

DESCRIPTION OF INTERMEDIATE
PHENOTYPES BETWEEN
PASSER HISPANIOLENSIS AND *PASSER DOMESTICUS*

Juan Carlos ALONSO*

INTRODUCTION

Although large-scale hybridization between the House Sparrow (*Passer domesticus*) and the Spanish Sparrow (*P. hispaniolensis*) is now considered to be a thing of the past by some authors (MEISE, 1936; JOHNSTON, 1969), others suggest that the present situation of phenotypical heterogeneity in N-Africa could be considered as a temporal phase in the process of ecological segregation (SUMMERS-SMITH & VERNON, 1972). Occasional hybrids have been cited for several localities around the Mediterranean Sea (references in SUMMERS-SMITH & VERNON, 1972, and BAUMGART & STEPHAN, 1974). References to possible hybrids in Iberia are scarce (VALVERDE, unpubl.; BERNIS, 1967; and one doubtful case in SAÇARRAO, 1973). In this paper we describe the plumages and measurements of some intermediate phenotypes housed in the collection of the Estación Biológica de Doñana or caught during a study of the biology of the Spanish Sparrow in Iberia (ALONSO, 1982).

MATERIAL AND METHODS

As females of both species are nearly indistinguishable, the results are based only on postjuvenile males: between 1978 and 1982, 718 male Spanish Sparrows and 159 male House Sparrows were mistnetted at several localities of Cáceres, Toledo and Madrid. All were measured and examined thoroughly. Additional material from the Canary Islands (21 male Spanish Sparrows), and from the collections of the Museo Nacional de Ciencias Naturales (33 male House Sparrows and 6 male Spanish Sparrows) and the Estación Biológica de Doñana (57 male House Sparrows and 54 male Spanish Sparrows) was also studied. JOHNSTON'S (1969) hybrid index was utilized. It is based on the following major plumage differences: 1. color of back: orange, rufous, buff and black in *domesticus*; pale buff, whitish, cream and black in *hispaniolensis*. 2. Rump spots: rufous, pale or none in *dom.*; black in *hisp.* 3. Posterior margin of bib: abrupt in *dom.*; with spearpoint-shaped black streaks in *hisp.* 4. Flanks: uniform buffy or gray in *dom.*; with black shaft streaks in *hisp.* 5. Shoulder: rufous with little black in *dom.*; black with little rufous in *hisp.* 6. Pileum: gray in *dom.*; rufous in *hisp.* Pure phenotypes of the House Sparrow are scored 0 on all six characters,

* Museo Nacional de Ciencias Naturales, C.S.I.C., José Gutiérrez Abascal, 2. 28006 Madrid.

for a summated score of 0, and pure phenotypes of the Spanish Sparrow are scored between 2 and 6 for each character, for a summated score of 17 (see Table I). In intermediate phenotypes character values were visually determined. We arbitrarily considered as intermediate phenotypes those ranging from 3 to 15.

Linear measurements were taken to the nearest 0.02 mm as follows: wing length: length of flattened wing; tail: from the insertion of the two middle rectrices to tip; tarsus: from the joint between the tarsus and the tibia to the

TABLE I
Hybrid index scores of sparrows showing intermediate phenotype
[Valores de los índices de hibridación de los gorriones con fenotipos intermedios]

