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Spatial patterns of *Pisidium chilense* (Mollusca Bivalvia) and *Hyalella patagonica* (Crustacea, Amphipoda) in an unpolluted stream in Navarino island (54° S, Cape Horn Biosphere Reserve)

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KEYWORDS

Pisidium chilense;
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Abstract The southern South American inland waters have many endemic species and some of them are considered as endangered for IUCN, that inhabits in unpolluted ecosystems, one of these ecosystems are the sub-Antarctic perennial forests located in the Cape Horn Biosphere Reserve at 54° S. The aim of the present study is to analyze the spatial patterns of *Pisidium chilense* Ituarte, 1999 (Mollusca Bivalvia) and *Hyalella patagonica* (Cunningham, 1871) (Crustacea, Amphipoda) in an unpolluted stream. Both species had aggregated spatial distribution, both have a negative binomial distribution pattern, and both are associated. The present results would agree with similar patterns in Patagonian rivers where both species coexist.

1. Introduction

The Southern Patagonia has unpolluted ecosystems with low human intervention due mainly to their geographic isolation and difficult access. There are many endemic species, especially in inland water bodies (Jara et al., 2006). The Cape Horn Biosphere Reserve is located in the southern island of South America with unpolluted and pristine sub-Antarctic perennial forests with unpolluted lakes, rivers and streams, the fauna is markedly endemic (Moorman et al., 2006). The benthic fauna

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spatial distribution can be explained in accordance to probabilistic models that can explain if the species have random, aggregated or uniform spatial distribution (Elliot, 1983; Zar, 1999). On this basis, the spatial pattern can adjust to Poisson, negative binomial or binomial distribution respectively (Elliot, 1983; Fernandes et al., 2003; De los Rios-Escalante, 2011). The aim of the present study is to analyze the spatial distribution of two species representative from Southern Patagonian inland waters, the bivalve *Pisidium chilense* Ituarte, 1999 and the crustacean *Hyalella patagonica* (Cunningham, 1871), *P. chilense* is considered as endangered for IUCN (IUCN, 2015). Both species are important in inland water communities in Southern Patagonia (Moorman et al., 2006).

2. Materials and methods

The studied site was a small stream close to Robalo river located close to Puerto Williams town in an protected unpolluted area, close to Cape Horn Biosphere Reserve, in Navarino island (54° 55′ 47,3′ S; 67° 33′ 43,8″ W, Fig. 1). Samples were collected from the riparian zone of this shallow stream using a ø L plastic cube with a 1 mm mesh, 20 replicas were collected random along a transect of 50 m from the study site, and the specimens were counted *in situ*. The site was visited and sampled on the 10th February 2010. It was used in a 2 × 2 contingency table analysis with the species *H. patagonica* and *P. chilense* as the first and second categorical variables. The Mean abundance (and variance) was calculated for both species with the aim of determining if their spatial dispersions are aggregated, random or uniform using Variable/Mean ratio to determine if both species are associated (Zar, 1999; Gotelli and Ellison, 2004). Software Xlstat 10.0 was used when the population dispersions were described by the negative binomial distribution (Zar, 1999; Fernandes et al., 2003).

3. Results and discussion

The results of the 2 × 2 contingence table revealed first that both species are not independent in the sampled site, this means that both species share the habitat together (χ^2

