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Short Note
A method for sexing the chicks of Antarctic shags

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Introduction

Several studies have been carried out during the last fifteen years on reproduction, population dynamics and diet of the Antarctic shag, *Phalacrocorax bransfieldensis* Murphy, at different localities in the South Shetland Islands (reviewed in Casaux & Barrera-Oro 2006). In both the colonies studied and in other colonies counted we observed that the number of breeding pairs was steadily decreasing (Casaux & Barrera-Oro 2006). Casaux & Baroni (2002) had earlier suggested that such a decreasing trend might be related, at least partially, to a marked decrease in the inshore populations of two fish prey species, the marbled notothen *Notothenia rossii* Richardson and the humphead notothen *Gobionotothen gibberifrons* Lönnberg (Barrera-Oro *et al.* 2000), which had been studied over a period of 19 years in coastal waters of the South Shetland Islands. Exactly how a reduction in prey availability affects the shag populations (e.g. migration of breeders to other colonies in the area or to new breeding areas, a decrease in the rate of recruitment, an increase in adult mortality, variation in the age at first breeding, etc) is not clear. To investigate this, we started a banding programme at Nelson Island, South Shetland Islands. We postulated that the processes might operate with different intensities on individuals of different sexes, so all individuals in each population studied needed to be sexed. This posed problems for chicks which have monomorphic plumage and no differences in vocalisations (Casaux & Baroni 2000), so that the normal methods for sexing in the field would not work. As most of the external morphological characters in the chicks of Antarctic shags have stabilized by 45–50 days old (Casaux 1998), Casaux & Baroni (2000) had suggested that the use of discriminant functions originally developed for adults could be an appropriate method to sex chicks more than 50 days old.

Thus, the aim of this study was to test the applicability, reliability and usefulness of discriminant functions for determining the sex of chicks in the field.

Material and methods

A total of 311 chicks of Antarctic shags were sexed and banded from the 1995–96 to the 2003–04 breeding seasons at Harmony Point (62°17'S, 59°14'W), Nelson Island, South Shetland Islands, Antarctica (Table I). Except during the 1995–96 breeding season, this included all the chicks that reached the age of 50 days old by the end of the field activities.

Chicks of 45 days old were preliminarily sexed applying the following discriminant function estimated for adult Antarctic shags:

$$D = (\text{tarsus length in mm} * 0.92321) - (\text{bill-shape index} * 0.00114) + 64.7423$$

where D is the discriminant score ($D < 0$ = males, $D > 0$ = females). The bill-shape index was estimated according to the equation described by Burger (1980): (CL*BDB*BWB)/10, where CL is the culmen-length in millimetres, BDB is the bill-depth at the base of the bill in millimetres and BWB is the bill-width at the base of the bill in millimetres. For bill and tarsus measurements we used a digital vernier calliper (accuracy 0.01 mm) and followed the procedures in Casaux & Baroni (2000). The equation had previously correctly classified 95.8% of adult males and 100% of adult females (overall 97.9%).

After sexing, chicks were banded with numbered metallic bands (males on the right leg and females on the left leg). Five to ten days after the first sex determination, the chicks were sexed again. If the result of the second sex determination was the same as the first one, the sex of the individual was confirmed. When the determinations differed, a third confirmatory determination was performed (and the band was placed accordingly).

When recaptured in subsequent seasons (recaptures were performed up to the end of the field activities in the 2004–05 breeding season), the individuals were sexed by vocalisations (males "honk" and females "hiss", see Brothers 1985, Green 1997, Casaux & Baroni 2000) and behaviour, which allowed us to test the accuracy of the method.

Results and discussion

Although for seven chicks (2.3% of the chicks sexed) a third confirmatory measurement was necessary to determine the

Table I. Number of chick Antarctic shags sexed and banded at Harmony Point, South Shetland Islands, from the 1995–96 to the 2003–04 breeding seasons, number of individuals recaptured in subsequent seasons and results of the sex determination.

	Individuals sexed		Individuals recaptured			
			Correctly sexed		Wrongly sexed	
	Males (149)	Females (162)	Males (14)	Females (20)	Males (1)	Females (2)
1995–96	3	1	—	—	—	—
1996–97	39	38	4	3	1	1
2000–01	30	27	3	1	—	—
2001–02	25	49	3	8	—	1
2002–03	41	40	4	7	—	—
2003–04	11	7	—	1	—	—

sex, the first measurements (carried out on chicks of 45 days old) did not differ statistically from the second ones (carried out 5–10 days later) (paired *t*-test, $P > 0.05$ for all measures and seasons).

The overall rate of return to the colony of the banded chicks was 11.9%; 10.1% for males and 13.6% for females. Almost all of the individuals recaptured were breeding or attempting to breed. Among the sexed chicks, the overall male-female relationship was 1 : 1.10.

The discriminant function used in this study was effective in the determination of the sex of chicks. The function correctly classified 93.3% of males and 90.9% of females; the overall effectiveness was 91.9% (Table I). These results are similar to those for the sex determination of adult Antarctic shags by means of discriminant functions (Casaux & Baroni 2000). It was important to check if the wrong determinations were due to the effectiveness of the discriminant function itself (which is strongly influenced by the degree of overlap in measures between genders) or to the validity of the method, so that when recaptured in subsequent seasons the individuals that were wrongly classified by the discriminant function were measured and classified again. In all of the three incorrect classifications the determination of the sex at recapture confirmed the previous classification supporting the validity of the method.

This shows that the use of discriminant functions to determine the sex of chicks older than 50 days is an acceptable method. Whilst potentially less accurate than DNA markers, this method is cheaper, easier and quicker in the field. Additionally, if the individuals are banded appropriately (male and female chicks on different legs and the colour of the bands changed every year), the gender differences in recruitment or in the age at first breeding, can be estimated without recapturing the individuals. It is expected that the methodology proposed here could also be applied to other dimorphic bird species in which the morphometric variables useful for sex determination stabilise before chicks fledge.

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