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Photoperiodic Control of Testis Activity in the Mongolian Gerbil (*Meriones unguiculatus*)

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The purpose of research work was to examine the effects of different photoperiods (24L:0D; 14L:10D; 8L:16D and 0L:24D) on testes and accessory sex organs in mature male Mongolian gerbils (*Meriones unguiculatus*). 14L-born and raised animals with functional testes were held under four different photoperiods for ten weeks. Testicular size were measured every week for ten weeks. At sacrifice, testes of 14L animals were large and showed full spermatogenesis and possessed tall columnar epithelial cells and secretion in the lumen of seminal vesicles. Transfer to 24L, 8L, or 0L resulted in a decrease in testes size; the seminal vesicles had an epithelium with low columnar or cuboidal cells and contained a reduced amount of secretion in lumen. The histological appearances of testes were similar in 24L, 8L and 0L. Therefore, very long and short photoperiods have a strong effect on reproductive system in this species.

Key words: Photoperiod, gerbil, testis, reproduction

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Introductions

Many seasonally breeding mammals show a marked annual cycle in gonadal size and activity as well as in other functions such as body weight and pelage color (Hoffmann, 1981). The seasonal change in day lenght provides a reliable cue for the regulation of reproduction in those species and this annual cycle in reproduction can be manipulated by photoperiod (Gaston and Menaker, 1967). In most of adult mammals, short photoperiod induce arrest of spermatogenesis and an ovulation while long photoperiods stimulate regrowth (Steinlechner and Niklowitz, 1992).

The Mongolian gerbil (*Meriones unguiculatus*), show a several interesting and dramatic physiological, behavioral and morphological transformations in response to changes in photoperiod (Clark and Galef, 1981). When exposed to short photoperiod and very long photoperiod (24L), adult gerbils undergo testicular regression (Benimettskii, 1975; Devries *et al.*, 1989; Karakaş and Gündüz, data to be published). This decrease in testis size associated with transfer to very long photoperiod (24L) is unusual for small mammals. Some species such as the Syrian and Siberian hamsters, very long photoperiods maintain functional testes activity (Goldman and Darrow, 1983).

The intent of this Investigation was to ask question concerning the reproductive response of adult gerbil to photoperiod: Is the difference in reproductive tissue weights observed in adult gerbils exposed to different photoperiod conditions reflected in differences in reproductive potential?

Materials and Methods

Mongolian gerbils were obtained from colony maintained at the Abant Izzet Baysal University. Adult male Mongolian gerbils (3-4 months old and 65-70 g) were raised under 14L (lights off at 20:00 h) and divided into groups which were exposed to different photoperiods (24L:0L, 14L:10L, 8L:16D and 0L:24L) for ten weeks. Animals were maintained in plastic cages (16 x 31 x 42 cm^3) with pine shaving used as bedding. They were given food pellets (Purina Rodent Chow) and tap water ad libitum and kept at 20 ± 1 °C. Testes were measured (length and width) with calipers to the nearest 0.5 mm by palpation of the testis in the scrotum. In most cases, we measured only one of the testes alternating sites on successive animals. Linear regression analysis (Watson-Whitmyre and Stetson, 1985) was used to determine the relationship between testicular volume and weights of paired testes. Data were recorded as testes weights. At the end of experiment, the animals were sacrificed. The testes and seminal vesicles were dissected, fixed in Bouin's fluid, dehydrated in a graded series of ethanol, and embedded in a paraffin wax. Sections of 10 μm thickness were cut with a microtome and stained with hematoxylin and eosin.

The results were statistically compared by a one-way analysis of variance (ANOVA, SASInst.,Ver.,6.06) followed by a t-test for the differences among multiple means. All Values were considered statistically significant at $p < 0.05$.

