PHYSICAL CHARACTERISTICS OF IBERIAN LYNXES (*LYNX PARDINUS*) FROM DOÑANA, SOUTHWESTERN SPAIN

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External and cranial measurements were determined for live-trapped Iberian lynxes and lynx skulls from Doñana National Park, Spain, and its surroundings. Skins of Iberian lynxes from the same population collected between 1895 and 1986 were examined to determine pelage-pattern characteristics. Adult (≥ 2 years old) males were larger and heavier (27.3%) than adult females. Age-classes were statistically different for most skull measurements. Considerable variation was found between juveniles (0.5-1 year old) and subadults (1-2 years old). In 10 of the 19 skull measurements, adult males were significantly larger than adult females, including length of m1, mandibular fossa—length of P4, height of mandible, length of skull, and condylobasal length. Iberian lynxes were similar in size to the Nearctic bobcat (*L. rufus*) and the Canadian lynx (*L. canadensis*). Three main pelage patterns were present in the Doñana population until 1960. Genetic variation of this population may have decreased during the past 3 decades as exemplified by the loss of the two rarest pelage patterns.

Key words: *Lynx,* Iberian lynx, biometry, Spain

Described as *Felis pardina* by Temminck (1824), the Iberian lynx (also referred as Spanish lynx or pardel lynx) has been listed either as a subspecies of the northern lynx (*Felis [Lynx] lynx*)—(Corbet, 1978; Ellerman and Morrison-Scott, 1965) or as a distinct species (Cabrera, 1914; Honacki et al., 1982; Miller, 1912; Novak, 1991; Werdelin, 1981, 1989, 1990; Wozencraft, 1989). Collier and O'Brien (1985) demonstrated that lynxes form a distinct group within the family Felidae, and Tumlison (1987) concluded that should *Lynx* become the accepted generic designation, it is likely that the forms *lynx, canadensis,* and *pardina* will be elevated to species rank. Another observation supporting species status is the Pleistocene distribution of the Iberian lynx (Kurtén, 1968; Kurtén and Grandqvist, 1987; Van den Brink, 1970, 1971; Werdelin, 1981), which overlapped extensively with that of the northern lynx. The latter species reached

northern Spain and may still occur in the Pyrenees Mountains (Navarre, 1976; Rodriguez and Delibes, 1990). Today, the range of the Iberian lynx is restricted to the southwestern Iberian Peninsula, with highly fragmented populations (Rodriguez and Delibes, 1990). Numbers of Iberian lynxes have been estimated at 1,000–1,200 (Rodriguez and Delibes, 1990). Listed as endangered by International Union for the Conservation of Nature (1986), the Iberian lynx is included in the Appendix I of CITES (Jackson, 1990).

There is a need for basic information on the biology of this species (Beltrán, 1987). Body mass and external data for a few specimens are listed in Chapman and Buck (1910), Cabrera (1914), and Valverde (1957, 1963). Cranial studies provide most of the information available on the Iberian lynx; however, few specimens have been measured (Cabrera, 1914; Miller, 1912; Vasiliu

and Decei, 1964), and most are of unknown gender (García-Perea et al., 1985; Werdelin, 1981).

In this paper, we report differences in body and cranial measurements by gender and age classes of the most southerly population of Iberian lynxes, centered in the Doñana National Park—(37°N, 6°30'W), on the Atlantic coast of southern Spain. Physical values of this population are compared with published data from other lynxes to determine similarities of body size. Finally, variation in pelage patterns of Iberian lynxes from Doñana National Park is described with special reference to changes detected since early in the 20th century.

MATERIALS AND METHODS

Standard external measurements were taken with a metallic tape from 17 Iberian lynxes live-trapped for radio-telemetry studies, and five found shortly (≤ 2 days) after death (J. Aldama, pers. comm.; Beltrán, 1988). Captures occurred from late October to April, 1983–1986. In the study area, peak parturition occurred in April. Each individual was classified within an age-class based on date of capture, body mass, and tooth wear; we considered subadults to be only those specimens previously captured as juveniles. Within an age-class, body measurements taken on successive captures of the same individual were averaged; body mass of specimens found dead in a starved condition were not included in our data base.

