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INVERTEBRATE COMMUNITIES ASSOCIATED TO *PARASTACUS PUGNAX* (DECAPODA, PARASTACIDAE) NORTHERN PATAGONIAN POPULATIONS (38° S, ARAUCANIA, CHILE): A FIRST EXPLORATORY ANALYSIS

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Invertebrate Communities Associated to *Parastacus pugnax* (Decapoda, Parastacidae) Northern Patagonian Populations (38° S, Araucania, Chile): a First Exploratory Analysis. De los Rios-Escalante, P. R., Jara-Seguel, P., Contreras, A., Latsague, M., Lara, G. — The burrowing crayfish *Parastacus pugnax* (Poeppig, 1835) inhabits the flooded plains in the central part of Chile (32–38° S), where it coexists with another representaives of invertebrate fauna. The aim of this study was to give the first description based on exploratory data of invertebrates associated to *P. pugnax* habitats in the Araucanía region, Chile. For comparison, published data on two similar habitats without *P. pugnax* populations were considered as outgroups. The obtained results revealed marked differences in species composition among sites with presence of *P. pugnax*, and without this species. A small number of species (1–5) was identified in the studied sites; Cladocera *Simocephalus expinosus* group was the most numerous and inhabited five of seven sites. Ecological and biogeographical topics were discussed.
Key words: *Parastacus pugnax*, flooded plains, invertebrates communities, *Simocephalus.*

Introduction

The Chilean crayfishes belongs to the Parastacidae family that contains the genera *Parastacus, Samastacus* and *Virilastacus* whose representatives inhabit between 32–46° S (Rudolph, 2013 a). One of them, *Parastacus pugnax* (Poeppig, 1835), is widespread in flooding plains called "vegas", streaching between 32–38° S (Rudolph, 2013 a, b; Velásquez et al., 2022) and forest wetlands at 38° S (Correa-Araneda et al., 2021, 2017). This species is the most studied and important as it is used for food in rural communities between 34–38°S regardless of seasonal change (Rudolph, 2013 b; Ibarra & Arana, 2012, 2011).

The habitats of *P. pugnax* are flood plains, where individuals excavate galleries as a shelter. During the rainy season (June–August), they come to the surface or to shallow zones, and after the end of the rainy season, in spring, summer and autumn, individuals are hidden in deep zones of their galleries (Rudolph, 2013 a, b). The associated communities of the habitats are poorly studied, with the exception of native forest wetlands at 38° S, where crustaceans such as amphipod *Hyalella patagonica* (Cunningham, 1871), isopod *Heterias exul* (Mueller 1892) and decapod *Aegla araucaniensis* (Jara, 1980) (Correa-Araneda et al., 2017) with high aquatic insect diversity (Correa-Araneda et al., 2021) were reported as associated fauna, which would be similar to the first descriptions of flooded plains at the same latitude (De los Rios Escalante et al., 2021).

Nevertheless, no studies have been conducted on the fauna associated to the galleries, but based on reports for *Virilastacus rucapihuelensis* galleries at 40° S latitude, endemic amphipods could be found (Grosso & Peralta, 2009). The aim of this study was to conduct the first preliminary investigation of invertebrate communities associated with *P. pugnax* habitats in the Araucania region, north of Chilean Patagonia (38° S).

Material and methods

Data from two sites Imperialito (38°48′ S; 73°04′ W) and Galvarino (38°24′ S; 72°47′ W) were collected in August 2022, during a rural community activity of *P. pugnax* extraction, called "crayfish festival", where the individuals were collected from their galleries using manual plunger pumps (Rudolph, 2013 a, b). Water collected from these pumps was filtered (3 L) through a 100 m screen, this volume was chosen based on the size of the water sample taken from the hand plunger pumps and the volume of water associated to *P. pugnax* galleries (De los Ríos- Escalante et al., 2021). The collected material was fixed with absolute ethanol, quantified and identified with literature descriptions (Dominguez & Fernández, 2009; Grosso & Peralta, 2009; González, 2003; Araya & Zúñiga, 1985). Also, data collected from flooded plains with *P. pugnax* described by De los Ríos-Escalante et al. (2021) was included for data set.

Data analysis: an abundance matrix was built, uploaded using Python software (Van Rossum & Drake, 2022), and the libraries Pandas (McKinney, 2022), NumPy (Harris et al., 2020), Matplotlib (Hunter, 2022) and Seaborn (Waskiiim, 2022) libraries, with the aim of apply exploratory analysis that explains the potential differences for studied groups involving statistical and programming techniques (VanderPlas, 2017). On this basis, cluster analysis was applied using Ward's method, which is a non-supervisory analysis method, since the final results of the order data set are based on the own data structure without the intervention of the researcher (VanderPlas, 2017; Geron, 2019). These statistical data analysis techniques and programming techniques can be applied to a small amount of data, as described in the present study (VanderPlas, 2017).

