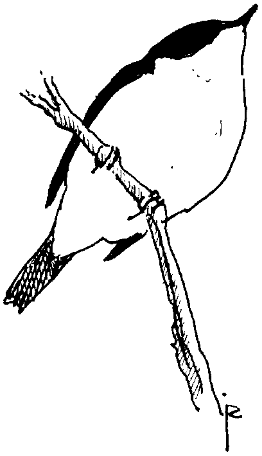
DO PARASITIC MITES DECREASE GROWTH OF NESTLING PIED FLYCATCHERS *FICEDULA HYPOLEUCA*?

VINCENT BAUCHAU



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The effect of a parasitic mite *Dermanyssus hirundinis* on the growth and survival of nestling Pied Flycatcher *Ficedula hypoleuca* was tested by an experiment where the parasite level was reduced in half of the nest boxes using an insecticide. Although the abundance of mites was significantly reduced in the experimental group, there was no difference in body mass, tarsus length or fledging rate between nestlings in the experimental and the unmanipulated group. There was however a negative correlation in the unmanipulated group between body mass and mite abundance, as had also been observed in an earlier, non-experimental study (Merino & Potti 1995). I suggest that this correlation is a consequence of variation in some aspect of parental quality and not a direct effect of the parasitic mites.

Key words: *Ficedula hypoleuca* - breeding - nestling growth - ectoparasites - *Dermanyssus*

Netherlands Institute of Ecology, P.O. box 40, NL-6666 ZG Heteren, The Netherlands; E-mail: bauchau@cto.nioo.knaw.nl.

INTRODUCTION

Interactions between parasites and their avian hosts have attracted a great deal of attention recently, especially with regard to coevolution and sexual selection (Loye & Zuk 1991). The Pied Flycatcher *Ficedula hypoleuca* and its parasites constitute an interesting host-parasite system because the Pied Flycatcher is one of the most used bird species in ecological studies (Lundberg & Alatalo 1992). There have, however, been few investigations of the effects of ectoparasites on this passerine. Two experimental studies did not find any effect of fleas on breeding success in this species (Orell *et al.* 1993, Mappes *et al.* 1994). The experiment by Orell *et al.* (1993), however, involved small sample sizes (eight pairs). The experiment by Mappes *et al.* (1994) suffered from the fact that the birds could choose between nest boxes with different levels of parasites. Two non-experimental studies are also available: Eeva *et al.* (1994) investigated the relationship between breeding success and number of ectoparasites in nests of the Pied Flycatchers in Finland. They found a positive correlation between nestling mortality and the number of fleas per nest (although they concluded that this effect is only minor) while no effect of blowflies was detected. In another correlational study, Merino & Potti (1995) observed that nestlings had smaller body mass and shorter tarsus in nests with many mites *Dermanyssus gallinoides* compared with nests with few mites; the difference was larger in 'low quality' than in 'high quality' nest boxes, nest box quality being estimated by how frequently they had previously been used. No difference in nestling mortality was observed. Nestling mortality, however, correlated with the number of blowfly larvae. Concluding that there is a detrimental effect of the mites on the growth and survival of nestling Pied Flycatchers, the same authors have later argued for the role of the mites in the ontogeny of sexual dimorphism (Potti & Merino 1996). They have observed that in nests containing many mites, young male Pied Flycatchers had smaller tarsi than ♀♀; in nests with few mites, there was no size difference between the tarsi of the two sexes. They conclude that sexual dimorphism in the adults arises from the effect of nest parasites on early growth: ♂♂ suffer more from the parasites as a consequence of a reduction of their immunocompetence induced by testosterone. In both studies, however, the level of parasites was not experimentally manipulated and therefore a causal relationship between mites and nestling growth could not be demonstrated: the correlation might be due, for instance, to phenotypic variation among the breeding birds with low quality birds having nestlings in lower condition and being less able to avoid ectoparasites. Only experimental studies in which the ectoparasites are experimentally manipulated (Moss & Camin 1970) can establish causality between ectoparasite load and breeding success. Here I report the results of such an experiment with Pied Flycatchers, designed to manipulate the level of a parasitic mite *Dermanyssus hirundinis*.

METHODS

The experiment took place in the spring of 1995 in the Buunderkamp, a mixed forest on poor sandy soil near Arnhem, The Netherlands. There were 300 nest boxes regularly distributed over 150 ha. Apart from the Pied Flycatchers, nest boxes are also used by Great Tits *Parus major* (at about the same density as the Pied Flycatcher), Blue Tits *P. caeruleus*, and a few other species in low numbers.

