

MORPHOMETRIC VARIATION OF THE HOUSE SPARROW IN THE AZORES

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With 2 figures and 3 tables

ABSTRACT. Three hundred and five adult specimens were collected at four sites at São Miguel island (Nordeste, Arribanas, Mosteiros and Vila Franca), at one site at Terceira island (Terra Chã) and at one site at Faial island (Horta). Tarsus length, tail length, middle toe length, bill length 1, bill length 2, bill width, bill depth and wing length were measured on each specimen.

There has been morphological differentiation in the Azorean house sparrow during its spread through the archipelago and after its introduction on 1960 from the Portuguese mainland:

1 - Males are bigger than females but females varie more in overall size;

2 - Azorean populations of house sparrow have differentiated less than Northwestern Europe populations, perhaps because of a higher number of alleles in the ancestral population and a restriction of genetic variability of the introduced populations;

3 - Specimens of the Central Group of islands are bigger than specimens of the Eastern Group.

INTRODUCTION

The main objective of this work is to see if there has been any morphological differentiation in the house sparrow (*Passer domesticus* LINNAEUS, 1758) in the quarter of a century since its introduction into the archipelago of the Azores (36° 55' to 39° 42' N and 25° 00' to 31° 30' W).

Introduced populations of this species, unlike other bird species, have shown a high degree of morphological differentiation in very short periods of time (CALHOUN, 1947). Over a 1000 house sparrows from England and Germany were introduced in many places in North America last century and almost at the same time 110 house

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sparrows from England were liberated in New Zealand (ROBBINS, 1973; PINOWSKI & KENDEIGH, 1977; BAKER, 1980). *Passer domesticus* populations show inter-locality variation in size in Europe, America as well as in New Zealand. This inter-locality size variation is two times greater in Europe than in North America but is much more restricted in New Zealand populations (JOHNSTON & SELANDER, 1972; KENDEIGH, 1973; PINOWSKI & KENDEIGH, 1977; BAKER, 1980; PARKIN & COLE, 1985). In the Azores a few tens of house sparrows were introduced from the Portuguese mainland in 1960 (AGOSTINHO, 1963; AGOSTINHO, 1964; BANNERMAN & BANNERMAN, 1966; KNECHT & SCHEER, 1971; STURHAN, 1973). Afterwards this species spread very quickly through all the nine islands of the archipelago.

MATERIALS AND METHODS

Three hundred and five adult specimens were collected during 1984 (from February to August) at the following localities: Nordeste (31 males, 15 females); Arribanas (42 males, 20 females); Mosteiros (25 males, 24 females); Vila Franca (24 males, 27 females); Terra Chã (30 males, 29 females); Horta (16 males, 22 females). Sample localities were at least 15 Km apart.

To avoid extra variation in size only adult specimens were collected. The age of the birds was determined by plumage examination (SVENSSON, 1984; MCGILLIVRAY & JOHNSTON, 1987).

Eight external characters were measured on each specimen: tarsus length; tail length; middle toe length; bill length 1; bill length 2; bill width; bill depth and wing length (maximum length). Detailed descriptions of these characters can be found in SVENSSON (1984), except middle toe length and bill length 2. The middle toe length is the distance between the intertarsal join (top of the toe) and the anterior edge of the skin. The bill length 2 is the distance between the anterior edge of the nasal opening and the tip of the bill.

To assess character variation, Student t tests, coefficients of variation (LEWONTIN, 1966), ANOVA and variance components analysis (SOKAL & RHOLF, 1979) were carried out using Exstatix 1.0.1 (Macintosh) at DEIOC of Faculdade de Ciências da Universidade de Lisboa (Portugal). Correlation among characters was studied with principal components analysis using the computer package NT-SYS (IBM) of RHOLF (1987) at Estação Agronómica de Oeiras (Portugal).

RESULTS

A comparison of male and female measurements at each locality showed significant differences, for six characters (table 1). Bill length 1 and bill width are the

only characters than don't show sexual dimorphism. Although all other characters show differentiation between the sexes only wing length and tail length show highly significant differences. In these characters males are bigger than females 2 to 3 mm (wing length in all populations and tail length in Nordeste, Vila Franca, Terra Chã and Horta). Table 2 shows that mean coefficient of variation of characters do not differ consistently between males and females.

Analysis of variance detected differences between localities in almost all characters of males and females, except in bill length 2 and bill width of females and bill depth of males (table 2). Females are more variable than males in the characters that show geographic variation.

