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Review

Reproduction in chinchilla (*Chinchilla lanigera*): Current status of environmental control of gonadal activity and advances in reproductive techniques

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Abstract

A review of the biology of reproduction of chinchilla, focusing on environmental control of the gonadal activity, is presented. Chinchilla is a South American hystricomorph rodent genus currently considered almost extinct in the wild. However, a domestic form is still widespread in breeding farms around the world. Information regarding their reproductive biology has been obtained from studies on captive animals. In the case of *Chinchilla lanigera*, a seasonal reproductive pattern has been frequently reported in breeding facilities, but factors that might trigger gonadal activity have not been identified. The available information on reproductive productivity in farms worldwide shows a range of 1.2 to 2.4 deliveries per female per yr (with up to 2.1 weaned young per female per yr). Indeed, as found in all rodents, chinchillas can multiply at high fecundity and fertility rates (4 to 6 follicles mature during estrous cycles). Some new research avenues are postulated to improve the control of gonadal activity by means of environmental and/or pharmacologic factors. Furthermore, reproductive techniques that have been validated in chinchilla are reviewed (noninvasive hormone monitoring, semen collection, sperm cryopreservation, estrus induction), and several technical steps are proposed to be able to achieve AI. Because domesticated chinchilla still share some genomic characteristics with their counterparts in the wild, validated reproductive techniques in chinchilla males and females might contribute to the success of breeding programs.

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Keywords: Chinchilla; Reproduction; Photoperiod; Semen collection; Noninvasive hormone monitoring; Artificial insemination

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1. Chinchillas (*Chinchilla* spp.)

The present work compiles all information published regarding the reproductive physiology of *Chinchilla* spp. since the review of Weir in 1970 [1]. In the wild, chinchillas are herbivores and live in colonies, in extensive burrow systems. The environmental conditions of their habitats are typical of tropical desert (15° S/34° S), with climatic variations exhibiting drastic temperature changes (from 30 °C to –22 °C) and low rainfall. Information regarding reproductive activity of this genus in nature is scarce, but it is known that females give birth from September to February in South America [2,3]. However, under captive conditions at similar latitudes, births can occur at any time, with peaks occurring in spring and summer [2,4–6].

Chinchilla spp. belongs to the Chinchillidae family; six species, namely *Lagostomus* spp., *Lagidium* spp., and *Chinchilla lanigera* and *Chinchilla brevicaudata*, are all endemic in South America. However, *Chinchilla* spp. is under threat (IUCN Red List of Threatened Species; <http://www.iucnredlist.org>) [7], with the existence of remnant colonies in the Argentine Andes being uncertain [8], and some reports regarding the presence of a wild strain in Chile [9–11]. Amori and Gippoliti [7] indicated that a domestic form is widespread in breeding farms around the world, and captive-bred chinchillas still share some genomic characteristics with their wild counterparts (based on cytochrome b sequence analysis). This close relationship of wild and domestic *Chinchilla lanigera* is to be expected, because the captive-bred specimens were mainly derived from a few wild individuals collected in Chile [12,13]. Therefore, we consider that this review provides scientific information that may be helpful for: (1) assessing ecological phenomena (by focusing on environmental endocrinology, i.e., quantifying concentrations of stress hormones in feral individuals of this species); (2) identifying healthy reproductive feral individuals to develop reproductive ex situ programs; and (3) indicating validated reproductive techniques for manipulation of chinchilla gonadal

activity to assist diagnosis of reproductive dysfunction in valuable farmed individuals.

Because domestic *C. lanigera* and wild *C. brevicaudata* have low levels of genetic variation [12] and morphologic similarities [3,8], perhaps validated reproductive techniques in *C. lanigera* will also be useful for studying reproductive functions in *C. brevicaudata*.

1.1. Reproductive development and gonadal cycles in *Chinchilla lanigera*

Information regarding their reproductive biology comes from studies on commercially exploited animals, especially *Chinchilla lanigera*. However, chinchillas have some characteristics that distinguish them from most rodents. Some authors have proposed that the chinchilla's longer reproductive cycles could be a result of adaptations arising during the colonization of ecological niches characterized by harsh environmental conditions, particularly at high altitudes or at high latitudes (highland tropical desert) [14].

Captive-bred chinchilla males have a short and rapid growth cycle (approximately 180 days) [15]. In adults, increased sexual activity in winter was inferred, based on morphometric changes in the male reproductive system [16], with a peak occurring in autumn through winter (under natural photoperiod and ambient temperature conditions) in the seminal glands [17] and urethral bulbs [18]. Moreover, there was a 30% reduction in average testis volume in the southern hemisphere in January and February (under natural photoperiod, 31° S/64° W). In our laboratory, although testis volume had a positive correlation ($r = 0.83$; $P = 0.001$) with body weight under similar experimental conditions, no seasonal changes were detected [19,20].

1.1.1. Testicular activity

Leal and Franca [21] indicated that proliferation of both Sertoli and Leydig cells occur up to 2 mo after birth and then the total number of these cells per testis reaches a plateau. In addition, based on spermatid release from the seminiferous epithelium and the presence of sperm in the epididymis, puberty in chinchilla

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