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Chewing lice (Phthiraptera) infesting breeding Suliformes (Aves: Aequornithes) of the Arabian Peninsula

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ABSTRACT

Despite the large diversity of the migratory and resident avifauna of the Arabian Peninsula, relatively few species have been sampled for chewing lice. In this study, three breeding species of Suliformes, *Phalacrocorax nigrogularis* Ogilvie-Grant & Forbes, *Sula dactylatra* Lesson and *Sula leucogaster* (Boddaert) were examined for chewing lice. Four species of chewing lice were identified, two from the suborder Amblycera (*Eidmanniella albescens* (Piaget, 1880) and *Eidmanniella nancyae* Ryan & Price, 1969) and two from the suborder Ischnocera (*Pectinopygus socotranus* Timmermann, 1964 and *Pectinopygus sulae* (Rudow, 1869)). Diagnostic characters, examined and other known hosts, an identification key, and images of hosts and chewing lice are provided.

KEY WORDS: Saudi Arabia, Oman, Amblycera, Ischnocera, chewing lice, cormorant, Booby.

INTRODUCTION

The chewing lice of the Kingdom of Saudi Arabia (KSA) have recently received attention after a decade of neglect (El-Ahmed *et al.* 2012; Al-Ahmed *et al.* 2014; Nasser *et al.* 2015), but these efforts should be viewed as preliminary, considering the notable diversity of these ectoparasitic insects of the region. With more than 4 000 species worldwide, the chewing lice form one of the most diverse orders of parasitic Hexapoda (Price *et al.* 2003). Most of these species infest birds, but taxa are known from mammals (Price *et al*. 2003). From an ecological point of view, the chewing lice that infest marine birds is an important and interesting group of lice. Throughout the Middle East, little is known about the ectoparasites of sea birds, including those of Suliformes (Negm *et al.* 2013).

The order Suliformes is a recently designated order of birds introduced by the International Ornithologists' Union (Gill & Donsker 2014). In the past the Pelecaniformes were considered a monophyletic group (Olson 1985). Recent molecular studies have indicated that the Pelecaniformes are polyphyletic and should be divided into different orders, one of which is the new Suliformes (Boles & Christidis 2008). Throughout the Arabian Peninsula, there are three breeding species of this order: the Brown booby, *Sula leucogaster* (Boddaert, 1783); the Masked booby, *Sula dactylatra* (Lesson, 1831) (Sulidae); and the Socotra cormorant, *Phalacrocorax nigrogularis* Ogilvie-Grant & Forbes 1899, (Phalacrocoracidae) (Porter & Aspinall 2013).

The Brown booby is a widely distributed sea bird, known from pantropical open oceans and warm seas (Anonymous 2012). Throughout the study region, the Brown booby breeds on remote rocky islands of the Red Sea (PERSGA 2003). The Masked

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booby occurs throughout the subtropics and tropics. In the Arabian Peninsula, there are three main breeding populations of this species, which use the Indian Ocean sandy beaches of the isolated islands of Oman and Yemen (Porter & Aspinall 2013). Outside the breeding seasons, the Brown and Masked boobies are "nomadic" and are considered true marine birds, spending months on the open water (Welty & Baptista 1990). Boobies are spectacular divers and feed mainly on small fish and squid (Alderton 2008).

The Socotra cormorant is the only species of Phalacrocoracidae that breeds in the Arabian Peninsula and is endemic to the region. It is considered a vulnerable endangered species by the IUCN. After the Gulf War in 1991, populations of this bird suffered large losses due to unprecedented oil spills (Evans *et al.* 1993). After the end of the war, major conservation efforts were directed at the Socotra cormorant in Bahrain, Kuwait, Qatar and the KSA, the results of which allowed populations to recover (Anonymous 2005).

There are two genera of chewing lice infesting birds of the order Suliformes, *Eidmanniella* (Amblycera) and *Pectinopygus* (Ischnocera) (Price *et al.* 2003). Several researchers have discussed the host/parasitic relationships of these genera (Kellogg & Kuwana 1902; Thompson 1940*a*, 1940*b*, 1946, 1947, 1948*a*, 1948*b*; Ryan & Price 1969), but there is little data for these genera of the Arabian Peninsula. The objective of this paper is to review the known information of these two genera in this region, and to provide a taxonomic review of the lice collected from Suliformes in the Arabian Peninsula.

