Effects of haematophagous mites on nestling house sparrows (Passer domesticus)

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Abstract

Haematophagous mites are frequently found on nestling house sparrows (Passer domesticus), but their effects are poorly known. In this study we investigated whether natural levels of infection by two mite species Pellonyssus reedi and Ornithonyssus sylviarum have any fitness consequences on their hosts, including some physiological indices of chick health, body condition and fledging success. Among the haematological variables, thrombocytes and heterophils, but not lymphocytes and eosinophil granulocytes showed positive correlations with mite loads. There was also a significant decrease in the haematocrit values of the nestling sparrows with increasing mite intensity. We found no significant effect of ectoparasites on short-term indices of nestling fitness, such as body mass or fledging success. These results suggest that the blood-feeding mites of the studied house sparrow population mainly affected the haematological parameters of their hosts: They generated a non-specific immune response, with inflammatory processes and anaemia. On the other hand, parasite infestation seemingly has only weak influence on feather and skeletal growth of nestling sparrows, and no effect on fledging success and body mass.

Keywords

Passer domesticus, Pellonyssus reedi, Ornithonyssus sylviarum, haematophagous mites, haematological variables, anaemia, immune response, body mass, fitness effects

Introduction

It is widely known that ectoparasites have diverse and wide-ranging effects on their avian hosts, with consequences on their morphology, physiology and behaviour (Loye and Zuk 1991, Clayton and Moore 1997). Ectoparasitic mites are present in most avian taxa, and evidence for blood feeding nest mites adversely affecting the fitness of their hosts comes from numerous field studies, including both observations and parasite load manipulations (reviewed by Proctor and Owens 2000). For example, nest mites may have direct detrimental effects, such as increased chick mortality and increased inter-clutch intervals (Møller 1990b, 1991, Clayton and Tompkins 1995, Stoehr et al. 2000). Indirect effects were also found in several studies, such as frequent nest abandonment and increased parental costs (Møller 1987, Moller 1993). Furthermore, high levels of mite parasitism may slow nestling development by inducing reduced body weight and size, or anaemia (Møller 1990a, 1993, Merino and Potti 1995, Potti et al. 1999, Stoehr et al. 2000). On the other hand, several studies found no unambiguous relationships between mite loads and hosts' reproductive success (e.g. Rendell and Verbeek 1996, Pacejka et al. 1998).

Haematophagous mites typically have a life cycle of 5-7 days, including larval, nymphal and adult stages (Richner and Heeb 1995). Hence these parasites can quickly build up large populations in the nests, with potentially two or three generations of mites per nestling period (for example, house sparrow (Passer domesticus) chicks leave nest within 13-15 days after hatching; Summer-Smith 1963). Blood meals are needed for moult by juvenile mites and for reproduction by adults.

Although a large number of studies have described various ectoparasites associated with house sparrows (Clark and Yunker 1956, Summer-Smith 1963, McGroarty and Dobson 1974, Brown and Wilson 1975, Hori et al. 1990, Kaczmarek 1991), few of them have analysed their possible detrimental effects and fitness consequences. In a recent observational study, Weddle (2000) reported a decrease in the body mass of house sparrow chicks due to high mite intensity. However, neither this latter study nor other ones investigated the effects of mites on physiological indices of nestling sparrows' health.

Our primary aim was to study whether there are any haematological responses to blood-sucking mite infection in free living house sparrow young. We hypothesised that if parasitic mites impose any health impact on their avian hosts, then different levels of infection should be revealed in some blood health indices, such as relative number of immunologically active leukocytes or reduced haematocrit level (anaemia). We also investigated the effects of mites on growth and fledging success of nestling sparrows.

Materials and methods

Our study took place in a rural population of house sparrows, breeding on the buildings of the Agrárgazdaság Ltd. milk farm near to Debrecen, Hungary (21 38' E, 47 32' N). Sparrows are abundant in this area, and breed mainly in holes inside the farm buildings. There are typically three broods per year in this sparrow population, and in this study we monitored chicks of the third broods, from July to August in 2000.

