Electronic Supplementary Material Files

for

Jealous females? Female competition and reproductive suppression in a wild promiscuous primate

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<u>This file includes:</u>

1   **Table S1:** Demography of J and L groups in the four study periods.

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Year	Number of adult males		Number of adult females		Number of juveniles*	
	J group	L group	J group	L group	J group	L group
2005	6-9	3	17	9	26	5-9
2006	4-5	4-5	17	9-11	36	18
2013	7-10	9-11	17	18-19	29-32	31-33
2014	7-8	9	18	17-19	35	29

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4   Demography varies due to emigrations, immigrations, births, deaths, and maturations.

5   *Subadult males (i.e. between 4 and 8 years old) are counted as juveniles in this study.

Table S2. Sample size of behavioural observations. One-hour focal observations were conducted on all adult females and spread equally across the day (divided into four 3h-time blocks) for each individual. We included only focal observations that lasted at least 45 minutes (mean focal length±standard deviation [sd]: 59.7±3.5 min). The choice of a focal individual was semi-randomised, in order to balance observations equally across individuals, time blocks and reproductive states. The same individual was not sampled more than once per half day to ensure independence between focal observations. In total, our sample comprises 2971 focal observations on 53 females across the following reproductive states.

Reproductive state of focal female	Sample size of focal observations
Lactating	884 observations, 45 females, mean±sd per individual: 19.6±10.5, range: 1–45
Pregnant	714 observations, 47 females, mean±sd per individual: 15.2±9.7, range: 1–46
Oestrous (unguarded)	882 observations, 39 females, mean±sd per individual: 22.6±21.5, range: 1-81
Oestrous (mate-guarded)	491 observations, 32 females, mean±sd per individual: 15.3±14.5, range: 1-53

Table S3. Number of pregnant and lactating females, oestrous females and of female friends per adult male, in J and L groups in the four study periods.

Year	Mean±SD daily number of pregnant and lactating females (range)		Mean±SD daily number of oestrous females (range)		Mean±SD daily number of female friends per male (range)*	
	J group	L group	J group	L group	J group	L group
2005	12.1±2.1 (2-14)	7.3±0.9 (2-8)	1.1±1.2 (0-4)	0.4±0.6 (0-2)	0.9±1.3 (0-5)	3.1±1.7 (0-5)
2006	12.3±3.5 (1-15)	5.8±2.1 (1-8)	1.1±1.4 (0-6)	1.6±1.5 (0-5)	2.5±2.8 (0-9)	1.0±1.0 (0-3)
2013	14.2± 0.7 (13-15)	10.1±0.6 (9-11)	0.9±0.7 (0-3)	2.9±2.1 (0-7)	1.1±1.8 (0-7)	0.7±0.8 (0-3)
2014	13.4±0.9 (11-15)	11.2±1.8 (8-14)	2.6±1.5 (0-5)	3.0±1.6 (0-6)	1.8±1.3 (0-5)	1.2±1.1 (0-4)

* we calculated the daily number of female friends (pregnant and lactating) for each resident male and averaged it over the time period. This mean daily number of friends per male was then averaged across all males of the period.

Appendix 1. Dominance ranks of males and females

Individual dominance ranks were assessed through focal and *ad libitum* observations of approach-avoid interactions (*supplants*, when one animal actively displaces another to take its place; *displacements*, when one animal passes close to another and makes it move away) and agonistic interactions (*attacks*, any agonistic physical contacts including hits, bites, or grabbing movements; *chases*, when one animal chases another for a distance of at least 3 m; and *threats*, including staring, head bobbing, and ground sweeping while oriented toward the targeted individual). Female dominance hierarchies were calculated separately in each year using Matman 1.1.4 (Noldus Information Technology 2003) and were always linear ($N_{2005} = 412$ interactions, $N_{2006} = 576$, $N_{2013} = 367$, $N_{2014} = 1259$ in group L; $N_{2005} = 184$, $N_{2006} = 460$, $N_{2013} = 590$, $N_{2014} = 978$ in group J, Landau's linearity index h: $p < 0.05$ in all cases). In the analyses, we used relative female rank to control for variation in group size, where absolute ranks were standardised to vary between 0-1 using the formula: $1-((1-r)/(1-n))$, where r is the absolute rank of an individual (ranging from 1 to the group size, n). In contrast to females, the male hierarchies were much less stable within a year [1], so male ranks were established using an Elo-rating procedure implemented in the R package EloRating (version 0.43) [2]. Compared to matrices of dyadic interactions where ranks are calculated over a given time period, an Elo-rating procedure continuously updates rankings according to the temporal sequence of interactions, and is better adapted to situations of unstable social dominance [2,3]. This gives a score for each individual on each day of observation. We derived a daily standardised rank by scaling the Elo-rating score of each individual proportionally between 0 (corresponding to the minimal score and thus the lowest ranking male) and 1 (corresponding to the maximal score and the highest ranking male).

