PANAMJAS
Pan-American Journal of Aquatic Sciences

New records of fairy shrimp (Anostraca, Branchinectidae) in temporary wetlands from Patagonia

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Abstract: Despite its widely distribution in pools or hypersaline lakes of Argentina, the anostracans are among the least known of all faunal elements in temporary aquatic environments. In this study we show new records of *Branchinecta vuriloche* for Patagonia, collected in two isolated forested temporary wetlands.

Key words: Neotropical; Branchiopoda; temporary environments; freshwater crustaceans; Branchinecta.

Nuevos registros de camarón hada (Anostraca, Branchinectidae) en humedales temporales de la Patagonia. Resumen: A pesar de su amplia distribución en charcas o lagos hipersalinos de Argentina, los anostrácodos se encuentran entre los elementos faunísticos menos conocidos de los ambientes acuáticos temporales. En este estudio mostramos nuevos registros de *Branchinecta vuriloche* para Patagonia, colectados en dos humedales temporarios boscosos aislados.

Palabras clave: Neotropical; Branchiopoda, ambientes temporarios; crustáceos dulceacuícolas; Branchinecta.

Anostraca (Branchiopoda) is an order of crustacean that generally inhabit vernal pools or hypersaline lakes, distribute from desert ecosystems to mountain lakes (Eng *et al.* 1990, Rogers & Aguilar 2020). Anostraca in the neotropic region is diverse (Bayly 1993). Twenty-nine species in three families are recorded from this region: Artemiidae, with two *Artemia* species (Vanhaecke *et al.* 1987, Gajardo *et al.* 1995); Branchinectidae, represented by 14 *Branchinecta* species (César 1989, Cohen 1995); and the Thamnocephalidae, with two *Thamnocephalus* species (Belk & Pereira 1982, Cohen 2002), one *Phallocryptus* species (Rogers 2003), nine species of *Dendrocephalus* (Pereira & Belk 1987, Rabet & Thiéry 1996), and the monotypic *Gurneya* (Brtek 1996). Anostraca typically inhabit shallow and temporary waters with few predators since they are easy prey due to its large size, slow and predictable movement, and lack of defensive structures (Cohen 2006). It has been suggested that escape from predation was one of the most important factors that determine the evolution of their complex survival strategies (Brendonck & Persoone 1993), including early hatching, rapid maturation and early start of egg production (Wiggins *et al.* 1980). The anostracan group is able to overcome the severe physiological demands imposed by the environment, such as high salinity levels (Vanhaecke *et al.* 1987).

In the Patagonian region two genera are distributed, *Artemia* with two species both distributed in Chile and Argentina and *Branchinecta* with 12 species, with only five species observed in Chile (Roger *et al.* 2008, De los Ríos Escalante 2013, Pérez 2019). Despite the widely distribution of anostraca in Patagonia, this group are among the least known of all faunal elements in seasonally aquatic environments. In this communication we show new records of fairy shrimp for Patagonia, collected in two isolated temporary wetlands.

During the late winter early spring 2022 we sampled two wetlands: Los Patos 2, situated close to bypass route of Bariloche (Argentina), and Juventus 2, situated at 0.3 km of large shallow lake Juventus (Nahuel Huapi National Park). Both wetlands were dried during 2020-2021 and inundate during the winter 2022. The wetlands were characterized in environmental variables using a multiprobe (AquaCombo HM3070). In addition, we monitored the presence of zooplankton taken ten sampled with a hand net (500 microns mesh). The samples were analyzed in the laboratory under a stereomicroscope (Olympus SZ30). Zooplankton and anostraca were identified following Bayly (1992) and Rogers *et al.* (2008), respectively.

The wetlands showed similar altitude, depth and dissolved oxygen values. In addition to size differences, the ponds had different conductivity values. In both environments, the fairy shrimp coexisted with the copepod *Boeckella* sp. (Table 1).

The comparison with morphological characters obtained in other studies show that the specimens found in both wetlands are *Branchinecta vuriloche* Cohen 1985 (Anostraca, Branchinectidae) (Rogers *et al.* 2008). In the males, the second antenna distal antennomere apex is rounded and proximal antennomere of the same antenna has minute digitiform projection. Also, the gonopod proximal has a rigid projection slightly curved. The specimens examined were deposited in the "Max Birabén" Collection of Branchiopods of Continental Waters of the Centro Nacional Patagónico (CENPAT-CONICET) under the codes CNP-BRA 193 (Los Patos 2) and CNP-BRA 194 (Juventus 2) for public access. Fairy shrimp showed significant size variation between populations (Los Patos 2: 19 ± 2 mm, n=7; Juventus 2: 22 ± 1 mm, n=9; t-test; t = -6.8, p < 0.001), probably due to the great morphological plasticity of the anostracans (Cohen 2006). The was a predominance of males in both ponds, with only one female recorded in Los Patos 2. This species was previously reported in Chile and Argentina, though without accurate information about the location of the Argentinean ponds or limnological data about them (**Table 2**). In the Chilean ponds, salinity levels below 12 g/l are conducive to calanoid copepods and *Branchinecta* (De los Ríos 2005, Rogers *et al.* 2008).

