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BLOOD PARASITES OF NESTLING GOSHAWKS

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There are a few studies which have investigated pathogenic effects of haematozoa on wild raptors. Ashford et al. (1990, 1991) were unable to demonstrate any effect of *Leucocytozoon toddi* on the mortality of nestling or adult European Sparrowhawks (*Accipiter nisus*) in England and Korpimaki et al. (1993) showed no effect of *L. ziemanni* on body mass or molting progress in almost 200 Tengmalm's Owls (*Aegolius funereus*) in Finland. They did, however, find that four of six females which laid unusually small clutches had relatively heavy infections. In a second large study, Korpimaki et al. (1995) found that mates of male European Kestrels (*Falco tinnunculus*) infected with *Haemoproteus* produced smaller clutches earlier than mates of uninfected males. It is unfortunate that the precise ages of these birds were unknown as this was likely to be the confounding variable.

The occurrence of blood parasites in nestling Northern Goshawks (*Accipiter gentilis*) is unknown and, if they do occur, their role as a factor of regulation of goshawk reproduction is unclear. The aim of this preliminary study was to investigate occurrences of blood parasites and to assess whether they are a significant mortality factor in nestling goshawks.

METHODS

Nests of Northern Goshawks were studied from March through late July 1994. Clutch sizes were determined by viewing nest contents in late April and early May 1994 with a mirror attached to a telescopic pole. We climbed into nests between 11–14 June to sex, band, weigh and measure wing lengths (standard B.T.O. maximum chord: Spencer 1984) of nestlings. Body mass was adjusted for crop contents by subtracting 60 g if nestlings had full crops and 15 g if they had crops that were half-full or less. Wing-length measurements were used to age nestlings (±4 d) from growth equations of Swedish goshawks (Kenward et al. 1993). The first

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Table 1. Distribution of infections of *Leucocytozoon toddi* in nestling Northern Goshawks by brood size and sex.

	Brood Size			Total
	1	2	3	Nests
# Infected broods	1	5	2	8
# Uninfected broods	4	6	5	15
# Infected males	1	3	0	4
# Infected females	0	2	3	5

egg-laying date, if not known from direct observations, was calculated by backdating from the age of the oldest nestling in a brood. The incubation period used was 38 d (36 d + 2 d), as incubation does not start until at least the second egg is laid, two days after the first egg is laid (Cramp & Simmons 1980). We are not aware of any instances of goshawks removing unhatched eggs from their nests, so any eggs that were unaccounted for, after thorough searches of nest material, were assumed to have hatched and the resulting young to have died. In late July, nesting territories were revisited to check for occupancy and fledgling mortalities. Juveniles were classified as having dispersed when they were >400 m from the nesting territory and its immediate vicinity.

Blood samples were taken at the same time as nestlings were banded. This was done by clipping the tip of the talon on the inner toe. All nestlings were handled in the same manner by the same observers. Blood smears were prepared in the field, immediately air-dried, fixed with absolute methanol and later stained with Giemsa stain in a laboratory. Slides were examined under a microscope and the parasite load was estimated on a logarithmic scale of 0 to 4, where 0 = no parasites seen in the entire film examined; 1 = fewer than 1 parasite per 100 high-power fields (×400); 2 = 1–10 parasites per 100 high-power fields; 3 = 11–100 parasites per 100 high-powered fields; 4 = more than 100 parasites per 100 high-power fields.

Results and Discussion

We examined the blood of 48 nestlings from 23 nests. Five female (26% of females) and four male (14% of males) nestlings from eight nests were infected with *Leucocytozoon toddi* (Table 1). One male was infected with a trypanosome, presumably *Trypanosoma avium*, but not with *L. toddi*. The single trypanosome infection suggested that trypanosomes had a negligible impact on nestling mortality. In Britain, avian trypanosomes are also found in blackflies (*Simulium* sp.) and European Sparrowhawks (Pierce and Marquiss 1983, Dirie et al. 1990).

The median date for first egg laying of infected broods (median = 13 April, range = 7–9 April, $N = 8$) was similar to that of uninfected broods (median = 9 April, range = 31 March–18 April, $N = 14$; Mann-Whitney U-test, $U_{8,14} = 35.0$, $P > 0.05$) suggesting parasite infection and date of egg laying were not related. *L. toddi* infections also did not appear to be associated with body mass or sex of nestlings, as male and female nestlings of differing body masses and ages were infected and, in general, the mass of infected individuals of both sexes were within ranges of uninfected nestlings (Fig. 1).

