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Sexual differences in physical condition in the White-backed Woodpecker *Dendrocopos leucotos* in relation to habitat type and across seasons

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Body-mass and wing-length of adult White-backed Woodpeckers *Dendrocopos leucotos* were measured in 57 males and 55 females in Surnadal community in western Norway during November–June from 1985 to 2001. The mean physical condition (ratio body-mass : wing length) of reproducing females in coastal areas was better than of females in inland areas. The physical condition of males was higher than that of females in each month. The mean condition of males was relatively stable during January–June, whereas that of females worsened slightly in the same period. The mean condition of females caught during March–April (just before egg laying) showed positive correlation with the mean temperature in January and February, whereas that of males did not.

1. Introduction

The White-backed Woodpecker *Dendrocopos leucotos* is a broad-leaved forest species distributed across the Palearctic in a continuous band from Fennoscandia and Poland through the southern taiga to Kamchatka and Japan, with some isolated populations south of the main range. It is strongly dependent on the occurrence of dead and dying trees where its main food, large wood-boring insect larvae, is found (Aulén 1988, Hogstad & Stenberg 1997). This specialization conflicts with commercial forestry, and several populations have been put at risk. Thus, as a result of forest management, the White-backed Woodpecker has disappeared or decreased drastically in numbers in many European countries (Spiridinov & Virkkala 1997), and has become an endangered species in Sweden (Aulén *et al*.1992, Stighäll *et al*. 2004) and Finland (Virkkala *et al*. 1993, Lehtiniemi 2001) and is considered vulnerable in Norway (Direktoratet for Naturforvaltning 1999). In Norway, the species is nearly absent in the south-eastern part of the country where it earlier was common (Stenberg 1994). However, in the western part of Norway, the White-backed Woodpecker is one of the most abundant woodpecker species (Stenberg & Hogstad 1992) and the population is probably the most viable in northern Europe. Here, both the density of woodpeckers in general and the breeding density of the White-backed Woodpecker in particular are high (Stenberg & Hogstad 1992, Stenberg 2004). Because the White-backed Woodpecker is very inconspicuous and difficult to observe, the species is rather poorly studied. All new information about the species is therefore important for development of conservation strategies for this endangered species.

As the biggest *Dendrocopos* species (ca. 100 g) in the Western Palearctic, the White-backed Woodpecker demands good access to insect larvae and may have difficulty in maintaining its metabolic needs during harsh winter periods. Consequently, it has been suggested that the winter temperature is an important determinant for the laying date and clutch size (Hogstad & Stenberg 1997). Here, we present data on sexual differences in physical condition from a viable population of White-backed Woodpeckers. Since the species starts laying about two weeks earlier than other woodpeckers in the study area (own unpubl.data), the female is probably more energetically stressed than her mate. Furthermore, as males use foraging sites that probably are more profitable than those used by females (Stenberg & Hogstad 2004), we hypothesize that the physical condition of males are better than that of females, both prior to and during the breeding season.

2. Material and methods

The study was made in Surnadal community in western Norway (about 63 °N), in an approximately 250 km^2 area extending from the fjord coastlines with their mixed forests of deciduous species and Scots pine *Pinus sylvestris*, to birch *Betula pubescens* forests further inland at an altitude of 400–500 m. The area has a (sub)oceanic climate and is characterized by mild winters and a high precipitation (Hogstad & Stenberg 1994). Because of frequent storms, resulting in many wind-felled trees, there is an abundance of dead and dying trees. Based upon differences in the climate and habitat quality, the area was divided into a coastal region (along branching fjords, <2 km from the sea) and an inland region (along the inner parts of fjord arms or inland 2–15 km from the sea). The coastal region is usually free from snow several days earlier than the inland region. A detailed description of the area is given elsewhere (Hogstad & Stenberg 1994).

Adult birds (57 males and 55 females) were caught in mist nets placed near feeders with suet (November–April) or in a sweep net close to their roost or nest holes (May–June) from 1985 to 2001. Each bird was marked with an individual combination of colour rings and a uniquely numbered aluminium ring. Their body-weight (body-mass) was determined using a spring balance and was measured to the nearest 0.5 g. Some birds were caught and weighed two or three times at intervals of one to eight years, but we used only the first weighing in the analyses to avoid sampling bias. The physical condition of the birds was estimated on the basis of the ratio of body-mass to wing-length. The wing length was measured to the nearest mm (maximum length; Svensson 1992). No differences in mean wing-length were found among years (one-way ANOVA – males: $F_{14,48} = 1.24$, ns; females: $F_{15,49} = 1.52$, ns).

