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Ectoparasites from native and introduced birds from Christchurch and surrounding areas, New Zealand

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ABSTRACT: Birds found dead as a result of window-strikes on the University of Canterbury campus (Christchurch, New Zealand) and other dead birds submitted to the Zoology Department were examined for ectoparasites. A total of 244 birds of 22 species were examined during 1998–2000. Silvereyes were found in greatest numbers (n = 133) and were infested with the feather louse, *Menacanthus eurysternus* (Burmeister, 1838) (Phthiraptera: Menoponidae), which reached greatest prevalence and intensity of infestation in the summer and early autumn months; in general, infestation with lice was not related to host sex. One silvereye was infested with a flea, *Ceratophyllus gallinae* (Schrank, 1803) (Siphonaptera: Ceratophyllidae), a new host–parasite record for New Zealand. The remaining 21 species of birds were infested with, collectively, at least 20 species of lice (including *M. eurysternus*). Infestation parameters for lice are provided for all host species examined. One male and one female of *Ornithoica* sp. (Diptera: Hippoboscidae) were found on blackbirds; one blackbird was infested with a male *C. gallinae*. Two of three Hutton's shearwaters examined were infested with the tick, *Ixodes uriae* White, 1852 (Acari: Ixodidae), a new host–parasite record for New Zealand.

KEYWORDS: New Zealand, ectoparasites, lice, Phthiraptera, fleas, Siphonaptera, Hippoboscidae, ticks, Ixodidae.

Introduction

The ectoparasites of birds in New Zealand have been the subject of considerable study. The chewing lice were summarised by Pilgrim & Palma (1982) and Palma (1999), and the fleas by Smit (1965, 1979, 1984) and Pilgrim (1980). Bishop & Heath (1998) provided a complete summary of the ectoparasites and their associated bird hosts, exclusive of the Phthiraptera (as Mallophaga).

Although the fauna of insect ectoparasites is reasonably well known, there have been few studies to investigate infestation parameters or seasonal dynamics of parasitism in any ectoparasites of New Zealand birds (*but see* Galloway & Challies 1992; Palma & Imber 2000). During 1998–1999, I had the opportunity to salvage birds that had died after striking windows on the University of Canterbury campus (Christchurch, New Zealand). My objectives were to determine what species of ectoparasites infested these birds, and, where the number of specimens permitted, how their infestation varied throughout the year. The species of feather mites collected during this study are reported elsewhere (Mironov & Galloway 2002a, b).

Materials and methods

Dead birds were collected throughout the day beneath glass-sided, overhead walkways connecting buildings on the University of Canterbury campus, mostly from August 1998 to June 1999. The first collections were made shortly after sunrise and visits to the windows on most days were repeated at 3–4 hour intervals, often until sunset. Most birds were fresh and often still warm when collected, so the numbers of ectoparasites leaving the body of their host was presumed minimal. Fleas and hippoboscids tend to be quite responsive to host death (pers. obs.) and an undetermined number of these taxa may have left some hosts. Occasionally birds were found beneath windows elsewhere on campus, and if it was possible to determine that they had died recently, they were collected. A number of birds that had been stored in the Department of Zoology freezer (Jim Briskie, University of Canterbury) and specimens submitted to the department by members of the public were also examined.

Each bird was placed individually in a polyethylene bag along with an appropriate label and frozen for a minimum of 72 hours to kill all ectoparasites before examination. Birds were thawed at room temperature and were washed vigorously in two changes of warm soapy water, and one of clear warm water. Each wash was passed through a 200-µm sieve and the contents were rinsed into a Petri dish for examination under a dissecting microscope. Ectoparasites were preserved in 70% ethanol; lice and fleas were eventually prepared onto slides for identification using the method described by Richards (1964). Host sex was determined primarily by dissection and examination of the reproductive organs after the ectoparasites had been removed. Voucher specimens have been deposited in the J.B. Wallis Museum of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada, and the Museum of New Zealand Te Papa Tongarewa, Wellington.

Common and scientific names for the birds are as cited in the Ornithological Society of New Zealand Checklist (1990). Infestation parameters are reported as prevalence (the percentage of hosts infested), mean intensity (the mean number of ectoparasites per infested host), and range. Comparisons in infestation parameters were conducted using Quantitative Parasitology 2.0, according to Rózsa *et al.* (2000).