Thirty-three skulls deposited in the Mammal Collection of Doñana Biological Station (MCDBS, Sevilla, Spain) were measured using a Mitutoyo vernier caliper (± 0.1 mm) (Appendix I). Nineteen skull measurements were taken following Valverde and Hidalgo (1974), Werdelin (1981), García-Perea et al. (1985), and Wiig and Andersen (1986): length of skull, condylobasal length, mastoid breath, length of C1–P4, length of P4, rostral breath at P4, mandibular fossa—length of P4, zygomatic breadth, breadth of postorbital constriction, interorbital breadth, breadth of postorbital processes, rostral length, palatal length, rostral breadth at canines, length of mandible, height of mandible, length of mandibular toothrow, length of c1–m1, and length of m1. Three age-classes were considered: juveniles (0.5

to ≤ 1 year); subadults (1 to ≤ 2 years); adults (>2 years). Juveniles were distinguished by the presence of open apical foramen in the lower canines. Subadults included animals that were captured as juveniles (Beltrán, 1988). The diameter of the pulp cavity of the lower canine as revealed by radiography (Mahan, 1979), from a sample of known-age individuals, was used to assess the age class of other specimens deposited in MCDBS. For adults, an additional estimate of absolute age was obtained by analysis of cementum annuli (Crowe, 1972; G. Matson, in litt.).

Data on Iberian lynxes provided in this study were used as references to estimate similarity among species of lynxes (Kurtén and Grandqvist, 1987); additionally, the average of such differences in cranial values (Reig, 1992) was computed as an overall estimate of size ranking. Because of adult sexual dimorphism in lynxes, males and females were analyzed separately. For body measurements, the sources were Haglund (1966), Stroganov (1969), van Zyll de Jong (1975), McCord and Cardoza (1982), Parker et al. (1983), Quinn and Parker (1987), Rolley (1987), and Novak (1991). Cranial measurements were obtained from Saunders (1964), Hall (1981), Schmidly and Read (1986), and Wiig and Andersen (1986).

Fifty-four skins of Iberian lynxes were examined in this study. The sample included recent material (43 skins, from 1954 through 1986, including those 22 reported for body measurements) from Doñana National Park and surroundings, and other populations of Iberian lynxes (skins deposited in MCDBS are listed in Appendix I); also 11 skins, collected early in this century, deposited in the British Museum of Natural History (BMNH, Appendix I). Iberian lynxes were individually photographed to document coat patterns; pictures of museum skins were taken to define models of pelage type. For such models, the spot design was drawn by overlapping an acetate layer over a picture of the skin. Size, density, and distribution of spots on the back, sides, neck and shoulders were used as criteria for classification of pelage patterns; no other pelage characteristics were considered. We assigned a pelage type to each pelt; pictures of the skin, and in most cases the skin itself, were compared with models of pelage type.

Statistical analysis was performed using the Statistical Analysis System (SAS Institute Inc., 1988). Variation between gender and age classes was analyzed by use of the GLM procedure, and

differences among group means were tested using Tukey's tests (for more than two groups) and *t*-tests (two groups).

RESULTS

Significant differences in body measurements were observed among means of juveniles, subadults, and adults, with exception of circumference of neck (Table 1). Size of males and females were not significantly different in juveniles and subadults. Adult Iberian lynxes, however, showed sexual dimorphism in some body measurements, with males larger than females in body mass ($P \leq 0.001$), length of hind foot ($P \leq 0.001$), total length ($P \leq 0.01$), length of ear-tuft ($P \leq 0.01$), and height of shoulder ($P \leq 0.05$).

Age-classes were significantly different ($P \leq 0.05$) in most skull measurements (Table 2). Considerable variation was present between juvenile and subadult age classes. No variation due to age occurred in length of P4 and postorbital constriction. Subadult and adult Iberian lynxes differed in eight skull measurements; total length of skull, mastoid breadth, length of mandibular fossa—P4, zygomatic breadth, breadth of postorbital processes, rostral breadth at canines, length of mandible, and height of mandible.

