BIRTH MEASUREMENTS, PARTURITION DATES, AND PROGENY SEX
RATIO OF *DAMA DAMA* IN DOÑANA, SPAIN

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The theory of parental investment contains the prediction that parents will invest more in offspring of the sex that has a greater variance in reproductive success, and that individuals receiving a greater-than-average investment are more fit (Clutton-Brock et al., 1981; Maynard-Smith, 1980; Trivers, 1972, 1985; Trivers and Willard, 1973). In polygynous mammals, the male generally is the sex that has the largest variance in reproductive success (Clutton-Brock and Albon, 1979; Le Boeuf and Briggs, 1977). Moreover, reproductive success of males probably is related to early growth and parental investment. Thus, a larger investment by the parents in sons than in daughters would be expected. Indeed, male offspring of some mammals are heavier at birth than females (Clutton-Brock et al., 1982; Dittus, 1979; Reiter et al., 1978), have longer gestation lengths (Clutton-Brock et al., 1982), tend to be born earlier in the season (Clutton-Brock et al., 1982; Conlson and Hickling, 1961; Stirling, 1971), and grow faster (Robbins and Moen, 1975; Short, 1970). Our aim was to test for differences in parental investment between sexes at birth in fallow deer (*Dama dama*).

The study was conducted at the Biological Reserve of Doñana, Doñana National Park in SW Spain, from May 1982 to July 1985; this period encompassed four fawning seasons. On the 7,500-ha Reserve, fallow deer inhabit an ecotone situated between maquis (Mediterranean shrubland) and marsh that dries during summer

TABLE 1.—Average birth date for male and female fallow deer in Doñana, Spain. Mann-Whitney U test was used to compare birth dates between sexes.

Year	Males				Females				Difference between sexes
	n	$\bar{X}$	SD	CV	n	$\bar{X}$	SD	CV	
1982	7	5 June	2.2	19.6	5	5 June	4.1	36.4	n.s.
1983	10	30 May	1.9	36.6	8	3 June	4.3	47.7	*
1984	5	31 May	1.5	23.6	9	2 June	4.7	60.3	n.s.
1985	7	3 June	1.8	20.2	6	3 June	2.9	31.5	n.s.
Totals	29	2 June	2.9	38.0	28	3 June	4.1	45.2	

No significant difference = n.s.

* $P < 0.05$

(Braza, 1975). This ecotone consists mainly of different kinds of meadows and areas of rushes (*Juncus*). These areas are used mostly by females that seek the cover of the *Juncus* for parturition. Average annual rainfall in the area is about 500 mm; the rainfall was 317 mm in 1981, 561 mm in 1982, 556 mm in 1983, 461 mm in 1984, and 612 mm in 1985.

The population of female fallow deer (adult and young) on the study area was 95 individuals in 1982, 115 in 1983, 118 in 1984, and 127 in 1985. The small population in 1982 was related to high mortality resulting from the previous drought.

During the fawning season in the first 2 weeks of June, the marked females (approximately 10% of the population) were observed from dawn to dusk to determine the date of birth and to find their recently born fawns. The unmarked females were counted daily and the age of their offspring, when the actual parturition had not been seen, was estimated by backdating according to the criteria of hoof hardening, degree of umbilical healing, and behavior based on offspring whose birth dates were known ($n = 19$); these criteria seemed to provide a reliable estimate of age for fawns ≤ 3 days old. Haugen and Speak (1958) used similar techniques for white-tailed deer (*Odocoileus virginianus*). We estimated that about 50% of the offspring born in the study area were captured.

Fawns were ear-tagged, weighed, and their sex determined, and body length, length of hind foot, shoulder height, tail length, half of chest girth, and ear length were measured.

Analysis was restricted to 57 fawns known ($n = 19$) or estimated ($n = 38$) to be ≤ 3 days old. The average ($\pm$ SD) age of fawns at first capture was 1.58 ± 0.66 days in 1982; 1.55 ± 0.70 days in 1983; 1.71 ± 0.82 days in 1984; and 1.30 ± 0.48 days in 1985. Chi-square tests, Mann-Whitney U tests, and two-way analysis of variance (Siegel, 1956; Sokal and Rohlf, 1979) were used to test for differences between sexes and among years, using a Vax-11 computer and BMDP statistical software (Dixon, 1983).

Though some mammals depart from a sex ratio of parity at birth (Clutton-Brock et al., 1985; Coulson and Hickling, 1961; Mech, 1975), the sex ratio of neonatal fallow deer ($n = 57$) was not different from unity (females/males = 0.97). Sex ratio varied annually from 0.71 in 1982 ($n = 12$) to 1.80 in 1984 ($n = 14$), but did not differ significantly from unity in any year.

Despite the nearly equal sex ratio obtained, differences were found in relation to the birth dates of fawns. We noted a tendency for males to be born earlier than females, with a significant difference in 1983 (Table 1). Similar differences in birth timing between male and female progeny have been found for seals (*Halichoerus grypus* and *Leptonychotes weddelli*; Coulson and Hickling, 1961; Stirling, 1971) and for red deer (*Cervus elaphus*; Clutton-Brock et al., 1982). As indicated by the lower variance in birth dates (Table 1), males were born within a shorter period than females. Birthing season lasted 8, 6, 5, and 6 days for males and 12, 14, 17, and 9 days for females in 1982, 1983, 1984 and 1985, respectively.

