–116	106–120 (2)
Anteprenotal lateral setae	0–2	0–1	0–2
Dorsocentrals	5–7	6–7	7 (2)
Acrostichals	4–8	2–4 (2)	2–3
Prealars	3–4	3–4	3
Scutellars	5–9	5–6	6–7 (2)
VR	1.32–1.45	1.34–1.54	1.34–1.4
C extension	14–36	0–20	0–32
Setae on R	0–3	2–6	1–2
Setae on R ₁	0	0	0–1
Squamals	7–12	7–12	9–11
Tibial spur PI	44–76	46–63	54–60
Tibial spur PII 1	16–18	20–24	20–22
Tibial spur PII 2	18–24	24–26	24–28
Tibial spur PIII 1	12–16	13–22 (2)	–
Tibial spur PIII 2	38–50	52–60	54 (2)
Width at apex of front tibia	28–36	38–40	34–44
Width at apex of middle tibia	30–36	33–44	32–50
Width at apex of hind tibia	34–44	45–56	44–44
Setae on comb III	13–14	12–14	13
Sensilla chaetica on tarsomere 1 PII	0–1	0–1	0
Sensilla chaetica on tarsomere 1 PIII	3–6	2–3	3–4
Setae on tergum IX	9–15	13–20	12–13
Setae on laterosternite IX	4–6	5–6	4–6
Anal point length	12–20	22–40	20–24
Phallapodeme length	48–62	60–72	50–60
Transverse sternapodeme length	72–94	80–98	74–82
Gonocoxite length	164–218	204–232	204–232
Inferior volsella ending	0.20–0.25	0.20–0.33	0.17–0.24
Gonostylus length	82–92	92–96	86–90
Megaseta length	8–14	14	12 (2)
HR	2–2.37	2.17–2.42	2.27–2.58
HV	2.71–3.35	3.64–3.77 (2)	3.24–3.40 (2)

Table 2. Comparison of lengths and proportions of leg segments from the original description with respect to specimens from the new localities in *Pampacladius gaucho* Donato, Zanotto Arpellino and Siri, male, n = 3 for each new locality.

Character	Original description	Río Negro specimens	Tierra del Fuego specimens
fe P ₁	473–600	600–694	576–592
fe P ₂	505–639	615–742	608–615
fe P ₃	552–679	686–757	655–679
ti P ₁	592–757	750–915	718–757
ti P ₂	513–631	647–789	631–647
ti P ₃	615–765	797–963	789–797
ta ₁ P ₁	363–450	466–552	426–458
ta ₁ P ₂	252–300	316–395	308–323
ta ₁ P ₃	308–371	379–466	371–395
ta ₂ P ₁	237–284	323–355	284–316
ta ₂ P ₂	150–174	213–237	181–189
ta ₂ P ₃	205–245	260–300	245–252
ta ₃ P ₁	174–213	245–260	205–229
ta ₃ P ₂	110–142	158–174	150
ta ₃ P ₃	166–189	213–237	197–213
ta ₄ P ₁	110–126	142–166	134–142
ta ₄ P ₂	63–79	87–103	79–95
ta ₄ P ₃	87–110	110–134	110
ta ₅ P ₁	79–95	95–110	95–103
ta ₅ P ₂	79–150	79–110	79–95
ta ₅ P ₃	79–95	95–103	95
LR P ₁	0.57–0.61	0.60–0.64	0.59–0.60
LR P ₂	0.46–0.49	0.49–0.51	0.49–0.50
LR P ₃	0.47–0.51	0.48	0.47–0.50
BR P ₁	2.32–2.52	2.25–2.42	2.25–2.39
BR P ₂	2.82–3.32	2.94–3.13	2.97–3.19
BR P ₃	2.71–3.07	2.71–2.83	2.76–2.88
SV P ₁	2.98–3.12	2.82–2.91	2.95–3.04
SV P ₂	4.03–4.33	3.83–4	3.90–4.03
SV P ₃	3.70–4.03	3.69–3.92	3.70–3.89

Discussion

New records of *Pampacladius gaucho* from the biogeographic provinces of Puna, Monte, and Patagonia extended its distribution to the South American transition zone (SAtz) and the Austral region, respectively (Fig. 1). The phylogenetic analysis obtained (Donato et al. 2024) showed that *Pampacladius* is part of a group with ancestral distribution in South America. The other genera that form the group all have distributions in continents that were part of Gondwana excepting some widespread genera and dated from 76.4 Mya (95% HPD: 90.4–61.5 Mya) when New Zealand,