Meteorological data were obtained from the Tingvoll meteorological station, about 10 km south-west of the study area. All tests are two-tailed, and were performed using SPSS 11.0. Means are presented ± 1 SD.

3. Results

3.1. Size and body mass

Males were larger and heavier than females (Table 1, wing length – males: 145.0 mm, females: 142.7 mm; t-test, $t_{110} = 4.8$, $P < 0.001$; body mass – males: 106.4 g, females: 100.3 g; $t_{107} = 6.7$, $P < 0.001$). Females from the coastal area (5 birds caught in May–June) did not differ in size from those caught in the inland area (16 birds caught in May–June; wing length – coast: 142.2 ± 1.6 mm, inland: 142.1 ± 2.7, $t_{19} = 0.1$, ns), but were heavier (body mass – coast: 103.6 ± 5.0 g, inland: 98.1 ± 3.8 g; $t_{19} = 2.7$, $P = 0.015$). Consequently, the physical condition of coastal reproducing females was better than the condition of females from the inland area (coast: 0.73 ± 0.03, inland: 0.69 ± 0.02; $t_{19} = 2.9$, $P = 0.01$). Males from the coastal ($n = 4$) and inland areas ($n = 10$) caught in the same period differed in size (wing length – coast: 141.5 ± 2.4 mm, inland: 145.1 ± 1.9 mm; $t_{12} = 3.0$, $P = 0.01$) but not in body mass (body mass – coast: 105.8 ± 5.6 g, inland: 105.8 ± 3.6 g). Due to the small sample size of coastal birds, and the difference between coastal and inland birds, only inland birds (46 males, 50 females) have been considered in the further analyses.

There was no significant variation in the mean body mass of the sexes over the years 1985–2001.

Table 1. Mean (± SD) of wing length (mm), body mass (g) and physical condition (ratio body mass: wing length) of adult male and female White-backed Woodpeckers caught during November–June in coastal and inland areas. Sample sizes between brackets. Statistical significance levels for the differences between coastal and inland areas are based on a two-tailed t-test.

	Total	Coast	Inland	t	d.f.	P
Males:						
Wing	145.0 ± 2.9 (57)	143.8 ± 3.3 (8)	145.2 ± 2.8 (46)	1.38	55	0.17
Body mass	106.4 ± 4.6 (54)	105.3 ± 3.8 (8)	106.6 ± 4.7 (46)	0.80	52	0.43
Condition	0.73 ± 0.03	0.73 ± 0.02	0.73 ± 0.03	0.10	52	0.92
Females:						
Wing	142.7 ± 2.2 (55)	142.2 ± 1.6 (5)	142.8 ± 2.3 (50)	0.53	53	0.60
Body mass	100.3 ± 4.6 (55)	103.6 ± 5.0 (5)	100.0 ± 4.8 (50)	1.58	53	0.12
Condition	0.70 ± 0.03	0.73 ± 0.03	0.70 ± 0.03	1.90	53	0.06

The mean body-mass of males varied from 94 g to 117 g (one-way ANOVA – $F_{14,45} = 0.98$, ns), and of females from 90 g to 114 g ($F_{15,49} = 0.73$, ns). The males (106.7 g) were heavier than females (100.0 g; $t_{94} = 6.8$, $P < 0.001$; Table 1).

The mean monthly body mass of males over the 17 years was nearly constant from January through June (Spearman rank-correlation: $r_s = -0.37$, $n = 6$, $P = 0.47$), whereas that of females tended to decrease during the same period ($r_s = -0.60$, $n = 6$, $P = 0.21$). The females increased their body-mass in April (laying period). If the April value is omitted from the correlation analysis, the decrease in body-mass of females is significant ($r_s = -0.90$, $n = 5$, $P = 0.037$).

3.2. Physical condition

The mean physical condition (ratio of body mass : wing-length) of males (0.73 ± 0.03, n = 46) was higher than that of females (0.70 ± 0.03, n = 50; $t_{94} = 5.4$, $p < 0.001$; Table 1). The mean condition of females was poorer than that of males in each month during the study period (monthly differences: 0.02 – 0.04, mean = 0.03).