Sexual dimorphism in cranial measurements of adults was significant for 10 variables (Table 3), including length of m1, length of mandibular fossa—P4, length of mandible, length of skull, and condylobasal length. Cranial values for males were larger (length of P4, 2%; height of mandible, 8%— male/female ratio as percent) than for females. However, interorbital breadth was wider in females than in males (3.8%, female/male ratio).

Based on body and cranial measurements, Iberian lynxes from Doñana National Park are more similar to the Nearctic lynxes, the bobcats, and the Canadian lynxes, than to the northern lynxes (Fig. 1). This similarity was best reflected by the average size difference in cranial measurements (Fig. 1b). Male northern lynxes were 24 (total length) to 44% (height of shoulder) larger

than male Iberian lynxes. For females the range of values was larger; 29 (total length) to 80% (body mass). In cranial values, the smallest difference was in zygomatic breath (5% larger in the sample of northern lynxes), and the largest in length of C1–P4, for both sexes. Bobcats and Iberian lynxes had the smallest differences in body mass (0%), and the largest difference in height of shoulder (9% smaller in the bobcat), for both sexes. Canadian lynxes had shorter tails (12%) and longer hind feet (27–30%, for males and females, respectively) than Iberian lynxes. Among the Nearctic lynxes, the maximum difference in cranial measurements with Iberian lynxes was 8% (molar length in male bobcats; Fig. 1b).

Three main patterns in the pelt design of Iberian lynxes were recognized (Fig. 2). Pelage pattern type A was characterized by the small size of the spots, distributed uniformly in a dense pattern throughout the fur. Spots tended to be smaller and concentrated along the dorsal midline (Fig. 2a). The two other types of pelage patterns showed large variation in size and shape of the spots, mainly on the neck, shoulders, and lower back (Figs. 2b and 2c). Nevertheless, in type B the spots tend to be arranged in lines, decreasing in size from the back to the sides. There also are two or more pairs of large spots on the shoulders (Fig. 2b). The relative frequencies of these three pelage types in the population at Doñana National Park, before ($n = 8$) and after 1960 ($n = 29$), were: 25 ($n = 2$) and 0%, respectively, for type A; 62 ($n = 5$) and 86% ($n = 25$) for type B; 12.5 ($n = 1$) and 14% ($n = 4$) for type C.

Type B was the more common coat pattern in the sample ($n = 30$); furthermore, all lynxes from Doñana National Park in 1983–1986 ($n = 22$) showed this pattern. Coat of pelage type A also was recognized in 11 skins of lynxes from other populations, including four collected after 1960; lynx pelts assigned to pelage type C came from several populations other than Doñana National Park, before ($n = 1$) and after 1960 ($n = 5$).

TABLE 1.—*Age-specific mean ± SE body measurements (mm) and sexual dimorphism in adult Iberian lynxes live-trapped at Doñana National Park, Spain. Range of values in parentheses; group means with significant differences share the same superscript letter (lowercase: Tukey's test among four groups: juveniles, subadults, adult females, adult males; uppercase: t-test, sexual dimorphism in adults, M: male, F: female).*

Measurement	Age (years)							
	0.5–1.0		n	1.0–2.0		n		>2.0		n
Body mass (kg)	5.7 ± 0.3^{abc}	(4.1–7.1)	10	9.4 ± 0.3^{ab}	(8.5–9.9)	4	F	9.3 ± 0.3^{cC}	(8.7–9.9)	4
							M	12.8 ± 0.5^{aC}	(11.1–14.5)	5
Total length	733 ± 13.7^{bcd}	(665–794)	9	895 ± 2.6^{b}	(890–902)	4	F	864 ± 14.2^{acB}	(823–914)	6
							M	936 ± 13.4^{adB}	(894–970)	6
Length of tail	129 ± 5.7^{a}	(95–150)	10	153 ± 4.3^{a}	(147–157)	4	F	143 ± 4.2	(127–160)	6
							M	148 ± 5.0	(125–160)	6
Length of hind foot	162 ± 2.5^{bc}	(145–175)	10	177 ± 4.6^{b}	(172–183)	4	F	171 ± 2.6^{aC}	(160–178)	6
							M	185 ± 2.2^{abC}	(180–195)	6
Length of ear	73.4 ± 1.2^{a}	(65–80)	10	78.2 ± 1.2^{a}	(75–80)	4	F	75.7 ± 2.1	(68–83)	6
							M	80.5 ± 1.5^{a}	(75–85)	6
Height of shoulder	362 ± 8.0^{abc}	(330–405)	10	428 ± 5.8^{b}	(417–437)	4	F	428 ± 9.6^{adA}	(405–470)	6
							M	468 ± 11.7^{cdA}	(435–515)	6
Length of ear-tuft	26.9 ± 1.6^{ab}	(21–37.5)	10	30.3 ± 3.4^{c}	(26–37)	4	F	38.8 ± 2.6^{bdB}	(30–50)	6
							M	49.8 ± 2.7^{acdB}	(45–60)	5
Circumference of neck	200 ± 5.6	(178–220)	7	225 ± 4.7	(213–235)	4	F	228 ± 13.5	(195–250)	4
							M	264 ± 15.3	(210–300)	5