Specimen number	Date and locality of capture	Individual character scores and ranges						Hybrid index
(Número del ejemplar)	(Fecha y localidad de captura)	(Valores y rangos de los caracteres individuales)						(Índice de hibridación)
		Back (0-2)	Rump spots (0-2)	Bib (0-2)	Flanks (0-3)	Shoulder (0-2)	Pileum (0-6)	
332 ^a	3. 7.57, Almería	1	0	0	0	0	2	3
362 ^a	16.10.57, Almería	1	0	0	0	0	3	3
363 ^a	16.10.57, Almería	1	0	1	0	1	4	7
365 ^a	16.10.57, Almería	2	1	0	0	1	3	7
342 ^a	8.10.57, Almería	2	0	1	0	1	4	8
367 ^a	17.10.57, Almería	2	1	1	0	1	4	9
1450 ^a	26.10.66, Sevilla	1	1	2	0	1	6	11
375 ^a	23.10.57, Almería	2	0	1	1	2	6	12
1747 ^a	29. 9.67, Huelva	2	1	1	0	2	6	12
1449 ^a	26.10.66, Sevilla	2	1	1	1	2	6	13
371 ^a	17.10.57, Almería	2	1	2	1	2	6	14
1448 ^a	26.10.66, Sevilla	2	1	2	1	2	6	14
JA-86163 ^c	20. 6.79, Cáceres	0	0	0	0	0	3	3
JA-86170 ^c	9. 5.79 ^d , Cáceres	0	0	0	0	0	3	3
JA-86775 ^c	23. 9.79, Cáceres	0	0	0	0	0	3	3
78031907 ^b	19. 3.78, Cáceres	1	1	0	0	0	4	6
79062119 ^b	21. 6.79, Cáceres	1	0	1	0	0	6	8
78190508 ^b	19. 5.78, Cáceres	2	1	1	1	1	4	10
JJ-32678 ^c	5. 7.78 ^d , Cáceres	2	0	1	1	2	4	10
78041521 ^b	15. 4.78, Cáceres	2	0	2	0	1	6	11
JJ-22301 ^c	3.11.79, Cáceres	2	2	0	0	2	6	12
JJ-32659 ^c	5. 7.78, Cáceres	2	2	2	1	2	4	13
78041501 ^b	15. 4.78, Cáceres	2	2	2	1	2	4	14

^a collection of the E. B. Doñana

^b author's collection

^c ring number of birds ringed and released

^d these birds were recaptured respectively on 20.6.79 and 10.5.79 at the same place and released

midpoint of the distal margin on the most distal undivided scute; culmen: chord between the bill tip and the cranio-facial hinge; bill length: from the anterior margin of nostril to bill tip; bill height: distance between surfaces of horny coverings of upper and lower mandibles immediately anterior to cranial feathering; bill width: distance between lateral surfaces of horny covering of upper mandible immediately anterior to loreal feathering. In order to minimize seasonal and interpopulational variability, statistical comparisons were made only within the same yearly period and population.

RESULTS

Hybrid index scores are 16.76 ± 0.05 s.e. for Spanish Sparrows and 0.10 ± 0.03 s.e. for House Sparrows from the Iberian Peninsula. These figures are very similar to the values given by MEISE (1936) and JOHNSTON (1969) for Spain. Of 1027 male specimens examined in detail, 23 show intermediate phenotypes (Table I and Appendix). The plumage intermediacy is not a consequence of any temporal physiological abnormality, since it was maintained in two recaptured birds (Table I), as it is in successive nuptial plumages of captive hybrids (ALONSO, 1984). The wide variety of their plumage character combinations resembles the phenotypic heterogeneity shown by certain wild hybrid populations in the Mediterranean region (MEISE, 1936; JOHNSTON, 1969; SUMMERS-SMITH & VERNON, 1972), as well as by F_1 -hybrids obtained in captivity (MACKE, 1965; ALONSO, 1984). As an average, flank streaking shows the lowest scores, this character being apparently readily lost in intermediate phenotypes.

Significant differences exist between pure House Sparrow and Spanish Sparrow Iberian populations in all bill measurements and tarsus length (Table II). Hybrid birds are intermediate between the two pure phenotypes also in all bill measurements and tarsus and show shorter wings and tails.

The size intermediacy of the sample of Spanish Sparrows from the Canary Islands between the peninsular samples of both species is also noteworthy. The insular sample is not statistically different from the peninsular samples of intermediate phenotypes, except for the wing length, which is significantly shorter in the Sparrows from the Canary Islands than in any of the other samples considered. Insular Spanish Sparrows are thus biometrically very similar to peninsular intermediate phenotypes, while they differ significantly from peninsular House Sparrows—significant differences in wing length (2), culmen length (1), bill height (2) and tail length (1)—, and even more from peninsular Spanish Sparrows—significant differences in wing length (2), culmen length (2), bill height (2), bill width (2), tail length (1) and tarsus length (2)— (Table II).

The samples of intermediate phenotypes from Cáceres and Andalucía are statistically identical in all body measurements ($p > 0.05$, Student's *t*-test).