The physical condition of males was relatively stable during January to June ($r_s = -0.29$, $n = 6$, ns), whereas that of females tended to worsen in the same period ($r_s = -0.60$, $n = 6$, $p = 0.21$; Fig. 1). The small improvement in the mean condition of females in April coincided with the laying period. However, the mean condition of the birds during the time of courtship display and laying varied between years and was related to winter cold. Thus, the mean condition of females in March and April correlated positively with the mean temperature in January and February, whereas males did not (Table 2).

4. Discussion

The mean temperature in January and February appears to be an important correlate of the physical condition of females in March and April, i.e. the most intense period of territorial activity and laying. Condition was low after cold winter months. We have earlier found that the energy reserves of

Table 2. The correlation (Pearson) between the physical condition of male (n = 13 years) and female (n = 12 years) White-backed Woodpeckers in March to April (the period of territorial activity, nest hole excavating and egg laying) and the mean temperature and the amount of precipitation in December to February.

	Males	Significance	Females	Significance
Temperature				
December	0.27	ns	0.17	ns
January	–0.16	ns	0.68	0.015
February	–0.20	ns	0.60	0.041
Precipitation				
December	0.44	ns	0.21	ns
January	–0.23	ns	0.03	ns
February	0.10	ns	–0.27	ns

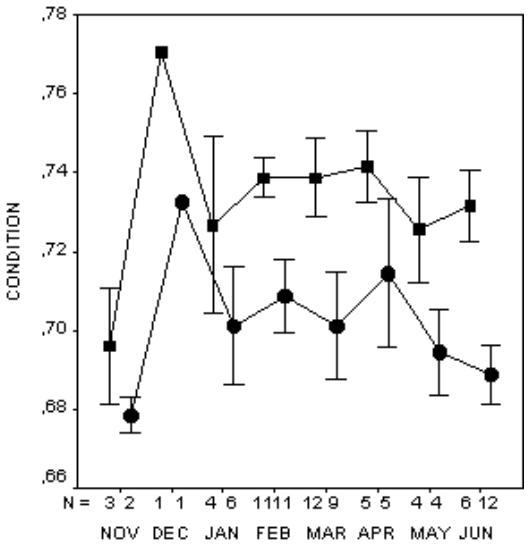

Fig. 1. Variation in mean physical condition (ratio body weight : wing length) of male (squares) and female White-backed Woodpeckers (circles) during November–June. Figures denote sample sizes.

females influence the breeding success: females in good shape start laying earlier, have a larger clutch size, feed their young more frequently and have fledglings with higher body-mass, than females in less good shape (Hogstad & Stenberg 1997). The decreasing mean values for the physical condition of females, but not of males, from January through June, may indicate that females have a lower energy intake rate than males or greater demands for energy.

Similarly, White-backed Woodpecker females' survival appeared more sensitive to weather condition prior to breeding than that of males (Stenberg & Carlson, unpubl. data). Thus, the mean survival in females was positively correlated to the mean temperature in February and March ($r_s = 0.93$, $n = 4$, $p < 0.05$; controlled for the amount of precipitation) and negatively related to the amount of precipitation in February and March ($r_s = –0.97$, $n = 5$, $p < 0.01$; controlled for temperature). In males, no such relationship between weather and annual survival was found (Stenberg & Carlson, unpubl.). Also in other Fennoscandian woodpeckers, e.g. Great Spotted *Dendrocopos major*, Middle Spotted *D. medius*, Lesser Spotted *D. minor* and Black Woodpeckers *Dryocopos martius*, the breeding densities have been found to decline after cold winters (Pettersson 1984, Nilsson *et al.* 1992, Saari & Mikusinski 1996). In a Swedish study on the Lesser Spotted Woodpecker, females suffered higher mortality than males, especially in spring before laying (Wiktander 1998). During the winter, the main challenge for the White-backed Woodpecker, and other woodpeckers as well, is to survive from one day to the next. The energy budget of the insect-eating woodpeckers is probably under considerable constraint during the winter months prior to breeding. In the lesser spotted woodpecker, females experienced an overall lower survival than males, which appeared to be related to a higher energy demand of females than of males in the breeding season (Wiktander 1998).

