

# Male and Female Degus do not differ in their Plasma Testosterone Levels: Are Male Degus Atypical with Respect to Other Mammals?

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## DESCRIPTION

Recently, we published two articles in which we examined the functional associations between the social environment and male and female plasma testosterone levels recorded over 11 years in a wild population of the social rodent *Octodon degus* [1,2].

We focused on degus because these rodents exhibit a complex and relatively atypical social system when compared with other group-living mammals [1,2]. Degu social organization typically include multimale-multifemale social groups, in which adult males and females share common burrow systems with offspring from communal litters [3]. Social structure is characterized by amicable interactions within and between the sexes and frequent male-male interactions with low levels of direct aggression [1]. Both male and females mate with multiple opposite sex individuals, including members of neighboring groups, implying that males do not monopolize females [4]. Additionally, females within groups cooperate through rearing their offspring communally, and males provide some level of parental care, and are not infanticidal [5,6]. In degus, sexual dimorphism is absent [1,2]. These attributes differ from relatively common mammalian social systems in which a dominant male defends multiple breeding females that rear offspring independently (e.g., most equids, pinnipeds, deers) or with the assistance of non-breeding individuals. Dominant males in these social systems are typically intolerant to other males, are dominant over females, and mate with multiple females. Female promiscuity is either absent or cryptic. Males in these systems generally do not provide parental care and are typically larger than females [7].

Studies examining hormonal underpinnings of relatively more typical mammalian social systems generally support that circulating testosterone titers in the males are on average one magnitude order larger than in the females, and that this hormone is also higher in breeding males compared with non-breeding (or subordinate) males. On the contrary, in species with atypical mammalian social system, like degus, presumably the presence of aggressive males exhibiting relatively high testosterone

levels may result in fitness detrimental interactions to the females and their offspring [8]. Accordingly, evidence from spotted hyenas (*Crocuta crocuta*) and bonobos (*Pan paniscus*, another atypical species) where males and females cohabit throughout the year, indicate that males exhibit lower testosterone levels when compared with the males of sister species exhibiting a more typical mammalian social system [9-12]. Additionally, French et al., highlighted eight mammal species (including hyenas, a few primates, rodents and procaviid mammals) to as “atypical mammals” [13]. These species are characterized by a reversal or absence of traditional sex roles, meaning that males and females are equally aggressive and attain similar social ranks (sex role absent) or females are more aggressive and dominant than males (sex role reversal) [13]. Interestingly, testosterone levels in the males of these socially atypical species are higher than those of the females [13], implying that French’s species examined are behaviorally atypical, but physiologically typical. However, within French’s atypical mammal’s species, the rock hyraxes (*Procapra capensis*) constitute an exception. In this species males and females have similar testosterone levels or females have higher testosterone levels than males [14]. Rock hyraxes, also have a complex social system, where males cohabit with females, and where females are dominant. Thus, rock hyraxes are behaviorally and physiologically atypical [13,14].

Based on the examination of 313 male and 525 female testosterone samples we found that male and female degus do not differ in their plasma testosterone levels, at least, during the nursing season. Similar to rock hyraxes degus exhibit a complex social system, and do not exhibit social hierarchy formation within groups, implying a relatively egalitarian society, without male or female dominance [15]. Thus, degus resemble rock hyraxes in being socially and hormonally atypical. However, our studies also revealed that male testosterone levels are low and that several males exhibit testosterone levels that fell below detectability limits of standard kits [1,2]. Critically, our findings similarly support that female reproductive status [16] and the number of females within social groups influence male testosterone

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levels [1]. Male testosterone titers are relatively high when females are receptive, but decrease when females are pregnant and nursing, a finding that resembles male human (*Homo sapiens*) testosterone dynamics during parenting [16]. Additionally, a negative association between the number of females in the social group and male testosterone levels has been recorded. Thus, male testosterone decreases as the number of females in the social group increase [1]. In contrast, unpublished results indicate that degu “roamer” males that do not seem to exhibit permanent residence to a social group (i.e., do not cohabit permanently with females) exhibit the highest testosterone levels yet recorded.

Based on the previous findings we hypothesize that female degus are typical mammals, as they exhibit relatively low testosterone levels. Thus, the sex similarity in testosterone levels is likely the consequence of a down regulation in male testosterone levels (a finding previously reported in bonobos), and where females could be the stimulus [1,11]. A previous study in spotted hyenas indicates that in this atypical species, the best male reproductive strategy is to be socially friendly with females to remain in the social group, where females are socially dominant [17,18]. This social strategy might be linked to a down regulation of circulating testosterone levels [8,17,18]. Until now, rock hyraxes and degus, are the unique mammal species in which males and females do not differ in testosterone levels. Curiously, and despite their differences, rock hyraxes, degus, bonobos and spotted hyenas are similar in two ways: (i) They have a complex and atypical social system, and (ii) Males that cohabit permanently with females have the lowest testosterone levels. Thus, we hypothesize that different components of these atypical social system, such as a social organization characterized by multimale-multifemale social groups, could influence male testosterone levels. We expect that the presence and proximity of females could result in the down regulation of testosterone production in males.

Studies about female testosterone in wild mammals, are surprisingly scarce, possibly because this hormone has been traditionally linked to male phenotypic and behavioral traits [19]. Thus, it is currently not possible to determine the extent to which female degus exhibit testosterone levels that are typical for female mammals. Additional studies based on multiple degu populations or contrasts with sister degu species exhibiting different social systems may help us to understand the ultimate causes driving our unexpected physiological findings and the functional role androgens on female social behavior [19,20]. Finally, it is urgent to carry out more studies in females of other mammal species, to identify if rock hyraxes and degus are a real exception [19].

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