Australia, South America, remained connected via Antarctica, whereas east Antarctica was adjacent to southern Australia. The clade *Pampacladius*, is related to the South American *Echinocladius* Cranston; the New Zealand taxa *Paulfreemania pictipennis* (Freeman), *Naonella* Boothroyd, and *Tonnoirocladius commensalis* (Tonnoir); and the Australian taxa genus ‘Australia’ and Orthocladinae ‘FNQ2’. The new distributional pattern of *P. gaucho* in the Austral region and SAtz contribute to strengthen the phylogenetic relationships and biogeographic affinities obtained. Other genera with a similar distributional pattern, differing in

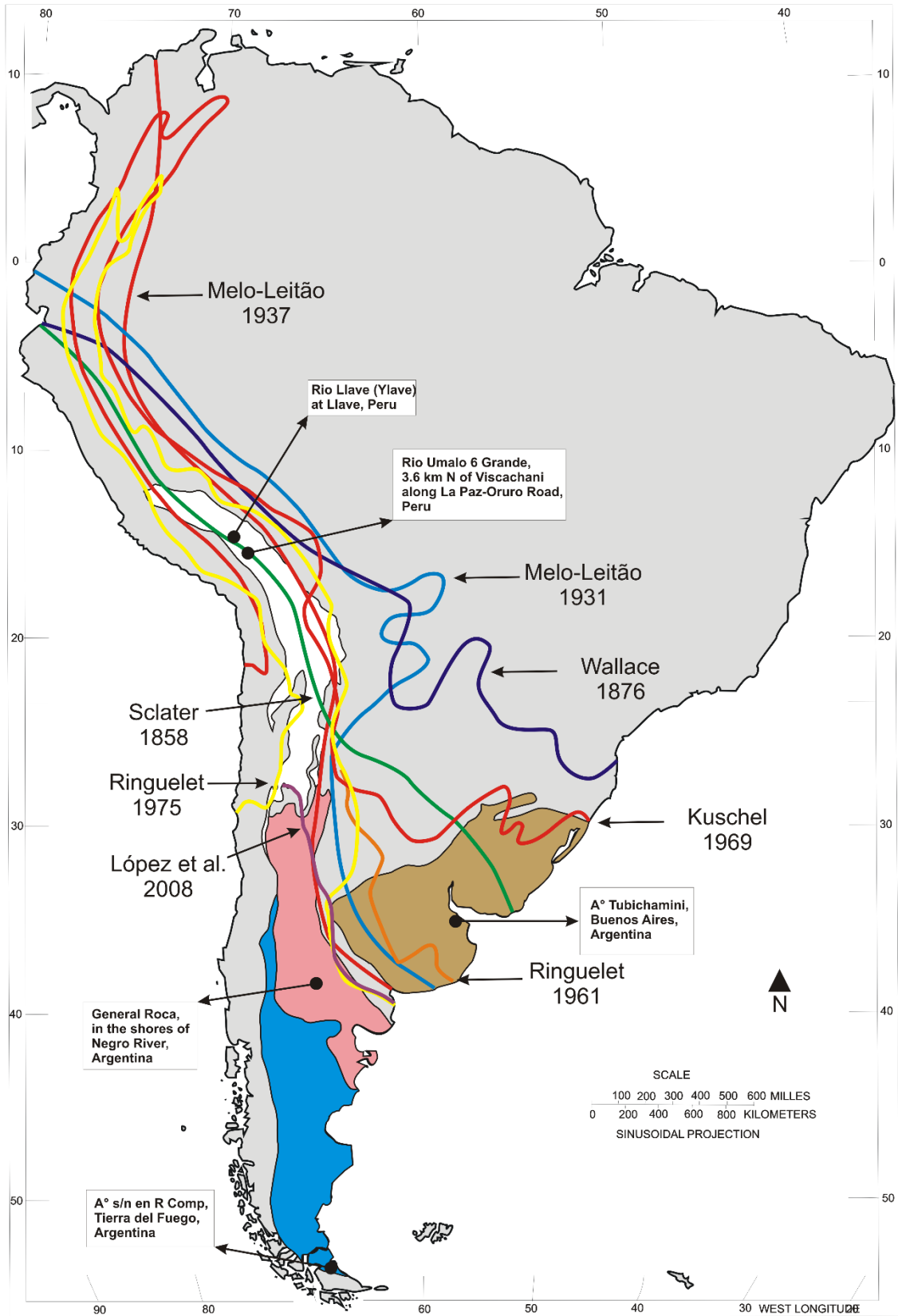


Figure 1. Lines drawn by different authors to delimit the Guiana-Brazilian and Andean-Patagonian subregions (modified from Morrone 2004). The black circles show the type locality of the genus and new localities where *Pampacladius gaucho* was collected. Those biogeographic provinces cited in the text were drawn: Puna (white), Pampean (brown), Monte (pink), Patagonian (blue).

the extent of distributional areas occupied in the SATz and Neotropics are *Barbadocladius* Cranston and Krosch, South American *Paraheptagyia* Brundin, *Parapsectrocladius* Cranston, South American *Parochlus* Enderlein, South American *Podonomus* Philippi, South American *Riethia* (Kieffer), South American *Stictocladius* Edwards, and *Physoneura* Ferrington and Sæther.

The concept of biogeographic regions started with Buffon, who first observed in 1761 that the large mammals of the tropical regions of the Old World and the New World are quite different. However, the world-wide system of biogeographic regions was founded by Augustin de Candolle in 1820 based on the distribution of plants (Cox 2001). Several authors after de Candolle, proposed modifications to the plant based biogeographical regions until present day. Zoogeography had been developing from the early nineteenth century onwards, but in a different way than plant geographers (for a complete historical revision see Cox 2001).

Since the mid-nineteenth century, there have been numerous attempts to systematize the distribution patterns of the Latin American and Caribbean biota in a diverse number of biogeographic regions, subregions and provinces. Although these biogeographic classifications differ in the criteria used to delimit the areas (e.g., geographic, paleontological, faunal and/or floristic), the different authors generally implicitly recognize that the units of their schemes represent historical entities (for a complete historical revision see Morrone 2001).

