



Chewing lice of *Procellaria aequinoctialis* Linnaeus, 1758 in Brazil with a new host record

Beatriz Brener^{*}, Sarah Lira, Magda Antonello

Universidade Federal Fluminense, Departamento de Microbiologia e Parasitologia, Instituto Biomédico, R. Professor Hernani Pires de Mello, 101, São Domingos, Niterói, Rio de Janeiro 24210-130, Brazil

ARTICLE INFO

Keywords:

Austromenopon echinatum
Louse
Ectoparasite
Seabird
Procellaria aequinoctialis
White-Chinned Petrel

ABSTRACT

The white-chinned petrel (*Procellaria aequinoctialis*) is a seabird widely distributed in the circumpolar sub-Antarctic islands and subtropical regions, including Brazilian waters. Among the parasites present on the white-chinned petrel are the chewing lice. This seabird is parasitized by 4 known lice species to date. In this study we evaluated the ectoparasites of 2 white-chinned petrels rescued by an animal rehabilitation center in Rio de Janeiro, Brazil and recorded 4 species of chewing lice, of which 3 are already known for this host. One of the species however, has never been recorded in Brazil and another one has never been recorded parasitizing *P. aequinoctialis*, making this a new host record.

1. Introduction

Brazil has great richness and diversity of birds in its fauna, harbouring approximately 1822 recorded species, representing 18% of all known bird species in the world [1]. Residents and migratory seabirds inhabit and permeate the Brazilian coastal environment every day [2].

The White-chinned petrel (*Procellaria aequinoctialis* Linnaeus, 1758), although considered globally vulnerable to extinction [3,4], is a widely distributed seabird, maintaining its breeding sites in the sub-Antarctic islands of France, New Zealand and South Africa, as well as in the South Georgia and Falkland Islands [5], but it is also found in subtropical regions, including Brazilian waters [6,7]. Although population data are scarce and accurate census data for several breeding sites are currently lacking, it is estimated that this species populations is on rapid decline due to very high rates of incidental mortality in longline fisheries, susceptibility of chicks to predation and degradation of breeding habitats in the recent decades [4,5].

Procellariiformes are commonly infested with ectoparasitic arthropods. Feather mites and lice are the most abundant ectoparasites. The birds of this order have about 128 louse species distributed over 117 host species. Many of these lice infest more than one host type [8].

Chewing lice are permanent and obligate ectoparasites, usually with a high degree of host specificity [9]. Some, however, are less host specific [10], as is the case of the 4 known species of lice found on the white-chinned petrel, which have also been recorded in several Procellariiform

hosts [8,11–15].

Although chewing lice are parasites with low pathogenic potential [16], when they occur at high intensities they are responsible for irritation and itching caused by movement through the host's body, which can lead to alterations in the host's metabolic rates [17]. Lice can also damage the plumage through feeding activity, which might affect the thermoregulation of the bird and its reproductive activities [18,19]. Thus, it is essential to know the distribution of chewing lice in seabirds, especially when the host population is in decline, as is the case of the white-chinned petrel.

The aim of this paper is to contribute to the knowledge of *Procellaria aequinoctialis* ectoparasites through the identification of its chewing lice from birds in Rio de Janeiro, Brazil, increasing the known species parasitizing this host.

2. Material and methods

The Santos Basin Beach Monitoring Program (PMP – BS) operates in the South and Southeast region of Brazil and is a project created by Petrobras with the objective of evaluating the possible impacts of oil production and flow activities on birds, turtles and marine mammals, through the monitoring of beaches and veterinary care for animals [20]. These animals are destined to animal rehabilitation centers, with the aim of reintroducing them to nature.

In August and September 2019, two marine birds of the species

^{*} Corresponding author.

E-mail address: beatrizbrener@id.uff.br (B. Brener).

<https://doi.org/10.1016/j.parint.2022.102718>

Received 19 November 2021; Received in revised form 29 November 2022; Accepted 29 November 2022

Available online 5 December 2022

1383-5769/© 2022 Elsevier B.V. All rights reserved.



Fig. 1. *Naubates (Naubates) fuliginosus*. Male on the left and female on the Right. Scale bar: 0.661 mm.

P. aequinoctialis were found weakened on the beaches of Rio de Janeiro, having been rescued by the PMP and sent to Centro de Tratamento Animal (CTA) (22°56'00.0"S 42°16'56.6 "W) to receive veterinary care and rehabilitation.

The birds that arrived at the rehabilitation center were deloused using ectoparasitocidal powder based on Carbaryl and Cypermethrin (Talfon Top brand). The powder was sprinkled over the animal and mixed into the feathers by hand. The lice fell on a plastic sheet placed on the floor of the bird's enclosure. The plastic was removed after approximately 30 min to collect the parasites, which were stored in 70% ethanol and sent to laboratory.

