

# Apparent Absence of Blood Parasites in the Patagonian Seabird Community: Is it Related to the Marine Environment?

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**Abstract.**—The geographic and specific distribution of avian Haematozoa is poorly understood and much basic information is still needed. Studies of blood parasites in avian communities are scarce despite of their potential for disentangling the relative importance of host-specific and ecological factors shaping blood parasite distributions. Here we present the first study of blood parasites in a breeding community of seabirds by scanning blood smears obtained from 560 birds belonging to 13 species breeding in Patagonia, Argentina. Seven of these species have not been sampled previously for blood parasites. No blood parasites were detected. The scarcity of vectors due to the marine environment and the dry conditions around the colonies is the most plausible hypothesis for explaining the apparent absence of blood parasites in the Patagonian seabird community, although other hypotheses should be examined. *Received 12 December 2000, accepted 8 May 2001.*

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Avian blood parasites are distributed around the world, infecting between 10% and 40% of individual birds depending on geographic regions (Bennett *et al.* 1991). However, geographic distribution and their occurrence in different bird species are far from being understood. Some ecological and evolutionary factors have been proposed for explaining differences in the distribution and abundance of blood parasites among avian hosts. Ecological factors are primarily linked to differences in the abundance of suitable vectors of blood parasites in different habitats and regions. The abundance of vectors (usually invertebrates) has been experimentally demonstrated to be a major determinant of geographic differences in blood parasite prevalence within a single bird species (Sol *et al.* 2000). Bennett *et al.* (1992a) found that Arctic birds were free from blood parasites, pointing to the lack of vectors due to weather conditions as the most plausible hypothesis. Little and Earlé (1995) suggested the scarcity of vectors in arid and semi-arid environments as the main reason for the absence of Haematozoa

(Protozoa) in three bird species in South Africa. Recently, Piersma (1997) suggested that marine environments might be free from parasites. This hypothesis gained support through a comparative study, showing that bird species breeding in freshwater habitats had more species of blood parasites than those breeding on marine areas (Figuerola 1999). Because of the lack of suitable vectors it seems that blood parasites may be particularly scarce in marine and arid environments.

From an evolutionary point of view, Bennett (1993) found that the seven most primitive orders of birds were free from haemoproteids. Bennett (1993) suggested that haemoproteids appeared as a genus (*Haemoproteus*) in the late Oligocene/early Eocene, at the same time as Piciformes and Coraciiformes appeared as bird orders. Although other bird orders existed at that time, they were not infested. This could offer an historical reason for why some bird species are free from blood parasites. On the other hand, prevalence of blood parasites has been found to be higher in avian species

with relatively short incubation periods (Ricklefs 1992; Tella *et al.* 1999), suggesting that species with longer periods of embryonic development might possess a better "maturation" of the immune system and thus a higher resistance to blood parasites.

Overall, the important factors determining the geographic distribution of blood parasites in the different bird species is still mainly unknown. The study of blood parasites in bird communities (Apanius *et al.* 2000; Bennett *et al.* 1992a) could help to determine these factors because temporal and spatial factors are controlled, facilitating the interpretation of the differences in blood parasitization among host species. Here we present the first survey of blood parasites for a community of seabirds, and discuss the ecological and evolutionary factors that could explain their current status of parasitization by Haematozoa.

#### METHODS

This study was conducted during three breeding seasons (from 1998-99 to 2000-01) in seabird colonies located in the coastline and islands of Chubut province (Patagonia, Argentina). Coastline and islands consist of sandy and rocky beaches and steep cliffs, surrounded by a dry shrub steppe lacking of freshwater points. Thirteen out of the 16 breeding seabird species were sampled (see Yorio *et al.* 1998 and Tella *et al.* 2001 for descriptions of the study area, distribution and size of colonies). A total of 560 birds were captured by hand or

nets and a few drops of blood were taken from their brachial or foot veins to prepare blood smears. All birds were released at the site of capture immediately after blood collection. Thin blood smears were air dried, fixed in ethanol in the field, and later stained with Giemsa stain. We have considerable experience in preparing, fixing and staining smears (see e.g., Tella *et al.* 1999), which is required to obtain good quality smears and to results on blood parasites be reliable (Cooper and Anwar 2001). Each blood smear was inspected for blood parasites for 10 minutes under a magnification of 1000x, scanning across the slide by one of us (R. J.) who has previous experience in the quantification and determination of blood parasites (e.g., Sol *et al.* 2000).

#### RESULTS

No blood parasites were detected from a total of 154 adults and 406 chicks (from 270 broods) from the 13 seabird species sampled (Table 1). According to the lists in Bennett *et al.* (1982) and Bishop and Bennett (1992), seven out of the 13 avian species examined in this study were sampled for blood parasites the first time (Table 1).