Empty sparrow nests found during regular searching were visited every second day to determine the dates of egg laying and hatching. Twelve days after hatching, we ringed the young and measured their body mass, tarsus, wing, tail and bill length. Fledging success was estimated as the brood size on the 12^{th} day after hatching divided by the number of hatched chicks. To assess ectoparasite loads, each chick was placed in a jar with chloroform vapour except the head, for 20 minutes (Brown and Brown 1996). All the collected mites were stored in ethanol and their number was counted later in the lab. In the analyses we used the mean mite intensity found on chicks, calculated as the total number of mites collected from one brood divided by the number of chicks sampled in the nest. Parasite intensity was assessed for a total of 100 chicks, in 25 broods. All measurements were made by K.Sz.

Blood samples for haematological measurements were taken from the brachial vein of each chick, using capillary tubes. For blood cell counts, a drop of blood was smeared on a microscope slide, which was then air-dried, fixed in methanol and stained with May-Grünwald-Giemsa. The rest of the blood sample was centrifuged for 10 min at 10000 rpm to determine haematocrit values. Blood smears were scanned at 1000x magnification following standard procedure. On each smear, we counted erythrocytes, thrombocytes and leukocytes (classified as lymphocytes, monocytes and three families of granulocytes, eosinophils, basophils and heterophils) in 40 microscope fields (Campbell 1988). The number of different leukocyte types and thrombocytes related to 10000 erythrocytes were defined as relative counts and used for the analyses. All haematological counts were made by A. Sz.

Since chicks from the same brood cannot be considered as independent sample points, we used the mean values of all chicks in a brood for all variables in the analyses (N= 25 for all statistical tests). Confidence intervals of mite prevalence, mean and median intensity were calculated with the Quantitative Parasitology 1.0 software (Rózsa et al. 2000), and were log transformed before statistical testing. Correlational analyses were performed with nonparametric Spearman rank correlations, using SPSS 9.0 (SPSS Inc. 1998). Significance levels were adjusted with Bonferroni corrections for multiple comparisons. Values reported are means (± SD) and two-tailed probabilities.

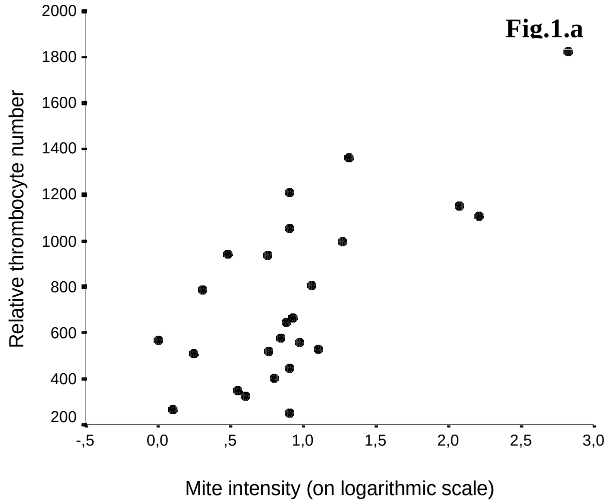
Results

We collected two mite species from nestling sparrows. Some specimens were identificated as Ornithonyssus sylviarum [Canestrini & Franzago 1877], a common haematophagous mite which feeds frequently on sparrows (Summer-Smith 1963), but the majority of specimens belong to the species Pellonyssus reedi (Zumpt & Patterson 1952), which has been previously also found in sparrows' nests (Clark and Yunker 1956). P. reedi has not yet been recorded from the European geographic region (A. Baker, personal communication). Both species are haematophagous, nest-living mites of the suborder Mesostigmata. Because both species are similar regarding their size, feeding habit and life cycle, we did not analyse their effects on chicks separately.