The lice went through the procedure of mounting permanent slides with Canada balsam, following the technique described by Palma (1978) [21]. The slides were analyzed under optical microscopy in an Olympus BX-41 microscope (Olympus, Tokyo, Japan) for specimen identification. The identification of Family and Genus was based on Price et al. (2003) [8]. The species were identified using the keys to species of Waterson (1914) [22], Price & Clay (1972) [13] and Palma & Pilgrim (2002) [23].

3. Results

Three distinct species of lice were identified on the two hosts examined. One of the birds examined also had a fourth species of louse. The observed lice belong to two suborders.

In the suborder Ischnocera, two genera were identified; *Naubates* and *Trabeculus*. The lice from the genus *Naubates* were identified as subgenus *Naubates* due to its clypeal signature without a depression and the posterior prolongation of the dorsal carinae reaching the level of the mandibles, as pointed out by Palma and Pilgrim (2002) [23]. The species was defined following the authors' key. Males had an enlarged first antennal segment, as long as segments II-V together and, slender parameres, closely aposed distally and occupying no greater width than the basal plate. The species was, therefore, defined as *Naubates (Naubates) fuliginosus* Taschenberg, 1882 (Fig. 1). The second louse species, was from the genus *Trabeculus*. This species presented six peg-like spines on head, one on each side of the signature, one on an extension of the antennal band above the first antennal joint and one at the end of another band which curves inward from the base of the antennae. The paramera is straight with parallel sides and the basal plate is narrow. These attributes characterize the species *Trabeculus hexakon* Waterson,



Fig. 2. *Trabeculus hexakon*. Male on the left and female on the Right. Scale bar: 0.328 mm.



Fig. 3. *Austromenopon popellus*. Male on the left and female on the Right. Scale bar: 0.274 mm.

1914 (Fig. 2), as described by Waterson (1914) [22] and pointed out by Timmermann (1959) [24].

The suborder Amblycera presented two other species, both of the genus *Austromenopon*. The first species presented 4 setae on each side of the gula. The males had asymmetrical genitalia. The tips of parameres were blunt with thornlike projections. The posterior margin of coxa I was rounded and the Temple width was less than 0,51 mm. These features characterize the species *Austromenopon popellus* Piaget, 1890 (Fig. 3) [13]. The second species present median anterior setae on some tergites. In males the marginal pronotal seta 3 was short, about equal to seta 1. Tergites VI and VII had lateral patches of spiniform setae. This species also has a very singular genitalia and genital sac, as drawn by Price and Clay (1972) [13]. This species was then classified as



Fig. 4. *Austromenopon echinatum*. Male on the left and female on the Right. Scale bar: 0.524 mm.

Austromenopon echinatum Edwards, 1960 (Fig. 4). The number of lice and species found on each bird are shown in Table 1. Measurements of the species were taken from the arithmetic mean of specimens randomly chosen and are given in Table 2.

4. Discussion

The species *Naubates (N.) fuliginosus* and *T. hexakon* are typical ectoparasites of the White-chinned petrel, having been widely recorded on this bird around the world. *Austromenopon popellus* is also known to parasitize *P. aequinoctialis*, although it has never been registered in Brazil, making this the first record of this louse-host association in this country. The species *A. echinatum* had never been recorded on this host. The type host of *A. echinatum* is *Calonectris diomedea* Scopoli, 1769, a seabird of the Order Procellariiformes, occurring in part of the Atlantic

Ocean and Mediterranean Sea [4]. It is known that *P. aequinoctialis* can also be parasitized by *Ancistronea vagelli* Fabricius, 1787, although this louse species was not found on the birds examined.

Valim et al. (2006) [25] mention that, a comparison between the distribution of lice and the phylogeny of the Procellariiformes shows some interesting aspects about the evolutionary tendency of lice. In their work they suggest that some genera of lice, including the genus *Austromenopon*, may disperse among Procellariiformes hosts.

Despite occupying different geographic regions around the globe, there are overlapping areas of occurrence of *P. aequinoctialis* and *C. diomedea*. The coast of Namibia, on the African continent and part of the South and Southeast regions of the Brazilian coast, on the American continent there are areas where both of these bird species are found. It is possible that both species use common landing and resting places, and there may be some contact between the birds.

Analyzing lice collected from the skin of Procellariiformes birds in a museum in Rio de Janeiro, Brazil, Valim et al. (2006) [25] found the species *N. fuliginosus* and *T. hexakon* parasitizing *P. aequinoctialis*. The authors also mention the presence of *Saemundssonsonia bicolor*, but classify it as an evident contaminant due to the lack of a natural host-lice association.