[A,a] $P < 0.05$.
[B,b] $P < 0.01$.
[C,c] $P < 0.001$.

TABLE 2.—*Age-specific mean ± SE cranial measurements (mm) of Iberian lynxes from Doñana National Park, Spain. Range of values in parentheses; group means with significant differences (Tukey's test) have been marked with the same superscript letter.*

Measurement	Age (years)					
	0.5–1.0	*n*	1.0–2.0	*n*	>2.0	*n*
Length of skull	109.8 ± 1.6[ab] (104.9–113.8)	5	124.5 ± 2.7[bc] (119.6–129.8)	4	132.4 ± 1.3[ac] (123.4–144.0)	21
Condylobasal length	100.5 ± 3.0[ab] (94.2–111.8)	5	114.9 ± 2.0[b] (109.0–118.2)	4	119.6 ± 1.5[a] (111.5–139.9)	21
Mastoid breadth	51.1 ± 0.6[ab] (49.6–52.4)	5	55.2 ± 1.0[bc] (51.9–57.8)	5	58.5 ± 0.5[a] (54.7–62.1)	21
Length of C1–P4	34.2 ± 0.5[ab] (31.9–35.4)	6	38.2 ± 0.5[b] (36.9–39.9)	5	38.3 ± 0.3[a] (35.9–42.0)	22
Length of P4	14.6 ± 0.3 (13.7–15.3)	6	15.3 ± 0.1 (14.9–15.6)	5	14.9 ± 0.1 (14.3–16.0)	21
Rostral breadth at P4	35.9 ± 0.4[ab] (34.4–36.9)	6	40.0 ± 0.4[b] (38.4–41.0)	5	41.7 ± 0.5[ac] (37.7–44.1)	21
Length of mandibular fossa–P4	44.5 ± 0.5[ab] (42.9–46.0)	6	50.8 ± 1.0[bc] (48.8–53.5)	5	54.1 ± 0.5[ac] (49.8–57.2)	22
Zygomatic breadth	77.4 ± 1.0[ab] (74.2–80.2)	5	88.7 ± 1.6[bc] (84.2–92.7)	5	95.8 ± 0.8[ac] (88.6–101.9)	19
Postorbital constriction	40.8 ± 0.4 (39.1–41.9)	6	40.2 ± 0.8 (38.1–42.5)	5	39.7 ± 0.4 (34.0–42.5)	22
Interorbital breadth	22.4 ± 0.4[ab] (21.3–23.7)	6	27.4 ± 1.2[b] (24.0–30.5)	5	29.8 ± 0.5 (26.0–34.6)	22
Breadth of postorbital processes	49.7 ± 0.4[ab] (48.8–51.7)	6	56.9 ± 1.6[bc] (52.6–60.5)	5	63.3 ± 0.7[ac] (56.6–68.8)	21
Rostral length	44.8 ± 1.0[ab] (42.1–49.2)	6	52.7 ± 0.9[b] (50.6–56.2)	5	55.2 ± 0.6[a] (50.5–60.4)	22
Palatal length	41.3 ± 0.9[ab] (37.8–43.6)	6	47.3 ± 0.9[b] (45.1–50.1)	5	49.4 ± 0.5[a] (46.2–53.9)	21
Rostral breadth at canines	28.4 ± 0.4[ab] (27.3–29.8)	6	32.2 ± 0.5[bc] (30.4–33.6)	5	34.4 ± 0.4[ac] (30.9–37.3)	22
Length of mandible	72.5 ± 0.9[ab] (69.6–75.5)	6	83.2 ± 1.3[bc] (80.3–86.4)	5	89.3 ± 0.9[ac] (82.0–96.9)	19
Height of mandible	28.5 ± 0.5[ab] (27.1–29.8)	6	34.0 ± 1.2[bc] (31.2–37.7)	5	38.4 ± 0.5[ac] (33.7–41.6)	19
Length of mandibular toothrow	42.4 ± 0.5[ab] (40.8–43.8)	6	47.1 ± 0.4[b] (46.2–48.3)	5	48.2 ± 0.5[a] (42.0–52.3)	21
Length of c1–m1	40.5 ± 0.5[ab] (39.1–42.6)	6	44.7 ± 0.5[b] (43.4–46.0)	5	45.8 ± 0.4[a] (43.0–50.1)	21
Length of m1	12.3 ± 0.2[a] (11.5–12.6)	6	12.9 ± 0.2 (12.2–13.4)	5	12.8 ± 0.1[a] (12.2–13.4)	20

