

SHORT REPORT



Male-biased investment during chick rearing in the Griffon Vulture *Gyps fulvus*

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ABSTRACT

Capsule: In Griffon Vultures *Gyps fulvus* both parents take part in all parenting tasks but males take a significantly larger part of the burden.

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There are many examples of sexual dimorphism in birds, either in body size or in colouration, which correlates with sexual variability in parental roles (Owens & Hartley 1998). Such division-of-labour can include performance of distinct activities or of shared activities in different proportions by males and females.

Studying nine species of birds of prey, Sonerud *et al.* (2014) concluded that diet determines asymmetry of parental roles in raptors. The common reversed size dimorphism (RSD), where females are larger than males, correlates with the necessity of the female's assistance in feeding the nestlings, and is greater if mammalian prey is larger or if prey consists of birds. While no scavengers were included in their study, the authors predict little asymmetry in parental roles in socially monogamous birds providing food which the offspring can handle unassisted, such as prey that is partly digested by parents and regurgitated.

The Griffon Vulture *Gyps fulvus* is a large vulture that feeds exclusively on carrion. They are gregarious and sociable; they forage in flocks and roost and nest in colonies on steep cliffs in mountainous regions (Cramp & Simmons 1980, Mundy *et al.* 1992). The species' distribution spans from northern Africa and southwestern Europe in the west to India and Tibet in the east. Griffon Vultures are monogamous, and a breeding pair raises a single nestling per year. Incubation period is approximately 55 days, and both sexes incubate, feed, brood and shade the nestling (Newton 1979, Mundy *et al.* 1992, Xirouchakis & Mylonas 2007). Feeding of the nestling is done by both parents, which swallow the food at the carrion source

and regurgitate it at the nest. The young leave the nest at the age of 120–140 days, and continue to receive food from their parents for several weeks after fledging, in or near the nest.

Griffon Vultures are sexually monomorphic in the sense that they lack plumage characteristics or external features from which sexes can be identified. Males, however, are slightly smaller than females for most body characters (Cramp & Simmons 1980). Measurements taken by Xirouchakis & Poulakakis (2008) on adult Griffon Vultures in Crete reveal almost identical mean body mass and wing measurements for the two sexes, slightly greater (by 3.9%) wing loading in females, while head length and width, bill length and bill-cere length were significantly larger for the male. Accordingly, it was interesting to learn how these similarities and differences are reflected in the division of labour between the parents.

The study area at Ein Avdat (31°38'N 34°51'E, 500 m above sea level) is a national park in the canyon of the Tsin Wadi in the Negev Desert of Israel. The park covers an area of 480 ha and contains a deep gorge (100 m deep, 200 m width) with several springs and a perennial stream. The climate is semi-desert: maximum average temperature 33.4°C (in July); minimum average temperature 4.5°C (in January); average annual precipitation 93 mm. A small colony of Griffon Vultures (approximately 10 nesting pairs) intermittently nested in the canyon during the period of our study.

Here, we present data on nine breeding events of Griffon Vultures in Ein Avdat which successfully

ended in the fledging of a nestling, and for which we could successfully identify the sex of each parent. These data, which were collected during the nesting seasons of 2000, 2001 and 2002 (three nests in each year), pertain to the parental investment of each parent throughout the chick rearing phase, from the day of hatching until fledging. Altogether we collected data on seven different pairs: two pairs were observed in two consecutive years. Observations were taken approximately once a week during chick rearing, from late February to late July, at distances of 150–200 m from the nests, using a 20–40× telescope and 9×25 binoculars. The observation time per nest was 117 ± 14 h (mean \pm sd). Data were collected on provisioning of the nestling by the parents and attendance at the nest. The latter behaviours include standing or sitting at the nest, thermoregulatory behaviour (brooding or shading the chick), preening the chick, guarding the nest (mainly against other Griffons, Bonelli's Eagles *Hieraaetus fasciatus*, Egyptian Vultures *Neophron percnopterus* or Brown-necked Ravens *Corvus ruficollis*) and various reactions to external intrusions (e.g. aircrafts, tourists or stormy weather).

