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Body mass and physical condition of breeding Dotterels *Charadrius morinellus* in Finland

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Abstract. The body mass and physical condition of beeding Dotterels *Charadrius morinellus* were determined in the Värriötunturi fell area in Finnish Forest Lapland. The decrease in the male body mass during the incubation period was 25%, i.e. greater than in southern Norway (7%). This resulted on average in poorer physical condition during the hatching and chick rearing periods. The differences in the mean body mass of the male Dotterel between three successive periods, egg laying, early and late incubation, were highly significant. In some cases the female helped her mate to incubate, in which case males lost on average a smaller proportion of their body mass during incubation. Dotterels cannot gather any substantial energy reserves for breeding at their breeding sites under the harsh conditions prevailing on the dry alpine heaths during the very short period between arrival and the commencement of egg laying and incubation. These reserves have to be gathered during their spring migration and/or at the wintering grounds.

Key-words: Mass reduction, stress of incubation, incubation duty, dry alpine heaths

Introduction

The breeding biology of the Dotterel *Charadrius morinellus* is exceptional in many respects. The female is usually bigger and brighter, lays a clutch of only three eggs, and may be polyandrous (e.g. Nethersole-Thompson 1973, Cramp and Simmons 1983). At Hardangervidda, southern Norway, the female lays a complete clutch, leaves male to incubate the eggs, and starts prospecting for new mates. In late clutches the female frequently shares the incubation duties with the male (Kålås and Byrkjedal 1984). At Värriötunturi, about 1 200 km further northeast, the female also leaves the male to incubate the eggs but she usually soon seems to disappear from the area and probably starts prospecting for males futher north. Only seldom does the female share the incubation duties with the male (Pulliainen and Saari, unpublished). In both areas the main incubation duty falls on the male. The alpine environment at Värriötunturi is very unproductive and we are therefore interested to know how the male manages to incubate successfully alone. The results are compared with those obtained on the alpine heaths of southern Norway (Kålås and Byrkjedal 1984), probably a more productive area situated considerably closer to the wintering grounds of the Dotterel.

At Värriö the Dotterel represents a typical breeding bird of the arctic tundra and the summits of subarctic fells, since it tends to concentrate its breeding activities into as short a period as possible (see Irving 1972). This means, that it commences egg-laying within a few days of arriving from its spring migration, and that most of the clutches are commenced within a few days (see Pulliainen 1970, Pulliainen and Saari 1992a). Thus the birds have practically no time to gather energy or other reserves for the breeding at the nesting site. How this situation affect the body mass and the physical condition of breeding Dotterels is the theme of this report.

Material and methods

Dotterels were studied at the Värriö Subarctic Research Station (67°44' N, 29°37' E), at the southern limit of the Finnish range of the species, in 1968-1990, most intensively in 1969-1974 (see Pulliainen and Saari 1992a). During the intensive study period in 1969-1974 all the incubating birds were trapped on the northernmost summit of the Värriötunturi chain (Värriö I), and several additional from the other summits. The birds were weighed with a Pesola spring balance in the field to the nearest g and the wing length was measured to the nearest mm. Several fields assistants, usually experienced ornithologists, were involved in this. We report here changes in body mass and physical condition during the breeding season. Physical cindition was defined as by Kålås and Byrkjedal (1984) as:

$$\frac{\text{mass (g)}}{\text{wing length (mm)}} \times 100$$

Wing lengths were measured in 67 cases (including three birds measured in two or more seasons), 79 birds were weighed (including 13 repeat weighings in the same or subsequent seasons) and body condition was assessed in 70 cases (including 10 repeats).

Sexing was based on plumage characteristics, behaviour, or in a few cases on dissection. The birds were classified as females (based on behaviour during courtship including egg-laying, on dissection, or on plumage characteristics if both members of the pair were ringed), males, and unsexed (where the plumage chatacterictis did not allow a positive identification).

Results

Year	Mean ± SD	n	Range
1969	149.4 ± 3.6	9	143-154 mm
1970	149.7 ± 3.8	7	144-155 mm
1971	147.2 ± 3.4	26	140-153 mm
1972	143.8 ± 5.2	5	136-148 mm
1973	147.2 ± 3.9	10	142-153 mm
Total	147.6 ± 3.9	57	136-155 mm

Table 1. Annual variation in wing length of the Dotterel (excluding females) in 1969-73.