TABLE II

Measurements of intermediate una pure phenotypes of *Passer hispaniolensis* and *P. domesticus* from I) Cáceres (1978-81, March-June)¹, II) South Andalucía (1957-68, October)², and III) Tenerife, Canary Islands³ (1980 and 1984, October). Sample sizes in parenthesis [*Medidas de fenotipos intermedios y puros de Passer hispaniolensis y P. domesticus de I) Cáceres (1978-81, marzo-junio)*¹, II) *sur de Andalucía (1957-68, octubre)*², y III) *Tenerife, Islas Canarias*³ (1980 y 1984, octubre): *Entre paréntesis, tamaños de muestra*]

	I) Intermediate phenotypes		P. domesticus		II) Intermediate phenotypes		P. hispaniolensis		P. domesticus		III) P. hispaniolensis		P. domesticus	
	\bar{x}	σ_n	\bar{x}	(n)	\bar{x}	(n)	\bar{x}	(n)	\bar{x}	(n)	\bar{x}	(n)	\bar{x}	(n)
Wing	79.287A	1.195	78.914B	79.448C	79.091a	80.171b	79.350c	77.143u	1.911	1.415	1.911	1.754	1.911	1.754
	σ_n	13.756D	13.804E	12.996F	13.687d	13.857e	13.407f	13.325v	13.407f	13.857e	13.407f	13.325v	13.407f	13.325v
Culmen	\bar{x}	0.397	0.495	0.396	0.396	0.233	0.416	0.521	0.359	0.416	0.359	0.521	0.359	0.521
	σ_n	10.108	10.029G	9.790H	9.756g	9.962h	9.632i	9.695	9.632i	9.962h	9.632i	9.695	9.632i	9.695
Bill from nostril	\bar{x}	0.388	0.505	0.344	0.344	0.257	0.311	0.407	0.349	0.311	0.349	0.407	0.349	0.407
	σ_n	8.732I	8.833J	8.259K	8.609j	8.609j	9.007k	8.456w	8.076l	9.007k	8.076l	8.456w	8.076l	8.456w
Bill height	\bar{x}	0.215	0.608	0.326	0.326	0.343	0.299	0.284	0.125	0.299	0.125	0.284	0.125	0.284
	σ_n	8.496L	8.643M	8.141N	8.267	8.402m	8.646n	8.360x	8.258n	8.646n	8.258n	8.360x	8.258n	8.360x
Bill width	\bar{x}	0.418	0.245	0.267	0.267	0.197	0.201	0.147	0.292	0.201	0.292	0.147	0.292	0.147
	σ_n	56.548	57.494	57.384	57.384	57.327o	58.640p	56.950y	59.180q	58.640p	59.180q	56.950y	59.180q	56.950y
Tail	\bar{x}	1.077	1.465	1.806	1.806	1.132	1.370	1.798	1.013	1.370	1.013	1.798	1.013	1.798
	σ_n	19.340	19.721O	19.044P	19.044P	19.220r	19.828s	19.413z	19.051t	19.828s	19.051t	19.413z	19.051t	19.413z
Tarsus	\bar{x}	0.882	0.517	0.702	0.702	0.765	0.723	0.725	0.650	0.723	0.650	0.725	0.650	0.725
	σ_n	(8)	(5)	(73)	(36)	(11)	(38)	(20)	(12)	(38)	(12)	(20)	(20)	(20)

1 collection of the author

2 collection of the E. B. Dofiana

3 collection of the author and data from F. J. Santana

Significance of the differences: within I:

p < 0.05 : LN

p < 0.01 : GH, IK

p < 0.001 : DF, EF, JK, MN, OP

within II:

ab, df, gh, st

ef, hi, op

jk, jl, kl, mn, nñ, pq

between III and I:

Fw, Kw, Mx, Oz

Au

Bu, Cu, Ev, Jw

between III and II:

nx, py, sz

au, cy

bu, cu, ev, kw, lw

Therefore, they are considered as a single population in the subsequent analyses. Their hybrid index is positively correlated with their tarsus length ($r=0.55$, $n=16$, $p<0.05$), culmen length ($r=0.52$, $n=16$, $p<0.05$), and bill width