Results

A total of 244 specimens of 22 species of birds were examined. Eleven species (225 specimens) were collected beneath windows on campus and 14 species (19 specimens) were from other sources. Species of ectoparasites and infestation parameters for each host species are treated below, dealing first with those species collected from beneath the windows (as indicated by '*').

1. *Zosterops lateralis lateralis* (Latham, 1901): tauhou, silvereye*

Silvereyes were collected in the largest number of all species at the windows on campus. A total of 133 specimens (66♂; 64♀; 3 not sexed) were examined. Most specimens were collected during March–May 1999 (n = 94), some were collected during the summer months October 1998 to February 1999 (n = 29), and relatively few were collected during the winter and early spring months, during May–September 1998 (n = 1) and in June 1999 (n = 9). None of the birds collected had developed gonads, though one female collected on 29 October 1998 had initiated ovarian development. The first individual that could be positively recognised as a juvenile was collected on 6 January 1999; the first bird collected in 1999 with winter plumage was noted on 17 March, and after 30 March all birds were in winter plumage.

The only species of louse found on silvereyes in this study was *Menacanthus eurysternus* (Burmeister, 1838), the only species reported from this host in New Zealand by Pilgrim & Palma (1982) and elsewhere (Price *et al.* 2003). Over the entire study, 49.6% (95% confidence limits: 0.408, 0.584) of the birds were infested at a mean intensity of 7.2 (95% confidence limits: 5.76, 9.20). The distribution of lice was strongly aggregated among their hosts, k = 0.268, Index of Discrepancy, d = 0.744. In general, infestation levels were low, and only 14 of 66 infested birds carried more than 10 lice. The most heavily infested silvereye was a female, collected on 13 April 1999, with 35 lice (4♂; 7♀; 24 nymphs).

Most of the *M. eurysternus* collected were nymphs (72.6%) and 79.4% of infested silvereyes carried immature lice (mean intensity = 6.5). There was no significant difference in the mean intensity of infestation by male and female lice (1.9 and 1.8, respectively), but more infested birds carried female lice (67.7%) than male lice (41.2%).

The study was divided into three sampling periods: May to December (pre-fledging, when no identifiable

Table 1 Prevalence (%) and mean intensity of infestation of male and female silvereyes (*Zosterops lateralis lateralis*) with *Menacanthus eurysternus* at different times of the year, collected on the University of Canterbury campus during 1998–1999. Values followed by different letters within columns are significantly different ($P \leq 0.05$), Fisher's exact test for comparing prevalences and bootstrap 2-sample t-test for comparing intensities.

	Males		Females		Not sexed		Total	
Sample Period	% (n)[1]	Intensity	% (n)	Intensity	% (n)	Intensity	% (n)	Intensity
10.v.–31.xii.1998	30.0 (10)	4.3	0 (6)	–	33.3 (3)	4.0	21.1 (19)[a]	4.3[c]
1.i.–30.iv.1999	63.9 (36)	8.4	67.6 (37)	7.2	–	–	65.8 (73)[b]	8.0[c]
1.v.–17.vi.1999	40.0 (20)	4.4	38.1 (21)	7.5	–	–	39.0 (41)[b]	5.9[c]

[1] Numbers of birds examined during the sample period.

juvenile birds were collected), January to April (post-fledging, when recognisable juveniles of the year were present), and May to June (post-breeding, when young of the year could no longer be identified with confidence), to demonstrate the distinctly seasonal pattern in louse infestation of silvereyes (Table 1). Prevalence was greater ($P \leq 0.05$) during the summer, January–April, sampling period than during the May–December period. Prevalence was also higher during the summer compared to the post-breeding period, but not significantly so ($P = 0.13$). Mean intensity was also greatest during the summer, but not significantly so ($P \geq 0.05$). No females were infested in the initial May–December sampling period (when sample size was small), but in the other two sample periods, there was no significant effect of host sex on infestation parameters.

One female silvereye collected on 21 February 1999 was infested with one male flea, *Ceratophyllus gallinae* (Schrank, 1803). Although this flea commonly infests a variety of species of birds in New Zealand, this is the first record from a silvereye (Smit 1965; Pilgrim 1980).

