Sex differentiation in the spotless starling (*Sturnus unicolor*, Temminck 1820)

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ABSTRACT. Five biometric variables (weight, and beak, tarsus, wing and middle-toe lengths) and the shape of throat feathers were analysed in spotless starlings (*Sturnus unicolor*) from Northern Spain. Sexes were correctly differentiated in 97.4% of the adults and 84.7% of the juveniles using a combination of wing and middle-toe lengths. All the adult birds and 88.3% of the juveniles were correctly sexed using only the shape of the throat feathers.

KEY WORDS: Spotless starling, *Sturnus unicolor*, biometry, sex differentiation

INTRODUCTION

Populations of starlings (*Sturnus vulgaris*, L. 1758) and spotless starlings (*Sturnus unicolor,* Temminck 1820) have increased in the Iberian Peninsula (FERRER et al., 1991; DOMINGO, 1993) and Southern France (CAMBRONY et al., 1993). Both are considered plague species since they can seriously affect agriculture and livestock (FEARE, 1989).

The control of plague species frequently involves distinguishing between sexes (MURTON et al., 1972; LACOMBE et al., 1987) especially when the species is polygamous. For this, reliable and simple sex differentiation characteristics are important, both for species management and scientific ringing (SVENSSON, 1992) and to establish intra- and inter-specific geographic differences (JAMES, 1970; BÄHRNANN, 1978).

After the post-reproductive or post-juvenile moult (July to October), spotless starling sexes are difficult to distinguish by morphology alone (PERIS, 1989; HIRALDO & HERRERA, 1974). In passerines without obvious sex dimorphism, sexes are normally differentiated by the shape of specific feathers or using biometry (SVENSSON, 1992). Some authors have used the middle-toe length to differentiate sexes in the loggerhead shrike, *Lanius ludovicianus* (COLLISTER & WICKLUM, 1996) and spotless starling (FALCETO et al., 1997). In this paper we present a sex differentiation method for the spotless starling using two biometric (wing and middle-toe length) characteristics and one morphological (throat feather shape) characteristic, which can also be applied to the starling and other passerines.

MATERIAL AND METHODS

From October to January, 1997-1999, during a legal control trapping we captured 229 spotless starlings in mist nets in roosts near Calahorra, Northern Spain (42º19'N 1º58'W). Of these, 208 were measured (following SVENSSON, 1992) for: a) maximum wing span, with a 1 mm precision ruler; b) tarsus, by the standard measurement; c) beak, from just before the nostril to the end; d) middle-toe, from the beginning of the nail to the beginning of the toe (Fig. 1); and e) weight, with a 1 g precision balance. Only some of these variables were measured in the remaining 21 birds (eight of them adults) because of beak or tarsus deformities or feather deterioration. Tarsus, beak and middle-toe lengths were measured with a 0.1 mm precision calliper.

To analyse sex differentiation by plumage, three throat feathers were extracted in 65 adults (32 ♂♂ 33 ♀♀) and 135 young (52 ♂♂, 83 ♂♂), taking into account the feather vane. Each feather was divided into three areas: anterior, central and posterior (Fig. 2).