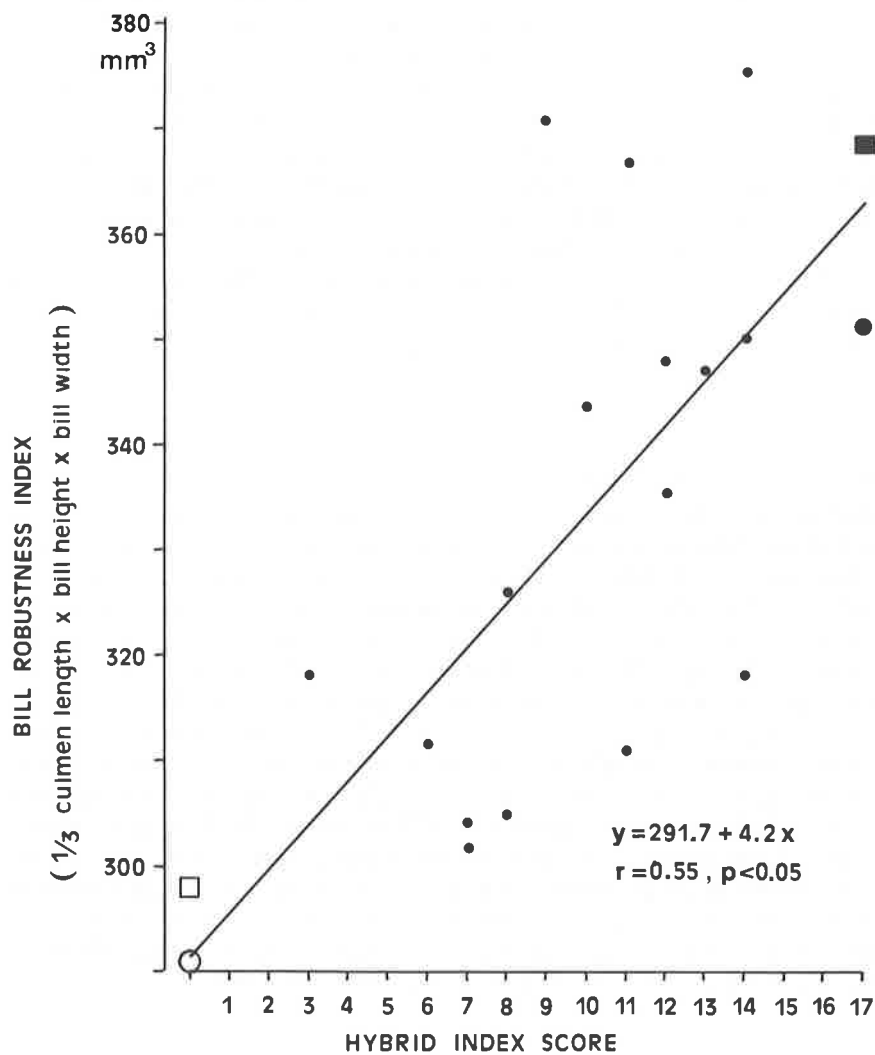


FIG. 1.—Correlation between hybrid index and bill robustness in the sample of intermediate phenotypes. Mean values for the samples of pure phenotypes of the E. B. Doñana collection (quadrats) and of the author's collection for Iberia (large dots) are also indicated: large solid symbols=Spanish Sparrow; large open symbols=House Sparrow.

[Correlación entre el índice de hibridación y el índice de robustez del pico en fenotipos intermedios. Se indican los valores medios correspondientes a los fenotipos puros de Gorrión Moruno para la Península (símbolos grandes negros) y Gorrión Común (símbolos grandes blancos) de las colecciones de la E. B. Doñana (cuadrados) y del autor (círculos grandes).]

($r=0.58$, $n=16$, $p<0.02$). The correlation coefficients for bill length from nostril and bill height are also positive, although they do not reach the 95% significance level ($r=0.26$ and $r=0.24$ respectively) probably due to the small sample size. However, the correlation between the hybrid index and a bill robustness parameter that combines the three bill dimensions is significant (Fig. 1). The proximity of the means for both Iberian samples of pure phenotypes to the regression line is noteworthy, supporting the validity of the correlation. The bill robustness index for the insular sample of Spanish Sparrows is 314, i.e. intermediate between the peninsular values for both pure phenotypes, and closer to the value for the House Sparrow than to the value for the Spanish Sparrow. Wing and tail lengths of intermediate phenotypes are not correlated with the hybrid index ($r=0.04$ and $r=0.16$ respectively, $p>0.05$).