2. *Turdus merula* Linnaeus, 1758: blackbird*

Thirty-four birds (18♂; 15♀; 1 not sexed) were salvaged on campus, most during January–April (n = 27). Nineteen of these (12♂; 7♀) could be determined as juvenile or young-of-the-year birds, the first of which was collected on 30 November 1998. Moulting to winter plumage was first observed on 3 March 1999. Two species of lice were found on blackbirds: *Philopterus turdi* (Denny, 1842) and *M. eurysternus*. Pilgrim & Palma (1982) and Palma (1999) recorded three additional species of lice from *T. merula* in New Zealand: *Brueelia merulensis* (Denny, 1842), *B. amsel* (Eichler, 1951), and *Myrsidea thoracica* (Giebel, 1874). The prevalence and intensity of infestation were: with *P. turdi* only 23.5% and 10.3 (range = 1–25), respectively; with *M. eurysternus* only, 32.4% and 10.5 (range = 1–44), respectively. Two birds (5.9%) were infested with both *P. turdi* and *M. eurysternus*.

Two blackbirds (one juvenile male, 13 January, and one juvenile female, 23 February; 5.9%) were each infested with one female and one male hippoboscid, *Ornithoica* sp., respectively. *Ornithoica stipituri* (Schiner, 1868) has been reported from blackbirds in New Zealand (Maa 1966), but the specific identity of the specimens collected in the current study was not determined. One male blackbird found on 24 February 1999 carried one male *C. gallinae*. Smit (1965, 1979) and Pilgrim (1980) recorded the blackbird as a host for *C. gallinae*. One additional male blackbird, collected by J. Briskie on 3 December 1998 from Kaikoura, was infested with *P. turdi* (2♂; 1♀; 8 nymphs).

3. *Turdus philomelos*, Brehm, 1831: song thrush*

Ten song thrushes (5♂; 3♀; 2 not sexed) were salvaged from 30 August 1998 to 5 June 1999. Four birds (40.0%) were infested with *P. turdi* (mean intensity = 9.3), and one additional bird (10.0%) was infested with two nymphs of a *Menacanthus* sp. (probably *M. eurysternus*). Pilgrim & Palma (1982) and Palma (1999) reported both these species infesting song thrushes in New Zealand, in addition to *B. turdinulae* Ansari, 1856.

4. *Carduelis flammea* (Linnaeus, 1758): redpoll*
Sixteen specimens (7♂; 7♀; 2 not sexed) were examined from 8 October 1998 to 30 May 1999. Nine specimens were clearly recognisable as juveniles. None were infested with lice. No lice have been recorded from redpolls in New Zealand (Palma 1999).

5. *Carduelis chloris* (Linnaeus, 1758): greenfinch*
Twelve greenfinches were examined (4♂; 6♀; 2 not sexed) from 21 August 1998 to 14 May 1999. Only one of these birds (8.3%) carried two nymphs of a *Myrsidea* sp. Pilgrim & Palma (1982) and Palma (1999) reported *Myrsidea serini* (Séguy, 1944) and *Brueelia* sp. from this host in New Zealand. It is likely that the lice collected from the bird on campus were *M. serini*, but this cannot be determined with certainty from immature specimens alone.

6. *Carduelis carduelis* (Linnaeus, 1758): goldfinch*
Six goldfinches (4♂; 2♀) were collected in this study; one (a male) was collected on 28 December 1998 and the rest were collected during 2–17 May 1999. One male *Brueelia* sp. was collected on 17 May. An unidentified *Brueelia* sp. was reported from this host by Pilgrim & Palma (1982), in addition to *M. serini*.

7. *Passer domesticus* (Linnaeus, 1758): house sparrow*
Thirteen house sparrows (8♂; 5♀) were collected on campus from 3 November 1998 to 18 April 1999. Of these, nine (prevalence = 69.2%) were infested with lice; eight carried *B. cyclothorax* (Burmeister, 1838) (mean intensity = 32.8; range = 2–96), and one carried *M. eurysternus* (1♀; 2 nymphs). Both species of lice were reported to occur on house sparrows in New Zealand by Pilgrim & Palma (1982).

8. *Fringilla coelebs* Linnaeus, 1758: chaffinch*
Two female chaffinches were collected on campus, one on each of 7 March and 3 April 1999. Neither bird was infested with lice; *F. coelebs* is not known to harbour lice in New Zealand (Palma 1999).