Only the first two principal components were extracted as they represent the major portion on the character variance and as it was possible to associate them with a morphological meaning. Table 3 shows the correlations of the original characters with the first two principal components. These correlations are also shown in figure 1 (males) and figure 2 (females) where we can also see the projection of the sample localities onto the first and second principal components. For both sexes all characters except bill width are positively correlated with principal component 1 which thus represents overall size. This component explains 60.3% of the total variation of males and 59.3% of that of females. For males, tail length middle toe length and wing length are the most important contributors to component 1 and Figure 1 shows that the largest animals are found at Horta and Terra Chã. For females, tarsus length, wing length and tail length are the most important contributors and the largest animals are found at Horta, Terra Chã and Arribanas, medium size ones at Mosteiros and smallest at Nordeste and Vila Franca. Principal component 2 represents bill shape (22.7% of the total variation of males and 22.8% of that of females) and reflects an inverse relationship between bill width and bill depth. Shape of the bill is similar between males and females. Males have bigger bills than females. There is a direct relationship between size of the birds and size of their bills.

DISCUSSION

Univariate analysis and principal component analysis show that males are bigger than females. This finding is similar to the ones of SELANDER & JOHNSTON (1967), HAMILTON & JOHNSTON (1978), FLEISCHER & JOHNSTON (1984) and MCGILLIVRAY (1984). Males are bigger than females perhaps because of the size advantages in intrasexual fights. As the females choose the winners of these fights (MOLLER, 1988; MOLLER, 1989; MOLLER, 1990) and the dominant males are more successful breeders it is expected that bigger males are selected. The bill characters show very little differentiation between the sexes (table 1), a finding which agrees with the following

studies: SELANDER & JOHNSTON, 1967; PACKARD, 1967a; PACKARD, 1967b. This is probably related to the diversity of foods taken by this species and lack of specialisation in diet. The constant availability of food around human settlements may also prevent intersexual differences in the bill. Coefficients of variation of all characters do not differ between sexes. This result is similar to that found by SELANDER & JOHNSTON (1967), JOHNSTON & SELANDER (1972) and BAKER (1980) for *P. domesticus* populations of North America, Northwestern Europe and New Zealand.

Mean variance component and principal components analysis show that females vary more in overall size than males. This is probably a result of the fact that females are more mobile than males (MEDEIROS in prep.). The mean variance components for external characters of Azorean house sparrows in the present study are: males 11.01 and females 15.94. These values are lower than the ones of Northwestern Europe populations (males 19.70 and females 27.19; JOHNSTON, 1976) and higher than the variance components for skeletal characters of North America populations (males 12.93 and females 9.43; BAKER, 1980) and New Zealand populations (males 5.32 and females 3.35; BAKER, 1980). These comparisons are not ideal ones because we are comparing variance components obtained from external characters with variance components obtained from skeletal characters, but the differentiation of characters of Azorean populations does seem to be lower than Northwestern Europe ones. The suggestion that Northwestern populations of house sparrows are more variable than Azorean populations may be the result of the high number of alleles in the former populations and the restriction of genetic variability of the introduced Azorean population. This may be because the small number of introduced individuals (some tens) that had only a small fraction of alleles of the European mainland populations. Although the Azorean populations of house sparrows are less differentiated than Northwestern European ones they show more geographic variation than North America and New Zealand populations that resulted from an earlier introduction of a higher number of specimens. This may be related to the sedentary nature of this species in the Azores (MEDEIROS in prep.) and the fact that the populations are geographically separated from each other.

Principal components analysis detected that specimens from the Central Group of islands are bigger than specimens of the Eastern Group. This may be because the Eastern Group populations of the house sparrow are even more genetically depauperated because only a few specimens came by boat to the last group of islands.

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TABLE 1 - Sexual dimorphism in size of the house sparrows of the Azores (1984).

