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SHORT NOTE

Ectoparasite abundance and apparent absence of hemoparasites in two albatross species in Sub-Antarctic Chile

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Abstract The Black-browed Albatross (BBA, *Thalassarche melanophrys*) and the Grey-headed Albatross (GHA, *Thalassarche chrysostoma*) are long-lived sympatric species breeding in the Atlantic and Pacific sections of the Southern Ocean. While the Atlantic populations of these two species have been the subject of several studies, little information is available on the most important colonies in the Southeast Pacific Ocean (Chile). The presence of parasites in these long-lived hosts has been described for the colonies in the Southern Atlantic, but not in those from Chile. Therefore, the objective of this study was to identify ectoparasites and hemoparasites associated with both species breeding in the Diego Ramírez Archipelago (56°S) in Southern Chile. Chicks were examined for ectoparasites during the breeding seasons in 2010 and 2011 (GHA, $n = 80$; BBA, $n = 40$). Parasites were collected manually, mounted, and identified to species level. The sex and developmental stage of adult ectoparasites were also determined. Ectoparasites were detected on 78.75 and 32.50% of GHA and BBA chicks, respectively. A total of 126 ectoparasites were obtained: 103 *Ixodes uriae* ticks (GHA 79.62%, BBA 20.38%); 22 *Parapsyllus longicornis* fleas (GHA = 31.8%, BBA = 68.2%); and a single *Austromenopon affine* louse (found on GHA). Diego Ramírez represents a new record and distribution range for *I. uriae* and *A. affine*. The presence of hemoparasites was explored on blood smears for GHA ($n = 26$) and BBA ($n = 119$), but none were recorded in either of these albatrosses.

Keywords Hemoparasite · Flea · Louse · Seabird · Southern Ocean · Tick

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Introduction

The Black-browed Albatross (*Thalassarche melanophrys,* BBA) and Grey-headed Albatross (*Thalassarche chrysostoma*, GHA) are long-lived seabirds distributed in the waters of the Southern Hemisphere. Almost the entire global population of BBA ($\sim$99%) and the greater portion of GHA numbers ($\sim$85%) reside in islands located in the SW Atlantic and SE Pacific regions of the Southern Ocean (Robertson et al. 2007). The Diego Ramírez Archipelago supports the largest numbers of BBA and almost the entire population of GHA in Chile, carrying $\sim$20 and $\sim$23% of global numbers, respectively (Robertson et al. 2007). BBA is the more abundant albatross species in the archipelago, with GHA breeding around the margins of BBA colonies or in separated groups (Robertson et al. 2007). In Diego Ramírez, these two species have nesting densities of 0.01 and 0.60 nests m^{-2}, respectively (Suazo unpubl. data). During the breeding season, BBA and GHA arrive in late August and early September, respectively, and leave in April (BBA) and in the first half of May (GHA), entering their nonbreeding seasons (Suazo unpubl. data). Diego Ramírez is the most representative breeding area for both

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albatross species in the sub-Antarctic waters of the Southeast Pacific.

Among seabirds, the tick *Ixodes uriae* (Acari: Ixodidae) is the most common ectoparasite infesting more than 60 different species (including BBA and GHA) in both hemispheres, most notably in polar regions (Dietrich et al. 2011). The life cycle of *I. uriae* includes four stages (egg, larva, nymph, and adult). All post-embryonic stages except for adult males need to feed from the host. *Ixodes uriae* is constrained to feed only during the breeding season when their seabird hosts have returned to land. During nonfeeding periods, *I. uriae* remains in the substrate near its host's nesting area (McCoy and Tirard 2002; Muñoz-Leal and González-Acuña 2015). The fleas (Siphonaptera) *Notiopsylla kerguelensis* (Pygiopsyllidae) and *Parapsyllus longicornis* (Rhopalopsyllidae) have been reported for both BBA and GHA (Murray et al. 1990). Lice (Phthiraptera) of the genera *Austromenopon* (Menoponidae), *Docophoroides* (Philopteridae), *Paraclisis* (Philopteridae), *Harrisionella* (Esthiopterinae), *Perineus* (Philopteridae), and *Saemundssonia* (Philopteridae) have previously been described in both albatross species in other sub-Antarctic islands (Price et al. 2003). Ectoparasites may directly affect the reproductive success of albatross populations (Bergström et al. 1999) and may transmit various pathogenic organisms (Barbosa and Palacios 2009). Hemosporidian agents that parasitize seabirds include the genera *Hemoproteus*, *Leucocytozoon*, *Babesia*, *Plasmodium*, and *Hepatozoon*, with *Hepatozoon albatrossi* being the only hemoparasite species detected in GHA and BBA in the South Georgia Islands (Quillfeldt et al. 2011). *Ixodes uriae* has been also associated with transmission of *Babesia* sp. in an Antarctic population of Chinstrap Penguins (*Pygoscelis antarctica*, Montero et al. 2016). Information is scarce regarding ectoparasite and hemoparasite prevalence and diversity in colonies of BBA and GHA breeding in the Pacific section of the Southern Ocean (Muñoz-Leal and González-Acuña 2015). The main objective of this study was to identify and characterize the ectoparasites and hemoparasites of two sympatric albatrosses from their breeding colonies in the southeast Pacific section of the Southern Ocean (Chile).

