

Changes in the sex ratio of the breeding stock modify hormone levels in rhea eggs: its usefulness in captive management

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1. Introduction

Maternal hormones in avian egg-yolks could be mediating an adaptive maternal effect that allows a flexible adjustment of development to the prevailing conditions. However, this adjustment requires some degree of flexibility in regulating yolk hormone deposition according to the offspring's environmental conditions.



The Greater Rhea (*Rhea americana*) is bred in captivity for conservation and production purposes. This species has a mating system that combines polygyny and polyandry, with a high degree of promiscuity.

As the male constructs the nest, incubates the eggs and cares for the chicks, the maternal influence appears to end once the eggs have been laid. This makes the Greater Rhea an excellent model to reveal the effects of yolk hormone deposition on embryo development, without the interference of other maternal effects during incubation and after hatching.

Previously, we found that yolk hormone deposition varies among eggs of different captive populations and could influence the chicks' physiology and behavior. However, it is unknown if females could modify yolk hormone deposition in a changing environment.

Objective

Evaluate whether Greater Rhea females modify yolk corticosterone and progesterone deposition, after a change in the breeding sex-ratio.

2. Methods

- ❖ We worked with a semi-extensive captive population located at Pampa Cuyen Farm in Balcarce city, Argentina.
- ❖ Animals were housed in a 1.5 ha enclosure. Initially, the population was formed by 20 adult females and 20 adult males (one female for every male). Then, 10 females were randomly chosen for removal, and the population was therefore composed of 10 adult females and 20 adult males (one female for every two males). In the social environmental conditions of 1 female per 1 male, we collected 16 eggs from the 5 active nests, and in the social condition of 1 female per 2 males, we collected 10 eggs from the 2 active nests.
- ❖ Yolk corticosterone and progesterone levels were determined using immunoassay kits validated for the yolk of Greater Rhea by Della Costa *et al.* (2016 and 2017).



3. Results and Discussion

Yolk hormone levels in Greater Rhea eggs produced in two social environment conditions. Levels of each variable not connected by the same letter are significantly different ($P < 0.05$).

Variable	1:1 female to male ratio (n = 16)	1:2 female to male ratio (n = 10)	Statistic values
Yolk corticosterone (ng/g)	63.46 ± 7.16 ^a	102.49 ± 13.12 ^b	$F_{1,20} = 9.68, P < 0.01$
Total corticosterone in the yolk (g)	10544.93 ± 1161.37 ^a	18380.46 ± 2632.68 ^b	$F_{1,20} = 13.84, P < 0.01$
Yolk progesterone (ng/g)	1671.16 ± 166.83 ^a	977.45 ± 165.85 ^b	$F_{1,20} = 7.76, P < 0.02$
Total progesterone in the yolk (g)	281031.72 ± 29840.84 ^a	182316,33 ± 36967,68 ^b	$F_{1,20} = 5.72, P < 0.03$

We found that females deposited on average higher yolk corticosterone and lower yolk progesterone levels after the change in the sex ratio.

Since corticosterone deposited into the yolk comes exclusively from the female's plasma, our results suggest that females have on average higher plasma levels of this hormone. The change in the sex ratio may increase the events in which females were exposed to male-male competitions, courtships, and matings, leading to corticosterone levels increasing in their plasma and being transferred to their eggs.

Our previous studies (Della Costa *et al.*, 2019) showed that higher yolk corticosterone and lower yolk progesterone had been associated with the production of chicks that have attenuated stress responses. Therefore, in a captive environment perceived as stressful by the females, where individuals cannot escape, an attenuated stress response in the chicks could improve their survival chances.

Our results suggest that the management of the sex ratio can have implications not only in the Greater rhea females but also in their offspring's quality.

References:

- Della Costa NS, Marin RH, Busso JM, Hansen C, Navarro JL, Martella MB. 2016. Influence of the rearing system on yolk corticosterone concentration in captive Greater Rheas (*Rhea americana*). *Zoo Biol* 35:246-250.
- Della Costa NS, Navarro JL, Busso JM, Marin RH, Martella MB. 2017. Distribution and concentration of maternal progesterone in the yolk of Greater Rhea eggs (*Rhea americana*). *J Exp Zool* 327A:143-148.
- Della Costa NS, Navarro JL, Bernad L, Marin RH, Martella MB. 2019. Effect of maternal environment on yolk immunoreactive corticosterone and its influence on adrenocortical and behavioral activity in chicks of Greater Rhea (*Rhea americana*). *Horm Behav* 114:104534.



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