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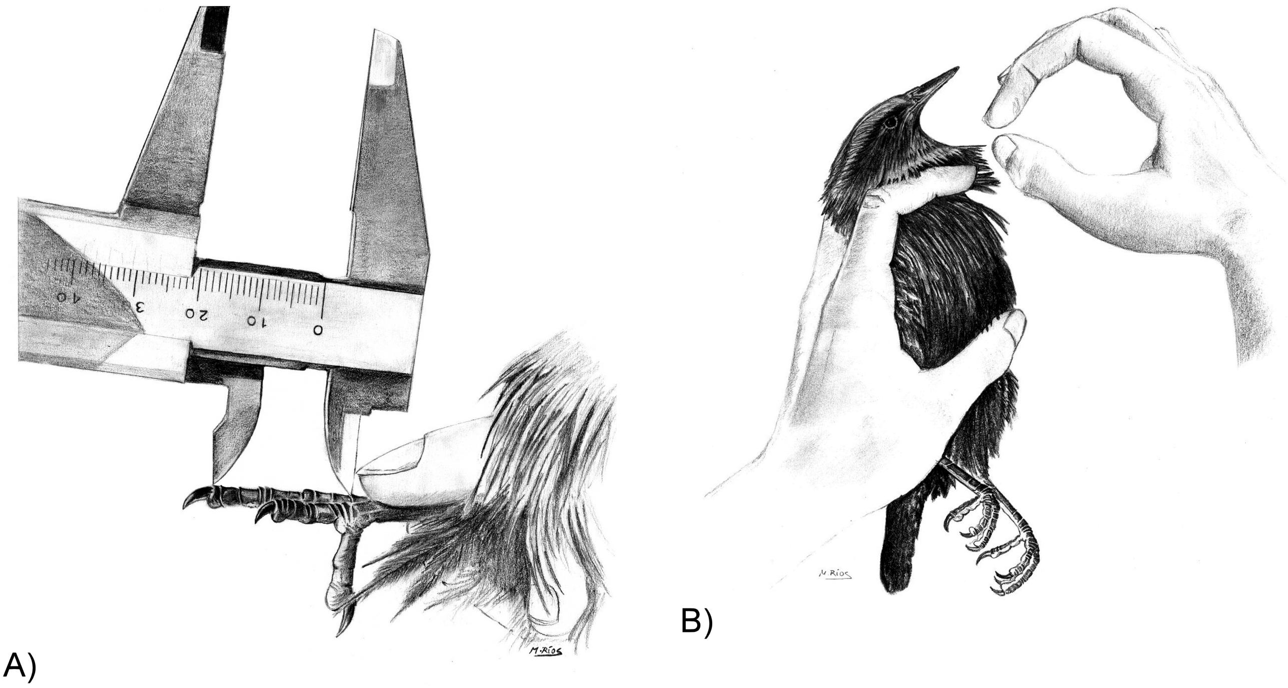

Fig. 1. – A) How to measure middle-toe length in spotless starlings. B) How to obtain throat feathers.

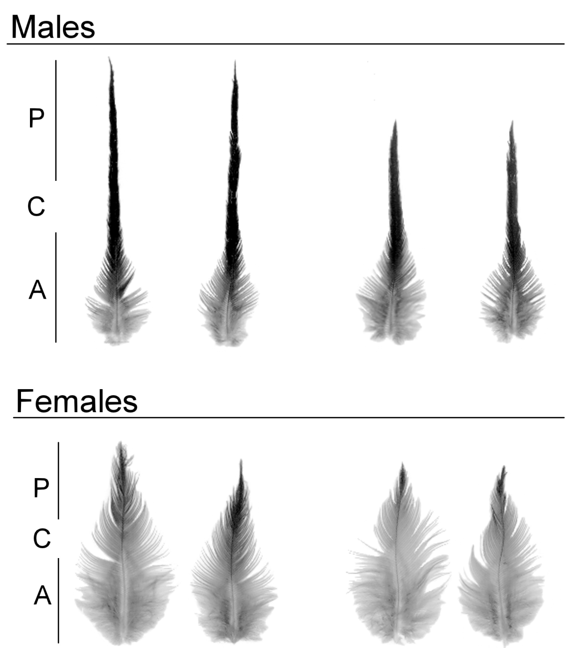

Fig. 2. – Throat feathers of male (above) and female (below) adult spotless starlings, distinguishing between the anterior (A), central (C) and posterior (P).

Bird sex was verified by dissection. The spotless starlings were grouped into two age classes: juveniles (first calendar year) and adults (second or later calendar year). All the juveniles had the relevant characteristics described by HIRALDO & HERRERA (1974).

The five measured variables followed a normal distribution, verified by the Kolmogorov-Smirnov test. The Student t-test was used to test if these values differed significantly between sexes. A discriminant analysis verified which variables more precisely segregated the sexes, using coefficients to determine the importance of each measurement (KLECKA, 1986). The more precise variables described a linear function with a limiting value, above or below which birds were either male or female, respectively.

RESULTS

TABLE 1

Averages (± SD) and ranges of the measured variable (length in cm, weight in g) in spotless starling males and females. N: sample size. t: Student t-test value (all P<0.001).

	♀♀	♂♂	t
Wing	12.78 ± 0.44	13.24 ± 0.26	9.44
Range	11.4 - 13.4	12.6 - 13.8	
N	122	107	
Middle-toe	2.13 ± 0.05	2.24 ± 0.05	15.11
Range	1.96 - 2.25	2.05 - 2.35	
N	114	9	
Beak	2.17 ± 0.09	2.25 ± 0.10	6.82
Range	1.97 - 2.39	2.07 - 2.62	
N	121	102	
Tarsus	2.84 ± 0.1	2.93 ± 0.09	6.07
Range	2.21 - 3.06	2.69 - 3.10	
N	123	105	
Weight	77.90 ± 5.40	84.40 ± 6.47	6.80
Range	64.0 - 89.0	72.0 - 105.0	
N	90	65	

Of the 229 spotless starlings captured, 144 were juveniles (61 ♂♂, 83 ♀♀) and 85 adults (45 ♂♂, 40 ♀♀). The values of the five measured variables overlapped between sexes but were significantly higher in males (Table 1).

