

Weight and external measurements of Red foxes (*Vulpes vulpes*) from SW Spain

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Red foxes (*Vulpes vulpes*) show a high variability in body size, in parallel to their widespread distribution, which was used as an example or as a deviation (DAVIS 1977; KOLB 1978) of ecogeographical rules (MAYR 1963). Nevertheless, this tendency was evaluated in relatively small areas, compared to the whole geographical distribution of the species. In spite of being one of the most well-studied carnivore species in most aspects of their ecology and behaviour, no reliable information is available on red fox body size for most of its complete range. In the present report, we present the weight and external body measurements of one of the southern-most populations of *Vulpes vulpes*. Our results provide basic information upon which geographic variation on a continental scale could be investigated.

Foxes were captured in the Doñana area in Southwestern Spain (37°00' N, 06°30' W) during the course of fox control programs from 1988 to 1992. The climate is Mediterranean with Atlantic influence, with mild and wet winters and hot and dry summers. Body weight and five external measurements were taken: (1) Maximum body length (maximum length from the tip of the snout to the dorsal edge of the perineum was recorded); (2) Tail length (from the dorsal edge of the perineum to the tip of the tail, excluding fur); (3) Hindfoot length (from the edge of the calcaneum to the tip of the third phalange, with the phalanges extended); (4) Ear length (from the base of the tragus to the tip of the pinna); and (5) Shoulder height (from the top of the withers to the tip of foreleg).

The age of foxes was determined by counts of cementum annuli in premolars and by cursory examination of complete dentition, which was sufficient for young foxes. Only foxes older than about seven months were included in the study. For each sex, juveniles (from seven to twelve months) and adults (older than one year) were considered separately. Weights of pregnant or lacting females were not considered. We were not able to perform all measurements in all individuals. Sexual dimorphism was evaluated through the ratio male measurement/female measurement. For weight we used the cube roots of original values. For all comparisons we used the Student t-test (ZAR 1984). Significant differences were considered when $p < 0.05$.

A total of 161 red foxes was measured. Adult males were significantly larger and heavier than vixens in all the measurements (Tab. 1). The juvenile class showed a similar pattern, but significant differences were observed only in hindfoot length and shoulder height (Tab. 1). Adult males were significantly heavier ($t = 4.19$, $p < 0.01$) and larger than juvenile males for head and body length ($t = 4.81$, $p < 0.01$) and hindfoot length ($t = 2.85$, $p < 0.01$). There were no significant differences between adult and juvenile females for all body measurements or weight.

Table 1. External body measurements and weights for juvenile and adult red foxes from Doñana National Park. Mean value (X), standard deviation (SD), sample size (n), and the significance level (p) of mean differences between male and female measurements for both age categories.

Measurements	Males			Females			
	Juveniles (7–12 month old)						
	X	SD	n	X	SD	n	p
Weight (g)	5 051	1 199	18	4 706	642	22	–
Head and body (mm)	659	45	18	648	29	23	–
Tail (mm)	382	36	18	377	25	22	–
Shoulder height (mm)	385	36	18	366	14	20	*
Hindfoot (mm)	151	9	18	145	8	23	**
Ear (mm)	97	5	18	96	5	22	–
Adults (> 1 year old)							
Weight (g)	6 330	968	64	5 124	854	60	**
Head and body (mm)	708	36	65	659	29	57	**
Tail (mm)	392	32	65	375	28	59	**
Shoulder height (mm)	401	22	59	370	16	60	**
Hindfoot (mm)	157	7	65	145	6	61	**
Ear (mm)	100	7	58	94	6	54	**

Significance levels: —: $p > 0.05$, *: $p < 0.05$, **: $p < 0.01$

Sexual dimorphism was significant only in adults for all measurements ($p < 0.01$ in all comparisons), with an average sexual dimorphism of 1.08, quite similar to that obtained from the data provided by KOLB and HEWSON (1974) for Scottish (1.05) and English (1.07) red foxes, and by LUND (1959) for Norwegian specimens (1.05). Following RALLS' (1976) criterium, this sexual dimorphism would be small and typical for mammalian species exhibiting long-term pair bonding, like the red fox (KLEIMAN 1977). The absence of sexual dimorphism in the juvenile class, together with the absence of size differences between juvenile and adult females, suggest that females reach their adult body size in their first year of life, while males continue to grow, a fact that is typical in mammals where males are larger than females (RALLS 1976).

Red foxes from Doñana are larger than predicted by Bergmann's rule (MAYR 1963), based only on a geographical basis. Male and female red foxes are lighter than Swiss equivalents (LÜPS and WANDELER 1983; WANDELER and LÜPS 1993) (7 080 and 5 930 g for Swiss males and females, respectively). The same is true for Scottish foxes (KOLB and HEWSON 1974) (7 300 and 6 200 g for males and females, respectively). Nevertheless, Doñana foxes are larger in body measurements but rather similar in weight compared with their conspecifics from England (KOLB and HEWSON 1974) (head and body length: 671 and 627 mm, weight: 6 700 and 5 400 g, for males and females respectively). These results provide additional evidence on size variability in the red fox, not fully explainable by single causes (KOLB 1978).

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Artikel/Article: [Weight and external measurements of Red foxes \(*Vulpes vulpes*\) from SW Spain 121-123](#)