

RELATIONSHIPS OF THE *Pterodroma* PETRELS FROM THE MADEIRA ARCHIPELAGO INFERRED FROM THEIR FEATHER LICE

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INTRODUCTION

Feather lice, Insecta: Phthiraptera (formerly Mallophaga) are ectoparasites of birds and have evolved to live and reproduce entirely upon the plumage of their hosts. They are flightless insects which feed largely by chewing feathers and reproduce by laying eggs which they fix to the feathers with a cement-like substance. When the eggs hatch the nymphs undergo three moults to reach the adult stage. For identification of some species entomologists have found that adult males are more reliable than females. Nymphs of similar species are very uniform in their characteristics, and are therefore very difficult to identify.

Some species of lice are host-specific at the level of bird species, and others are host-specific at the genus level, and very few are common to different genera within a given order of birds. Virtually all living birds have feather lice and most have one or more species of louse infesting their plumage. Some individuals have very few lice, while others of the same species can have many. There appears to be some seasonality in the abundance of lice upon some hosts, but the life cycle and population dynamics of the lice are relatively unknown for most species.

Feather lice generally relate in size and shape to the areas of bird 'habitat' which they occupy. Thus elongate lice, such as *Halipeurus*, live mostly on the long feathers of the wings, flanks and tail, while squat lice such as

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Saemundssonina are usually found amongst the short feathers of the head and neck. Their degree of host specificity make feather lice useful secondary aids to understanding the taxonomic relationships of birds (Pilgrim & Palma, 1982). Lice are inherited naturally by physical contact from parent to chick and from adult to adult. In the Procellariiformes, most species are gregarious at the breeding sites but many nest individually in burrows. Some species of petrels are presently numerically very rare, or have highly restricted breeding ranges, eg. *Pterodroma madeira*, *Pt.cahow* and *Pt.magenta* while others such as *Oceanites oceanicus* are regarded as numerically the most abundant bird species on earth. Because of their habits of nesting on fast eroding islands, or being indifferent to man or susceptible to introduced predators, many Procellariiformes are currently endangered or have recently become extinct. With extinction of the birds also go their host-specific parasites.

METHODS & MATERIALS

Four species of Gadfly petrels (*Pterodroma* spp.) are currently known to breed on islands of the North Atlantic, from an approximate total of 27 species in the world (Imber, 1985). These are *Pterodroma hasitata* the Diablotin of the West Indies, *Pterodroma cahow* the Cahow of Bermuda, *Pterodroma madeira* the Freira of mainland Madeira only, and *Pterodroma feae* Fea's Petrel which breeds on Bugio Island, (one of the Desertas Islands and part of the Madeiran Archipelago) and on some of the Cape Verde Islands (where it is known as the Gon-gon). Other species breeding on the islands of the South Atlantic include *Pterodroma mollis* the Soft-plumaged Petrel *Pterodroma incerta* the Atlantic Petrel of the Tristan da Cunha group of islands, and *Pterodroma arminjoniana* the Trinidad Petrel on the islands off Brazil. The feather lice of all these species have been collected as well as those from the believed extinct *Pterodroma caribbaea*, the Jamaica Petrel known only from Jamaica. Thus their varying degree of relationships may be deduced, utilising the similarities and differences in their parasites to support taxonomic conclusions (Imber, 1985).

Until the period of this study only very few of the above bird species had been deloused and consequently their species of lice and relationships based on them were unknown. However, lice from *Pterodroma* petrels at some localities, e.g. Cape Verde Islands, have not yet been collected and therefore the relationships can not be established for all known species and/or subspecies occurring in the North Atlantic. Lice are obtained by combing through the

feathers of living birds with fine point forceps, by searching the skins of specimens in museum collections, by using a delousing agent on living birds and by picking them up from freshly dead specimens. The latter method renders the greatest number of lice.

Table 1. *Pterodroma* Hosts, Localities, and their Feather lice

Madeiran Freira (Madeira) ***Pterodroma madeira***

Halipeurus sp. nov. (A)

Saemundssonina sp.