	MALES			FEMALES			t
	N	Mean	(confidence limits)	N	Mean	(confidence limits)	
NORDESTE							
Tarsus length	31	18.16	17.90-18.42	15	17.65	17.15-18.16	2.09*
Tail length	31	57.02	56.38-57.65	15	54.40	53.67-55.13	5.14*
Middle toe length	31	13.74	13.46-14.01	15	13.24	12.80-13.67	2.08*
Bill length 1	31	13.06	12.91-13.21	15	13.11	12.87-13.35	0.35
Bill length 2	31	9.69	9.51-9.88	15	9.58	9.37-9.79	0.78
Bill width	31	7.09	7.00-7.17	15	6.97	6.83-7.10	1.65
Bill depth	31	7.43	7.30-7.56	15	7.46	7.30-7.62	0.29
Wing length	31	76.68	75.92-77.43	15	73.40	72.40-74.40	5.26*
ARRIBANAS							
Tarsus length	42	18.33	18.10-18.56	20	18.32	18.03-18.61	0.07
Tail length	42	57.36	56.79-57.93	20	56.63	55.80-57.47	1.47
Middle toe length	42	13.86	13.62-14.10	20	14.20	13.95-14.45	1.75
Bill length 1	42	12.89	12.73-13.04	20	13.11	12.87-13.35	1.64
Bill length 2	42	9.46	9.33-9.59	20	9.67	9.43-9.91	1.76
Bill width	42	7.00	6.90-7.11	20	7.08	6.92-7.24	0.85
Bill depth	42	7.51	7.41-7.61	20	7.47	7.34-7.60	0.45
Wing length	42	77.73	77.19-78.27	20	75.45	74.61-76.29	4.81*
MOSTEIRO							
Tarsus length	25	17.67	17.37-17.98	24	17.94	17.70-18.17	1.42
Tail length	25	57.06	57.29-57.83	24	56.28	55.40-57.17	1.37
Middle toe length	25	13.74	13.48-14.00	24	13.42	13.00-13.82	1.41
Bill length 1	25	12.82	12.61-13.02	24	13.12	12.89-13.35	1.98
Bill length 2	25	9.55	9.35-9.75	24	9.92	9.70-10.13	2.55*
Bill width	25	6.82	6.72-6.92	24	6.95	6.81-7.09	1.58
Bill depth	25	7.53	7.42-7.64	24	7.70	7.58-7.83	2.12*
Wing length	25	76.08	75.19-76.97	24	74.21	73.35-75.07	3.11*
VILA FRANCA							
Tarsus length	24	17.65	17.27-18.03	27	17.43	17.05-17.82	0.82
Tail length	24	56.35	55.59-57.12	27	53.92	53.25-54.58	4.99*
Middle toe length	24	13.77	13.49-14.04	27	13.29	12.95-13.62	2.22*

* comparisons that are statistical different ($p < 0.05$)

Bill length 1	24	13.17	13.00-13.34	27	12.96	12.78-13.15	1.71
Bill length 2	24	9.80	9.64-9.97	27	9.64	9.47-9.81	1.39
Bill width	24	7.04	6.93-7.16	27	6.97	6.87-7.08	0.88
Bill depth	24	7.45	7.33-7.57	27	7.44	7.35-7.53	0.18
Wing length	24	76.13	75.22-77.03	27	72.72	72.02-73.43	6.21*

TERRA CHÁ

Tarsus length	30	18.31	18.10-18.52	29	18.32	18.10-18.53	0.03
Tail length	30	58.10	57.45-58.75	29	55.90	55.13-56.66	4.52*
Middle toe length	30	13.97	13.78-14.15	29	14.01	13.80-14.22	0.31
Bill length 1	30	13.47	13.28-13.65	29	13.69	13.51-13.88	1.76
Bill length 2	30	9.74	9.57-9.90	29	9.80	9.63-9.97	0.56
Bill width	30	6.89	6.80-6.97	29	6.88	6.76-7.00	0.15
Bill depth	30	7.54	7.44-7.64	29	7.59	7.50-7.67	0.67
Wing length	30	78.16	77.10-79.22	29	75.09	74.56-75.62	5.32*

HORTA

Tarsus length	16	18.34	17.93-18.76	22	18.25	17.97-18.54	0.39
Tail length	16	58.95	57.99-59.92	22	55.91	55.08-56.74	4.98*
Middle toe length	16	14.42	13.97-14.87	22	14.11	13.85-14.38	1.29
Bill length 1	16	13.46	13.22-13.70	22	13.46	13.21-13.70	0.02
Bill length 2	16	10.04	9.82-10.26	22	9.92	9.77-10.08	0.97
Bill width	16	7.98	6.87-7.08	22	6.90	6.82-6.99	1.09
Bill depth	16	7.54	7.42-7.65	22	7.50	7.41-7.58	0.62
Wing length	16	79.16	78.03-80.28	22	76.02	72.27-76.78	5.04*

TABLE 2 - Variation in external characters of the house sparrows of the Azores (1984). Only the comparisons that are statistical different are shown ($p < 0.05$).