Results and discussion

The results obtained revealed a small number of species at each site: there were five species at the Galvarino 1 and Imperialito 2, and only one species was found at the Ranquilco site (table 1). The most frequent species was *Simocephalus exspinosus* (Koch, 1841) that was present in five of seven studied sites. The Cluster analysis revealed the existence of one main group, that included as main similar sites to Imperialito 1 and Imperialito 2, that are similar to the pair joined by Nehuentue and Galvarino, that simultaneously are joined with site Ranquilco, and finally the most different sites were Galvarino 2 and Pichinhual (fig. 1).

The exposed results revealed similarities in species composition to the first reported sites in flooded plains with *P. pugnax* presence and absence (De los Ríos-Escalante et al., 2021), and forest wetlands (Correa-Araneda et al., 2021, 2017). Nevertheless, the presence of amphipod specially *H. chiloensis* and *Rudolphia* sp., have not been reported for *P. pugnax* habitats, and

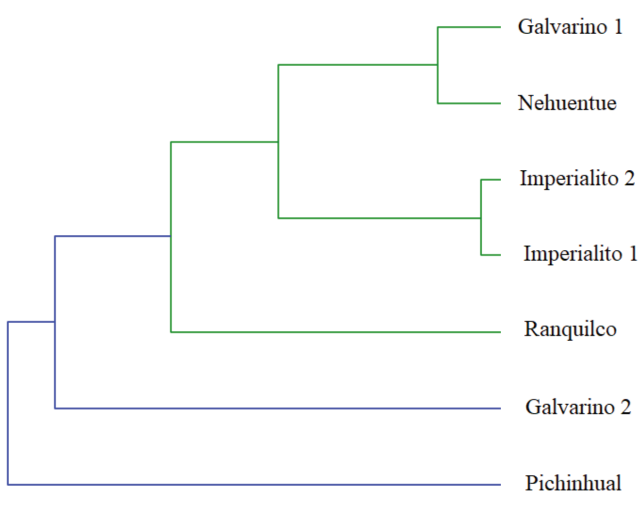

Fig 1. Cluster analysis for invertebrate communities reported for sites included in the present study.

Table 1. Average abundance (ind/L) invertebrate species reported for sites included in the present study (n = 3 by each site)

	Galvarino 1	Galvarino 2	Imperialito 1	Imperialito 2	Pichinhual	Ranquilco	Nehuentue
Geographical location	38°24´S; 72°47´W	38°24´S; 72°47´W	38°48´S; 73°04´W	38°48´S; 73°04´W	38°43´ S; 73°22´ W	38°43´S; 73°03´W	38°45´ S; 73°25´ W
Simocephalus expinosus (Koch, 1841)	0.11	0.00	0.00	0.11	3.60	0.00	0.63
Daphnia sp. (juvenile)	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Mesocyclops araucanus Löffler, 1962	0.00	0.00	0.00	0.00	0.97	0.00	0.00
Calanoids copepodites	4.33	0.00	0.00	0.00	0.00	0.00	0.00
Cyclopoids copepodites	0.11	0.00	0.00	0.11	3.07	0.00	0.00
Ostracoda indet	3.00	0.33	0.00	1.44	0.00	0.00	0.83
Nauplius	0.00	0.33	0.00	0.00	0.00	0.00	0.00
Rudolphia sp	0.00	0.00	0.11	0.11	0.00	0.00	0.00
Hyalella chiloensis Gonzalez & Watling 2001	0.00	0.00	0.00	0.44	3.83	0.00	0.00
Diptera	0.22	0.56	0.00	0.00	0.33	0.00	0.00
Chileporter sp	0.00	0.00	0.00	0.00	0.00	0.73	0.00
Acari	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Source	*	*	*	*	**	**	**

Source: *present study; ** De los Ríos-Escalante et al., 2021.

probably shows an important scenario on an ecological and biogeographical viewpoint. The presence of *H. chiloensis* in ground waters was reported from coastal water springs at 40° S, associated to the endemic amphipod *Patagondidiella wefkoi* (Perez-Schultheiss, 2013), from this point of view, the presence of *H. chiloensis* associated to ground waters in the present study would be an important ecological record.

In according to the checklist of ground water crustaceans of De los Ríos et al. (2016), only the presence of *Rudolphia* sp., was mentioned there, nevertheless the presence of ostracods, and zooplanktonic cladocerans (including *Simocephalus serrulatus*) and copepods are similar with descriptions of De los Ríos-Escalante & Romero-Mieres (2020) for ground waters within Temuco town, at similar latitude to studied sites. According to the literature, cyclopoid copepods (Williams, 1993; Strayer & Reid, 1999; Reid et al., 2006; Brancelj & Dumont, 2007) and cladocerans have adaptations for groundwater colonization (Dumont & Negrea, 1996; Brancelj & Dumont, 2007).

The exposed results denote new findings, that confirm the colonization of zooplanktonic cladocerans and copepods in ground waters and revealed more detailed data on invertebrate communities in comparison to the first descriptions of De los Ríos-Escalante et al. (2021). However, more research is needed to understand patterns in community ecology.

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