

# Evaluation of stress response in Western lowland gorillas (*Gorilla gorilla gorilla*) and De Brazza's monkeys (*Cercopithecus neglectus*) facing the departure of an individual from the gorilla group

## Analysis of fecal glucocorticoid metabolites

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### INTRODUCTION

The hypothalamic-pituitary-adrenal (HPA) axis regulates the **stress response** in animals by releasing glucocorticoids, such as cortisol. Although this response is adaptive in the short term, prolonged exposure to stress can have negative effects on the body. The activity of the HPA axis can be evaluated by measuring cortisol levels in different biological matrices such as blood, saliva, hair, feces or urine. However, capturing and handling animals to obtain blood samples can cause additional stress. Therefore, the analysis of **fecal glucocorticoid metabolites (FGM)** has become a valuable tool, since it allows non-invasive and continuous sampling over time. It has been used in wildlife and conservation studies to assess well-being and stress in different species including non-human primates.

### OBJECTIVES

- Evaluate the stress response by measuring FGM levels in a group of Western lowland gorillas (*Gorilla gorilla gorilla*) facing the departure of an individual from the group.
- Comparative evaluation of the stress response in a group of De Brazza's monkeys (*Cercopithecus neglectus*) in the facility adjacent to the gorillas group.

### MATERIAL AND METHODS

Table 1. Composition of the group Western lowland gorilla

INDIVIDUAL	AGE	SEX	STATUS	n
Gorilla 1 (G1)	37	Male	Silverback	9
Gorilla 2 (G2)	44	Female	Adult	9
Gorilla 3 (G3) <sup>a</sup>	20	Female	Adult	9
Gorilla 4 (G4) <sup>a</sup>	19	Female	Adult	9
Gorilla 5 (G5)	17	Female	Adult	9
Gorilla 6 (G6)	6	Male	Juvenile	9

<sup>a</sup>Contraceptive treatment

n = 54



Table 2. Composition of the group De Brazza's monkey

INDIVIDUAL	AGE	SEX	STATUS	n
Brazza's monkey 1 (M1)	10	Male	Adult	9
Brazza's monkey 2 (M2)	16	Female	Adult	9
Brazza's monkey 3 (M3)	17	Female	Adult	9
Brazza's monkey 4 (M4)	37	Female	Adult	9