[a] $P < 0.05$.
[b] $P < 0.01$.
[c] $P < 0.001$.

DISCUSSION

Body size in Iberian lynxes from Doñana National Park is remarkably similar to the Canadian lynx and the bobcat, species that share some common ecological characteristics (Aldama et al., 1991; Beltrán, 1987; McCord and Cardoza, 1982). Body size of Iberian lynxes has decreased since the Pleistocene and was triggered by competition with other species of felids, including northern lynxes (Werdelin, 1981). Iberian lynxes were adapted to feed upon smaller prey, such as lagomorphs, whereas northern lynxes remained principally predators of cervids

TABLE 3.—Sexual dimorphism in cranial measurements for adult (eight males, five females) Iberian lynxes from Doñana National Park, Spain.

| Measurement	Male		Female		ANOVA	
	Mean ± SE	Range	Mean ± SE	Range	F	P
Length of skull	132.8 ± 1.7	125.2–137.6	126.7 ± 1.7	123.4–133.0	5.64	0.03
Condylobasal length	120.3 ± 1.9	113.1–126.8	114.1 ± 1.6	111.5–120.3	5.55	0.04
Mastoid breadth	58.8 ± 0.9	54.7–61.8	56.2 ± 0.9	54.8–59.9	3.86	0.07
Length of C1–P4	38.4 ± 0.5	36.2–40.6	36.9 ± 0.6	36.1–39.2	3.22	0.10
Length of P4	14.93 ± 0.2	14.4–16.0	14.58 ± 0.2	14.3–15.3	1.65	0.22
Length of mandibular fossa–P4	41.6 ± 0.5	39.3–44.1	40.6 ± 1.0	37.7–42.9	1.07	0.32
Rostral breadth at P4	54.4 ± 0.6	51.9–56.3	51.6 ± 0.7	49.8–54.0	8.44	0.01
Zygomatic breadth	96.3 ± 1.1	91.6–99.2	92.1 ± 1.2	88.6–95.9	6.32	0.03
Postorbital constriction	39.4 ± 0.8	34.0–42.4	40.9 ± 0.5	39.7–42.5	1.79	0.20
Interorbital breadth	29.5 ± 0.7	27.0–33.1	28.8 ± 0.4	27.5–30.0	0.51	0.49
Breadth of postorbital processes	63.7 ± 1.3	56.6–67.8	61.4 ± 0.8	58.5–63.2	1.45	0.25
Rostral length	55.8 ± 0.8	52.6–58.7	52.7 ± 1.0	51.0–56.4	5.45	0.03
Palatal breadth	49.6 ± 0.7	47.3–52.0	47.8 ± 0.9	46.2–56.2	2.55	0.14
Rostral breadth at canines	34.5 ± 0.6	32.1–37.3	33.0 ± 0.6	30.9–35.0	2.46	0.14
Length of mandible	90.2 ± 1.2	85.5–94.0	84.8 ± 1.3	82.0–89.5	8.17	0.01
Height of mandible	38.9 ± 0.7	35.6–41.2	36.1 ± 0.7	33.7–38.2	6.73	0.02
Length of mandibular toothrow	47.9 ± 0.1	42.0–50.3	46.5 ± 0.6	45.6–48.8	1.07	0.32
Length of c1–m1	46.3 ± 0.5	44.5–48.1	44.4 ± 0.7	43.0–47.3	4.64	0.05
Length of m1	12.97 ± 0.1	12.7–13.4	12.52 ± 0.1	12.2–12.6	10.26	0.008
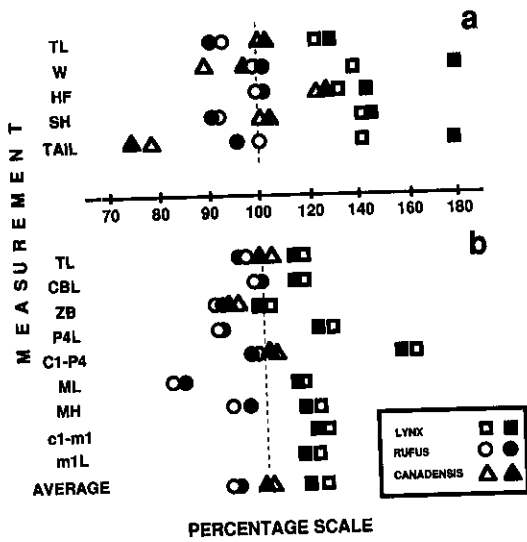
FIG. 1.—Comparison of selected (a) body measurements and (b) cranial measurements among living species of lynxes using the values for Iberian lynxes (*Lynx pardinus*) in this study as standard of reference (100%): males, open symbols; females, closed symbols. Body measurements: body weight (W); length of hind foot (HF); height of shoulder (SH); length of tail (TAIL); total length (TL). Skull measurements: total length (TL); condylobasal length (CBL); zygomatic breadth (ZB); length of P4 (P4); length of C1–P4 (C1–P4); length of mandible (ML); height of mandible (MH); length of c1–m1 (c1–m1); length of m1 (m1); average of size differences among the selected cranial variables. References for sources of values are given in the text.