The haematophagous mite, *Dermanyssus hirundinis*, a close relative to the poultry red mite *D. gallinae*, was the most common and abundant ectoparasite. They overwinter in the boxes. I have observed them at low density in nest boxes throughout the winter presumably feeding on roosting Great Tits. Populations of mites build up from very few to some thousands of individuals during the breeding season. They feed at night and during the day are observed mostly on the upper part of the box, under the lid. Mites can potentially transmit viral, bacterial and protozoan diseases (Moss 1978). Other ectoparasites found in the nests and the boxes were fleas *Ceratophyllus gallinae* and blowfly larvae *Protocalliphora* sp.

Nest boxes were checked at regular intervals to record laying date, clutch size, hatching date, and the number of nestlings that hatched and fledged. Nestlings were ringed, measured (tarsus length) and weighed on day 12 after hatching. Old nests were removed before the breeding season. New nests were collected shortly after the chicks had fledged, enclosed in plastic bags, brought to the laboratory and searched for unhatched eggs, dead nestlings and ectoparasites.

The experimental manipulation of the number of mites was made as follows. On the day that the first egg was laid in each box, boxes were randomly allocated to experimental treatments. One nest box out of two was sprayed with insecticide on all interior surfaces (where mites hide during the day), while the Pied Flycatcher's eggs were covered by a paper tissue. The other box was left intact as an unmanipulated control. The active ingredient of the spray was Deltamethrin 0.028%, a synthetic pyrethroid; it was chosen for its high effectiveness against the parasitic mite *Dermanyssus* (LC_{50} = 7.8 μg m^{-2} ; Zeman & Zelezny 1985) and for being innocuous to birds (oral toxicity: LD_{50} > 4 g kg^{-1}; Hill 1985). Each nest box received *c*. 25 ml of solution.

The number of haematophagous mites were estimated twice, first in the field at day 12 after hatching and later in the laboratory, from the nests collected after fledging. In the first case, I estimated the number of mites hiding under the lid cover of the nest box, where they aggregate during the day. In the second case, I estimated the number of mites seen aggregated in the corner of the plastic bags enclosing the nests. The two counts were positively correlated ($r_s = 0.56$, $P < 0.001$). Mean number of mites per infected nest was calculated from the count made at the nest box at day 12. Fleas and blowflies in the nest were counted after fledging, immediately after collecting the nests and again several weeks later, when the next generation of adult fleas and blowflies had emerged. The number of parasites per nest given here are minimal figures, because some parasites escape detection (especially small mites) and/or disperse from the nest before estimation.

Forty-six clutches were included in the experiment. Four of these (one unmanipulated, three sprayed) were predated (probably by humans), one was deserted without apparent cause (sprayed), and in one clutch (unmanipulated) one of the eggs was broken by an observer. These six clutches have been excluded from the analyses. Thus the sample size for the analysis is 40 (23 unmanipulated and 17 sprayed); tarsus length and body mass were obtained from 38 broods (no chicks survived to day 12 in two broods, both from the 'sprayed' group). Nest mean body masses and tarsus lengths were used in the analyses.

RESULTS

The experimental spraying significantly reduced the abundance of parasitic mites (Table 1). Only the unmanipulated boxes sustained large (several hundred individuals) populations of haematophagous mites. Fleas and blowflies were rare, both in terms of the proportion of infected nests and number of parasites per nest; the proportion of infected nests was lower in the sprayed than in the unmanipulated group but the difference was not statistically significant (Table 1).

The two experimental groups did not differ in laying date (Table 1), so comparisons do not have to be controlled for this variable. There were no significant differences between the sprayed and control nests in clutch size, the number of young hatched or fledged, or the tarsus length or nestling body mass at day 12 post hatch (Table 1). Moreover, the direction of the differences between sprayed and unsprayed broods was not consistent: clutches in sprayed nests were larger, but had a lower fledging rate, so that the number of young fledged was similar (Table 1). The difference between the two groups in tarsus length or body mass remained non significant even when controlling for date and/or clutch size (analysis of covariance, $0.13 < P < 0.99$). Thus, the results do not suggest that parasitic mites had an effect on nestling growth or fledging rate in the population under study.

Table 1. Abundance of ectoparasites and breeding parameters in the unmanipulated and sprayed Pied Flycatcher nests. Figures are percentage or mean (and standard deviation). χ^2 contingency test with 1 *df*, *z*-value from Wilcoxon test, or *F*-ratio from one-way ANOVA. Fledging rate is the number of young fledged per egg laid.