Materials and methods

Study site and ectoparasite sampling

This study was performed in the Diego Ramírez Archipelago (56°31′S; 68°44′W; Fig. 1), Sub-Antarctic Chile, during the reproductive seasons of 2010 and 2011 (September–April). In this particular study, we only included discrete subcolonies of GHA and BBA that were not spatially mixed. Chicks (GHA = 80; BBA = 40) were

each inspected manually for 5 min, focusing on areas where ectoparasites were considered likely to be found (head-crown, throat, flanks-apteria, legs, and cloaca). The study was performed during the brood–guard periods for both BBA and GHA; thus, the inspected chicks had similar ages and weights ($\sim$18–23 days post-hatching, 700–1000 g), and their bodies were entirely covered by down feathers. Fleas, ticks, and lice were collected with tweezers and preserved in 96% alcohol. Ticks were observed directly with a microscope, and identification was based on papers by Durden and Keirans (1996) and Kleinjan and Lane (2008). Fleas and lice were mounted following standard techniques described in Palma (1978) and Trolle and Jensen (2001), respectively. The specimens were identified following the keys provided by Price et al. (2003) for lice and Johnson (1957) and Smit (1987) for fleas. The developmental stage and sex of ticks, fleas, and lice were also determined.

Hemoparasite sampling and analyses

Blood was obtained from the brachial vein of each individual (119 BBA and 26 GHA) using 25 G needles and collected in heparinized capillary tubes. To determine the presence of hemoparasites, blood smears were stained using Quick Panoptic stain (1:10 concentration) and each slide was analyzed by oil-immersion microscopy ($\times$1000) for 30 min. The examination procedure and identification of the blood parasites followed the descriptions in Clark et al. (2009).

Results and discussion

Three ectoparasitic species were identified among the two albatross species: *I. uriae*, *P. longicornis* and *A. affine*. No hemoparasites were detected in blood smears. The developmental stages of the ectoparasites are summarized in Table 1.

Ixodes uriae was the most abundant ectoparasite with a total of 103 individuals collected from 58 GHA and 13 BBA chicks. This species has been previously identified as the dominant tick species in seabirds, which coincides with our observations, and is considered to be mainly a result of its nest-associated behavior (McCoy and Tirard 2002; Dietrich et al. 2011). Male adult ticks were not collected during chick inspections. This is consistent with the observation that adult male *I. uriae* ticks do not interact with their hosts (McCoy and Tirard 2002). This is the first report of *I. uriae* in Diego Ramírez.

Parapsyllus longicornis was the only flea species recorded in this study (N = 22) from 3 GHA and one BBA chicks.

Fig. 1 Diego Ramírez Archipelago in the northern section of the Drake Passage (56°S), sub-Antarctic Chile Modified from Robertson et al. (2007)
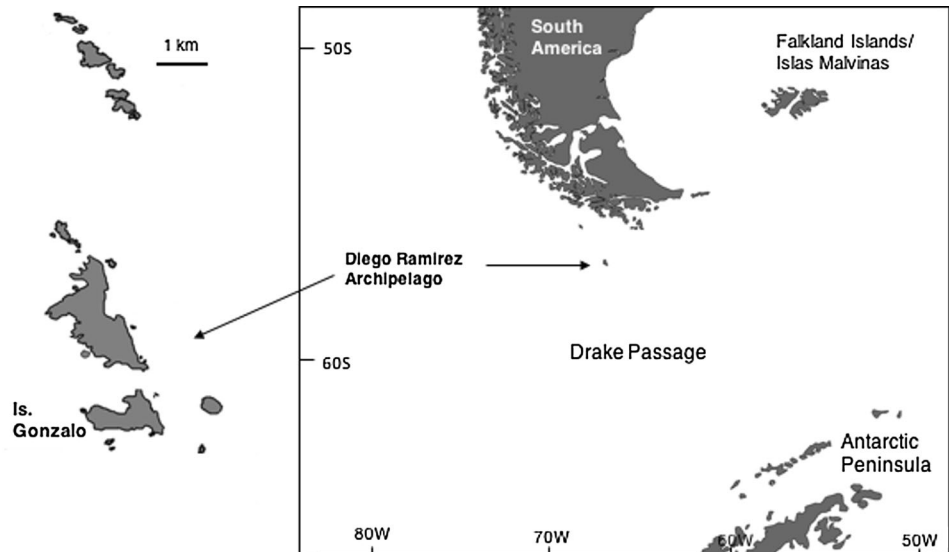
Table 1 Ectoparasites and their prevalence (% in brackets) for each developmental stage collected in Black-browed Albatross (BBA) and Grey-headed Albatross (GHA) nesting in Diego Ramírez Archipelago