9. *Hirundo tahitica neoxena* Gould, 1843: welcome swallow*
Two specimens, both males, were examined; one collected on campus on 25 May 1999 and one picked up on a road on Banks Peninsula (J. Briskie) on 5 January 1999. Neither bird was infested with lice. No lice have been recorded from the welcome swallow in New Zealand (Palma 1999).

10. *Chrysococcyx lucidus lucidus* (Gmelin, 1788); pipiwharauroa, shining cuckoo*
Two shining cuckoos (not sexed), one found on campus on 6 February 1999 and one collected as a window-kill in Christchurch on 14 September 2000 and submitted to the Zoology Department by a member of the public, were examined. No ectoparasites were found. The philopterid, *Cuculicola kui* Kettle, 1980, has been recorded from the shining cuckoo in New Zealand (Pilgrim & Palma 1982).

11. *Anas superciliosa superciliosa* Gmelin, 1789: parera, grey duck*
The identity of the hosts examined here is in question, since both specimens displayed evidence of some degree of hybridisation with the introduced mallard, *Anas platyrhynchos platyrhynchos* Linnaeus, 1758. Two ducks were examined in this study. One specimen was a window-strike on campus on 13 November 1998; no lice were found on this specimen. The other duck was submitted to the Department of Zoology in 1998, but no date was recorded. It was infested with *Trinoton querquedulae* (Linnaeus, 1758) (1♂; 14 nymphs), *Anatoecus icterodes* (Nitzsch, 1818) (11♂), *Anatoecus dentatus* (Scopoli, 1763) (1♂), and *Anatoecus* spp. (21♀; 12 nymphs). *Anaticola crassicornis* (Scopoli, 1763) has been reported on mallards and grey ducks and also *Holomenopon leucoxanthum* (Burmeister, 1838) on mallards (Pilgrim & Palma 1982), but none were collected in this study.

12. *Puffinus huttoni* Mathews, 1912: Hutton's shearwater
Three specimens were examined (1♂; 1♀; 1 not sexed), all collected as road-kills by J. Briskie near Kaikoura from 2 November to 8 December1998. All three specimens were infested, each with the four species of lice recorded for this host in New Zealand (Pilgrim & Palma 1982): *Naubates harrisoni* Bedford, 1930 *s. l.* (mean intensity = 5.3; range = 3–7), *Halipeurus (Halipeurus) spadix* Timmermann, 1961 (mean intensity = 14.0; range = 6–22), *Trabeculus flemingi* Timmermann, 1959 (mean intensity = 64.6; range = 49–82), and *Austromenopon paululum* (Kellogg & Chapman, 1899) (mean intensity = 24.3; range = 2–53). The male and the female birds were each infested with four larvae and with one female, three nymphs and 17 larvae of the tick, *Ixodes uriae* White, 1852 (Acari: Ixodidae), respectively. Although this tick is not host specific and has been recorded from at least 27 species of sea birds in New Zealand, it has not been reported previously on *P. huttoni* (*see* Bishop & Heath 1998).

13. *Emberiza citrinella* Linnaeus, 1758: yellowhammer
One specimen (not sexed) was collected by J. Briskie near Kaikoura on 24 October 1998. It carried one female of *B. delicata* (Nitzsch, 1866). This species and *Myrsidea serini* have been reported from the yellowhammer in New Zealand (Pilgrim & Palma 1982; Palma 1999).

14. *Rhipidura fuliginosa fuliginosa* (Sparrman, 1787): piwakawaka, South Island fantail
One male salvaged by L. de Groot at Tuahiwi on 14 April 1999 was examined. The specimen was infested with *Menacanthus* sp. (4♂; 1♀; 15 nymphs) and one nymph of *Philopterus* sp., both genera reported from this host in New Zealand (Pilgrim & Palma 1982).

15. *Anthus novaeseelandiae novaeseelandiae* (Gmelin, 1789): New Zealand pipit
One female pipit was collected as a road-kill by T. de Groot at Tuahiwi, on 29 April 1999. The specimen had no lice. *Menacanthus eurysternus* and *Myrsidea* sp. have been reported from this host in New Zealand (Palma 1999).