Although only one of the hosts analyzed in this study showed parasitism by *A. echinatum*, this finding does not appear to be contamination, since many lice (87) were found on the examined bird.

The wide distribution of parasitic species among hosts of the same Genus, Family or higher taxonomic unit is nothing new. The *Austromenopon* louse genus is quite broad, with a huge diversity of species described in marine and aquatic birds from 3 avian orders: Procellariiformes, Charadriiformes and Pelecaniformes [13]. Both *C. diomedea* and *P. aequinoctialis* belong to the Procellariidae family, in addition to having similar habits and regions of overlapping habitats. The lice samples collected from *P. aequinoctialis* included many males, females and nymphs.

5. Conclusion

This work contributes to the epidemiological mapping of seabird chewing lice in Brazil being the first record of *Austromenopon popellus* parasitizing *Procellaria aequinoctialis* in Brazil. It also registers a new louse-host association between *Austromenopon echinatum* and *P. aequinoctialis*.

Table 1

Species and quantities of lice found in *Procellaria aequinoctialis* Linnaeus, 1758 analyzed at the Centro de Tratamento Animal (CTA – Meio ambiente), Araruama Base, in August and September 2019. ♂ = Males, ♀ = Females, N = Nymphs.

Host – Date	<i>Naubates (Naubates) fuliginosus</i>			<i>Trabeculus hexakon</i>			<i>Austromenopon popellus</i>			<i>Austromenopon echinatum</i>			Total
	♂	♀	N	♂	♀	N	♂	♀	N	♂	♀	N	
PA1–30/08/2019	141	139	787	65	58	37	90	293	299	27	41	19	1996
Total - PA1	1067			160			682			87			
PA2–06/09/2019	34	29	45	16	18	11	25	36	5	*	*	*	219
Total - PA2	108			45			66			0			

Table 2

Measurements in millimeters (mm) of the lice species found in *Procellaria aequinoctialis* Linnaeus, 1758 analyzed at the Centro de Tratamento Animal (CTA – Meio Ambiente). ♂ = Males, ♀ = Females.

	<i>Naubates (Naubates) fuliginosus</i>		<i>Trabeculus hexakon</i>		<i>Austromenopon popellus</i>		<i>Austromenopon echinatum</i>	
	♂	♀	♂	♀	♂	♀	♂	♀
Head Length	0.90	0.96	0.54	0.55	0.26	0.28	0.35	0.36
Head Width	0.60	0.65	0.56	0.57	0.47	0.51	0.69	0.68
Thorax length	0.66	0.73	0.34	0.36	0.27	0.30	0.53	0.53
Thorax Width	0.61	0.71	0.48	0.49	0.42	0.47	0.58	0.68
Abdominal Length	2.01	2.43	0.73	0.91	0.76	0.94	1.51	1.50
Abdominal Width	0.72	0.89	0.73	0.79	0.55	0.69	0.87	0.92
Total Length	3.58	4.12	1.61	1.81	1.28	1.54	2.44	2.44

Further studies on the lice associated with birds from other localities of Rio de Janeiro and other Brazilian states are highly encouraged, since the country avifauna is huge and little explored.

Funding

This work was supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) Finance Code 001 and Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors are grateful to CTA-Meio Ambiente, for the donated samples that made it possible to conduct this research.