Brood size varied from 2 to 6 chicks, with an average of 4.0 (1.08) nestling. We found no evidence of nestling mortality due to parasitism or starvation. Parasite prevalence was 1 (95% confidence limits are 0.9637 and 1.0), i.e. we found in each nest. The abundance of mites in sparrow nests was highly variable, with a range of 6-1998 mites per nest. The average intensity was 37.3 mites per nestling (95% confidence limits are 15.8 and 59.1). Median intensity was 8 mites per chick with 95% confidence limits from 6 to 8 mites.

Among the measured haematological variables, there was a strong positive correlation between mite intensity and the number of thrombocytes in the peripheral blood (Table 1, Fig. 1a). Heterophil granulocytes also showed a marginally significant positive correlation with mite intensity (Table 1, Fig. 1b). On the other hand, the heterophil/lymphocyte ratio, a common measure of stress was not related to the mite infection (r_s = 0.183, p= 0.38), along with another stress measure method, the leukoyte/erythrocyte ratio (r_s = 0.215, p= 0.301).

Similarly, mite intensity was not related to the relative number of lymphocytes and monocytes in the peripheral blood, and this was also the case for two families of granulocytes, the eosinophils and basophils (Table 1). We found a significant decrease in the haematocrit values of the nestling sparrows with increasing mite intensity (Table 1, Fig. 1c). Clutch size was not related with the total number of parasites in the nest (r_s= -0.064, p= 0.76), and likewise fledging success was also unrelated to parasite load (r_s= -0.126, p= 0.548). After Bonferroni correction, we found no significant effects of ectoparasites on body mass (Fig. 2) or other measured biometric variables of nestling sparrows, such as tarsus, wing, tail and bill size, however in wing and bill measures, there was an explicit trend for negative correlation (Table 2).



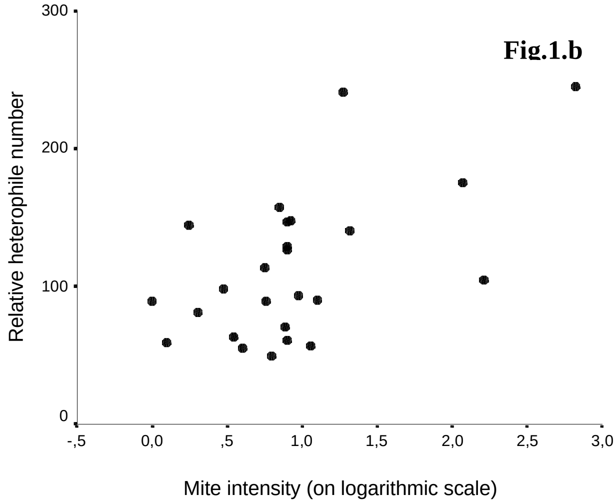


Fig. 1. Relationship between mite intensity and (a) relative number of thrombocytes, (b) relative number of heterophile granulocytes, and (c) haematocrit values of chicks. Mite numbers are log transformed, data points are mean values per brood.