MATERIAL AND METHODS

As part of the survey on chewing lice parasitising wild birds of the KSA, we examined three species of Suliformes that are typically difficult to capture. A sick adult Brown booby was caught by hand at Jazan Tourism Marina, KSA (16°54'7"N 42°32'28"E); juvenile Masked boobies were captured on nests on Al-Hallaniyah Island, Oman (17°29'59"N 56°4'51"E); and an adult Socotra cormorant was captured near Karan Island, KSA (27°43'5"N 49°49'31"E) using a mist net deployed over a partially sunk boat near the coast of the island, on which the birds had several times been observed resting (Fig. 1). The feathers and skin scales of these birds were examined visually for chewing lice, and clean forceps and a fine-toothed comb (teeth spaced 0.2–0.3mm apart) were used to collect individual lice.

Handling of the birds followed strict guidelines and was authorised by the National Commission for Wildlife Conservation and Development (NCWCD) (Abuzinada 1993). The birds were examined for lice and released unharmed at their capture location. Unfortunately, the sick Brown booby died during the visual inspection. All lice were preserved in 95% ethyl alcohol. Specimens were then mounted on slides using Pauri's medium (Smart *et al.* 1965). The lice were identified using Kellogg and Kuwana (1902), Bienko (1964), Ryan and Price (1969) and Price *et al.* (2003).

The slides were examined under a Nikon Eclipse 80i microscope and photographed using a Panasonic Lumix FT2 14 mp camera. All photographic images were produced using a Canon Sx40 Hs and the map was produced using DIVA-GIS. Measurements were taken in cellSens Dimension 1.6 (Olympus Corporation, Center Valley, Pennsylvania) from digital photos. All measurements are given in millimetres. Abbreviations used for measurements: HL = head length along midline; HW = postantennal head width;

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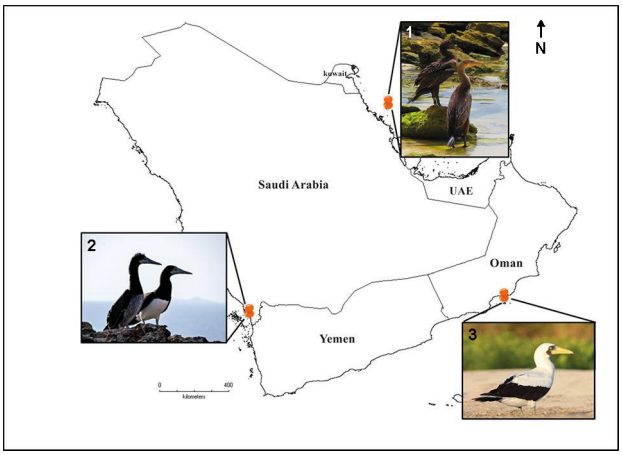


Fig. 1. Map of the Arabian Peninsula indicating bird collection sites: (1) Socotra cormorant; (2) Brown booby; (3) Masked booby.

HI = head index; TL = thoracic length; AL = abdominal length at midline; Total L = total length. All lice specimens were deposited in the King Saud University Museum of Arthropods, King Saud University, Riyadh.

RESULTS

Key to chewing lice infesting the Suliformes of Arabian Peninsula

1 Maxillary palps present; antenna clavate, hidden in fossa at rest (Amblycera: *Eidmanniella*) 2
– Maxillary palps absent; antenna filiform not hidden and completely exposed outside head (Ischnocera: *Pectinopygus*).....3

2 Head with clear preocular slit; prothorax with large acute tip spine; host, Socotra cormorant .....***E. nancyae*** Ryan & Price, 1969
– Head with faint preocular slit; prothorax with small flat medium spine; recorded from many species of boobies.....***E. albescens*** (Piaget, 1880)

3 Mid and hind legs equal in length; 5th antennal segment of female brown.....
.....***P. sulae*** (Rudow, 1869)
– Hind legs longer than middle legs; all segments of female antenna brown.....
.....***P. socotranus*** Timmermann, 1964

A total of 38 chewing lice representing four lice species were collected from the three Suliformes species: *Eidmanniella albescens* (Piaget) and *Pectinopygus sulae* (Rudow) are new records for the Arabian Peninsula.

Genus *Eidmanniella* Kéler, 1938

Eidmanniella albescens (Piaget, 1880)

Fig. 2a

Menopon albescens Piaget, 1880: 491.
Menopon singulans Kellogg & Kuwana, 1902: 485.
Eidmanniella sula Tendeiro, 1958: 443.