↙ *Trabeculus schillingi* Rudow, 1866

Cahow (Bermuda) ***Pterodroma cahow***

Halipeurus sp. nov. (A)

Trabeculus sp. (female only)

Soft-plumaged Petrel (Tristan da Cunha) ***Pterodroma mollis mollis***

Austromenopon popellus (Piaget, 1890)

Halipeurus procellariae (J.C. Fabricius, 1775)

Longimenopon sp (female only)

Naubates pterodromi Bedford, 1930

Trabeculus schillingi Rudow, 1866

Jamaica Petrel (Jamaica) ***Pterodroma caribbaea*** ←

Halipeurus theresae Timmermann, 1969

Saemundssonina jamaicensis Timmermann, 1962

Trabeculus schillingi Rudow, 1866

Fea's Petrel (Bugio Island, Desertas) ***Pterodroma feae*** deserta

↙ *Halipeurus theresae* Timmermann, 1969

Naubates sp (female only)

↙ *Trabeculus schillingi* Rudow, 1866

Diablotin (off eastern U.S.A.) ***Pterodroma hasitata***

Austromenopon popellus (Piaget, 1890)

Halipeurus theresae Timmermann, 1969

Saemundssonina jamaicensis Timmermann, 1962

↙ *Trabeculus fuscoclypeatus* (Johnston & Harrison, 1912)

RESULTS

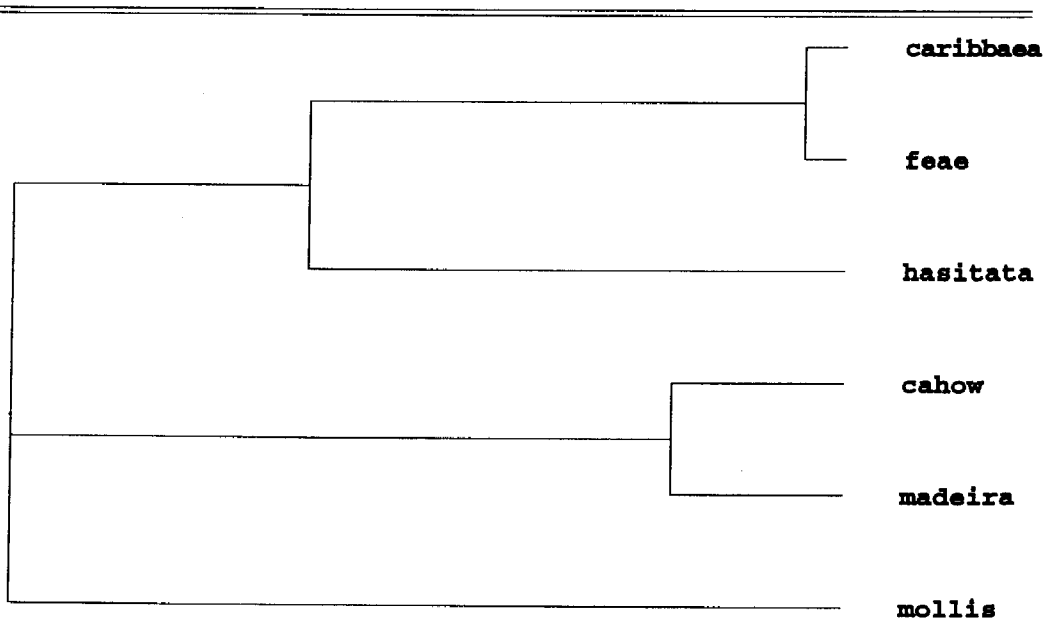
The louse genus *Halipeurus* has been found on all the species of North Atlantic Procellariiformes, with the exception of the Fulmar *Fulmarus glacialis*. In the *Pterodroma* petrels of the North Atlantic two species of *Halipeurus* lice have been found infesting the five species involved (table 1.). Some of the lice from *Pterodroma hasitata* show affinities with those from *Pt.feeae* and *Pt.caribbaea*. *Pterodroma mollis* of Tristan da Cunha harbours *Halipeurus procellariae*, and the same species is found on *Pterodroma incerta* which breeds sympatrically. The *Halipeurus* species found on *Pterodroma madeira* is a different, but closely related species to *H.procellariae*, (R.L.Palma, pers. comm.). The same *Halipeurus* species from *Pt.madeira* is also shared by *Pterodroma cahow*, which indicates a close relationship between these two petrels, probably having evolved from the ancestors of *Pterodroma mollis* from the South Atlantic.