A general pattern is that females gain weight during the pre-laying period (Moreno 1989). Among the medium-sized and large European woodpeckers, the White-backed Woodpecker has the smallest mean clutch size (Cramp 1985) and the most thin-shelled eggs (authors, unpubl. data). The White-backed Woodpecker starts laying about two weeks earlier than other woodpeckers in the same area (Matsuoka 1979, Winkler *et al.* 1995, own observations), probably because the nestling period of the species largely coincides with the biomass peak of the coleopteran larvae (Cerambycidae), the main nestling food (Bily & Mehl 1989, Hogstad & Stenberg 1997, unpubl. data). An increase in the breeding success of early breeders (Hogstad & Stenberg 1997) indicates that there is a payoff between early breeding and the physical condition of the females. Since woodland birds like tits, the Nuthatch *Sitta europaea* and the Great Spotted Woodpecker are known to have difficulty in obtaining sufficient calcium for their eggs (cf. Perrins 1996), it may be suggested that also White-backed Woodpecker females probably have to reduce the time they can devote to foraging, because they have to spend a great deal of time searching for and consuming calcium. The females nevertheless gained weight and increased their condition in April, just before or during laying. On the other hand, as the smallest of the sexes, female White-backed Woodpeckers may be socially subordinate to males. It has been found that the males of several *Dendrocopos* species are dominant over females (Kilham 1970, Peters & Grubb 1983, Osiejuk 1994). The poorer physical

condition of females may therefore be due to dominance by males which compel the females to occupy a less preferred foraging niche when food is scarce, as found for the Three-toed Woodpecker *Picoides tridactylus* (Hogstad 1991) and several North American woodpeckers (e.g. Jackson 1970, Wilson 1975, Austin 1976, Peters & Grubb 1983). However, male and female White-backed Woodpeckers were rarely seen close together (< 50m) during the winter in our study area, and no sign of aggression between the sexes was observed. A possible male dominance was observed at feeders where the male was feeding before his mate (in 5 out of 7 cases when the sexes appeared together in November–January). The female then waited to enter the feeder until the male had left the feeder.

The physical condition of female White-backed Woodpeckers during pre-breeding and the laying period correlated positively with the mean temperature in January and February. Thus, the outcome of reproduction, as well as survival prior to breeding, in the White-backed Woodpecker appears to be strongly affected by the weather in winter. The winter temperature may also influence the phenology of development and thereby the size-mediated profitability of the woodpecker's insect prey (wood-boring larvae). In the Three-toed Woodpecker, another species that relies upon wood-boring beetle larvae for reproduction, Fayt (2003) found adults to start breeding earlier, to lay larger clutches and feed their nestlings with more wood-boring larvae in habitats where wood-boring beetles were more abundant and bark-living beetles developed earlier. In Austria, Frank (2002) found White-backed Woodpeckers to select preferentially steep south-exposed habitats for breeding, i.e. in habitats with the largest dead wood supply and the earliest prey development.

In our study area, White-backed Woodpecker females from the coastal area were heavier and were in a better condition than those from the inland area. Also the mean body mass of male and female fledglings reared in the coastal area was markedly higher than that of those reared in the inland area (Hogstad & Stenberg 1997). Coastal pairs, moreover, started laying earlier and fed their nestlings with more wood-living larvae than inland pairs did (Hogstad & Stenberg 1997). All these factors indicate that the coastal area is a qualitatively better habitat for the woodpeckers than the inland area. As the topography along the western coast of Norway in many places makes forest management difficult (cf. Stenberg & Hogstad 1992), there are still areas with mixed forests of natural (not planted) coniferous and deciduous trees. Furthermore, with its sub-oceanic climate with mild winters, forests in western Norway may satisfy the requirements the woodpeckers have for staying in the area the whole year round. This may in part explain the distribution of the species in Norway.

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57 koiras- ja 55 naarasvalkoselkätikan *Dendrocopos leucotos* painot ja siivenpituudet mitattiin Länsi-Norjassa Surnadalissa marras–kesäkuussa vuosien 1985 ja 2001 välisenä aikana. Lisääntyvien naaraiden keskimääräinen kunto (painon ja siivenpituuden suhde) oli suurempi rannikolla kuin sisämaassa. Koiraat olivat naaraita paremmassa kunnossa jokaisena kuukautena. Koiraiden kunnossa ei havaittu juurikaan muutoksia tammi–kesäkuun aikana. Naaraiden kunto sen sijaan huononi hieman tuona aikana. Maalis–huhtikuussa (juuri ennen munintaa) kiinniotettujen naaraiden kunto korreloi positiivisesti tammi – helmikuun keskilämpötilojen kanssa. Samaan aikaan kiinniotettujen koiraiden kunto ei korreloinut tammi–helmikuun keskiläpötilojen kanssa.

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