Ectoparasite species	BBA (n = 40)			GHA (n = 80)		
	Adult	Nymph	Larvae	Adult	Nymph	Larvae
Ixodes uriae	14 (20.0)	4 (10.0)	3 (2.5)	68 (62.5)	4 (5.0)	10 (11.2)
Parapsyllus longicornis	2 (2.5)	–	10 (2.5)	10 (3.75)	–	–
Austromenopon affine	–	–	–	–	1 (1.25)	–

Fleas were identified as 7 females, 5 males, and 10 larvae. Because most fleas live in the nest substrate and not on their hosts (Whiting et al. 2008), it is likely that the real prevalence of this species in BBA and GHA was underestimated. The genera *Parapsyllus* is distributed throughout the pan-Antarctic region, mainly on the Antarctic mainland and southern sub-Antarctic coastal islands (Whiting et al. 2008). *Parapsyllus* exclusively parasitizes seabird species, such as *Pterodroma defilippiana*, *Spheniscus humboldti*, *S. magellanicus*, *Stercorarius chilensis*, *T. melanophrys*, and *T. chrysostoma* (Beaucournu et al. 2014). *Parapsyllus longicornis* has been described from BBA in the Falkland/Malvinas Islands in the South Atlantic and BBA and GHA in Diego Ramírez and the Campbell Islands (Smit and Wright 1965; Murray et al. 1990; Beaucournu et al. 2014) for the sub-Antarctic section of the Pacific.

Austromenopon affine was collected from a single GHA chick but previously has been described as parasite of both BBA and GHA in South Georgia, and also for three other albatross species (*Diomedea epomophora*, *D. exulans*, and *T. cauta*) (Clay and Moreby 1970; Price and Clay 1972). The very low prevalence of the lice in nestling could be explained because in the guard period, the chicks still present down feather, this type of feather would not be suitable for the subjection of the lice, and it is possible that infestation of nestlings by lice occur in a later phase when nestlings begin to develop feathers instead of down. It is also possible for parents to be able to remove lice from the chicks; however, experimental studies are needed to assess this (Brook 2010). Nevertheless, information regarding the ecology of the *Austromenopon* genus remains scarce (Price and Clay 1972). This is the first identification of this parasite in Diego Ramírez.

No hemoparasites were detected in this study. A low prevalence, or an apparent absence, of blood parasites has been reported previously in other studies concerning sub-Antarctic and Antarctic seabirds (Quillfeldt et al. 2010). Generally, the absence of hemoparasites has been attributed to the nonexistence of an appropriate vector (Sol et al. 2000). However, we found *I. uriae*, which is able to transmit hemoparasites (i.e., *Babesia*). Hemoparasites may be absent from the peripheral blood of seabirds for periods of days to weeks, commonly reappearing during the breeding season of their hosts (Quillfeldt et al. 2011). In fact, samples were collected from chicks during the early and half brood–guard period (mean duration ~35 days;

Suazo unpubl. data) so that it is unlikely that the absence of hemoparasites was related to the timing of blood collection.

Studies involving hemoparasites have applied molecular techniques or a combination of both microscopy and molecular methods (e.g., Sehgal et al. 2001; Ribeiro et al. 2005; Montero et al. 2016). In this study, we used light microscopy to search for hemoparasites in blood smears, which might fail to detect the presence of hemoparasites when the intensity of infection is low (Quillfeldt et al. 2011). Although we did not find hemoparasites in albatross chicks nesting in Diego Ramírez, this does not necessarily imply that vectors in the area are free of infection. Recently, the presence of *Babesia* sp. was reported in Antarctica (Montero et al. 2016), suggesting that *I. uriae* is able to maintain *Babesia* infections even in the face of harsh cold environments. We encourage the future application of molecular methods to investigate hemoparasite infection in the vector species present in Diego Ramírez, e.g., the presence of *Babesia* in *I. uriae* ticks. Furthermore, a molecular approach similar to that used in studies by McCoy et al. (2005, 2012) could enable exploring the genetic diversity and possible genetic flow among *I. uriae* populations of Diego Ramírez and from seabird populations at other geographic locations.

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