(Breitenmoser and Haller, 1987; Werdelin, 1981). Aldama et al. (1991) found that sexual dimorphism in body size in Iberian lynxes has considerable energetic implications, with daily energy expenditure of females being 74% of males.

Our data do not support previous work by García-Perea et al. (1985) who assigned probable gender to specimens of adult Iberian lynxes from different populations by bivariate plots of selected skull measurements. We observed overlap between gender for such variables, even for individuals from the same population. Thus, previously published measurements for adult male and female Iberian lynxes based on such as-

sumptions may be misleading. However, when only specimens of known gender were considered, our data from Doñana National Park agreed with the range of cranial values of Iberian lynxes reported from other populations (Cabrera, 1914; García-Perea et al., 1985; Miller, 1912; Vasiliu and Decei, 1964).

In Iberian lynxes, sexual dimorphism in physical characteristics becomes significant after the 2nd year, a result of males growing for a longer period than females. This phenomenon is shared with other species of lynxes (Andersen and Wiig, 1984; Crowe, 1975; Saunders, 1964). In carnivores, most skull measurements increase at slower rates, even after age of sexual maturity is reached. Studies on skull dimensions usually account for this growth (Reig, 1992; Wiig and Andersen, 1986). In this study, we have not performed such corrections, in part because of our small sample. The five adult female Iberian lynxes in our sample averaged 6 years old, which would explain the overlap in some skull measurements with the younger ($\bar{X} = 3.4$ years old) sample of adult males.

In Norwegian lynxes, Wiig and Andersen (1986) observed sexual dimorphism in 15 skull variables, males averaging 5–10% (rostral breadth to height of mandible) larger than females. Among the variables that best discriminated between genders were length of mandible, height of mandible, condylobasal length, and length of m1 (Wiig and Andersen, 1986); postorbital constriction, however, was smaller in males than in females. Our data on Iberian lynxes suggest a similar pattern of variation between genders. Wiig and Andersen (1986) interpreted sexual dimorphism to be functionally related to feeding apparatus. Sexual differences in feeding habits have been reported in bobcats, with males preying on larger species (i.e., cervids) than females (Litvaitis et al., 1984). In Doñana National Park, young cervids are included in the autumn-winter feeding habits of Iberian lynxes (Beltrán et al., 1985; Delibes, 1980).