The mean wing length for all the birds measured was 148.6±4.8mm (range 136-161,n=67). The mean for the males was 147.8±4.3(range 136-155,n=28), for the females 154.6±5.3(range 145-161,n=10), and for the unsexed birds 147.4±3.7 (range 140-153,n=29). The females had significantly longer wings than the males (±=3.92, df=36, P≤0.01 two-tailed.) According to the wing measurements most of the unsexed birds were males. The annual means in wing length (excluding females) are shown in Table 1. Only 1972 seemed to differ from the others. In the tabulation below the mean wing length in 1972 is compared with that of the other years:

1972 vs 1969 t=2.19 df=12 P≤0.05 (two tailed)
1972 vs 1970 t=2.07 df=10 P≤0.10 -"-
1972 vs 1971 t=1.79 df=29 P≤0.10 -"-
1972 vs 1973 t=1.40 df=13 ns

However, this difference does not need to be biological. Several field assistants were measuring the Dotterels in 1969-1973 and the ornithologist collecting the 1972 data took the measurements only that year. The differences may only be measure variance: three males were measured in two or more breeding seasons giving wing lengths of 143-144-145 mm (in 1969-1971), 146-143 mm (in 1971 and 1973), and 136-142 mm (in 1972-1973).

Body mass decreased as the season progressed. This was seen when the breeding season was divided into four parts approximately corresponding to laying (up to 5 May), early incubation (6-20 June), late incubation (21 June - 10 July), and chick rearing periods (from 11 July onwards). These time limits are course somewhat arbitrary, e.g. some late breeders are placed in the wrong category, but owing to a compressed period of clutch commencement (mean date 7 June, median date of hatching 4 July; see Pulliainen and Saari 1992a), and the fact that most of the birds were captured at the nest renders this classification quite reliable. Thus the birds in the „chicks rearing period" were either from late nests where the chicks were just about to hatch out or males tending the broods. In order to correct for any bias introduced by females, all the known cases were omitted from Table 2 (the mass of one male weighed in the late incubation period sharing the incubation duties with the female was also omitted, see below). Thus the results in Table 2 refer to the reductions of mass in males incubating alone (most of the incubation is done by the males, see e.g. Nethersole-Thompson 1973, and the wing length of the unsexed birds were almost identical to those of the males). The limited data on females are treated separately (see below). The body mass and physical condition in males decreased highly significantly between laying and early incubation periods (t=4.48,df=35,and 4.63,df=28, two-tailed P≤0.01 for both), and between early and late incubation periods (t=3.67,df=50,and 3.44, df=41,two-tailed P≤0.01 for both). Owing to a small sample size in the brood period the differences were not as clear between late incubation and chick rearing periods (t=1.83,df=28,two-tailed P<0.10, and t=2.07, df=26, two-tailed P<0.05, respectively).

If the female shared the incubating duties with her mate, the male was heavier than when incubating alone. This was seen on 2-3 July 1969, a few days before hatching, when four males incubating alone weighed 85-102 g (mean 96.8±7.9 g), but in a nest where both the male and female were incubating the masses were 132 and 120 g, respectively.

Ten birds were definitely sexed as females: five birds caught at the nest in the laying period between 30 May and 5 June (mean wing length 157.4±4.2 mm, mean body mass 136.9±14.8 g, mean physical condition 87.1±10.3), three birds (four measurements; the mean mass from a bird weighed twice was taken) during the late incubation period between 1 and 7 July sharing the incubation duties with the males (mean wingh length 151.0±5.2, mean body mass 125.7±6.3, mean physical condition 83.3±4.6), and two birds shot between 22 July and 12 August (mean wingh length 153.0±7.1, mean body mass 102±0, mean physical condition 66:8±3.09. One female sharing the incubation with her mate lost only 1 g between 1 and 7 July (125 g on 1 July).

These limited data indicate that the decrease in mass from the laying to the chick rearing period may be about the same for both sexes. The high mean for females in the egg laying period is partly due to one female captured

just prior to laying (mass 160 g, physical condition 102.6). When four males and four females captured between 3 and 5 June in 1970-1971 are compared the mean mass for the males was 134.5±5.3 and for the females 131.1±8.3. two males and two females shot in late July - early August in 1969 weighed 98.0-98.8 and 101.9-102.0 g, respectively. In the combined material the range in body mass was 85-160 g, but from the latter perhaps 17 g should be subtracted (mean egg mass at laying, Pulliainen and Saari 1992b).

In order to correct for the above biases, the masses of the males captured repeatedly during the same or subsequent seasons were studied, the means being 127.7±4.0 (n=3), 109.8±6.3 (n=7) and 100.6±6.0 (n=10) g for the laying, early incubation and late incubation periods, respectively. The differences between the succesive periods were highly significant (t=4.07,df=8,and 2.66,df=15,respectively). At five nests the males were weighed twice during the same breeding season (dates ranging between 15 June and 3 July, thus mostly in the late incubation period), and the daily decrease in mass was recorded as 0.93±0.52 g. Calculated for the whole incubation period (25 days, see Pulliainen and Saari 1992a), this would indicate a loss of approx. 23 g. Between the laying and the chick rearing periods the Dotterel loose approx. 32 g (Table 2), i.e.25% of their initial mass. This is a higher figure than that obtained from the daily rate and indicates that the mass decreases faster in the early incubation period. Table 2 also shows that the decrease in mass is greater between laying and early incubation than between early and late incubation. The males incubating alone and weighed near hatching had a mass similar to that of the chick rearing period. It is thus probable that usually no further decrease takes place while rearing the chicks. This was the case with male 3/69, for instance, which weighed 101 g on 15 June, 85 g on 3 July and still 85 g on 1 August (the chicks had hatched by 6 July).