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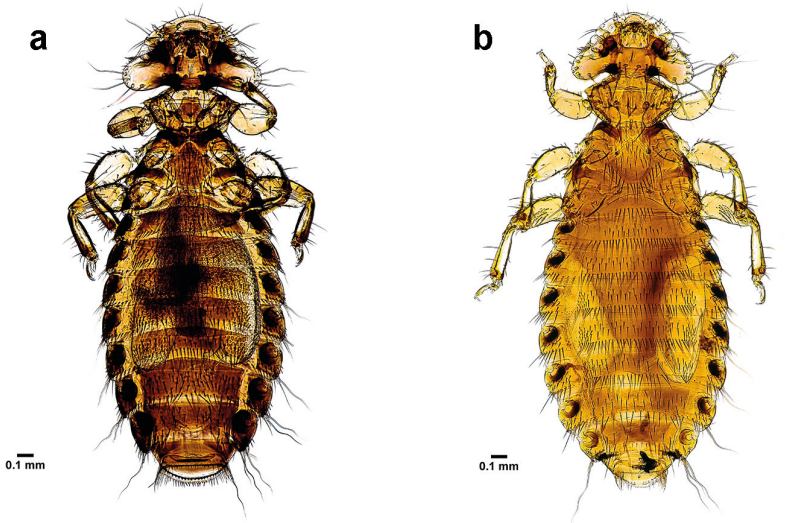


Fig. 2. (a) Female *Eidmanniella albescens* (Piaget); (b) female *Eidmanniella nancyae* Ryan & Price.

Description:

Measurements: Female (n=2): HL: 0.44–0.46; HW: 0.84–0.87; HI: 0.52–0.54; TL: 0.7; AL: 1.66–1.69; Total L: 2.8–2.9.

Head semilunar, wider than long with faint preocular slit; hypopharyngeal sclerite well developed; antennae with characteristic club-shaped third and fourth segments with a constricted base attached in part with second antennal segment; temple expanded outward with four long setae; gula oblong with two small setae. Thorax with characteristic pointed median process on the prothorax; margin of prothorax with numerous short setae (14–18); legs long, nearly equal in length, concolorous, and third femur with sparse ventral setal brush. Abdomen elongated oval in shape, ventral brush not clearly apparent on segments III–V, last tergite with characteristic short blunt spiniform setae across the posterior margin, which separates this species from other *Eidmanniella* spp.; male genitalia weakly chitinised.

Material examined: *Ex Sula leucogaster* 6♀ Jazan Tourism Marina, Saudi Arabia, 23.iv.2013. Ex *Sula dactylatra* Lesson 1♀ Al-Hallaniyah Island, Oman 15.ix.2014.

Known hosts

Morus serrator Gray, Australasian gannet (type host); *Papasula abbotti* (Ridgway), Abbott's booby; *Sula nebouxii* Milne-Edwards, Blue-footed booby; *Sula variegata* (Tschudi), Peruvian booby; *Sula dactylatra* Lesson, Masked booby; *Sula sula* (L), Red-footed booby; *Sula leucogaster* (Boddaert), Brown booby (Suliformes: Sulidae).

Local hosts

Sula dactylatra, Masked booby; *Sula leucogaster*, Brown booby.

Eidmanniella nancyae Ryan & Price, 1969

Fig. 2b

Eidmanniella nancyae Ryan & Price, 1969: 821.

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Description:

Measurements: Female (n=2): HL: 0.42–0.43; HW: 0.73–0.75; HI: 0.58–0.59; TL: 0.6; AL: 1.91–1.93; Total L: 2.93–2.97.

Head semilunar, wider than long with clear preocular slit; hypopharyngeal sclerite weakly developed; third and fourth antennal segments large without constricted base, third antennal segment with two small leaf-like setae; temple completely rounded forming small connection at occiput with prothorax, occiput with two separated black spots; prothorax with characteristic sharp median spine; legs long, nearly equal in length, concolorous, third femur with sparse ventral setal brush. Abdomen elongated, with highly chitinised spiracles, segments III–V with prominent lateral ventral brush last plate on tergum with a row of small setae; male genitalia highly chitinised.

Material examined: *Ex Phalacrocorax nigrogularis*, 9♀ Karan Island, Saudi Arabia, 17.vi.2012.

Known hosts

Phalacrocorax nigrogularis Ogilvie-Grant & Forbes, Socotra cormorant.

Local host

Phalacrocorax nigrogularis, Socotra cormorant.

Genus *Pectinopygus* Mjöberg, 1910

Pectinopygus socotranus Timmermann, 1964

Fig. 3a, b

Pectinopygus socotranus Timmermann, 1964: 274.