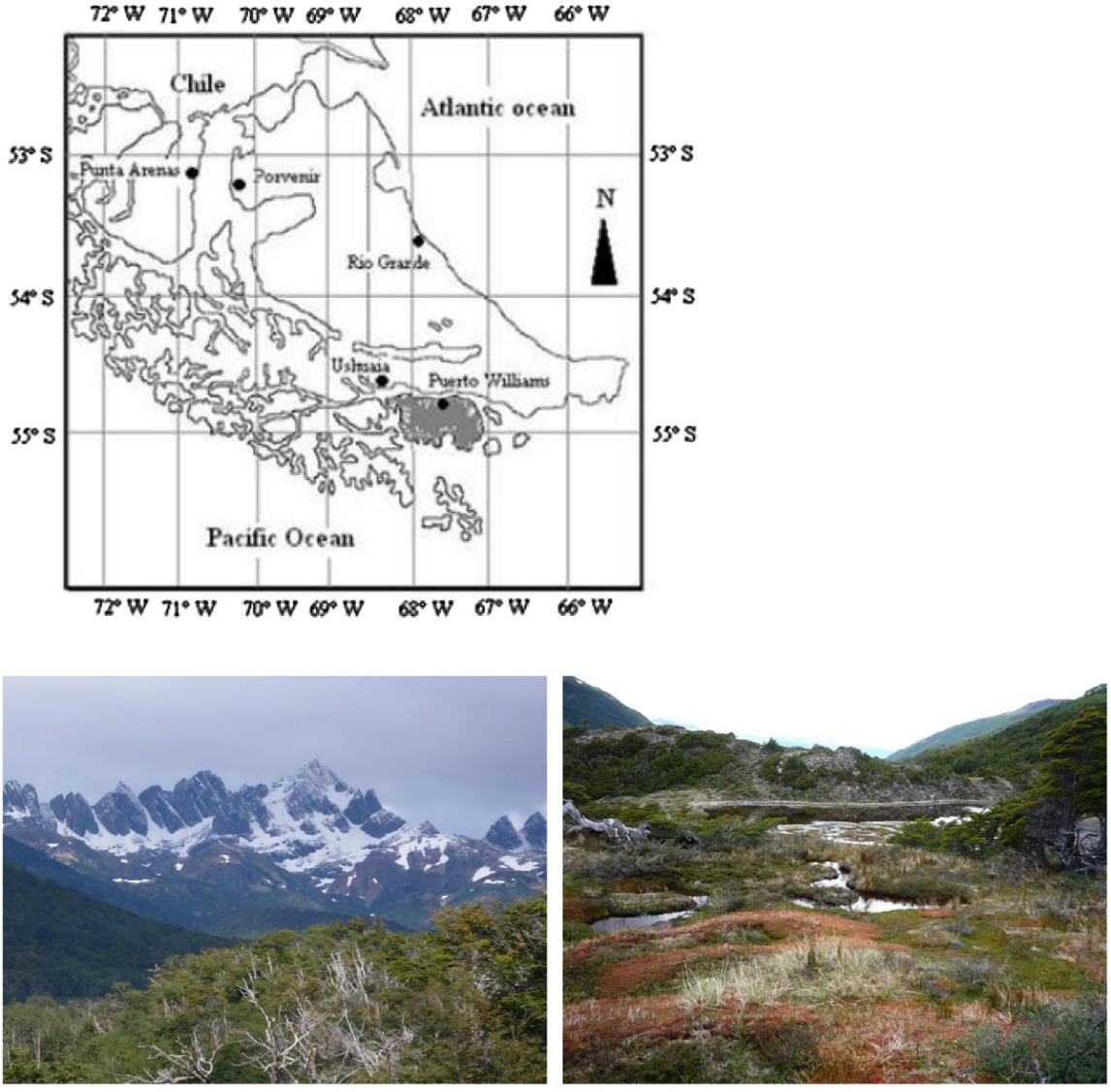

Figure 1 Location Navarino island (in gray), Puerto Williams town and photograph of studied site.