In Griffon Vultures, sex identification in the field is not possible. The vultures in our study were unmarked and initially unsexed. We identified the sex of parents in each of the nine breeding events by first distinguishing between the two parents using minor plumage differences, such as dark spots and markings on greater and median coverts. These patterns are unique for each individual and can easily be observed in the field when the birds perch with their wings folded, and in adults remain almost the same from year to year – probably due to the very minor changes of adult Griffon's plumage patterns and colours after successive moults (Zuberogoitia *et al.* 2013). A similar approach was demonstrated for White-headed Vultures *Trigonoceps occipitalis*, where variation in the median wing covert pattern was sufficient for birds to be individually identifiable in the field (Murn 2012). Like in some other vultures (White-backed Vulture *Gyps africanus*, Robertson 1986; Cape Vulture *Gyps coprotheres*, Mundy *et al.* 1992; Bearded Vulture *Gypaetus barbatus*, Bertran & Margalida 1999), within-pair copulations in Griffon Vultures are not restricted to the period before egg laying, but also occur during the weeks before fledging. We used the position during such copulations as indicators of the sex of each parent (Xirouchakis & Mylonas 2007, Gil *et al.* 2017).

For each nesting event, we calculated the frequency of parental provisioning bouts (times per hour) of each sex, and the percentage of time each sex stayed in the nest. We then calculated the asymmetry between the male's

and the female's contributions with regard to each activity, by the commonly used scaled difference between the male's (M) and the female's (F) contributions: $(M - F)/[\frac{1}{2}(M + F)]$. For each activity, the mean (over all seven pairs) of the asymmetry measure was calculated as the weighted average of the asymmetry of each pair (giving each of the two pairs that were observed twice, in two consecutive years, a two-fold weight than the other pairs). The standard error of the mean was calculated accordingly, and a t -test was performed to evaluate the deviation from zero. P values are given for two-tailed alternatives.

The nestling provisioning rates, the proportions of time attending the nest and the asymmetry measures for these two activities are given in Table 1. The mean feeding rates (provisioning bouts/h, mean \pm se) were 0.100 ± 0.005 and 0.072 ± 0.010 for the males and the females, respectively. The mean proportions of time staying at the nest were 0.484 ± 0.039 and 0.334 ± 0.025 for the males and the females, respectively. The asymmetry in the feeding rate was 0.336 ± 0.135 (mean \pm se), and was significantly different from zero ($t_6 = 2.488$, $P = 0.047$). The asymmetry in the proportion of time spent at the nest was 0.367 ± 0.070 and was also significantly different from zero ($t_6 = 5.284$, $P = 0.002$). Hence, with respect to both parental activities, feeding and staying in the nest, the mean contribution of males was significantly greater than that of females.

Figure 1 clearly demonstrates the asymmetry between the male and female contributions to parental care. In this 'toothpicks' diagram, each line segment corresponds to a particular breeding event – its two endpoints represent the contribution of each parent in the Staying \times Feeding plane. Under the division-of-labour hypothesis, we expect the majority of lines to have a negative slope – but here we see the contrary. For seven of nine breeding events, the lines have a positive slope, that is, one of the parents contributed more in both provisioning and attending at the nest. Moreover, in these cases, it was the male parent which contributed more.

Studying the post-hatching period, our new finding is that even though both sexes in the Griffon Vulture participate in parental care activities, they do not share them equally. Moreover, while in all nine breeding events, the male took the greater share in within-nest activities, it was also the male that in most cases (seven out of nine breeding events) took the greater share in provisioning the nestling. We have no simple explanation for this asymmetry. In many raptor species, RSD can explain the fact that males do most of the hunting (Slagsvold & Sonerud 2007). Nevertheless, for the Griffon Vulture, which is an obligatory

Table 1. The mean nestling provisioning rate (feed bouts/hour; Prov.) and the proportion of time attending (Attend.) at the nest for the two sexes in each breeding event, with the asymmetry measure between the male and the female (shaded). Note that Pair 1 was observed both in 2000 and in 2001, and Pair 5 was observed both in 2001 and in 2002.

Pair		2000			2001			2002		
		Male	Female	Asymmetry	Male	Female	Asymmetry	Male	Female	Asymmetry
1	Prov.	0.119	0.092	0.256	0.069	0.084	-0.196			
	Attend.	0.498	0.294	0.515	0.425	0.283	0.401			
2	Prov.	0.116	0.065	0.564						
	Attend.	0.453	0.295	0.422						
3	Prov.	0.098	0.129	-0.273						
	Attend.	0.560	0.427	0.270						
4	Prov.				0.116	0.042	0.937			
	Attend.				0.441	0.333	0.279			
5	Prov.				0.072	0.056	0.250	0.109	0.058	0.611
	Attend.				0.295	0.216	0.309	0.440	0.390	0.120
6	Prov.							0.085	0.063	0.297
	Attend.							0.589	0.474	0.216
7	Prov.							0.116	0.063	0.592
	Attend.							0.657	0.290	0.775

scavenger on carcasses of large mammals, such an explanation is irrelevant. One suggestion is that the asymmetry in parental care in the Griffon Vulture is a handicap (Zahavi 1975) carried by the males to honestly impress their mates, thus tightening the pair's bond – similar to the suggested function of frequent copulations as a signalling system by which males

advertise and females assess the male's physical condition (Tortosa & Redondo 1992). It is interesting to compare our results with Bassi *et al.*'s (2017) on the Bearded Vulture population in the Alps of northern Italy. Unlike the Pyrenean population of this species, where both parents equally share nesting duties (Margalida & Bertran 2000), in the Alps it is the