Clutton-Brock et al. (1982) found that although males tend to be born before female offspring in red deer, the gestation period is longer for males, indicating they are conceived earlier in the season. We have no data on dates of conception or the duration of the gestation period for fallow deer.

Male offspring were significantly heavier than females (Table 2). Differences in birth weight between the sexes have been observed in red deer (Clutton-Brock et al., 1981, 1982; Guinness et al., 1978). Furthermore, our results indicated that males were significantly larger than females at birth for five of six linear measurements (Table 2). These differences in the size of male and female offspring suggested that maternal investment before birth is larger in individual sons than in individual daughters.

A significant increase in the weight of offspring and in hindfoot length was detected during the 4-year study (Table 2). This increase was greatest between 1983 and 1984. The drought on the Doñana Reserve in 1980 and 1981 had an important effect on the size of the population and on the physical condition of

TABLE 2.—Sexual and annual differences in mean ($\pm$ SD) body measurements (mm) and body weight (kg) at birth of fallow deer fauns in Doñana. Two-way analysis of variance was used to compare the effects of sex and year. Sample sizes are given in Table 1.

Character and sex	Years				Difference between	
	1982	1985	1984	1985	Totals	Sexes Years
Body length						
Male	661.3 $\pm$ 27.4	688.1 $\pm$ 24.5	680.2 $\pm$ 50.3	701.0 $\pm$ 40.7	675.0 $\pm$ 34.4	
Female	655.0 $\pm$ 25.5	657.9 $\pm$ 25.7	683.2 $\pm$ 18.6	651.3 $\pm$ 17.8	664.1 $\pm$ 24.8	* n.s.
Hind-foot length						
Male	227.6 $\pm$ 6.2	229.1 $\pm$ 5.8	238.2 $\pm$ 15.3	225.0 $\pm$ 7.6	229.3 $\pm$ 9.2	
Female	220.4 $\pm$ 7.4	216.2 $\pm$ 7.4	221.1 $\pm$ 7.6	214.0 $\pm$ 9.3	218.0 $\pm$ 8.0	**** *
Shoulder height						
Male	481.2 $\pm$ 10.6	494.3 $\pm$ 11.7	489.2 $\pm$ 27.4	492.8 $\pm$ 26.7	490.2 $\pm$ 19.0	
Female	478.4 $\pm$ 18.9	475.4 $\pm$ 18.0	469.4 $\pm$ 39.0	468.5 $\pm$ 14.9	472.5 $\pm$ 25.4	** n.s.
Tail length						
Male	101.7 $\pm$ 4.4	100.9 $\pm$ 9.4	105.2 $\pm$ 4.7	99.0 $\pm$ 4.9	101.3 $\pm$ 6.8	
Female	96.4 $\pm$ 11.5	86.5 $\pm$ 7.4	96.4 $\pm$ 5.2	93.5 $\pm$ 9.2	93.0 $\pm$ 8.7	**** n.s.
Half chest girth						
Male	169.2 $\pm$ 12.4	182.1 $\pm$ 6.8	189.4 $\pm$ 20.4	195.8 $\pm$ 19.6	183.6 $\pm$ 16.5	
Female	164.0 $\pm$ 9.9	173.1 $\pm$ 8.4	162.5 $\pm$ 35.8	180.0 $\pm$ 12.6	169.6 $\pm$ 22.2	** n.s.
Ear length						
Male	85.0 $\pm$ 4.0		87.0 $\pm$ 2.7	82.1 $\pm$ 6.9	84.4 $\pm$ 5.3	
Female	84.8 $\pm$ 3.0		83.8 $\pm$ 3.0	82.7 $\pm$ 2.9	83.7 $\pm$ 2.9	n.s. n.s.
Weight						
Male	4.6 $\pm$ 0.4	5.1 $\pm$ 0.4	6.1 $\pm$ 0.6	5.3 $\pm$ 0.7	5.7 $\pm$ 0.7	
Female	4.4 $\pm$ 0.4	4.6 $\pm$ 0.7	5.6 $\pm$ 0.9	4.6 $\pm$ 0.5	4.9 $\pm$ 0.8	** ****

No significant difference = n.s.

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$

individuals. Clutton-Brock et al. (1982) found a positive correlation between weather conditions and the weight of offspring at birth for red deer; a similar correlation seems to exist for the fallow deer in Doñana. Though the average rainfall in Doñana in 1982 was higher than 1980–1981, its distribution was irregular. For this reason, complete physical recovery of individuals was not possible after the 2 years of drought, all of which was reflected in an atypical rutting season in autumn of 1982 (Braza et al., 1986). An increase in the size of offspring did not result until the spring of 1984. Although weight and size of fawns varied across years, males were significantly heavier and larger than females in all years.

In conclusion, although the sex ratio did not differ significantly from parity, our results on biometry and birth dates appear to support the hypothesis of higher parental investment in male offspring during gestation.

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