16. *Larus novaehollandiae scopulinus* Forster, 1844: red-billed gull
One female specimen was salvaged by J. Briskie near Kaikoura on 3 December 1998. It was infested with *Saemundssonia lari* (O. Fabricius, 1780) *s. l.* (7♂; 2♀; 18 nymphs), *Quadraceps punctatus* (Burmeister, 1838) *s. l.* (2♂; 4♀; 8 nymphs), and *Austromenopon* sp. (1 nymph; probably *Austromenopon transversum* (Denny, 1842), *see* Pilgrim & Palma 1982). *Actornithophilus piceus* (Denny, 1842) *s. l.* has also been recorded from this host in New Zealand (Pilgrim & Palma 1982).

17. *Phalacrocorax carbo novaehollandiae* Stephens, 1826: kawau, black shag
One specimen (not sexed), a road-kill from West Melton, was submitted to the department on 2 May 1999. It was infested with *Pectinopygus gyricornis* (Denny, 1842) (5♂; 7♀; 57 nymphs), and *Eidmanniella pellucida* (Rudow, 1869) (5♂; 4♀; 11 nymphs), both of which have been recorded from this host in New Zealand by Pilgrim & Palma (1982).

18. *Circus approximans* Peale, 1848: kahu, Australasian harrier
One specimen (not sexed), a road-kill from West Melton, was submitted to the Department of Zoology on 2 May 1999. It was infested with *Colpocephalum turbinatum* Denny, 1842 (30♂; 78♀; 141 nymphs) and *Degeeriella fuscus* (Denny, 1842) (2♂; 5♀; 21 nymphs). No other ectoparasites were found on this specimen. One additional species of louse, *Nosopon lucidum* (Rudow, 1869), has been reported from harriers in New Zealand (Pilgrim & Palma 1982).

19. *Callipepla californica brunnescens* Ridgway, 1884: California quail
One chick, salvaged by J. Briskie near Kaikoura on 27 November 1998, was infested with one female *Oxylipeurus ellipticus* (Kéler, 1958). Two additional species of lice have been previously reported from this host in New Zealand: *Goniodes stefani* Clay & Hopkins, 1955, and *Lagopoecus docophoroides* (Piaget, 1880) (Pilgrim & Palma 1982).

20. *Gymnorhina tibicen hypoleuca* (Gould, 1837): white-backed magpie
One specimen (not sexed) was salvaged by J. Briskie at the Hurunui Bridge on Highway 1 on 5 November 1998. It carried one species of louse, *B. semiannulata* (Piaget, 1883) (18♂; 26♀; 47 nymphs). This host has one additional species of louse recorded for New Zealand, *Myrsidea* sp. (Pilgrim & Palma 1982).

21. *Gerygone igata* (Quoy & Gaimard, 1830): riroriro, grey warbler
One specimen (not sexed) was examined from the Zoology Department freezer, collected during the early months of 1998 from an unknown location, though probably locally. It had no lice. Pilgrim & Palma (1982) recorded the grey warbler as a host for three species of lice: *Myrsidea* sp., *Philopterus* sp. and *Ricinus* sp.

22. *Nymphicus hollandicus* (Kerr, 1792): cockatiel
One specimen (not sexed) was submitted to the department by a member of the public who found it dead on a Christchurch street on 10 May 1999. The road-killed bird was undoubtedly an escaped captive bird. No lice were found on the bird, but it was infested with 106 feather mites, *Nymphicilichus perezae* Mironov & Galloway, 2002 (Mironov & Galloway 2002b).

Discussion

Salvaging accidentally killed birds offers a valuable source of specimens for faunal analysis and for determination of infestation parameters for ectoparasites; no birds need to be sacrificed specifically for study. However, there are

numerous limitations imposed by this approach. First of all, the method is neither a random means of sampling all host species present nor a random means of sampling within a population of a host species. For example, there were an additional 11 species of birds observed in the immediate vicinity of the walkways at the University of Canterbury, some of which were nesting on campus, but were never observed striking the windows (e.g. rock dove, black-backed gull, European starling, grey warbler, fantail, hedge sparrow). There was also a strong seasonal component in the numbers of birds striking the windows. The greatest proportion of birds was collected during the summer months, when the trees surrounding the walkways were in full leaf and when there were large numbers of inexperienced, juvenile birds about. Not all birds striking the windows were examined for ectoparasites. If birds were only stunned, they were held until they recovered and were released unharmed. On several occasions, scavengers (e.g. feral cats, black-backed gulls) were observed carrying away birds from beneath the windows. There was initially concern that some ectoparasites would escape before the host could be collected; although, this loss could not be quantified, it was probably restricted to certain taxa (e.g. fleas and hippoboscids). To collect fresh hosts required intensive surveillance of the area, with frequent visits throughout the day.