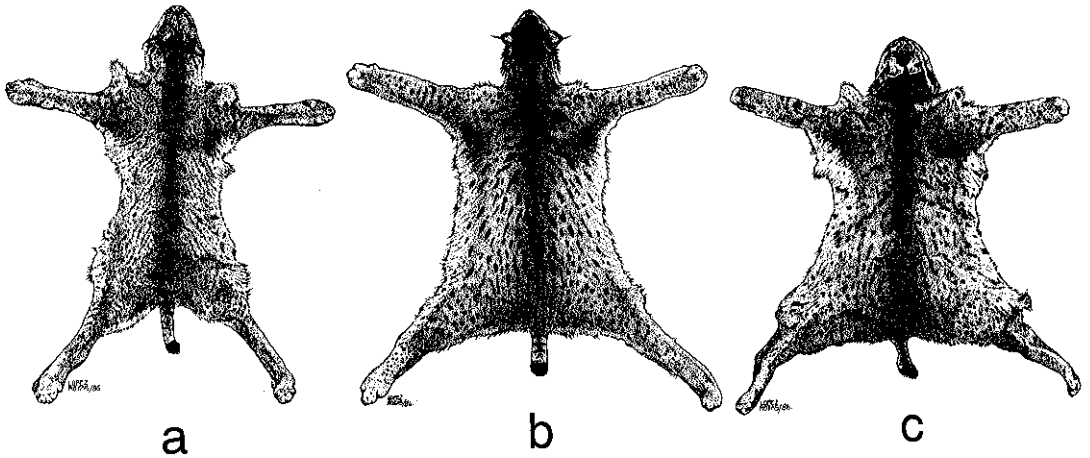Fur of Iberian lynxes often is noted by its

FIG. 2.—Variation in the pelage pattern of Iberian lynxes that were present until 1960 in the population centered in Doñana National Park, southwestern Spain: (a) pelage type A (MCDBS collection number 1382, from Jerez, Cádiz, southwestern Spain); (b) pelage type B (MCDBS 1384, from Doñana National Park); (c) pelage type C (MCDBS 1390, from Córdoba, southern Spain).

heavily spotted pattern (McCord and Cardoza, 1982; Novak, 1991). The pelage patterns in Iberian lynxes observed from Doñana National Park before 1960 were similar to those pictured by Vasiliu and Decei (1964) for specimens collected in the 1950s from Sierra Morena Mountains (ca. 100–150 km north of Doñana National Park). In fact, among the four pelts showed there (Vasiliu and Decei, 1964), there is one that resembles our type B, which we observed only in the sample from Doñana National Park. In early 1900, expeditions to southwestern Spain (including Coto Doñana) already documented the presence of two kinds of pelage patterns of Iberian lynxes: the so-called "mota pequeña" (i.e., small spotted) fur, and another recognized by its big spots (Chapman and Buck, 1910). Miller (1907) stated, "The material in the British Museum shows that two colour patterns occur among Spanish lynxes, in one of which, apparently the more usual, the spots on the back and sides are small, mostly about 10 mm in diameter, the rows indistinct; . . . while in the other the spots are larger and more distinct, many of them 20 mm in diameter, the rows containing only about a dozen spots between the shoulder and base of tail." Cabrera (1914) also reported the existence of pelts of Iberian lynxes with the spots on the flanks arranged in rossetes. Since that time, numbers of Iberian lynxes have decreased sharply (Delibes, 1979).