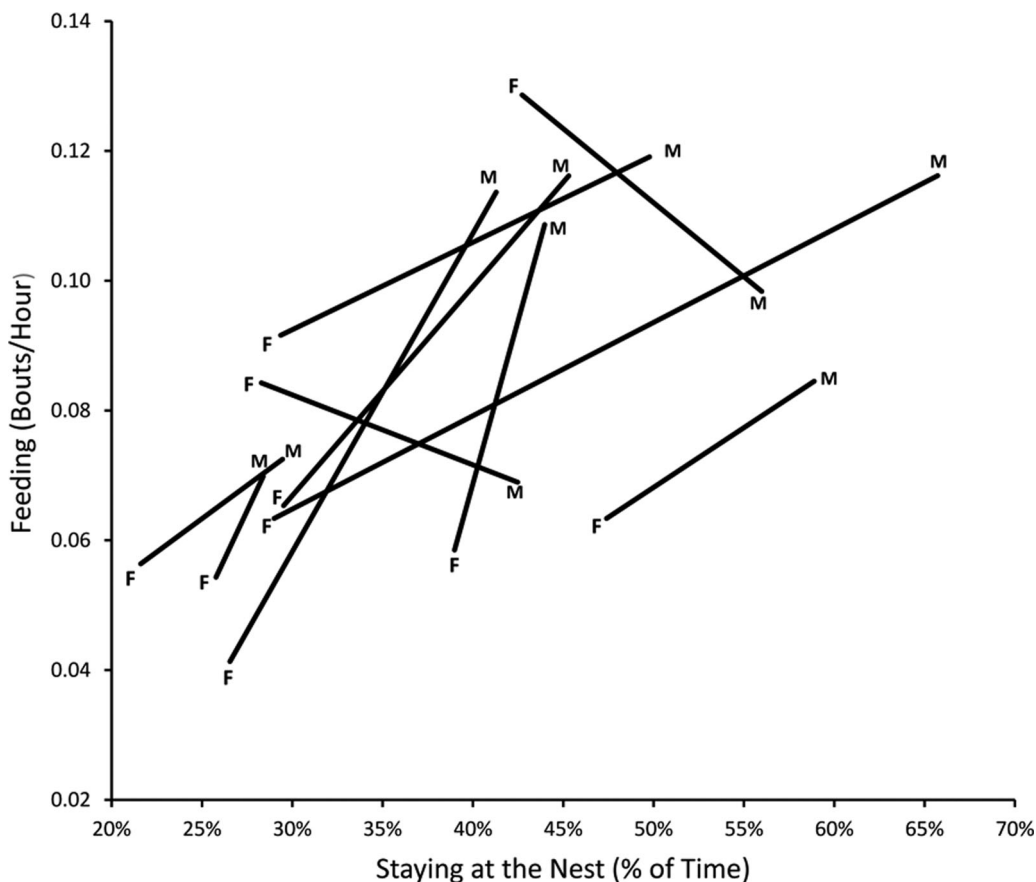


Figure 1. A 'toothpicks' diagram presenting the parental contribution of each parent. Each line segment corresponds to a particular breeding event – its two end points represent the contribution of each parent in the Staying × Feeding plane..

female that carries more of the parental burden. Bassi *et al.* suggest that the large amount of natural prey and carrion in the area may contribute to this observed asymmetry. Our study area, however, is located just 8 km away from an active vulture feeding station.

A possible explanation to the male-biased investment found in this study could be related to the lower wing load of males and their slightly bigger head (Xirouchakis & Poulakakis 2008). These can slightly increase the males' flying performance, as well as improve their capabilities to defend the nest and its content from predators. Nevertheless, we believe that there is a need for further research on this matter.

The vultures in our study were neither marked nor tagged. We chose a non-invasive and non-intrusive approach in order to minimize the disturbance to the shrinking population of Griffon Vultures in Israel. Human interference in nesting colonies of Griffon Vultures, especially if the number of suitable nest-sites is a limiting factor, can lead to abandonment of this site in consecutive seasons (Freund *et al.* 2017).

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