Appendix 2. Details on the identification of heterosexual friendships

The male friend of each pregnant and lactating female was identified using a combination of spatial proximity and grooming allocation indices, following an established method [1]. First, we calculated dyadic proximity and grooming scores between all pregnant or lactating females and resident males. The grooming allocation index was calculated as the number of grooming bouts that a female gives to a male divided by the total number of grooming bouts given by that female to any male of the group. The dyadic spatial proximity index was calculated as the number of scans where the male was the female's nearest neighbour divided by the total number of scans collected for that female. Second, for each behavioural index (grooming and spatial proximity), we investigated if one or two males had an outstandingly

54 high score compared to other males, hereafter referred as the "preferred male(s)": we ranked

55 males from the highest to the lowest score, then calculated the ratio of the highest index

56 divided by the second highest index and the ratio of the second highest index divided by the

57 third highest index. If the first ratio was higher than two (i.e. the male with the highest index

58 had twice as many interactions with the female than the second male), we assigned only one

59 preferred male - the one with the highest score - to the female. If the second ratio was also

60 higher than two, we assigned two preferred males - the ones with first and second highest

61 indices - to the female. Otherwise, we considered that the female had no preferred male for

62 this reproductive state. Thus, pregnant/lactating females could have one, two or no preferred

63 male(s) if no male had a highly differentiated score compared to the others. Then, we

64 compared the preferred male(s) designated by each behavioural index and considered as

65 "male friend" the male that was preferred according to both grooming and proximity indices.

66

67 **Appendix 3. Details on the GLMM procedure**

68 All GLMMs were run using the glmer function of the lme4 package [4] in R version 3.4.1 [5].

69 All quantitative variables were z-transformed to have a mean of zero and a standard deviation

70 of one (by subtracting the mean from each value and dividing the result by the standard

71 deviation) to facilitate model convergence. The significance of the fixed factors was tested using a

72 likelihood ratio test (LRT), assuming an asymptotic chi-square distribution of the test statistic and

73 using the full model (to avoid problems arising from stepwise model selection procedures: [6,7]).

74 Only interactions for which we had clear predictions were included. We tested their

75 significance by comparing the fit of the models with and without the interaction using a LRT.

76 Non-significant interactions were omitted from the model to avoid over-parameterization. To

77 test for the significance of fixed effects, we computed their 95% profile-likelihood based

78 confidence intervals using confint.merMod, and checked that they did not cross zero. To test

79 for all differences between levels of multilevel categorical variables (e.g., "mate-guarding

80 status"), we changed the reference category sequentially and refitted the model [8]. To

81 diagnose the presence of multicollinearity, we calculated the variance inflation factor for each

82 of the predictors in each model. These VIFs varied between 1.02 and 2.79, which are below 3,

83 and thus do not indicate serious multicollinearity [9].

84

85 **Appendix 4. Calculation of male mating skew**

86 The extent of female competition over male care is influenced by how matings (and thus

87 paternity) are distributed across males. If there is a high reproductive skew among males, then

88   the intensity of reproductive competition among females is also likely to be high. To assess

89   the potential for paternal care dilution (and female competition), we calculated the extent of

90   mating skew among males during our study period, using the binomial skew index (B) [10].

91   For each study group and across all study years, we listed all the observation days where at

92   least one female was in her peri-ovulatory period (POP) and mate-guarded, and established a

93   list of all adult males that were present during each of these days. We then recorded which

94   male mate-guarded a given female on a given POP day. If a male mate-guarded a female the

95   entire day, he was awarded one point. If he mate-guarded her for less than a full day (e.g., if

96   there was a switch of mate-guarding between two males during the day), he was awarded 0.5

97   point. We then calculated (1) the total number of points that each male acquired in a given

98   group (i.e. the number of mate-guarding episodes captured by each male) across all years,

99   noted M_{POP}, (2) the total number of POP days where mate-guarding occurred in a given group

100   across all years, noted POP_{MG} (thus, if there are two POP females who are mate-guarded on

101   the same day, this would count as two days), and (3) the total number of POP_{MG} days during

102   which each male was present across years (i.e. a proxy for the number of mate-guarding

103   opportunities of each male). We then calculated the B index separately for each group (L and

104   J) but across all study years as follows:

$$B = \sum_{i=1}^{N} (p_i - \frac{n_i}{n_t})^2 - \frac{(1 - \frac{1}{\check{N}})}{K}$$

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106

107   where N is the total number of males observed in the group across all years, p_i is the

108   proportion of the total mate-guarding success gained by male i, calculated as M_{POP} divided by

109   n_i, the total number of POP_{MG} days where he was present, n_t is the sum of n_i across all males

110   of the troop, K is POP_{MG} (i.e. the total number of mate-guarding opportunities across all

111   years), $\check{N}$ is calculated as n_t divided by the total number of POP_{MG} days of a group across

112   years.

113   B index values that stand close to one indicate a high reproductive skew, while values

114   that stand close to zero indicate a low skew, with zero indicating a random distribution.