The biometrical intermediacy of the intermediate phenotypes is noteworthy, since they were initially identified as such on the basis of color pattern only, and supports their hybrid nature.

CONCLUSION

The distribution of hybrid scores in Iberia is such that two distinct populations are clearly involved. They are maintained separated by strong ecological and behavioural isolating mechanisms (ALONSO, 1982). The existence of higher biometrical differences between sympatric populations of both species precisely in bill (feeding apparatus) and tarsus (locomotion) suggests that some feeding-niche-related factors may be operating as isolating mechanisms (HESPENHEIDE, 1973; ALONSO, 1982). This is supported by the intermediacy of the Spanish Sparrow population of the Canary Islands, where the House Sparrow is absent. The reproductive barriers between both peninsular phenotypes may be sometimes broken, specially due to disturbances of their original habitats caused by human activities, with the result that the two still interfertile populations (MACKE, 1965; ALONSO, 1984) occasionally hybridize. Nevertheless, selection should be expected to operate against hybrids, since their plumage and size intermediacy probably makes them less attractive for a potential mate and less adapted to the typical habitats of both parental species (SIBLEY, 1961; SHORT, 1972). This is supported by the scarcity of intermediate phenotypes, despite the sympatric distribution in Iberia (ALONSO, 1982).

ACKNOWLEDGEMENTS

We are grateful to all those collaborators who assisted us in the collection of the material, and to J. BACALLADO and F. J. SANTANA for the sparrows and data from Tenerife. The kindness of the officials of the E. B. Doñana, from which the collection of sparrows was borrowed, is gratefully acknowledged. I also thank Prof. Bernis and the Cátedra de Vertebrados of the Complutense University for the facilities provided. The field work was supported by a FPI-grant of the Ministerio de Educación.

SUMMARY

23 intermediate phenotypes between *Passer hispaniolensis* and *P. domesticus* collected in Spain are described. Their hybrid index score, which is based on color pattern, is correlated with some body measurements, in which they are intermediate between both pure phenotypes.

KEY WORDS: intermediate phenotypes; *Passer domesticus*; *Passer hispaniolensis*; Spain.

RESUMEN

Descripción de fenotipos intermedios entre Passer hispaniolensis y Passer domesticus.

Se describen 23 fenotipos intermedios entre *Passer hispaniolensis* y *P. domesticus* colectados en España. El tamaño de sus picos y tarsos es intermedio entre los de las dos especies citadas, existiendo una correlación positiva entre dichas medidas y el índice de hibridación basado en los caracteres del plumaje que diferencian a ambas especies.

PALABRAS CLAVE: España; fenotipos intermedios; *Passer domesticus*; *Passer hispaniolensis*.

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[Recibido: 9.7.84]

APPENDIX

Description of hybrid characters of intermediate phenotypes (see Table I): 332: grey region of pileum small and showing dark chestnut feathers, back dark; 362: pileum with dark chestnut

feathers; 363: back and shoulder dark, bib posterior margin not abrupt, anterior region of pileum like *domesticus*, posterior like *hispaniolensis*; 365: dark back and shoulder, dark rump spots, partial melanism on crown; 342: dark back and shoulder, streaked bib margin, melanic crown; 367: back, rump spots and shoulder dark, streaked bib margin, melanic crown; 1450: back, rump spots and shoulder dark, streaked bib margin, crown chestnut; 375: like *hispaniolensis*, but rump greyish and bib margin and flanks only slightly streaked; 1747: flanks lacking shaft streaks, rump and bib intermediate; 1449: rump intermediate, bib margin and flanks only slightly streaked; 371: rump spots and flank streaks only insinuated; 1448: like 371; JA-86163, JA-86170 and JA-86775: abundant chestnut on crown; 78031907: back and rump intermediate, crown feathers chestnut with black tips; 79062119: back with abundant chestnut, bib not abrupt, crown chestnut; 78190508: shoulder with abundant rufous, flanks and bib margin only slightly streaked, few rump spots; JJ-32678 and JJ-32659: melanism on anterior crown, few streaks on flanks; 78041521: rump lacking spots, flanks lacking streaks, shoulder with abundant rufous; JJ-22301: bib margin and flanks lacking streaks; 78041501: upper crown region melanic, flanks poorly streaked.