The limited number of records for fairy shrimps in Patagonia is maybe due to its particular life cycle (Cohen 2006), and to the fact that the samplings has historically been occasional (Pérez 2019). In addition to this, the biology and chemistry of Patagonian temporary wetlands in remote locations are poorly known. The presence of fairy shrimps at a particular site can have several explanations. Stochastic dispersal events can lead anostracans to new and remote environments (Pérez 2019); for example, anostracans cysts can be naturally dispersed over long distances by becoming

Table 1. Environmental features and crustacean present in the studied ponds.

	Wetland	
	Los Patos 2	Juventus 2
Geographical location	41°09'56.3"S 71°16'21.7"W	41°21'32.7"S 71°31'37.6"W
Altitude (m a.s.l)	936	926
Z_{max} (m)	0.6	0.8
Area (ha)	2.83	1.01
Water temperature (°C)	6.2 ± 0.1	9.2 ± 0.1
pH	6.9 ± 0.1	Not available
Electrical conductivity (µS cm^{-1})	81.2 ± 1.6	49.0 ± 0.1
Dissolved oxygen (%)	56.2 ± 9.8	63.2 ± 6.2
(PPM)	6.6 ± 1.4	6.6 ± 0.2
Crustacean		
Anostraca	*Branchinecta vuriloche*	*Branchinecta vuriloche*
Copepods	*Boeckella* sp.	*Boeckella antiqua*

Table 2. List and geographical location of *Branchinecta vuriloche* population reported in the literature. Approximate coordinates are shown in italic.

Country	Environment	Geographic coordinates	References
Argentina	Los Patos 2 (Rio Negro)	41°09′56.3"S 71°16′21.7"W	Present study
	Juventus 2 (Rio Negro)	41°21′32.8"S 71°31′37.7"W	
	San Carlos de Bariloche (Rio Negro)	*41°09'S 71°18'W*	Cohen 1985; Belk and Brtek 1995
	Raimunda Lake, Meseta de Somuncura (Rio Negro)	*41°35'S 67°09'W*	
Chile	Balmaceda 1 (Aysén)	*45°53'S 71°40'W*	De los Ríos et al. 2008; Rogers et al. 2008
	Balmaceda 2 (Aysén)		
	Balmaceda 3 (Aysén)		

attached to the feathers or after surviving passage through the digestive system of birds or short distances being carried by wind (Cohen 2006, Rogers 2014). On the other hand, the presence of fairy shrimps does not occur in permanent waters with fish, as anostracans are defenseless against their predation. However, in Patagonian temporary wetlands there are numerous invertebrate predators, such as large copepods, insects and planarians (Jara *et al.* 2013). Indeed, we revisited the ponds during December and the fairy shrimp were not present, possibly the life cycle of these populations star early when pond inundate (autumn) and ends with the advance of spring when risk of predation increases due to the colonization by several predaceous invertebrates.

The diversity and distribution of Patagonian fairy shrimps are still unknown; many new species remain to be discovered and most described species are known only from the site from which the species was originally described. It is likely that many populations will be lost before they are discovered (Lefebvre *et al.* 2019). Accurate identification of anostracans is a critical starting point for wildlife management. For future researches, we highly recommend to capture the population dynamics of the Patagonian fairy shrimps and its interactions with possible depredators and abiotic factors.

Ethical statement

Collection of biological samples were conducted following all applicable ethical regulations regarding collection of biological samples and experimentation with animals. Wetlands were sampled under permit No. 52-AP-16 (Municipalidad de Bariloche), and permit APN N°1758.

Acknowledgements

This work was supported by the Agencia Nacional de Promoción Científica y Tecnológica Foncyt (PICT 2019-00358; PICT 2021-I-INVI-00412), Consejo Nacional de Investigaciones Científicas y Técnicas (PIBAA 28720210100538CO) and Universidad Nacional del Comahue (UNCo 04/B237). RDG and FGJ are CONICET researchers. MSA is CONICET Fellow. The authors have no relevant financial or non-financial interests to disclose. A special thanks to Cristian Perez for his help in taxonomic determination.

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Received: January 2023
Accepted: April 2023
Published: September 2023