115   Negative values indicate a more even distribution of paternity than would be expected by

116   chance. We found a value of 0.63 in L troop and 0.70 in J troop, indicating an important

117   mating skew among males. These values are larger than those previously found in savanna

118   baboons (i.e. *P. ursinus*: 0.05, *P. anubis*: 0.12) [11]. This might be due to the fact that we are

119   using mate-guarding success <u>during peri-ovulatory periods</u> instead of the number of

120   copulations obtained throughout the fertile phase (which is less biased toward high ranking

121   males).

122

123   **Appendix 5. Calculation of the correlation between male mating success and rank**

124   To further assess the extent of male mating skew among males during our study period, we

125   measured the correlation between the proportion of mate-guarding episodes captured by a

126   male during the POP periods and his dominance rank. Similarly, we calculated (1) the number

127   of mate-guarding episodes captured by each male, like M_{POP}, but per group and <u>per year</u>, (2)

128   the corresponding total number of POP_{MG} days where each male was present per group and

129   <u>per year</u> and (3) the mean dominance rank of each male over the POP_{MG} days in a given year

130   (using the daily estimate of male rank - see Appendix 1). We then ran a linear mixed model

131   using the male M_{POP} scores as the response variable. Fixed effects comprised mean male

132   dominance rank, the number of POP_{MG} days where the male was present (to control for

133   variation in the time spent by each male in the group), year and group. We also included one

134   random effect, the identity of the male (to control for male pseudoreplication across years).

135   We found that the proportion of all mate-guarding episodes secured by a male during the

136   fertile window (POP) of any female was strongly correlated with his dominance rank:

137   $\beta\pm SE=13.44\pm2.23$, 95% CI=[9.02;17.74], $\chi^2_1=29.26$, p<0.001, N=62 male-year-group

138   combinations, see Figure S1), indicating a high male mating skew. The conditional coefficient

139   of determination (representing the variance explained by the entire model, including both

140   fixed and random effects) is 0.76 and the marginal coefficient of determination (representing

141   the variance explained by the fixed effects only) is 0.57. On average across the 8

142   combinations of year and troop, males with the highest rank position across the POP_{MG} days

143   monopolize 48.20% (min=17.26%, max=80.00%) of the possible mate-guarding events.

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146   **Figure S1.** Influence of male dominance rank on the proportion of all mate-guarding episodes

147   secured during the fertile window (POP) of females. We present the raw data over the four

148   study periods and the two social groups.

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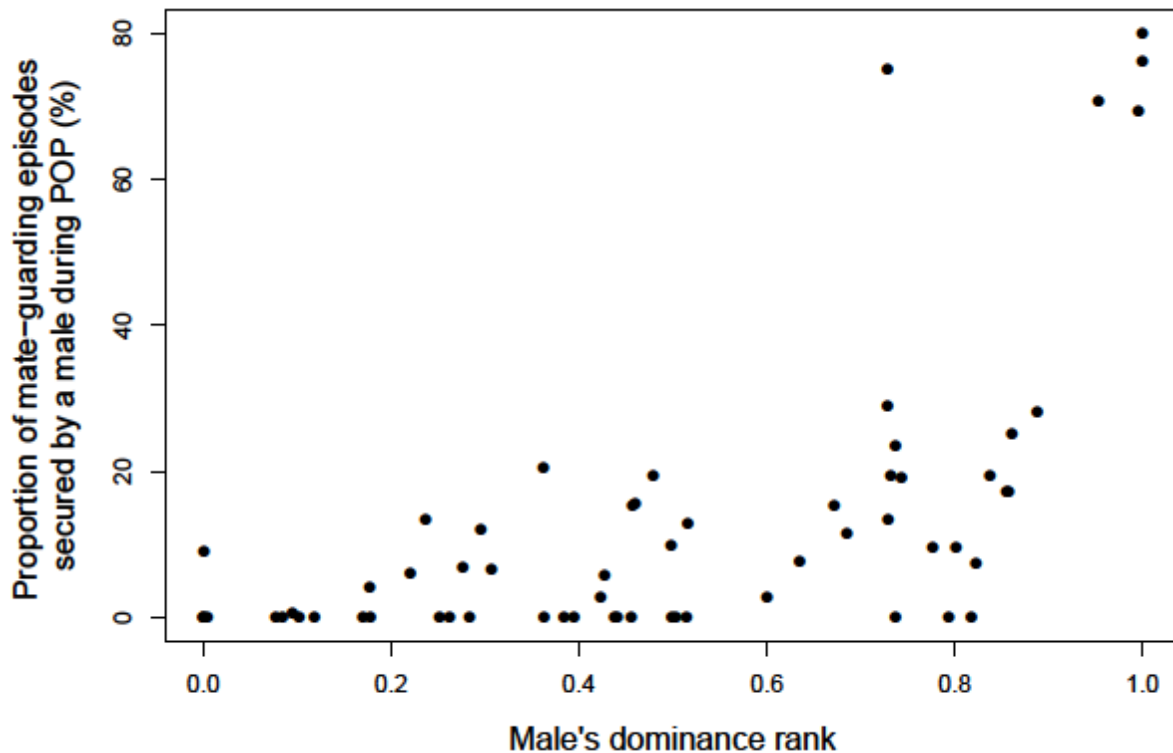
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