In contrast, the current proximity in breeding range of *Pterodroma feae* to *Pterodroma madeira* has until recently meant that these species were considered as no more than subspecies (Bourne, 1983). Convergent evolution and the pressures of adaptation have presumably produced plumage similarities which have helped to mask their differences. Studies by Zino & Zino (1986) have shown that not only the birds are morphometrically different but that they breed at different times of the year. The different feather lice reinforce the distinctness of the two species. The *Halipeurus* louse found on *Pterodroma feae* (Deserta Islands) is *H.theresae*, quite different from that on *Pterodroma madeira*, and is in turn shared by *Pt.hasitata* and the extinct *Pterodroma caribbaea*. *H.theresae* is also found on several *Pterodroma* petrels in the Pacific, but it is not found on any of the Tristan da Cunha birds nor on the species *Pterodroma arminjoniana* which has a different species of *Halipeurus* (R.L.Palma pers.comm.). *Pterodroma feae* from the Cape Verde Islands has been little studied and its lice are as yet unknown. It is unwise to speculate about the relationships of this population until much more is known about its biology. The *Trabeculus* louse from *Pt.hasitata* is also found on several Pacific species of *Pterodroma* but occurs on *Pt.arminjoniana* as well (R.L.Palma pers.comm.). The relationship, if any, between *Pt.hasitata* and *Pt.arminjoniana* does not seem obvious at this stage.

TAXONOMIC RELATIONSHIPS REVEALED BY THE LICE OF THE MADEIRAN *PTERODROMA* PETRELS

The *Halipeurus* louse fauna of *Pterodroma feae* (Deserta Islands) differs from that of *Pterodroma madeira*, but the geographical proximity of the two birds is probably the result of colonisation of an area of suitable habitat and abundant food at different epochs within the late Pleistocene, rather than a localised divergence. If relationships were at the subspecific level or if the birds interbred in any way, the feather lice would probably be identical. Clearly *Pterodroma madeira* and *Pterodroma feae* behave as distinct species, and should be regarded as such. Their feather lice support the distinctness shown by other features (Zino & Zino, 1986). Cluster analysis using Complete Linkage (figure 1) shows *Pt. madeira* and *Pt. feae* belonging to different clusters. Only remnant populations of both species remain at present.

Figure 1. Dendrogram (Complete Linkage) showing the relationships between some species of *Pterodroma* on the basis of their feather lice



SUMMARY

1. As indicators of taxonomic distinctness, the *Halipeurus* feather lice of the two species of *Pterodroma* petrels found in the Madeiran Archipelago were found to differ, and since lice under natural circumstances, can only be transferred through physical contact, usually in the nest, it appears that *Pterodroma feae* and *Pterodroma madeira* have been ancestrally isolated.
2. The relationships within the genus which can be deduced from the feather lice are that *Pterodroma madeira* and *Pterodroma cahow* are closest and more directly related to *Pterodroma mollis*. *Pterodroma feae*, on the other hand, appears not recently related to any of the three previous species but may have descended through a lineage which includes Caribbean and Pacific *Pterodroma* species, which share the same *Halipeurus* louse species.
3. The physical proximity of two species of the same genus may be due to colonisation of mainland Madeira by *Pt.madeira* and, later, the Desertas by *Pt.faeae*, which has acted as a crossroad in the evolution of two superficially similar, but in many ways distinct, species.

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