	Mean coefficients of variation	Degrees of freedom	F	Variance components
Tarsus length				
Males	4.08	5,162	4.82	12.17
Females	4.00	5,131	6.16	18.55
Tail length				
Males	3.15	5,162	4.91	12.41
Females	3.23	5,131	7.50	22.31
Middle toe length				
Males	5.03	5,162	2.36	4.72
Females	5.27	5,131	7.53	22.37

		Bill length 1			
Males	3.51	5,162	8.55	21.51	
Females	3.81	5,131	7.39	22.02	
		Bill length 2			
Males	4.56	5,162	4.69	11.81	
Females	4.49	-	-	-	
		Bill width			
Males	3.79	5,162	3.68	8.85	
Females	3.37	-	-	-	
		Bill depth			
Males	3.57	-	-	-	
Females	4.03	5,162	3.69	10.61	
		Wing length			
Males	2.81	5,162	6.49	16.61	
Females	2.36	5,131	11.50	31.67	
	Mean			Mean	
Males	3.81			11.01	
Females	3.82			15.94	

TABLE 3 - Eigen values and eigen vectors of the first two principal components of Azorean sparrows.

CHARACTERS	PRINCIPAL COMPONENT			
	1		2	
	Males	Females	Males	Females
	M	F	M	F
Tarsus length	0.73	0.95	0.11	0.28
Tail length	0.98	0.87	0.16	0.24
Middle toe length	0.95	0.84	0.08	0.48
Bill length 1	0.78	0.78	0.34	-0.28
Bill length 2	0.66	0.75	0.49	-0.48
Bill width	-0.16	-0.32	0.92	0.83
Bill depth	0.67	0.49	-0.74	-0.60
Wing length	0.95	0.93	0.04	0.29
Eigen value	4.82	4.75	1.82	1.82

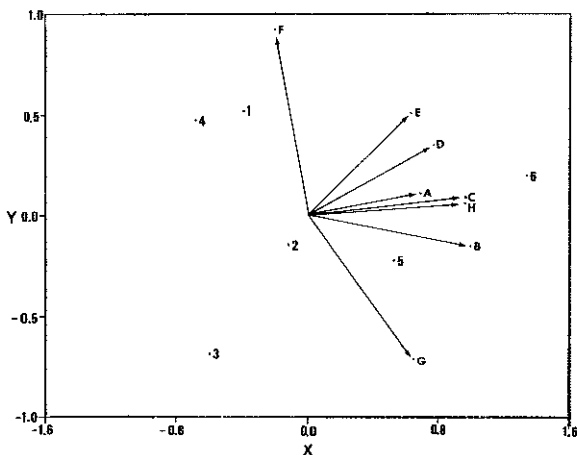


Figure 1 - Projection of the males points and the original characters onto the first and second principal components: X-first component; Y-second component; 1-Nordeste; 2-Arribanas; 3-Mosteiros; 4-Vila França; 5-Terra Chã; 6-Horta; A-tarsus length; B-tail length; C-middle toe length; D-bill length 1; E-bill length 2; F-bill width; G-bill depth; H-wing length.

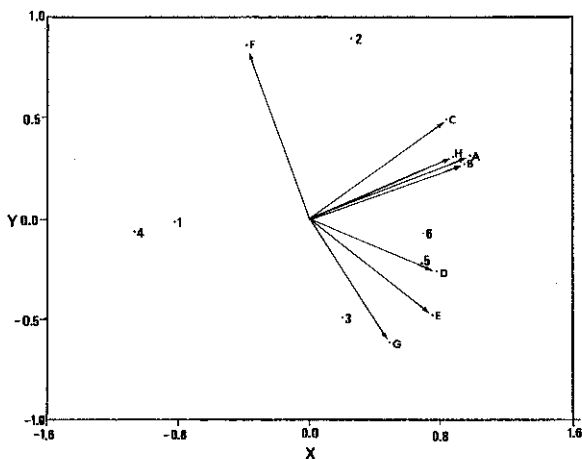


Figure 2 - Projection of the females points and the original characters onto the first and second principal components: X-first component; Y-second component; 1-Nordeste; 2-Arribanas; 3-Mosteiros; 4-Vila França; 5-Terra Chã; 6-Horta; A-tarsus length; B-tail length; C-middle toe length; D-bill length 1; E-bill length 2; F-bill width; G-bill depth; H-wing length.