

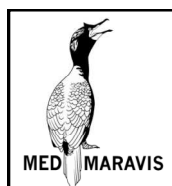
**ECOLOGY AND CONSERVATION
OF MEDITERRANEAN SEABIRDS
AND OTHER BIRD SPECIES UNDER THE BARCELONA CONVENTION**

UPDATE & PROGRESS

*Proceedings of the
13th Medmaravis Pan-Mediterranean
Symposium*

Editors

Pierre Yésou - Nicola Baccetti - Joe Sultana



2012

Body mass variation in Scopoli's Shearwaters *Calonectris diomedea* breeding at Linosa Island

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Summary: We investigated body mass variation during the reproductive season in male and female Scopoli's Shearwaters *Calonectris diomedea* breeding at Linosa Island, Sicily channel. Birds were weighed in three main periods: before and during egg-laying (mid-May - mid-June), around hatching (second half of July) and during the early stages of chick rearing (mid-July - mid-August). In addition, some measurements were taken during fledging (second half of October). When possible, the same individuals were weighed repeatedly. Overall, there was a marked difference in body mass between sexes; males weighing on average c.100g more than females. Body mass was higher in males before the engagement in breeding activities (just after the return from their winter migration) and decreased soon thereafter. Conversely, body mass was lower in females during laying and increased during the initial phase of incubation. No other significant variations on the time course of body mass emerged from the analyses. The difference between the sexes in body mass profile could be related to a differential effort during the early phases of the reproductive season.

Key Words: *Calonectris diomedea*, Scopoli's Shearwater, body mass, reproductive stress.

Introduction

The Scopoli's Shearwater *Calonectris diomedea* (Procellariidae) is a colonial bird characterized by a high reproductive investment (up to eight months), including a long incubation period (54 days) and a long phase of chick-rearing (90 days). The birds lay a single egg and the parental cares are equally shared between partners. The energetic demands might vary largely during the breeding season and can be different between females and males (Navarro et al. 2007). A reduction in body weight might be caused by reproductive stress. When breeding birds are engaged in an intense activity, the high energetic expenditure can produce an imbalance of physiological processes which might influence body mass (*reproductive stress hypothesis*, Moe et al. 2002). On the other hand, weight reduction could benefit the efficiency of foraging trips (*programmed anorexia hypothesis*, Navarro et al. 2007). An investigation on the variation of body mass of shearwaters breeding in Linosa Island provided the opportunity to test which of the two hypotheses was more likely supported.

Materials and methods

Body mass variation was recorded during 2007-2011 on breeding birds (about 150 pairs) in a colony characterized by nests in crevices in lava rocks at Linosa Island (Sicily Channel, Italy). Adult shearwaters of both sexes were ringed and captured repeatedly during the study period. Sex was assigned on the basis of morphology and vocalization (the male has a sharp pitch call, while the female has a heavy, lower-tone raucous call). Birds were weighed with Pesola® balance (accuracy 5g). Manipulation time was short; less than 3 minutes per bird.

Statistical analysis. We used the body mass data collected during the five years but we did not consider the Year factor. Data were pooled over two-week periods from mid-May until mid-October, therefore there were eight time periods (there were no data for September) which could be used to provide the time course of the body mass variation during the whole breeding period. However, the body mass measures were not repeated measures on same individuals, and the Time could not be treated as Repeated Measures but was treated as main Factor. Time and Sex and their interaction, were therefore analyzed using a Two-Way ANOVA, after having checked for the normal distribution of data.

Results

Body mass of the adult birds varied significantly depending on Sex ($F_{1,733}=269.13, p<0.001$) and Time period ($F_{7,733}=7,36, p<0.001$). Males were on average 104g heavier than females and the temporal profile of body mass (data of sexes pooled) was characterized by a higher mass in the first two weeks after engaging in the breeding followed by a relatively stable situation. The interaction between the two factors was also significant ($F_{7,733}=8.21, p<0.001$) and revealed between-sex differences during the laying and the initial phase of incubation (Figure1). In fact, around mid-May, at the start of incubation, males were at their highest mass (about 711 g) compared to that of the following periods ($p<0.05$ or less within sex comparisons) and in the second half of June they reached their lowest mass. On the contrary, the mass of females (corrected for egg mass), had a peak in the period just after egg-laying, when it increased to about 10% compared of the mean weight across the whole season ($p<0.05$ or less within sex comparisons).