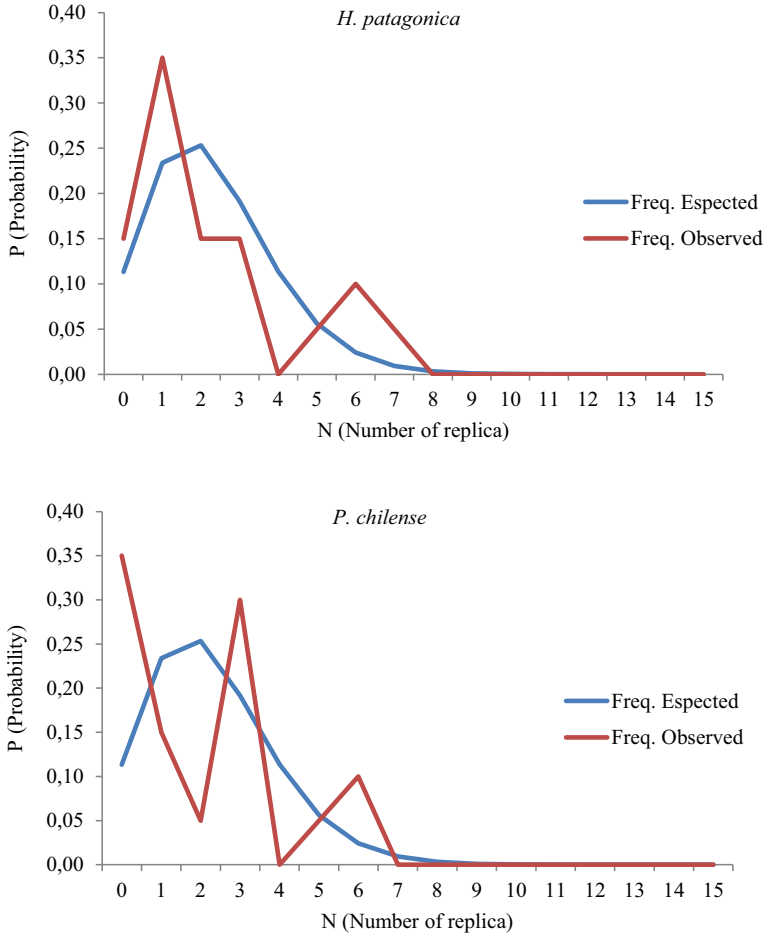

Figure 2 Results of negative binomial distribution observed for *H. patagonica* and *P. chilense*.

Table 1 Specimen numbers in sampling unit (½ L) of *H. patagonica* and *P. chilense* observed in the present study.

Sampling unit	*Hyalella patagonica*	*Pisidium chilense*
1	3	1
2	1	0
3	7	0
4	0	0
5	2	3
6	2	0
7	1	3
8	0	0
9	3	0
10	3	6
11	1	3
12	0	3
13	1	3
14	1	3
15	2	1
16	1	6
17	5	0
18	1	5
19	6	1
20	6	2
Mean	2.30	2.00
Variance	4.54	4.11

observed = 1365.03 > χ^2 table, 3.841), about spatial pattern, the population has an aggregated distribution pattern (Table 1; χ^2 observed = 0.656 <; χ^2 table, 0.05;14 = 3.841) and a negative binomial distribution pattern for *H. patagonica* (χ^2 observed = 0.031 <; χ^2 table, 0.05;14 = 23.685; Fig. 1) and *P. chilense* (χ^2 observed = 1.114 <; χ^2 table, 0.05;1 = 23.685; Fig. 2). The results in density would be similar with ecological observations for central Chilean rivers where both species can coexist mainly in middle zones of the rivers with high organic matter contents (Figueroa et al., 2003, 2007; Dominguez and Fernández, 2009).

The coexistence of genus *Hyalella* and *Pisidium* was also described for small streams in Uruguay at temperate latitude (Morelli and Verdi, 2014) and in tropical wetlands in Colombia (Rivera et al., 2013). The association of both species would agree with associations of *Hyalella* and *Pisidium* genus in central Chilean Patagonia at 45° S, because both species are frequent preys of native fish populations (Belk et al., 2013). Also, both species are present in salmonid diets, these results would agree with descriptions for Iceland *Salvelinus alpinus* populations (Woods et al., 2013). The obtained results agree with descriptions of Anderson et al. (2014) who mentioned associations between *Hyalella* and *Pisidium* in different kinds of waterbodies in Tierra del Fuego island and Beagle Channel islands in sites with beaver (*Castor canadiensis*) presence and absence.

Negative binomial distribution pattern observed in both populations agree with the literature descriptions about ecological data (Hilborn and Mangel, 1997; Zar, 1999; Maruyama et al., 2002; Fernandes et al., 2003), mainly benthic data (Elliot, 1983; Gray, 2005; Noro and Buckup, 2010), for ectocommensals (De los Ríos-Escalante, 2014) and parasitological interactions (Shaw et al., 1998; Peña-Rehbein and De los Ríos-Escalante, 2012; Peña-Rehbein et al., 2013). Nevertheless, De los Rios-Escalante (2011) did not find distributions for benthic crustaceans in lakes and rivers which would be due to marked environmental heterogeneity of different studied sites that would not happen in the present study.

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