n = 36

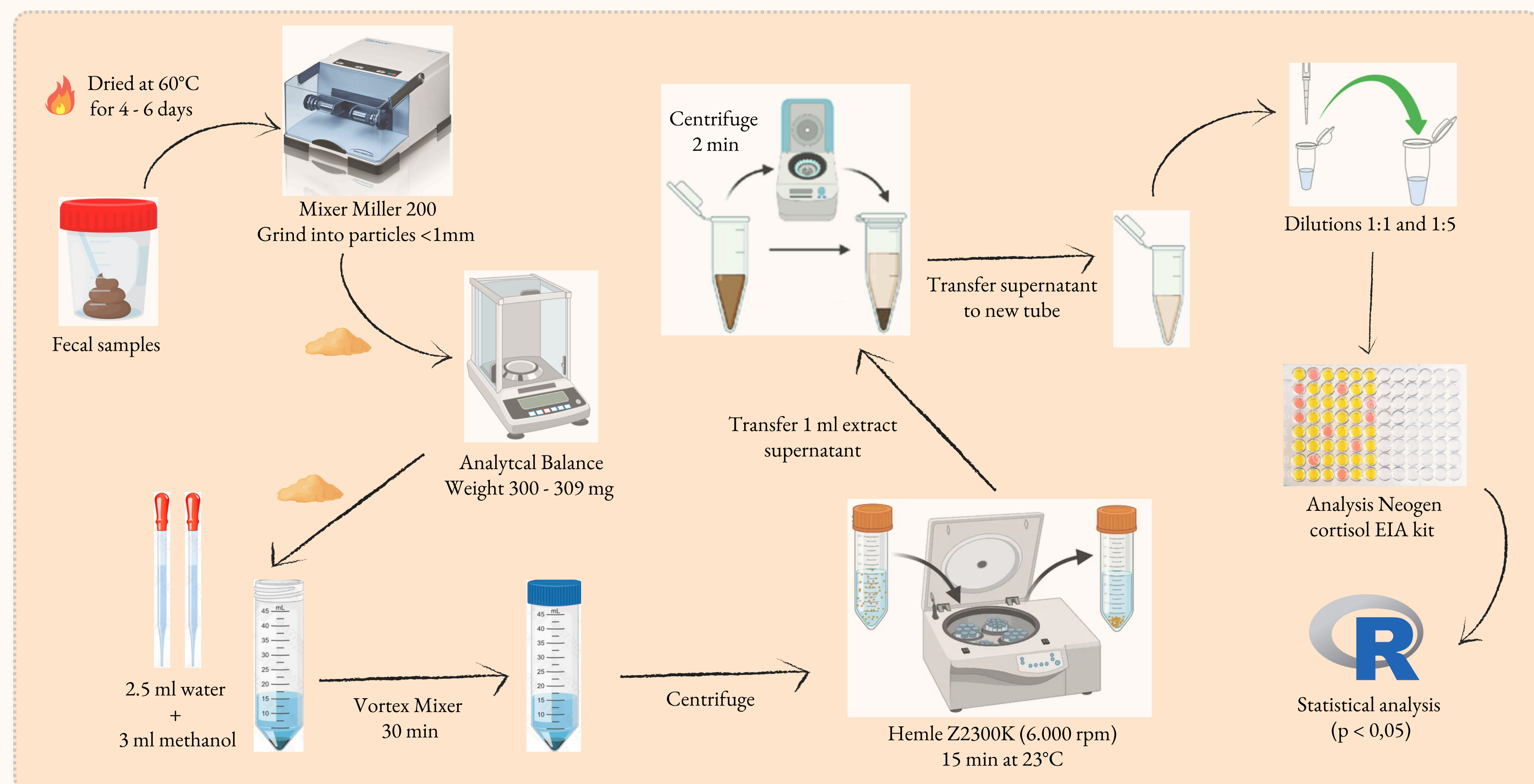


Figure 1. Procedure of extraction of fecal steroid hormones

### RESULTS

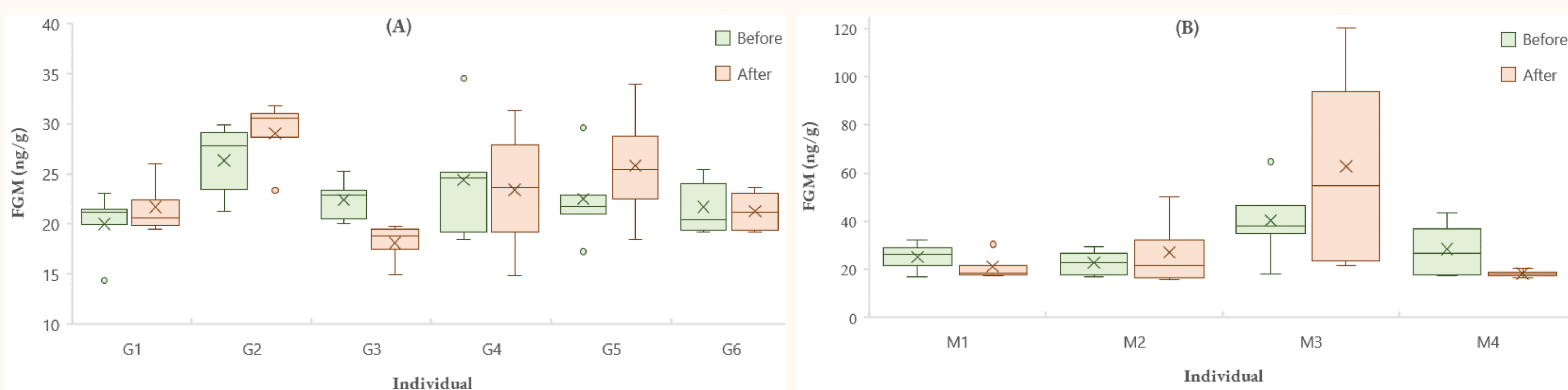


Figure 2. Comparative of the levels of fecal glucocorticoid metabolites (FGM) before (green) and after (red) the individual's departure: in six gorillas (A) and in four Brazza's monkeys (B). The "X" mark inside the box indicates the mean FGM (ng/g) levels and the dots outside the box represent outliers.

Table 3 and 4. Represents the individual baseline (+SD) of the concentrations of fecal glucocorticoid metabolites (FGM), the baseline cut-off (calculated as the baseline + 1.5 x SD), the number of peaks (before and after the departure of the individual from the group gorillas), and the proportion of peaks in the group of six Western lowland gorillas and four De Brazza's monkeys, respectively.

Individual	FGM (ng/g)		Number of peaks		Proportion of peaks
	Baseline (+SD)	Baseline Cut-Off	Before	After	
Gorilla 1 (G1)	20,09 ± 2,57	23,95	-	1	11%
Gorilla 2 (G2)	27,53 ± 3,83	33,27	-	-	0%
Gorilla 3 (G3)	19,90 ± 2,65	23,87	1	-	11%
Gorilla 4 (G4)	21,37 ± 2,26	27,77	1	1	22%
Gorilla 5 (G5)	20,87 ± 2,56	24,71	1	2	33%
Gorilla 6 (G6)	21,02 ± 2,11	24,19	1	-	11%

Individual	FGM (ng/g)		Number of peaks		Proportion of peaks
	Baseline (+SD)	Baseline Cut-Off	Before	After	
Brazza's monkey 1 (M1)	23,41 ± 6,04	32,47	-	-	0%
Brazza's monkey 2 (M2)	21,53 ± 5,41	29,65	1	-	11%
Brazza's monkey 3 (M3)	30,57 ± 10,98	47,05	1	2	33%
Brazza's monkey 4 (M4)	17,60 ± 0,71	18,67	3	1	55%

### CONCLUSION

This study evaluated the stress response by measuring MGF in Western lowland gorillas and De Brazza's monkeys after an individual left their group. Although no changes we found in MGF levels in either species, individual variability was highlighted, emphasizing the influence of social factors such as hierarchy and resilience in modulating the HPA axis. This underscores the need for future studies to better understand long-term stress responses and expand evaluation in these species.

### DISCUSSION

The results revealed **differences in MGF levels among individuals**, but not between the periods before and after the individual's departure. Previous studies highlight the importance of considering intra- and interspecific variability in stress response (Heistermann *et al.*, 2006). However, the factor that generated individual variability could not be identified because this study was not designed with that aim. **The lack of changes in MGF levels between periods** could be due to animals adaptability, such as the stability of social hierarchy or enriched environment. Another reason could be the sensitivity of the methods used to measure MGF levels. It is essential to consider various endogenous, environmental, and methodological factors.

Among the **limitations of the study**, its short duration and the context applied to the evaluated situation stand out, which made it impossible to identify the long-term stress response nor gradual changes in MGF levels. The exclusive use of a non-invasive biological matrix also limited the understanding of stress response and result interpretation. Therefore, the inclusion of direct observations of behavior and the use of complementary methods, such as physiological parameters or other non-invasive biological matrices, would have been useful to enhance understanding of the stress response in the evaluated subjects.



Information about this study!