Fig.1.c

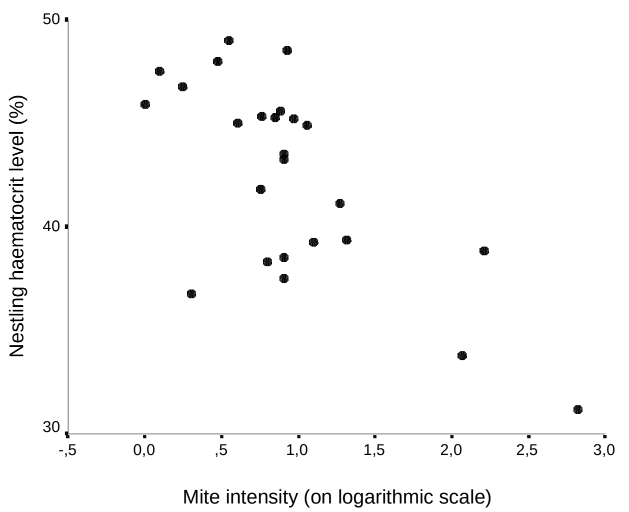


Fig.2

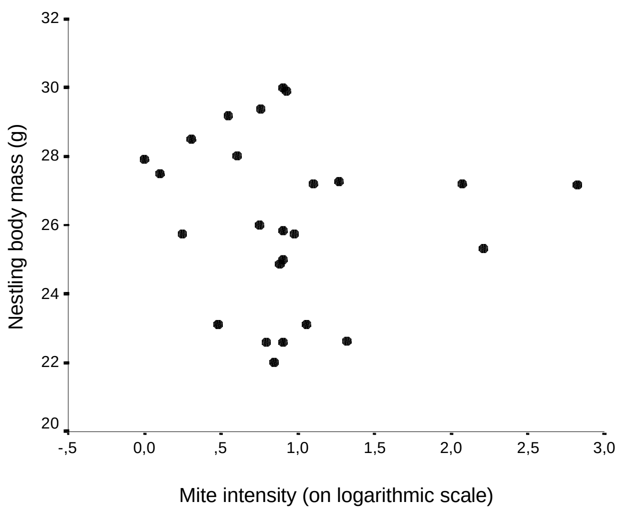


Fig. 2. Nestling body mass (g) in relation to mite intensity. Mite numbers are log transformed, data points are mean values per brood.

Table 1. Correlations between brood means of haematological variables and brood means of mite intensity in house sparrow nestling. Results of Spearman rank correlations are given (N = 25 broods).

Haematological variables							
	Haematocrit	Lymphocytes	Monocytes	Eosinophils	Basophils	Heterophils	Thrombocytes
r_s	-0.558	0.173	0.079	0.002	0.429	0.48	0.571
P	0.004*	0.408	0.709	0.995	0.052	0.015	0.003*

* Significant at the 0.05 level after Bonferroni correction. (α = 0.0071)

Table 2. Correlations between brood means of biometric variables of ckicks and brood means of mite intensity. (Spearman rank correlations, N= 25 broods).

Biometric variables	Body mass	Tarsus length	Wing length	Tail length	Bill length
r_s	-0.203	-0.245	-0.435	-0.371	-0.501
P	0.330	0.238	0.03	0.068	0.011

There were no significant results after Bonferroni correction. ($\alpha = 0.01$)

Discussion

In this paper we report the results of a correlational study on the impact of natural levels of haematophagous mite infection on nestling house sparrow hosts. The crucial point in our investigation was the question whether ectoparasitic mite infections have any physiological and general health consequences, and whether there is a detrimental impact on the chicks due to this parasitism.

Mite intensities apparently related to the blood profile of young sparrows. Mite intensity showed a significant positive correlation with heterophils, but not with other leukocytes participating in immune responses, such as lymphocytes and eosinophils. In addition, we found a strongly significant positive correlation between thrombocyte number and parasite load. Another conspicuous consequence of mite parasitism was a definite anaemia of the chicks suffering from high mite intensity, and that manifested in form of low haematocrit levels.

Changes in blood profile could be ascribed to many factors, such as pathogens or intense physical activity. In face of its aspecificity, blood smear analyses are widely used in many empirical works, mainly because it is a simple method to gain information about general physiological processes, including immune responses. There is however still uncertainty in the interpretation of blood profile results. For instance, it is not evident whether low levels of circulating white blood cells indicate a relative healthy individual, or a depleted leukocyte pool caused by persistent infection. Similarly, elevated leukocyte numbers may indicate an activated immune system or lowered immunocompetence (Owens and Wilson 1999).

Heterophils are involved in fighting the infection in the bloodstream via non-specific phagocytosis of pathogens and dead tissue parts. Peripheral heterophylia is a widely recorded symptom recurring in almost any kind of stress, inflammation and infection (Maxwell 1993, Parslow 1994). Immunologically reactive components of mite saliva may cause such an aspecific inflammatory reaction as a consequence of frequent bites. Therefore, because of the conspicuous relation between mite load and relative heterophile number, we suggest that Pellonyssus and Ornithonyssus infections were associated in our study with an increased stress level and acute phase of inflammation in the nestling sparrows.

