Probabilistic model for understand presence of *Temnocephala chilensis* (Moquin-Tandom 1846) (Platyhelminthes: Temnocephalidae) on adults of a population of *Parastacus pugnax* (Poeppig 1835) (Decapoda: Parastacidae) in southern Chile

Modelo probabilistico para comprender la presencia de *Temnocephala chilensis* (Moquin-Tandom 1846) (Platyhelminthes: Temnocephalidae) en una población adulta de *Parastacus pugnax* (Poeppig 1835) (Decapoda: Parastacidae) en el sur de Chile

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ABSTRACT

The literature reported ectocommensals associated to *Parastacus pugnax* (Poeppig, 1835), but there are not ecological studies about abundance of these on *P. pugnax*. The aim of the present study was to analyze the abundances of ectocommensal *Temnocephala chilensis* (Moquin-Tandom, 1846), on *P.pugnax*. It had not correlation between *T. chilensis* number with total length and total weight of *P. pugnax*. *T. chilensis* has an associated spatial distribution and negative binomial distribution. Ecological and evolutive topics were discussed.

Keywords: *Parastacus pugnax, Temnocephala chilensis,* negative binomial distribution, ectocommensals.

RESUMEN

La literatura reporta la presencia de ectocomensales asociados a *Parastacus pugnax* (Poeppig, 1835), pero no hay estudios ecológicos sobre la abundancia de estos sobre *P. pugnax*. El objetivo del presente estudio fue analizar la presencia de *Temnocephala chilensis* (Moquin-Tandom 1846), en *P.pugnax*. No hubo correlación significativa entre el número de individuos de *T. chilensis* con el largo total y el peso total. *T. chilensis*tiene un patrón de distribución espacial agregada y distribución binomial negativa. Se discuten tópicos ecológicos y evolutivos.

Palabras clave: *Parastacus pugnax, Temnocephala chilensis,* distribución binomial negativa, ectocomensal.

The Chilean inland water malacostracan have been poorlystudied in many biological topics, including their species interactions (Rudolph 2002, 2010, 2013). In Chile there are six species of crayfish of the family Parastacidae, which live in littoral zones in rivers, swamps, or flooded plains in Central and Southern Chile (Rudolph 2010). For the *P. pugnax* there are studies about commensals such as *Temnocephala chilensis* (Moquin-Tandom 1846) (Plathyelminthes; Temnocephalida), *Stratiodrilus pugnaxi* Vila and Bahamonde 1985 (Polichaeta, Histriobdellidae), *Operculigera assymetrica* (Clamp 1991), *O. insolita* (Clamp 1991), *O. parastaci* (Clamp 1991), *O. seticola* (Clamp 1991), *O. striata* (Clamp 1991), *Lagenophys andops* (Jankoswki 1986), *L. antichtos* (Clamp 1991)(Ciliophora, Peritricha, Lagenophryidae)(Rudolph 2013). Nevertheless there are not quantitative studies about the presence of these species on their hosts.

Specimens of *P.pugnax* were collected from Ranquilco valley, a flooded plain close to Temuco (38º42'S; 73º04'W),

Chile. Fresh specimens were observed under microscope and for each one wasextracted *T. chilensis* specimens that were fixed in absolute ethanol. Each crustacean was weighted and total length from tip of the telson to the top of rostrum was measured with manual caliperin laboratory. Specimens were collected in two different times during August 2011.

The obtained data were analyzed in two steps; in a first step, it was determined the presence of potential association between abundance of *T. chilensis* individuals by total length and total weight using a correlation analysis. Posteriorly, a non randomness test was applied considering the variance and mean ratio of *T. chilensis* individuals by *P. pugnax* individuals with the aim to determine if *T. chilensis* individuals are distributed random, or aggregate (Zar 1999). On the basis of these last results, it was applied a second probability test to determine if the *T. chilensis* individuals had Poisson, negative binomial or positive binomial distribution (Fernandez et al. 2003). All statistical analysis was applied using the software Xlstat 5.0.

The total length of *P. pugnax* adults varied between 32 to 49 mm whereas total weight varied between 2.1 and 36.8 g and abundance of *T. chilensis* individuals varied from 0 to 20 (Table 1). The results revealed the absence of significant correlation between abundance of *T. chilensis* individuals and total length and total weight (Fig. 1).The results of non randomness test revealed for the two sample groups the existence of an aggregated pattern (Table 1), and this pattern was adjusted to a negative binomial distribution (Table 1, Fig. 2).