Populations of Iberian lynxes also were jeopardized by the rabbit epizootic of myxomatosis affecting Europe during the 1950s, which reached Doñana National Park during the autumn of 1957 (Delibes, 1980). An estimate of the geographic distribution of Iberian lynxes in 1960 (Rodriguez and Delibes, 1990) showed that although migration among habitats supporting populations of *L. pardinus* existed throughout most of its range, the population of Iberian lynxes at Doñana National Park had become isolated. A recent survey estimated 45 individuals present in the Coto Doñana area (Palomares et al., 1991); however, the effective population number (Ne—Chepko-Sade et al., 1987) may be considerably smaller, as radiotracking data suggest that few individuals are successfully reproducing. Small populations may be heavily affected by genetic drift (Falconer, 1981). In these populations, alleles with low frequency are likely to disappear first from the population gene pool. Our data, although preliminary, sug-

gest that this may be happening in Doñana National Park during the past 3 decades. Future studies on population genetics are needed to support our results based on analyses of pelage pattern; new genetic method such as the polymerase-chain-reaction (PCR) technique may add new insights into this matter, since it is possible to determine past genetic variability of former populations from museum specimens (Hillis and Moritz, 1990; Thomas et al., 1990).

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Appendix I

Specimens of Iberian lynx examined in this study deposited in the Mammal Collection of Doñana Biological Station (MCDBS, Sevilla, Spain) and the British Museum of Natural History (BMNH, London, United Kingdom).

Skulls and Pelts Deposited at MCDBS

Listed by collection number, additional data include: sex (M = male, F = female, U = unknown), locality if different than Doñana National Park, collection date, S = skull when used in this study, and type assigned to pelt.

From Doñana National Park and surroundings. — 1372 (M, 1973, type B); 1375 (U, 1970, S, type C); 1379 (U, 1965, type C); 1381 (U, 1968, type C); 1383 (U, 1959, type C); 1384 (M, 1971, S, type B); 1386 (U, 1959, type A); 1389 (U, 1974, type C); 1392 (M, 1959, S); 1395 (M, 1957, S); 1396 (U, 1959, S); 1397 (U, 1973, S); 1398 (U, 1965, S); 1400 (F, 1956, S); 1401 (F, 1959, S); 1402 (U, 1954, S); 1404 (U, 1961, S); 1405 (M, 1962, S); 1779 (U, 1974, type B); 3995 (U, 1982, S); 4373 (F, 1983, S, type B); 4374 (F, 1982, S, type B); 5955 (M, 1984, S, type B); 5956 (M, 1984, S, type B); 6973 (M, 1984, S, type B); 6974 (M, 1984, S, type B); 6976 (F, 1985, S); 7099 (F, 1984, S, type B); 7105 (M, 1984, S, type B); 7106 (M, 1984, S, type B); 7428 (F, 1985, S, type B); 8740 (U, 1981, S); 17165 (U, 1988, S); 17938 (F, 1988, S); 17993 (M, 1988, S, type B); 18063 (U, 1986, S); 18064 (M, 1987, S); 18129 (U, 1988, S); 18216 (F, 1983, S, type B); 18293 (F, 1988, S, type B).

Pelts from other areas. — 846 (U, 1968, Piedralaves, Avila, type A); 1373 (U, year unknown, La Contienda, Huelva, type A); 1374 (F, Jerez, Cádiz, 1966, type C); 1376 (U, Villasrrubias, Salamanca, 1977, type C); 1378 (U, 1975, Mora de Toledo, type C); 1382 (U, Jerez, Cádiz, 1957, type A); 1385 (F, Andújar, Jaén, 1954, type A); 1387 (U, Andújar, Jaén, 1963, type A); 1388 (U, 1963, Torrecampo, Córdoba, type A); 1390 (U, 1961, Córdoba, type C); 1731 (U, 1974, Béjar, Salamanca, type A); 1732 (U, 1962, Despeñaperros, Jaén, type C).

Pelts Deposited at BMNH

Not catalogued. Collected early in the 20th century although most have no collection date; collector's name is included to facilitate identification: male (1906, Coto Doñana, F. Buck, type A); 2 males (unknown, likely early in the 20th century, Coto Doñana, A. Chapman, type B); 2 unknown sex (unknown, Coto Doñana, A. Chapman, type B); male (1895, Villamanrique, Sevilla, A. Rios, type B); male (unknown, Sierra Morena, Lord Lilford, type A); female (unknown, Old Castilla, Lord Lilford, type C); 2 kittens of unknown sex (unknown date, Sevilla, Lord Lilford, type A); 1 unknown sex (unknown date, Sierra Morena, Captain S. E. Widdrington, type A).