Use of a negative binomial distribution to describe the presence of *Trifur tortuosus* Wilson, 1917 in *Merluccius gayi gayi* (Guichenot, 1848).

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ABSTRACT

This paper describes the frequency and number of *Trifur tortuosus* Wilson, 1917 in the skin of *Merluccius gayi gayi* (Guichenot, 1848), an important economic resource in Chile. The analysis of a spatial distribution model indicated that the parasites tended to cluster. Variations in the number of parasites per host could be described by a negative binomial distribution. The maximum number of parasites observed per host was one, similar patterns was described for other parasites in Chilean marine fishes.

Key words: *Trifur tortuosus*; *Merluccius gayi gayi*; negative binomial distribution

RESUMEN

El presente estudio describe la frecuencia y número de *Trifur tortuosus* Wilson, 1917 en la piel de *Merluccius gayi gayi* (Guichenot, 1848), un recurso económico importante en Chile. El análisis de un modelo de distribución espacial indicó que los parásitos tendían a agruparse. Las variaciones en el número de parásitos por huésped podrían describirse mediante una distribución binomial negativa. El número máximo de parásitos observados por huésped fue uno, se describieron patrones similares para otros parásitos en peces marinos chilenos.

Palabras clave: *Trifur tortuosus*; *Merluccius gayi gayi*; Distribución binomial negativa

INTRODUCTION

The genus *Trifur* Wilson, 1917, includes currently three species *T. chlorophthalmi* Yamaguti, 1939, *T. godfroyi* (Quidor, 1913), *T. tortuosus* Wilson, 1917 (WoRMS, 2015), *T. tortuosus* can parasite marine fishes in and Atlantic Pacific zone of South America (Oliva & González, 2004; Timi et al., 2008; Etchegoin et al., 2009). To date, copepods have been found to be parasitic in less than 2% of aquatic invertebrates and less than 20% of fish (Morales-Serna & Gómez, 2012). Damage inflicted by *Trifur* spp. is mainly aesthetic, as the parasites leave unsightly scars deep in the flesh of affected fish (Etchegoin et al., 2009). Holdfasts that are left behind following parasite death cause abscesses 2 cm or more in length. In Germany, regulations prohibit the sale of fillets that are more than 5% affected by the parasite for human consumption, and therefore heavily infected fish are used for fish meal or pet food (Woo, 2006). The aim of this study is to determine the frequency distribution of *Trifur tortuosus* on *Merluccius gayi gayi* (Guichenot, 1848) using probabilistic models.

MATERIAL AND METHODS

We studied two hundred and ninety nine *M. gayi gayi* samples obtained in June and July of 2012 from two marketplaces and one supermarket in Temuco, Chile. Parasites isolated from the skin of the fish were fixed in 96% ethyl alcohol and stored in properly labeled containers until analysis was performed at the School of Veterinary Medicine, Universidad Católica de Temuco, Chile.

The pattern of randomness in the distribution of the number of parasites per host was investigate (Zar, 1999). We used the variance/mean ratio and the Morisita index to characterize the data as randomly patterned, uniform or clustered (Peña-Rehbein & De los Ríos-Escalante, 2012; Peña-Rehbein et al., 2013). Furthermore we applied the Poisson distribution, the negative binomial distribution or the binomial distribution according to the data pattern observed. We used a χ 2 test to evaluate the fit of the data to the expected distribution (Fernandes et al., 2003). All analyses were performed with the XLSTAT 5.0 program (Addinsoft, New York, USA).

RESULTS AND DISCUSSION

The values of the variance/mean ratio and the Morisita index were 1.736 and 460.33 respectively. These results showed that the data followed an overdispersed frequency distribution in their hosts. We therefore used the negative binomial distribution to model the data. The data fit this distribution (χ 2 Observed = 0.747 < χ 2 table = 168.130; p > 0.05). Many individuals were found not to contain *T. tortuosus*. The maximum observed number of parasites was one per host (Table 1, Figure 1).

Our findings are similar to the results of Peña-Rehbein and De los Rios-Escalante (2012) who studied the nematode *Anisakis* in *Thyrsites atun*. Confirmation of a negative binomial distribution describing the number of parasites per host suggests a robust model that permits an informative interpretation of parasite distribution patterns (Shaw et al., 1998, Peña-Rehbein et al., 2013) and ectocommensals (De los Ríos-Escalante et al., 2014).

Table 1. Numbers of *Trifur tortuosus* parasites observed in the skin of *Merluccius gayi gayi gayi* samples obtained from the fish market of Temuco (Araucanía region, Chile).

Number of parasites observed	Number of *M. gayi* with parasites
0	279
1	14
2	3
3	3
4	0
5	0
6	0
7	0
8	0
9	0
10	0

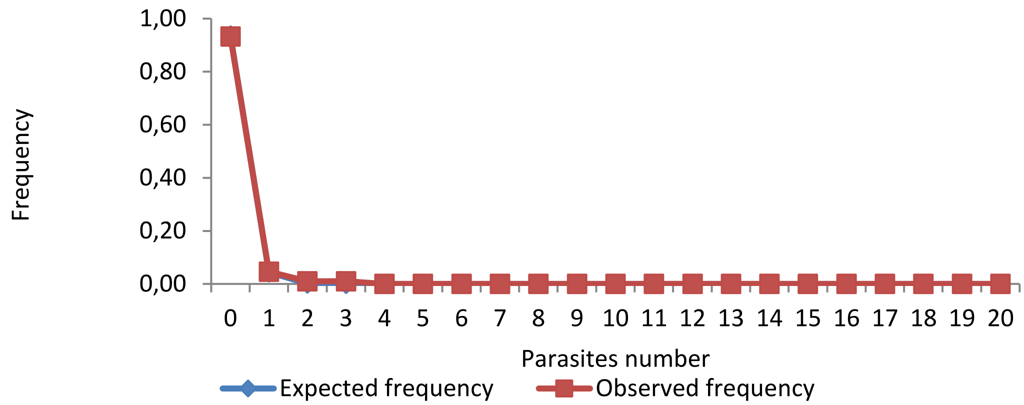

Figure 1. Expected and observed frequencies for the negative binomial distribution model describing the presence of *Trifur tortuosus* in the skin of *Merluccius gayi gayi gayi* obtained from the fish market of Temuco (Araucanía region, Chile).

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