	Unmanipulated		Sprayed		Test statistics	*P*
n	23		17			
% infected by ≥ 50 mites	65.2		23.5		$\chi^2 = 6.8$	0.009
no. mites/infected nest	364	(344)	33	(30)	$z = 3.25$	0.001
% infected by fleas	35.3		5.9		$\chi^2 = 2.76$	0.10
no. fleas/infected nest	23.8	(25)	2.0	(-)	-	-
% infected by blowflies	17.3		11.8		$\chi^2 = 0.24$	0.62
no. blowflies/infected nest	6.5	(4.4)	15.0	(14.1)	$z = 0.48$	0.63
mean laying date, May	10.6	(6.0)	11.3	(4.5)	$F = 0.13$	0.72
mean clutch size	5.91	(0.9)	6.35	(0.9)	$z = 1.54$	0.12
mean no. young hatched	5.42	(1.0)	5.94	(0.9)	$z = 1.47$	0.14
mean no. young fledged	4.48	(1.7)	4.41	(2.3)	$z = 0.27$	0.79
fledging rate	0.76	(0.28)	0.70	(0.36)	$z = 0.19$	0.85
mean tarsus length, mm	17.52	(0.5)	17.74	(0.4)	$F = 2.18$	0.15
mean body mass, g	13.41	(1.3)	13.23	(1.5)	$F = 0.16$	0.70
body mass/tarsus	0.77	(0.7)	0.75	(0.08)	$F = 0.68$	0.42

Although there is no difference between the two experimental groups, there is however, within the control group, a negative correlation between body mass and the number of mites (r_s = -0.47, P = 0.02, n = 23); this correlation remains when controlling for clutch size (analysis of covariance, mites: $F_{1,19}$ = 10.5, P = 0.004; clutch size: $F_{1,19}$ = 4.1, P = 0.06; interaction: $F_{1,19}$ = 0.91, P = 0.35). For tarsus length, the correlation is not statistically significant but goes in the same direction (r_s = -0.19, P = 0.38, n = 23).

DISCUSSION

Like Merino & Potti (1995), I observed that the body mass of the nestlings (in unmanipulated nests) correlates negatively with the abundance of mites. However, when the abundance of mites was experimentally reduced, there was no difference between the two groups. This suggests that the observed correlation does not result from a direct effect of the mites on nestling growth, but from both mite abundance and nestling growth being correlated to other variable(s), presumably some form of parental quality. Parents of high phenotypic quality may select nesting site and/or material less likely to be infected, or may be able to remove mites from the nest.

Other experimental studies of the effect of *Dermanyssus* sp. have also yielded conflicting results. Nestlings from infected broods had lower body mass than nestlings from uninfected broods in Purple Martins *Progne subis* (Moss & Camin 1970) and in Rock Doves *Columbia livia* (Clayton & Tompkins 1995). However Johnson & Albrecht (1993) found very little or no effect of *D. hirundinis* and blowflies on nestling House Wrens *Troglodytes aedon* (but they suggested that the parents pay the cost later). For other mite species, an effect on breeding success has been experimentally demonstrated, notably by Møller (1990) in the Barn Swallow *Hirundo rustica*. However this conclusion cannot be automatically extended to all parasite-host systems, because some bird species may be more resistant to parasites than others. Compared to the Great Tit, a sympatric, ecologically similar species, Pied Flycatchers had lower rates of infection by ecto- and endoparasites (Bauchau in press). So far in the Pied Flycatcher, there is no firm experimental evidence that mites reduce nestling growth; effects on other fitness components are expected but not yet demonstrated. In the meantime, correlational data should be used with caution.

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SAMENVATTING

Het effect van parasitaire mijten *Dermanyssus hirundinis* op de groei en overleving van nestjongen van Bonte Vliegenvangers *Ficedula hypoleuca* werd getest door middel van een experiment waarin met behulp van een insecticide in de helft van de nestkasten het aantal parasieten werd teruggebracht. Hoewel in de experimentele groep de talrijkheid van mijten aanzienlijk werd gereduceerd, werd er geen verschil gevonden in lichaamsgewicht, loopbeenlengte of het uitvliegsucces tussen de jongen in de experimentele groep en de controlegroep. Er werd echter een negatief verband gevonden in de controle groep tussen lichaamsgewicht en de dichtheid aan mijten, zoals ook al in een oudere, niet-experimentele, studie van Merino & Potti (1995). Ik veronderstel dat deze correlatie een gevolg is van variatie in een of ander kenmerk van ouderkwaliteit en geen direct effect is van de parasitaire mijten.

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