Description:

Measurements: Male (n=3): HL: 0.57–0.58; HW: 0.46–0.47; HI: 1.24–1.27; TL: 0.5; AL: 1.95–1.97; Total L: 3.02–3.09. Female (n=3): HL: 0.60–0.62; HW: 0.47–0.48; HI: 1.28–1.29; TL: 0.56–0.57; AL: 1.72–1.74; Total L: 2.88–2.90.

Head conical in shape with few lateral setae, frontal part slightly expanded; antenna sexually dimorphic, in male elbowed in shape, in female filiform, first antennal segment of male slightly longer than all the other segments combined, all antennal segments of female equal in size, brown, temporal margin flatly convex. Thorax trapezoidal in shape with very short fore legs and very long mid and hind legs, the hind legs are the longest; metathorax with irregular margins with three long setae on posterior lateral margin. Abdomen elongated, female abdomen with grainy texture, tergal and sternal plates with two short central setae; 9th segment of female deeply angularly emarginated with numerous setae; male genitalia asymmetrical.

Material examined: *Ex Phalacrocorax nigrogularis*, 9♀ Karan Island, Saudi Arabia, 17 June 2012.

Known hosts

Phalacrocorax nigrogularis Ogilvie-Grant & Forbes, Socotra cormorant.

Local host

Phalacrocorax nigrogularis, Socotra cormorant.

Pectinopygus sulae (Rudow, 1869)

Fig. 3c, d

Lipeurus sulae Rudow, 1869: 43.
Lipeurus helleri Kellogg & Kuwana, 1902: 479.
Lipeurus tuberculatus Piaget, 1885: 61.

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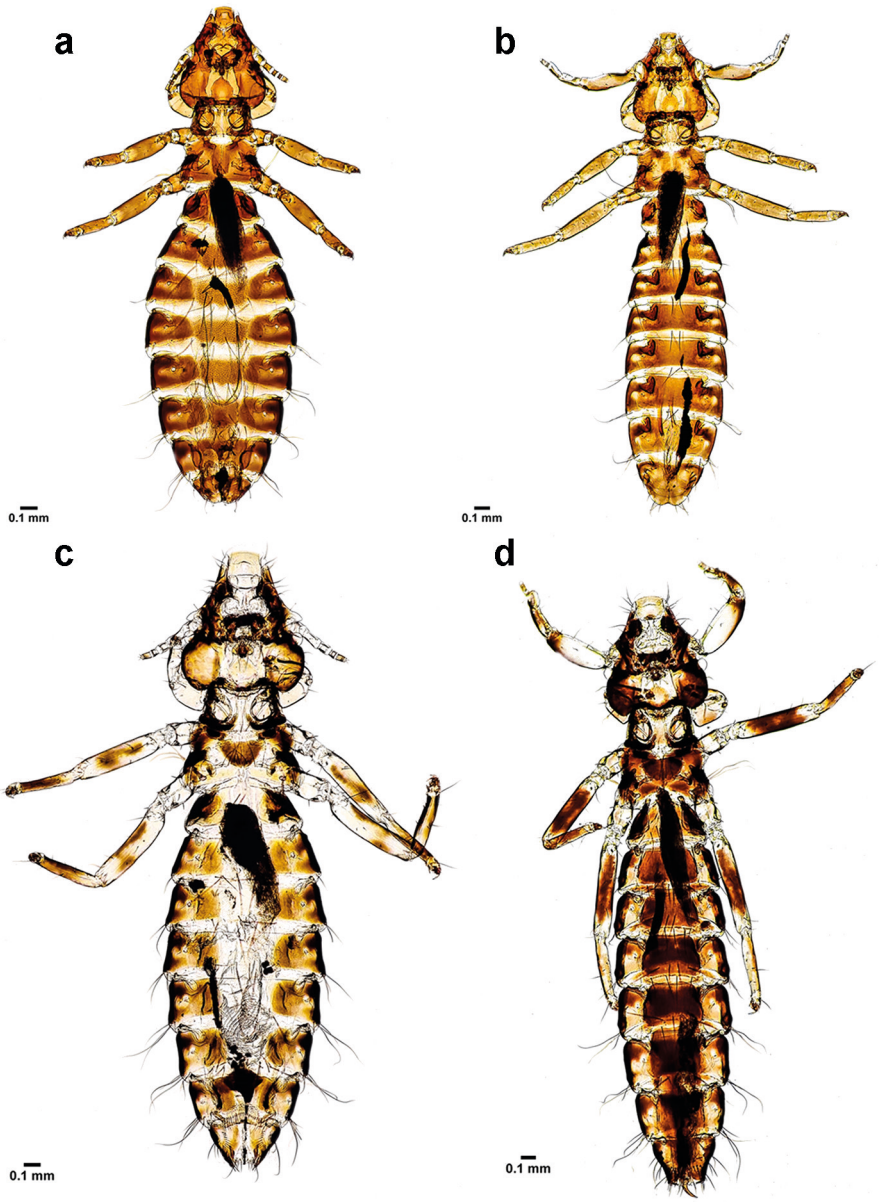