Lymphocytes are immune cells that assist in the recognition and destruction of many types of pathogens. In some avian taxa, a typical response to infectious disease is an increase in lymphocytes and heterophils (Campbell 1988). Furthermore, decline in the lymphocyte level is an indicator of general stress or immunosuppression caused by pathogens, and changes in heterophil/lymphocyte ratio are thought to have the same background (Maxwell 1993). Our blood smear analyses however didn't show this decline in lymphocyte number, even in the most heavily parasitised broods. Thus, there was no evidence for such a suppression in the immune functions by the parasitic mites.

Thrombocytes are involved mostly in processes of haemostasis (Campbell 1998). High levels of thrombocytes therefore suggest an activated haemostatic function, that may be the result of the frequent injuries due to feeding of mites. Finally, haematocrit values associated with mite loads show that these ectoparasites cause anaemia in their host due to depletion of the erythrocyte pool, as was also found in other studies investigating bird-mite interactions (Merino and Potti 1995, Potti et al. 1999, Stoehr et al. 2000). This form of physiological handicap may have detrimental fitness consequences in the fledging period, because difficulties in oxygen uptake and transport may result in lower foraging ability and increased predation risk (Phillips et al. 1985, Clark 1991). On the whole these haematological results suggest that haematophagous mites mainly activate non-specific immune responses in sparrow chicks. Their detrimental physiological effects consist primarily of inflammatory processes and anaemia because of the depletion of the erythrocyte pool.

Contrary to the blood profile variables, our results suggest that blood-sucking Pellonyssus and Ornithonyssus mites may have no strong direct detrimental effect on growth and survival to fledging of sparrow chicks. First, intensity of mite infestation seemed not to induce chick mortality and decrease in fledging success. Second, general measures of chick size such as tarsus, bill, wing and tail length showed little or no affection by mite numbers. Third, nestling body mass was also unrelated to intensity of infections. Nestling's body mass at fledging is an important fitness component because it considerably affects offspring survival in the postfledging period (Lindström 1999). In accordance with many studies reporting decreased body weight due to ectoparasitic mites, Weddle (2000) found a negative effect of Pellonyssus reedi on sparrow nestling body mass in house sparrows. The same effect of this mite species was shown in an experimental study with nestling house finches (Carpodacus mexicanus), along with the possibility of mite-induced mortality (Stoehr et al. 2000).

It is not clear why our study failed to find such detrimental effects of mites on their hosts as regards chick growth and fledging success. One reason may be that differences among the studies may reflect population differences, e.g. either in the susceptibility of sparrows to infection or in the virulence of the parasitic mites. Second, parasite effect may differ depending on environmental conditions. Under poor circumstances, parasites affect their nestling hosts usually stronger as in a good habitat or a good year. Favourable conditions permit the parents to compensate harmful parasite effects on their chicks. Our study area on the milkfarm seems to be a highly appropriate habitat for sparrows, with overabundant food sources. In addition, the study may happen to have been conducted in a favourable year. These possibilities call for further testing, preferentially by experimental manipulations of parental efforts and parasite loads on nestling sparrows.

Acknowledgements

We are grateful to the Agrárgazdaság Ltd. for allowing the fieldwork on their milk farm. Anne Baker at the Natural History Museum London kindly identificated the collected mites and Zoltán Serfőző at the University of Debrecen submitted his microscope for haematological analyses. We also thank Lajos Rózsa and two anonymous referees for their helpful comments on an earlier version of the manuscript. Both ZB and AL were supported by a Békéssy György Postdoctoral Fellowship and by the Hungarian Research Found (OTKA, grants T030434 to BZ and F026595 to AL).

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