#### DISCUSSION

Although no blood parasites were detected, it remains possible that our sampling underestimated the prevalence of blood parasites in the Patagonian seabird community (Cooper and Anwar 2001). However blood smears were obtained during the breeding season, when the intensity of blood parasites

**Table 1. Species and number of birds inspected for blood parasites. Data on previous studies come from Bennett *et al.* (1982) and Bishop and Bennett (1992).**

Order	Species	Adults	Chicks	Previous studies
Sphenisciformes	Magellanic Penguin ( <i>Spheniscus magellanicus</i> )	36	300	<i>Plasmodium relictum</i> ; <i>Toxoplasma</i> sp.
Procellariiformes	Southern Giant Petrel ( <i>Macroneptes giganteus</i> )	23	0	2 negative records
Pelecaniformes	King Cormorant ( <i>Phalacrocorax albiventer</i> )	30	17	Not sampled before
	Imperial Cormorant ( <i>Phalacrocorax atriceps</i> )	6	0	2 negative records
	Guanay Cormorant ( <i>Phalacrocorax bougainvillii</i> )	2	0	Not sampled before
	Rock Cormorant ( <i>Phalacrocorax magellanicus</i> )	16	14	Not sampled before
	Olivaceous Cormorant ( <i>Phalacrocorax olivaceus</i> )	3	0	7 negative records
Charadriiformes	Southern Skua ( <i>Catharacta antarctica</i> )	14	13	Not sampled before
	Kelp Gull ( <i>Larus dominicanus</i> )	6	23	Microfilaria of <i>Eukimdana rauschorum</i>
	Olog's Gull ( <i>Larus atlanticus</i> )	0	2	Not sampled before
	Dolphin Gull ( <i>Larus scoresbii</i> )	7	10	Not sampled before
	Cayenne Tern ( <i>Sterna eurynatha</i> )	11	6	Not sampled before
	Royal Tern ( <i>Sterna maxima</i> )	0	21	1 negative record

was expected to be at maximum (Allander and Sundberg 1997). Moreover, it is the season with highest chance of parasite infection because individuals (chicks and adults) are potentially exposed to vectors on land, while after breeding they mostly live at sea, which is vector free. Although no information is available on the two blood parasites previously reported for these bird species (Table 1), the age of chicks at sampling ( $68 \pm 8$  days-old for Magellanic Penguins *Spheniscus magellanicus*; see Tella *et al.* 2001) largely exceeds the minimal prepatent period reported for some blood parasites on chicks of other avian species (e.g., 9 days; Merino and Potti 1995). The inspection of blood smears may not be the best method to detect *Plasmodium* (Forrester *et al.* 1974), *Trypanosoma* or microfilaria (Apanius 1991). However, Merino and Potti (1995) found a high prevalence of *Trypanosoma* in nestling Pied Flycatchers (*Ficedula hypoleuca*) using the same methodology as we used. We can conservatively affirm that the prevalence of blood parasites in the Patagonian seabird community examined is, at least, extremely low.

Six out of the 13 species sampled belong to the order Charadriiformes, one to the Procellariiformes, one to the Sphenisciformes and five to the Pelecaniformes. A total of 23% of the Charadriiformes previously examined by others has been found to be infected with Haemoproteidae, with some species having high prevalences (Ruiz *et al.* 1995; Bosch *et al.* 1997). The other three orders sampled in earlier studies were free of Haemoproteidae (Bennett 1993). In fact, the only previous record of a blood parasite in Magellanic Penguins was from wild-caught individuals that were probably infected by *Plasmodium* after arriving at a zoo (Fix *et al.* 1988). The absence of blood parasites in the Patagonian seabird community could not be explained only by the evolutionary history of the interaction between blood parasites and birds, since almost half of the sampled species belong to orders in which species was found to be infected in other blood parasite surveys. Two of the avian species we sampled had been previously found infected by blood parasites (Table 1), indi-

cating that our results could not be explained by the lack of parasite species able to exist in the studied bird species.

The avian families sampled here are in the top half on the rank of families with respect to the length of their incubation periods (Ricklefs and Starck 1998). However, they are close to other families with long incubation periods where blood parasites are present (e.g., Owls or Accipitridae). Therefore, although species we studied had relatively long periods of incubation, their lack of blood parasites could not be exclusively explained by this factor.

Merino *et al.* (1997) reported the lack of Haematozoa in Chinstrap Penguins (*Pygoscelis antarctica*) breeding on Deception Island ( $63^{\circ}00'S$ ,  $60^{\circ}40'W$ ), suggesting that it could be caused by the low temperatures found on the Antarctic region, and that their results must be contrasted with those from other penguin species breeding farther north. Our survey on Magellanic Penguins conducted in more temperate latitudes suggests that not only low temperatures, but other factors causing the lack of vectors could explain the absence of blood parasites in penguins and in other seabirds. In our study, the low presence of vectors could be inferred from the arid habitat where the seabirds studied breed and the marine environment shared by these birds all along the rest of the year. Furthermore, some blood-sucking ectoparasites that are known to transmit Haematozoa, such as ticks (Bennett *et al.* 1992b) and louse flies (Sol *et al.* 2000), are absent or extremely rare in the colonies of seabirds we sampled (authors, unpubl. data). The lack of suitable vectors in marine environments (Piersma 1997; Figuerola 1999) remains as the most plausible hypothesis for explaining why blood parasites are lacking in all the sampled species of seabirds. Further experimental studies would be desirable to clarify variability in blood parasitization rates among avian hosts.

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