Period	Mass ± SD	(n)	Body condition ± SD	(n)
Laying	129.4 ± 5.8	(11)	87.1 ± 4.2	(11)
Early incubation	116.1 ± 8.8	(26)	78.4 ± 5.1	(19)
Late incubation	106.8 ± 9.1	(26)	73.0 ± 7.1	(24)
Chick rearing	97.5 ± 9.5	(4)	64.8 ± 6.8	(4)

Table 2. Mean adult mass (g) and mean physical condition [(mass/wing length) × 100] of Dotterel males at different stages in breeding. The differences in sample sizes in the same periods are due to missing wing measurements (mostly in 1974). For details, see text.

Physical condition varied in the same way as body mass (Table 2), decreasing by 26% from laying to chick rearing. The daily rate of decrease in four nests monitored closely was 0.49±0.18 points, which would indicate a loss of 12.25 for the whole incubation period. According to Table 2 the loss was 22.3 points. The extremes in the whole data set were 57.0-102.6 (93.3 omitting the female about to lay).

Discussion

The summits of the Värriötunturi fell represent a very barren habitat for birds like the Dotterel, since they do not leave the dry heaths characterized by a vegetation of *Vaccinium, Arctostaphylos, Empetrum*, lichen, etc. at all during the breeding season. Thus it is to be expected that these conditions will be reflected in the body mass and physical condition of the Dotterels during the course of the breeding season.

The body mass range reported for the Dotterel during the breeding season is 88-142 g. the mass during migration or in winter being around 100 g (Glutz von Blotzheim *et al.* 1975). The birds at Värriötunturi weighed on average about 130 g during the laying period, but less than 100 g around hatching and when the chicks were reared. The decrease in mass during the course of incubation was 25%. At Hardangervidda, southern Norway, this figure was only 6.9% (Kålås and Byrkjedal 1984) and none of the birds had a physical condition below 70 according to Fig. 9 in Kålås and Byrkjedal (1984), although a male in „poor physiological condition" was recorded in 1985 (physical condition 66.4, Kålås and Løfaldli 1987). The daily rate of decrease in male mass was 0.39±0.32 g (n=6) in Norway (Kålås and Byrkjedal 1984) and 0.93±0.52 g (n=5) at Värriö. However, owing to small sample sizes this difference was only nearly significant (t=1.91, df=9, two-tailed P<0.10). These data indicate that the breeding habitat at Värriö is quite unproductive. Kålås and Løfaldli (1987) suggest that when the „limit" for mass reduction has been reached, periods off the nest become longer as the survival of the adult takes priority over that of the eggs. This would explain the suggested more rapid rate of decrease in mass in the early incubation period at Värriö. As their body mass approaches 100 g, the birds have to start feeding more in order to prevent excessive weight reduction. The Dotterels at Värriö seem to be in poorer physiological condition at hatching (average body condition in the chick rearing period 64.8) than at Hardangervidda, but despite this they breed quite successfully. At Värriö 86% of the nests were successfull (Pulliainen and Saari 1992a), in Norway 52% (Kålås and Byrkjedal 1984).

Kålås and Løfaldli (1987) discussed why the clutch size of the Dotterel is only three. They were able to show experimentally that the addition of one egg to the clutch

resulted in a rapidly deteriorating physical condition of the incubating males. As the physical condition deteriorates faster at Värriö than in southern Norway, it seems very probable that the Dotterel male at Värriö would not be able to incubate successfully a c/4 without the assistance of the female. The female seems physically able of laying at least two clutches. Thus the male uses his reserves for incubation, the female for laying eggs. If both members of the pair incubate the same clutch the physical stress seems small and the body mass decreases only a little. Thus to maximize the annual production it is beneficial for the female to leave the male to incubate the first clutch (which he is usually able to do well alone), and to start prospecting for new males.

The birds are heavy at Värriö in the laying period. The short period between arrival and the commencement of egg laying is probably not enough to gather reserves needed for breeding, particulary under harsh conditions on the alpine heaths in late May-early June. The discrepancy between the data on body mass winter quarters/spring migration, and the laying period at Värriö indicates that either the staging areas have not all been found or at least that no weighing has been done in the right places. However, it is known that the Dotterels are easily overlooked during migration since they tend to concentrate on a few traditional spots in habitats not usually visited by ornithologists (see e.g. Østergaard 1982). The known staging areas are in Denmark, the Netherlands, and on the Ukrainian and Hungarian steppes (Østergaard 1982. Cramp and Simmons 1983).

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