The discriminant analysis ordered the variables according to their importance in sex discrimination (standardised coefficients are in brackets): toe (0.889), wing (0.287), weight (0.253), beak (-0.021) and tarsus (-0.138). The first three correctly classified 87.8% of the 208 specimens, while wing and toe correctly classified 89.3%. The variable, weight, did not contribute to the discriminant capacity of the other two variables. The correlation between tarsus length and middle-toe length was relatively low (r=0.536, n=207, P<0.01). For this reason we chose wing length and middle-toe length for the sex differentiation analysis.

The discriminating functions between sexes using the wing and middle-toe (Table 2) helped us to correctly classify 97.4% of the adult spotless starlings (Fig. 3) and 84.7% of the juveniles.

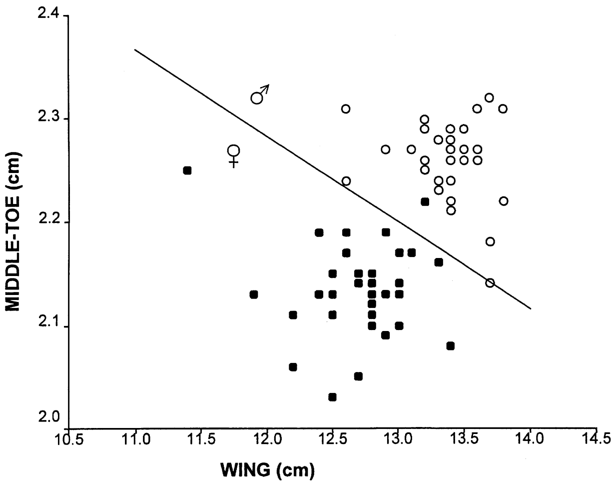

Fig. 3. – Relationship between the wing and middle-toe lengths (cm) in adult male (♂) and female (♀) spotless starlings. The line represents the discriminant function.

TABLE 2

Discriminant functions between sexes in the spotless starling (below, the simplified functions) obtained using the wing (A) and middle-toe (D) lengths (cm). Values for y>0 correspond to males, values y<0 correspond to females. Sample size in brackets.

	Discriminant function	Correctly classified birds
Juveniles	y = 16.251 D + 0.824 A – 45.930	84.7% (131)
Adults	y = 22.222 D + 1.870 A – 73.174	97.4% (77)

Throat feathers were clearly different between adult males and females (Fig. 2). All males had feathers with an abrupt narrowing of the barbs in the anterior and/or central region that continued towards the posterior end. The vane width in all the female adults gradually decreased. This sex difference was less precise for juveniles, of which we correctly classified 88.3% of the males and 100% of the females.

DISCUSSION

The spotless starling is fundamentally sedentary and moves approximately 10 km during daily displacements from the roost to foraging areas (PERIS, 1991). For this reason, population overlap with starlings of a different geographic origin (or different size) would tend to be rare.

Using a combination of wing and middle-toe measurements, we could precisely sex the majority of adult spotless starlings. Only one female, whose middle-toe length was above normal (2.25 cm), was classified erroneously. For one male specimen, the value of the discriminating function was slightly higher (y=0.07) than the separation, and it was classified as doubtful. Thus, the reliability of our discriminating function can be considered high, and, in any case, better than other characteristics used to date. On the other hand, all our specimens could be sexed by using both morphometric and plumage data.

In juveniles this reliability was lower, doubtless because of phenological differences in hatching, since the first egg-laying bout is in April and the second in May-June (PERIS, 1984).

As in other passerines, further studies are necessary to clarify why male and female spotless starlings have different middle-toe lengths. Throat feather shape clearly differentiates spotless starling adults by sex. It was also less precise in juveniles possibly because adult males use these feathers for mate attraction in the breeding season (FEARE, 1986), while they are not completely developed in male juveniles. The shape of some feathers has also been used to differentiate sexes in other Passeriformes (e.g. goldcrest, *Regulus regulus*, and rose-coloured starling, *Sturnus roseus*, SVENSSON, 1992).

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