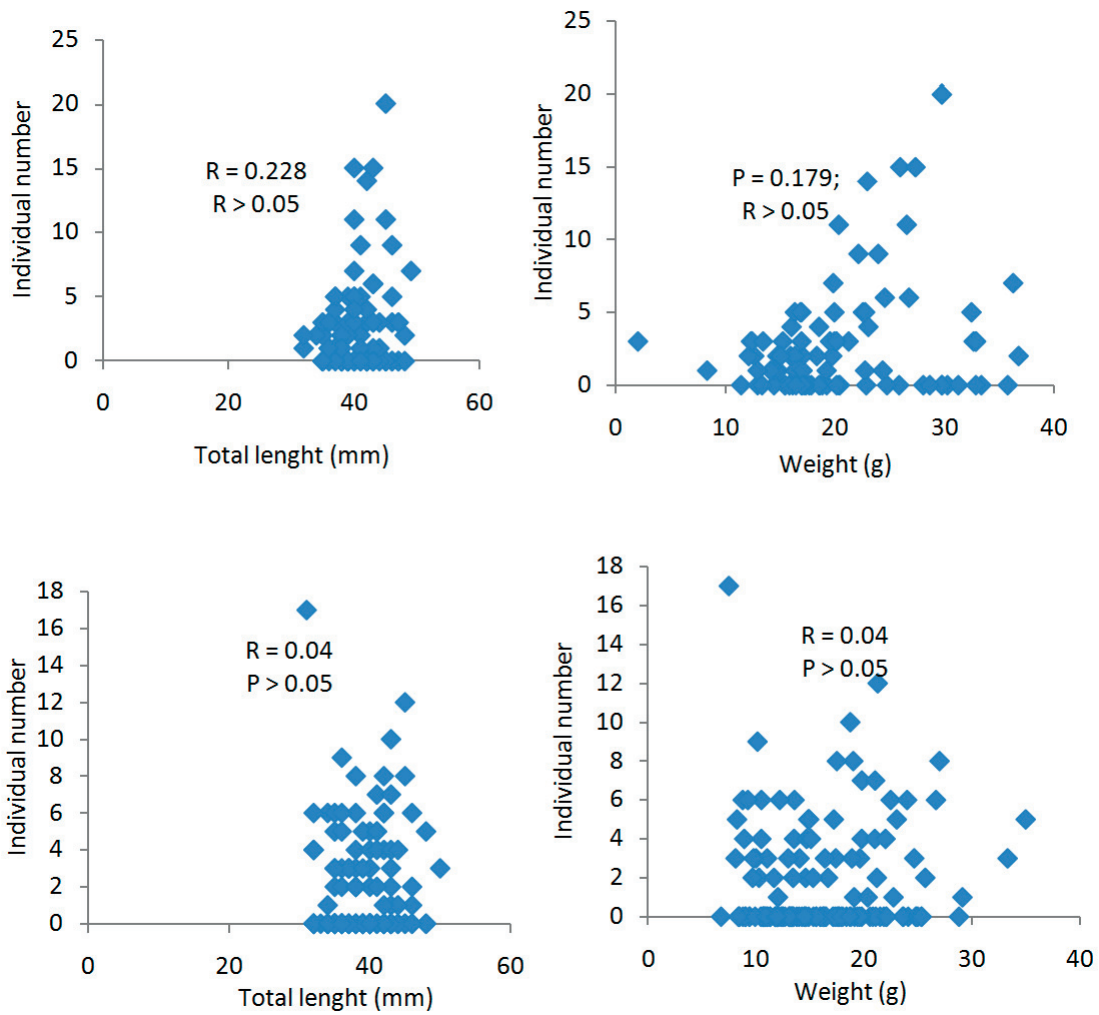

Figure 1. Correlation analysis between *T. chilensis* individuals with total length and total weight in two *P. pugnax* sampled groups (first group up, 01th August 2012, second group low, 30th August 2012).

Figura. 1. Análisis de correlación entre individuos de *T. chilensis* con el largo total y peso total en dos grupos muestreados de *P.pugnax* (primer grupo 01 de agosto de 2012, segundo grupo 30 de agosto de 2012).

Table 1. Data of *P. pugnax* and *T. chilensis*, and results of variance /mean ratio of *T. chilensis* sampled in the present study.