Fig. 3. (a) Female *Pectinopygus socotranus* Timmermann; (b) male *Pectinopygus socotranus* Timmermann; (c) female *Pectinopygus sulae* (Rudow); (d) male *Pectinopygus sulae* (Rudow).

Description:

Measurements: Male (n=2): HL: 0.80–0.81; HW: 0.68–0.69; HI: 1.18–1.21; TL: 0.56–0.57; AL: 2.60–2.63; Total L: 3.96–3.99. Female (n=3): HL: 0.80–0.83; HW: 0.70–0.71; HI: 1.14–1.19; TL: 0.56–0.58; AL: 2.30–2.32; Total L: 3.66–3.69.

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Head conical in shape with numerous setae, especially around the hyaline margin, frontal part slightly expanded; first antennal segment of male as long as all the other segments combined, the first antennal segment of female largest and the 5th antennal segment brown; temporal margin flatly convex. Thorax trapezoidal, fore legs very short, mid and hind legs very long, equal in length; metathorax with irregular margins with five long setae on posterior lateral margin. Abdomen elongated with highly chitinised margins in both sexes, all segments with complete dark brown bands, tergal plates with two short central setae; each sternum with four short setae, 9th segment of female deeply angularly emarginated with numerous setae; male genitalia asymmetrical with sharp pointed end.

Material examined: *Ex Sula leucogaster*, 5♂ 3♀ Jazan Tourism Marina, Saudi Arabia, 23.iv.2013. *Ex Sula dactylatra*, 3♂ 1♀ Al-Hallaniyah Island, Oman, 15.ix.2014.

Known hosts

Sula leucogaster, Brown booby (type host); *Sula dactylatra*, Masked booby; *Sula sula* (L.), Red-footed booby.

Local hosts

Sula leucogaster and *Sula dactylatra*.

DISCUSSION

Little is known about the ectoparasites of the large number of marine birds of the Arabian Peninsula (Negm *et al.* 2013; Nasser *et al.* 2015). The Suliformes, which form one of the most important components of marine ecosystems, especially for tropical seas, include the interesting endemic Socotra cormorant (Causey & Padula 2013). The order also contains many birds that have conservational value, such as the vulnerable Socotra cormorant (Jennings 2010). There are three genera of chewing lice known to infest birds of the order Suliformes: *Eidmanniella* Kéler, 1938 and *Piagetiella* Neumann, 1906 of the suborder Amblycera, and Pectinopygus Mjöberg, 1910 of the suborder Ischnocera (Price *et al.* 2003). Several researchers have revised the information on chewing lice of these genera (Kellogg & Kuwana 1902; Bedford 1931; Thompson 1940*a*, 1940*b*, 1946, 1947, 1948*a*, 1948*b*; Timmermann 1964, 1967; Ryan & Price 1969).

For the Arabian Peninsula no data is available for chewing lice infesting Suliformes except for the materials that were collected from Aden and used in the original description of *E. nancyae* Ryan & Price, 1969 and *P. socotranus* Timmermann, 1964. So, from a taxonomic point of view, the four species of lice that have been collected and reported here are new records for Saudi and Oman parasitic fauna. The high-definition photos presented form the only available photos for these species to date.

One of most interesting phenomena that appears clearly in Suliformes/lice interaction is the characteristic parasite/host distribution. Chewing lice show a high degree of host specificity for different species of cormorants, but not for the boobies. Each species of the genus *Pectinopygus* parasitises a unique species of cormorant while *Pectinopygus sulae* is known from three species of boobies (Price *et al.* 2003). On the other hand, species such as *Eidmanniella albescens* has been recorded from five species of boobies (Price *et al.* 2003). No doubt such relationships are related to overlapping distributions of the boobies, whereas cormorant species are allopatric. Further research is needed on this interesting group of birds, particularly using geographical information systems (GIS) to study the relationship between parasite specificity and distribution of hosts, in order to better understand their role in marine ecosystems.

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