References

- [1] T. Sigrist, *The Avis Brasilis Field Guide to the Birds of Brazil: Plates and Maps*, First edition, 2009 (Vinhedo-SP: Avisbrasilis Editora. 480p).
- [2] C.M. Vooren, L.F. Brusque, Biodiversidade e Status das Espécies, in: *As Aves do Ambiente Costeiro do Brasil: Biodiversidade e Conservação*, Funbio, Rio Grande, RS, Brazil, 1999, pp. 134–146.
- [3] Ministério do Meio Ambiente, Lista Nacional das Espécies da Fauna Brasileira Ameaçadas de Extinção. <https://www.legisweb.com.br/legislacao/?id=75658>, 2003.
- [4] BirdLife International, IUCN Red List for Birds, Downloaded from, <http://www.birdlife.org>, 2021. on 26/08/2021.
- [5] ACAP - Agreement on the Conservation of Albatrosses and Petrels, White-Chinned Petrel *Procellaria aequinoctialis*, Disponível em, www.acap.aq, 2019.
- [6] D. Onley, P. Scofield, *Albatrosses, Petrels and Shearwaters of the World*, Christopher Helm, London, 2007.
- [7] C.J. Carlos, Seabird diversity in Brazil: a review, *Sea Swallow* 58 (2009) 17–46.
- [8] R.D. Price, R.A. Hellenthal, R.L. Palma, K.P. Johnson, D.H. Clayton, The Chewing Lice: World Checklist and Biological Overview, Illinois Natural History Survey Special Publication vol. 24, Illinois Natural History Survey, Champaign, Illinois, 2003, <https://doi.org/10.1080/10635150490468521>, 501p.
- [9] K.P. Johnson, D.H. Clayton, The biology, ecology, and evolution of chewing lice, in: R.D. Price, R.A. Hellenthal, R.L. Palma, K.P. Johnson, D.H. Clayton (Eds.), *The Chewing LICE: World Checklist and Biological Overview* vol. 24, Natural History Survey Special Publication, Illinois, 2003, p. 501, <https://doi.org/10.1080/10635150490468521>.
- [10] T. Clay, Geographical distribution of the Mallophaga (Insecta), *Bull. Br. Ornithol. Club* 84 (1964) 14–16.
- [11] T. Clay, C. Moreby, *Mallophaga and Anoplura of Subantarctic Islands*, Pacific Insects Monogr. 23 (1970) 216–220.
- [12] A.B. Amerson Jr., K.C. Emerson, Records of Mallophaga from Pacific Birds, *Atoll Research Bulletin*, Smithsonian Institution, Washington, 1971, pp. 1–30, <https://doi.org/10.5479/si.00775630.146.1>. No. 146.
- [13] R.D. Price, T. Clay, A review of the genus *Austroromenopon* (Mallophaga: Menoponidae) from the Procellariiformes, *Ann. Entomol. Soc. Am.* 65 (2) (1972) 487–504, <https://doi.org/10.1093/aesa/65.2.487>.
- [14] R.L.C. Pilgrim, R.L. Palma, A List of the Chewing Lice (Insecta: Mallophaga) from Birds in New Zealand. Supplement to Notornis vol. 29 and National Museum of New Zealand Miscellaneous Series No. 6, 1982, pp. 1–32.
- [15] R.L. Palma, Amendments and additions to the 1982 list of chewing lice (insects: Phthiraptera) from birds in New Zealand, *Notornis* 46 (1999) 373–387.
- [16] D.H. Clayton, D.M. Tompkins, Ectoparasite virulence is linked to mode of transmission, *Proc. R. Soc. Lond. B* 256 (1994) 211–217, <https://doi.org/10.1098/rspb.1994.0072>.
- [17] D.T. Booth, D.H. Clayton, B.A. Block, Experimental demonstration of the energetic cost of parasitism in free-ranging hosts, *Proc. R. Soc. Lond. B* 253 (1993) 125–129, <https://doi.org/10.1098/rspb.1993.0091>.
- [18] D.H. Clayton, Mate choice in experimentally parasitized rock doves: lousy males lose, *Am. Zool.* 30 (1990) 251–262, <https://doi.org/10.1093/icb/30.2.251>.
- [19] D.H. Clayton, R.J. Adams, S.E. Bush, Phthiraptera, the chewing lice, in: C. T. Atkinson, N.J. Thomas, D.B. Hunter (Eds.), *Parasitic Diseases of Wild Birds*, Wiley-Blackwell, Ames, Iowa, 2008, pp. 515–526.
- [20] Comunicação Bacia de Santos, Disponível em: <https://www.comunicabaciadesantos.com.br/programa-ambiental/projeto-de-monitoramento-de-praias-pmp.html>, 2021.
- [21] R.L. Palma, Slide-mounting of lice: a detailed description of the Canada balsam technique, *New Zeal. Entomol.* 6 (4) (1978) 432–436, <https://doi.org/10.1080/00779962.1978.9722313>.
- [22] J. Waterson, On some Ectoparasites in the South African Museum, Cape Town, *Ann. S. Afr. Museum* 10 (Part IX) (1914) 217–321.
- [23] R.L. Palma, R.L.C. Pilgrim, A revision of the genus *Naubates* (Insecta: Phthiraptera: Philopteridae), *J. R. Soc. N. Z.* 32 (1) (2002) 7–60, <https://doi.org/10.1080/03014223.2002.9517683>.
- [24] G. Timmermann, Taxonomie und hospitale Verbreitung der Mallophagengattung *Trabeculus* Rudow, 1866, *Zeitsch. Parasitenk., Berl.* 19 (1959) 485–502.
- [25] M.P. Valim, M.A. Raposo, N.M. Serra-Freire, Associations between chewing lice (insecta, Phthiraptera) and albatrosses and petrels (Aves, Procellariiformes) collected in Brazil, *Rev. Brasil. Zool.* 23 (4) (2006) 1111–1116, <https://doi.org/10.1590/S0101-81752006000400019>.