Tabla 1.Datos de *P. pugnax* y *T. chilensis* y resultados de la razón varianza media de *T. chilensis* muestreados en el presente estudio.

First group (n = 90) sampled August 01st, 2011.			
	Total length (cm)	Total weight (gr)	Number of *T. chilensis*
Average	4.05	20.57	2.74
Minimum	3.20	2.10	0.00
Maximum	4.90	36.80	20.00
Standard deviation	0.39	6.86	3.87
Variance / mean = 5.45			
Second group (n = 150), sampled August 30th, 2011.			
	Total length (cm)	Total weight (gr)	Number of *T. chilensis*
Average	3.90	15.95	1.73
Minimum	3.10	6.79	0.00
Maximum	5.00	34.97	17.00
Standard desviation	0.40	5.51	2.83
Variance / mean = 4.62			

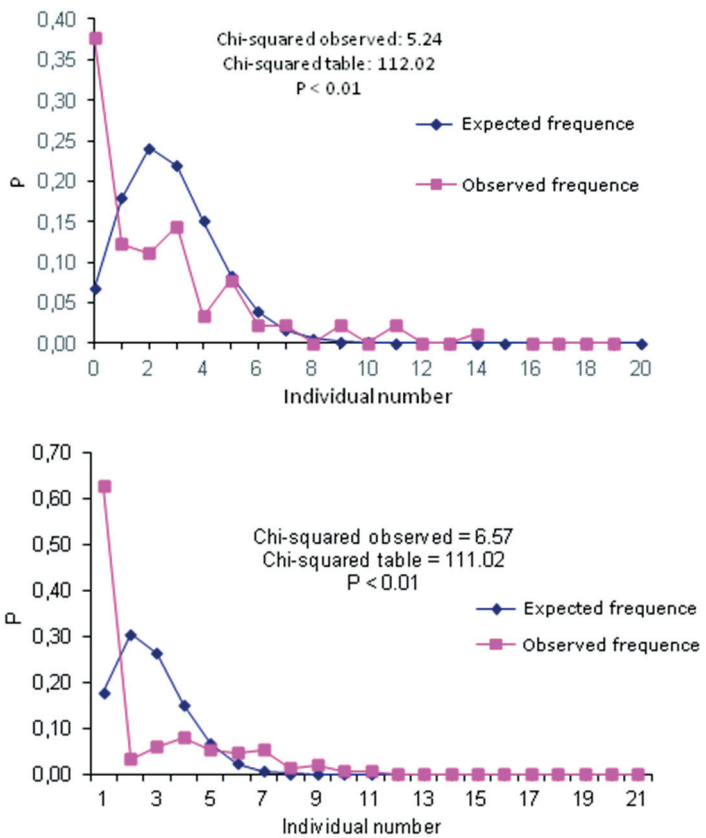

Figure 2. Results of negative binomial distribution of *T. chilensis* individuals on *P. pugnax* sampled groups (first group up, 01th August 2012, second group low, 30th August 2012; Y axis: expected frequency; x axis individual numbers).

Figura2. Resultados de la distribución binomial negativa de individuos de *T. chilensis* en los dos grupos muestreados de *P.pugnax* (primer grupo 01 de agosto de 2012, segundo grupo 30 de agosto de 2012).

The presence of this ectocomensal species has been described for *Samastacus spinifrons* and *P. pugnax* for Chilean inland waters (Rudolph 2002, 2013), and for species of *Aegla* genus from Central and Southern Argentina and Chile (Damborenea and Cannon 2001). Also, Damborenea & Cannon (2001), cited to this species for the genus *Parastacus* in Talcahuano, Chile, unfortunately it was not specified the species of *Parastacus*. The literature about *Temnocephala* indicated that this genus has 19 species widespread in neotropical region that are commensals on crustaceans, mollusks, and insects (Damborenea & Cannon 2001).

The results about aggregate pattern of *T. chilensis*, agree with results for another parasitological studies (Peña-Rehbein & De los Ríos-Escalante 2012), and insects in crop fields (Fernandes et al. 2003). Aggregated pattern is caused by a series of factors as diet, behavior, or immunity, among others. This pattern has consequence for organisms, becauseincrease competition but also allow their reproduction (Poulin 2007). If we considered that many malacostracan inland water species are endemic (Rudolph 2002, 2013), it is probably the existence of marked microendemism at level of parasites and commensals.In this scenario, it would be probably on an evolutive view point that the aggregated pattern would provide an advantage for successful presence of parasites and commensals.

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