Research Note

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Use of a negative binomial distribution to describe the presence of *Sphyrion laevigatum* in *Genypterus blacodes*

Uso de distribuição binomial negativa para descrever a presença de *Sphyrion laevigatum* em *Genypterus blacodes*

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Abstract

This paper describes the frequency and number of *Sphyrion laevigatum* in the skin of *Genypterus blacodes*, 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 two.

Keywords: *Sphyrion laevigatum*, *Genypterus blacodes*, negative binomial distribution.

Resumo

Este artigo descreve a frequência e o número de *Sphyrion laevigatum* da pele de *Genypterus blacodes*, o qual é um importante recurso econômico no Chile. A análise baseada em modelos de distribuição espacial, demonstrou que os parasitos tendem a ficar agrupados. A variação numérica de parasitas por hospedeiro pode ser descrita por distribuição binomial negativa. O número máximo observado de parasitas por hospedeiro foi dois.

Palavras-chave: *Sphyrion laevigatum*, *Genypterus blacodes*, distribuição binomial negativa.

Within the order Ophidiiformes, the genus *Genypterus* Philippi 1857 contains those species that are most economically important. Three of these species are found in Chilean waters: *Genypterus chilensis* (Guichenot, 1881), *Genypterus maculatus* (Tschudi, 1846) and *Genypterus blacodes* (Forster, 1801), the latter being the most economically significant of the three (CANALES-AGUIRRE et al., 2010). *Genypterus blacodes* are elongate ell-like fish that are confined to the continental shelf and slope of the southern hemisphere, including the coasts of Australia, New Zealand, Argentina, Uruguay and Chile (CANALES-AGUIRRE et al., 2010; CORDO, 2001; FRANCIS et al., 2002; RIFFO, 1994; WARD; REILLY, 2001). *G. blacodes* is a tertiary predator characterized by a diet that is dominated by demersal and benthic fish (NYEGAARD et al., 2004; RENZI, 1986).

The genus *Sphyrion* is comprised of three species, *Sphyrion laevigatum* (Quoy & Gaimard, 1824), *Sphyrion lumpi* (Krøyer, 1845) and *Sphyrion quadricornis* Gaevskaya & Kovaleva, 1984 (HO, 1992; WALTER; BOXSHALL, 2012). *S. lumpi* is a common parasite of deep water pelagic fish in the Atlantic Ocean, New Zealand, and the Beaufort Sea (GORDON, 2009; HO; KIM, 1989; MILLER, 2012; WOO, 2006). Other studies have investigated the ecology of *S. laevigatum* among populations of *G. blacodes* in New Zealand, Australia, Chile, and Falkland Islands (BRICKLE et al., 2003), but in general, the ecological characteristics of parasitic copepods have been poorly investigated. To date, copepods have been found to be parasitic in less than 2% of aquatic invertebrates and less than 20% of fish (MORALES-SERNA; GOMEZ, 2012).

Damage inflicted by *Sphyrion* spp. is mainly aesthetic, as the parasites leave unsightly scars deep in the flesh of affected fish (PAINE, 1986). 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 *S. laevigatum* on G. *blacodes* using probabilistic models.

We studied two hundred and nine *Genypterus blacodes* samples obtained in June and July of 2012 from two marketplaces and one supermarket in Temuco, Chile. Parasites isolated from the skin of

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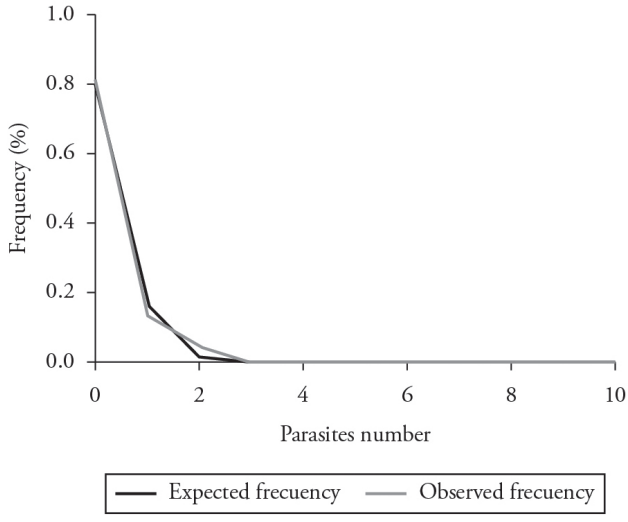

Figure 1. Expected and observed frequencies for the negative binomial distribution model describing the presence of *Sphyrion laevigatum* in the skin of *Genypterus blacodes* obtained from the fish market of Temuco (Araucanía region, Chile).

Table 1. Numbers of *Sphyrion laevigatum* parasites observed in the skin of *Genypterus blacodes* samples obtained from the fish market of Temuco (Araucanía region, Chile).

Number of parasites observed	Number of *G. blacodes* with parasites
0	171
1	29
2	9
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0

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 investigated (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 RIOS-ESCALANTE, 2012). 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).

The values of the variance/mean ratio and the Morisita index were 1.16 and 105.72 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 = 0.037 < χ^2 table = 28.336; $p > 0.05$). Many individuals were found not to contain *S. laevigatum*. The maximum observed number of parasites was two 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).

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