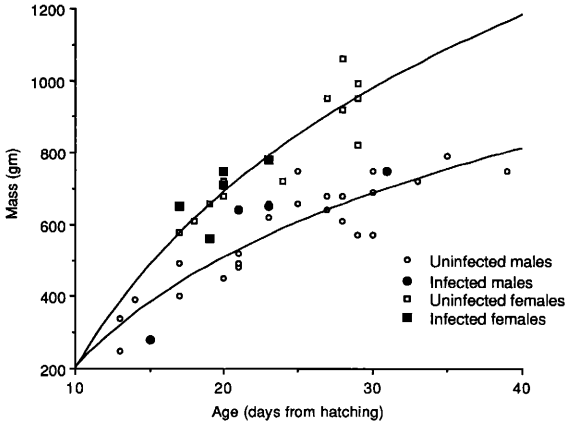

Figure 1. Effect of *Leucocytozoon toddi* infection on growth of male and female nestling Northern Goshawks in Wales in 1994. Males: Y= −805.9 + 1010.0log(x), females: Y= −1434.5 + 1632.8log(x).

There was no apparent association between infections and brood size (Likelihood ratio test, $\chi^2_2 = 1.182$, $P > 0.05$, Table 1), nor was there any apparent clustering of infections by sex with brood size ($\chi^2_2 = 6.352$, $P > 0.05$). Four male nestlings had infection loads of 1 and 2 and none had loads of 3. Conversely, only two female nestlings had infection loads of 1 and 2 and three had loads of 3. Although higher infection loads were higher in females this was not significant ($\chi^2_2 = 5.094$, $P > 0.05$).

The mean clutch size, brood size at banding and fledglings at dispersal in infected and uninfected broods were similar (Table 2). The mortality of young goshawks up to time of banding (>13 d) in infected broods (5 from 19 broods) was not significantly higher than in uninfected broods (4 from 28 broods; Fisher's exact 1-tail test, $P = 0.255$, Table 2). Parasites take around 14 d to appear in the blood (Pierce and Marquiss 1983), but infected nestlings

Table 2. Productivity and survival of Northern Goshawk eggs and nestlings in nests infected ($N = 6$) and uninfected ($N = 10$) with the blood parasite *Leucocytozoon toddi* in Wales in 1994.

	Uninfected Nests (Number)	Infected Nests (Number)
Eggs laid	33	22
Unhatched eggs	5	3
Nestlings hatching	28	19
Nestlings dying	4	5
Nestlings fledging	24	14
Fledglings dying	1	0
Fledglings dispersing	23	14

may be ill and possibly die during this prepatent period. Further studies involving a larger sample size are needed to examine if there is a higher mortality of young goshawks in infected broods. If so, this might explain why only light infections were found since heavy infections, if they occurred, would have resulted in death before 13 d of age.

There was no association between infection and mortality in a brood between banding (13–39 d) and fledging as nestlings from both infected and uninfected broods died ($\chi^2_1 = 0.166$, $P > 0.05$). This suggested that infections did not reduce the survival of nestlings past the young nestling stage (>14 d).

The geographic distribution and physical characteristics of nesting territories of infected goshawks were compared to those of uninfected goshawks (Mann-Whitney U-test). There were no statistically significant differences ($P > 0.05$) between distances to nest trees in other nesting territories and running water, or between nesting territory elevations of infected and uninfected goshawks. The distribution of infected nestlings within the study area did not suggest any clustering. Physical characteristics of nesting territories of infected and uninfected territories were also similar. This was not surprising because most nests were built in larch (*Larix* sp.) trees ≥25 yr old and larch was the most common tree providing a suitable nesting substrate for goshawks.

Our results suggest that parasitic infections are likely to cause no short-term mortalities in goshawks in the post-dispersal period. Infection loads were light compared with those of sparrowhawks (Ashford et al. 1990, 1991).

RESUMEN.—Nosotros encontramos nueve pajaritos de *Accipiter gentilis* (cinco hembras y cuatro machos) en ocho nidos de 48 pajaritos en 23 nidos en Wales que estaban infectados con *Leucocytozoon toddi* y un macho que estaba infectado con *Trypanosoma*. La mortalidad de los pajaritos hasta el tiempo de ser marcados (>13 d) en crías infectados no fue considerablemente mas alto que en crías que no estaban infectados, ni hubo ninguna asociación entre infecciones y mortalidad en una cría entre los marcados (13–39 d) y los pájaros jóvenes porque los pajaritos de los infectados y sin infección murieron.

[Traducción de Raúl De La Garza, Jr.]

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