The method of removing ectoparasites from their hosts was considered to be extremely efficient for lice, fleas, and hippoboscids. After three washes in soapy water and clear water, more than 99% of these ectoparasites were removed and none passed through the sieve used to strain them from the water (Galloway, unpublished data). However, when the hosts' feathers were examined under the microscope after they had been washed, there were always some feather mites present. No attempt was made to quantify the efficiency of the collecting method for feather mites, but since the method was standardised, at least some consistency in the numbers obtained can be expected.

Only one host species, the silvereye, was obtained in sufficient numbers to provide data on seasonal occurrence of ectoparasites. *Menacanthus eurysternus*, as it is currently defined, has a worldwide distribution and infests an extremely wide range of host species (Price 1975). There are undescribed species of *Menacanthus* known to occur on endemic birds in New Zealand, for example, the *Menacanthus* sp. found on a fantail in this study (Palma & Price, in press); however, the sources for infestations of *M. eurysternus* on silvereyes in New Zealand are speculative. Rather than *M. eurysternus* being a New Zealand endemic, it is more likely that this species was introduced to New Zealand on European birds, as has clearly been the case for other species of lice (e.g. *Philopterus turdi*). It is unknown whether *M. eurysternus* transferred to silvereyes exclusively after they became established in New Zealand in the 1850s, or whether colonising silvereyes brought their lice with them from Australia.

Prevalence and intensity of infestation by *M. eurysternus* were greatest on silvereyes during the summer and early autumn. A similar seasonal distribution has been reported elsewhere (Boyd 1951; Ash 1960; Kettle 1983) for *Menacanthus* spp. on other host species, where these lice have been observed to overwinter primarily in the egg stage attached to the hosts' feathers (Boyd 1951). No attempt was made in the present study to examine hosts for louse eggs. It has been suggested that reproduction in lice that feed on blood may be affected by the host's hormones (Foster 1969), but experimental evidence is lacking. It is interesting that all silvereyes examined were infested with feather mites, among which no seasonal pattern in the overall numbers of feather mites was evident.

There is little published information available on the geographic distribution of lice on birds within New Zealand. For some introduced birds in this study, only a limited subset of the known ectoparasites was collected. For example, there are five species of lice recorded from blackbirds (Pilgrim & Palma 1982; Palma 1999), and yet only two species were collected in the Christchurch area in the present study. This may be because some of these species were present at low levels of infestation during the study period and were undetected in the small sample sizes. On the other hand, it is possible that there are discontinuities in the distributions of some species of lice relative to the ranges of their hosts. Not all species of lice recorded for these birds in Europe and Great Britain appear to have been introduced into New Zealand, or at least some have so far escaped detection. This phenomenon is not unusual, as noted for parasites of house sparrows in North America (Brown & Wilson 1975) and in New Zealand (Paterson *et al.* 1999). Additional collections are required to be able to establish attributes of biogeography of lice on New Zealand birds.

Even though the data presented here are limited, these are the first published observations on quantitative estimates of infestation parameters of New Zealand native

birds, i.e. Hutton's shearwater, grey duck, black shag, red-billed gull, Australasian harrier, silvereye, welcome swallow, shining cuckoo, fantail, New Zealand pipit, and grey warbler. Even for the introduced species of birds examined in this study, there are few references to infestation parameters or their dynamics throughout the season for anywhere they occur. Most studies have been conducted for taxonomic purposes or to establish an inventory of species of ectoparasites present in a given locality. As the ectoparasite fauna becomes better known, researchers hopefully will turn their attention to the host–parasite interactions among these species. It is important to understand the nature of these interactions in the context of potential impact on their hosts and the implications for host fitness and well being. Ultimately, the success of conservation programmes may hinge on an understanding of interactions of hosts with their parasites and, in fact, parasites also deserve attention in conservation efforts.

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