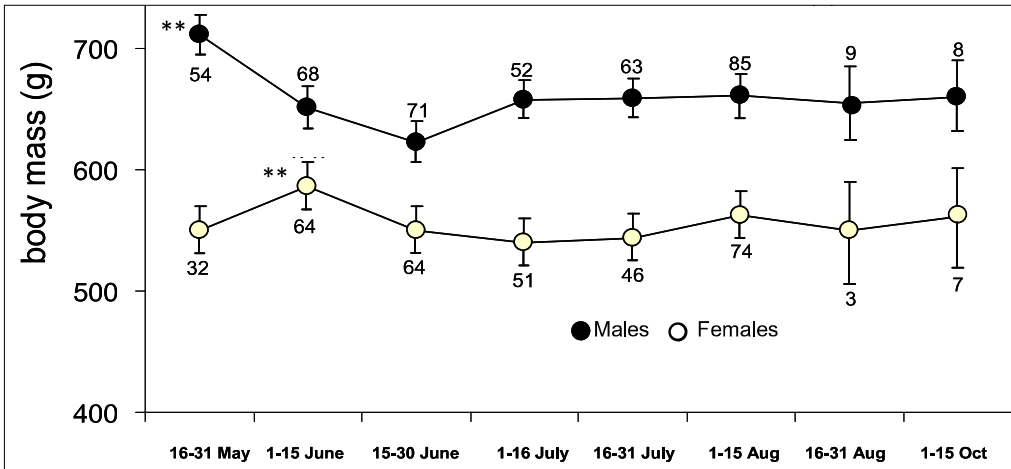


Figure 1. Body weight variation (means \pm SE) in male and female Scopoli's Shearwaters during the breeding season at Linosa Island. The breeding season covers from mid-May to mid-October. Numbers indicate the sample size; ** $p< 0.01$ in within-sex comparisons.

Discussion

A previous study on weight variation during a single breeding season has been carried out at Linosa in 1982-1984 (Massa & Lo Valvo 1986), thirty years before our study. In this work it was also reported that weight fluctuated across the breeding season, but there were no between-sex

comparisons and data were based on a smaller sample size. Overall, our study shows that after three decades, body mass of Scopoli's Shearwaters has remained the same and the fluctuations observed are within the range of those observed previously.

Usually, shearwaters undertake a pre-laying exodus that consists of extended foraging trips. These long trips are supposed to help the birds to store energy reserves in order to afford the high reproduction costs. These trips, last on average eight days in males and up to 19 days in females. It has been hypothesized that during these trips females store fats and proteins needed to produce the egg (Brooke 2004, Jouanin *et al.* 2001).

We observed that females were leaving the nest soon after having laid (often the day after), probably to recover from the effort of laying. Their first foraging trips were longer, often more than a week, and during this time females gained weight. Therefore, the males are committed to start the incubation with a first long period at the nest and consequently a long fast, resulting in a significant reduction in weight. As a consequence, in the central part of the incubation period (second half of June) male body mass reached the minimum value. This could be explained as the result of the more prolonged nest attendance for supporting the long recovery trips of the females. Later in the season nest attendance was balanced more equally between partners and body weight was stabilized. During the phase of chick-rearing a marked decrease in body weight of the parents was expected (Navarro *et al.* 2007), but contrary to expectations the time course was stable in both sexes. In conclusion, it seems that the sharing of the parental care resulted in a similar energetic expenditure in both parents during the whole breeding period, except for the period around the onset of the incubation. The marked decrease in body mass observed in males during this phase could be related to higher costs encountered, thus supporting the *hypothesis of reproductive stress*. Conversely, the *hypothesis of programmed anorexia* was not supported by our observations.

Acknowledgments. We thank the Department of DEMETRA (University of Palermo) and *Ornis Italica* for supporting the field work.

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CITATION: The editors recommend that for references to this work the following citation should be used:

Becciu, P., Massa, B. & Dell'Omo, G. 2012. Body mass variation in Scopoli's Shearwaters *Calonectris diomedea* breeding at Linosa Island. (Pp.16-18). In Yésou, P., Baccetti, N. & Sultana, J. (Eds.), *Ecology and Conservation of Mediterranean Seabirds and other bird species under the Barcelona Convention - Proceedings of the 13th Medmaravis Pan-Mediterranean Symposium*. Alghero (Sardinia) 14-17 Oct. 2011. Medmaravis, Alghero.