South America is a composite area, with southern South America closely related to the southern temperate areas (Australia, Tasmania, New Zealand, New Guinea, and New Caledonia), and tropical South America closely related to Africa and North America (Crisci et al. 1991). Because of this, it is understandable that the different biogeographic schemes proposed for South America differ at the boundaries between these two regions (Fig. 1). The diverging interpretations in the limits of the Neotropical and the Andean regions are understandable based on unequal selection and evaluation of animal groups considered (Fittkau 1969). Morrone (2004, 2006) proposed the transition zones, located at the boundaries between biogeographic regions representing areas of biotic overlap, which are promoted by historical and ecological changes that allow the mixture of different biotic elements. In transition zones, pronounced changes in species richness and/or high spatial replacement of species occur. The South American transition zone (SATz) comprises North Andean Paramo, Puna, Coastal Peruvian Desert, Prepuna, and Monte provinces.

This area of change in the geographic distribution areas of species in South America coincides with the arid diagonal that marks the transition between phytogeographic regions characterized by a temperate-cold climatic regime in the southwest (Andean region and South American transition zone) and a subtropical one in the northeast (the Chaco subregion) (Morrone 2006). The cold-adapted chironomids that are generally widely distributed in the southern part of the continent only occur above 1700 to 1800 m in the tropical Andean region, corresponding to the lower limit of the cloud forest zone (Fittkau and Reiss 1979).

Although the Pampean province belongs to the Chacoan subregion, the presence of several Andean–Patagonian species, such as *Allocladius globosus* (Mauad et al. 2013), *Podonomus tehuelche* and *P. quinquesetosus* (Podonominae) (Siri & Donato 2012), along with new records of Brazilian lineages like *Pseudosmittia adunca* and *P. joaquimvenancioi* (Fuentes & Mauad 2015), highlights the complexity of this biogeographical unit, influenced by shifts in the latitudinal position of the arid diagonal zone from the Pleistocene to the present driven by glaciations, as evidenced by the rich fossil record of mammals. During glacial periods, the Pampean province experienced arid and cold climatic conditions, which led to the northward displacement of Patagonian mammal fauna (Donato et al. 2024, and references therein).

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