Results

The testicular weights of the animals in different photoperiods are shown in Fig. 1. Males in 14L had large testes, weighing about 1.5 g, while those maintained in 24L, 8L, and 0L has small testes weighing about 1.1 g at week 10. Histological examination showed that in testes of the males kept in 14L photoperiod complete spermatogenesis was evident (Fig. 2)where as only sertoli cells, spermatogonia and a few spermatocytes were observed in males in 24L, 8L, and 0L photoperiods (Fig. 3). Seminal vesicle of 14L-exposed gerbils had tall columnar cells and secretion in the lumen (Fig. 4). The epithelial cells of seminal vesicles of other groups were

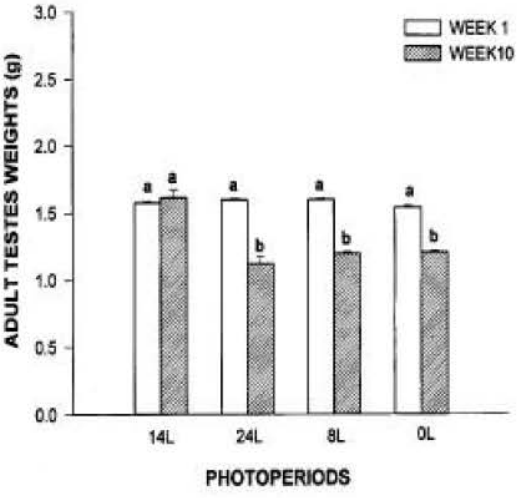

Fig. 1: Testicular weights of Mongolian gerbils maintained in 14L, 24L, 8L, and 0L photoperiods. Open bar represents testes weights at week 1 and hatched bar represents testes weights at week 10. Groups with different letters in each photoperiod are significantly different from one another. Each bar represents mean ± SEM of 10 male gerbils.

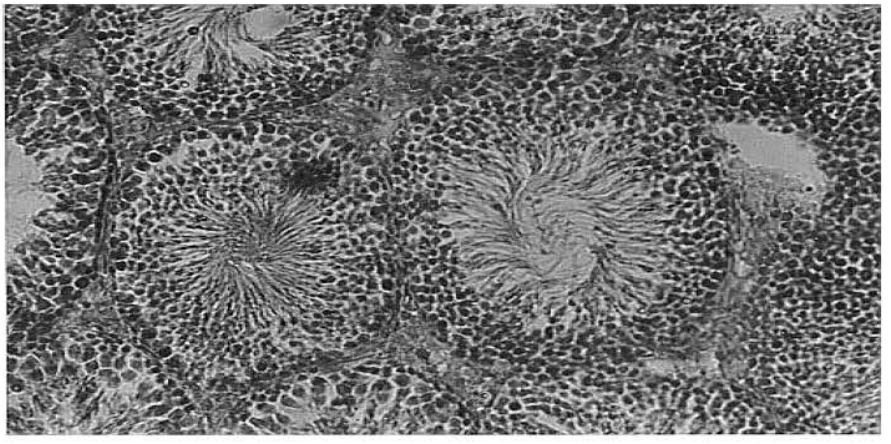

Fig. 2: Testis of a gerbil exposed to a long (14L:10D) photoperiod. Note presence of various stages of spermatogenesis (x400).

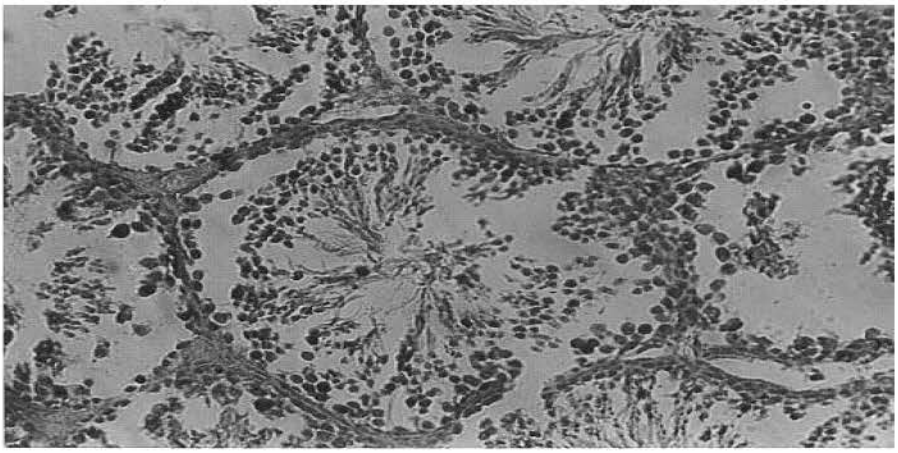

Fig. 3: Testis of a gerbil exposed to a short (8L:16D) photoperiod. Note arrest of spermatogenesis, smaller Leydig cells. Testes of gerbils exposed to 24L and 0L photoperiods are histologically similar (x400).

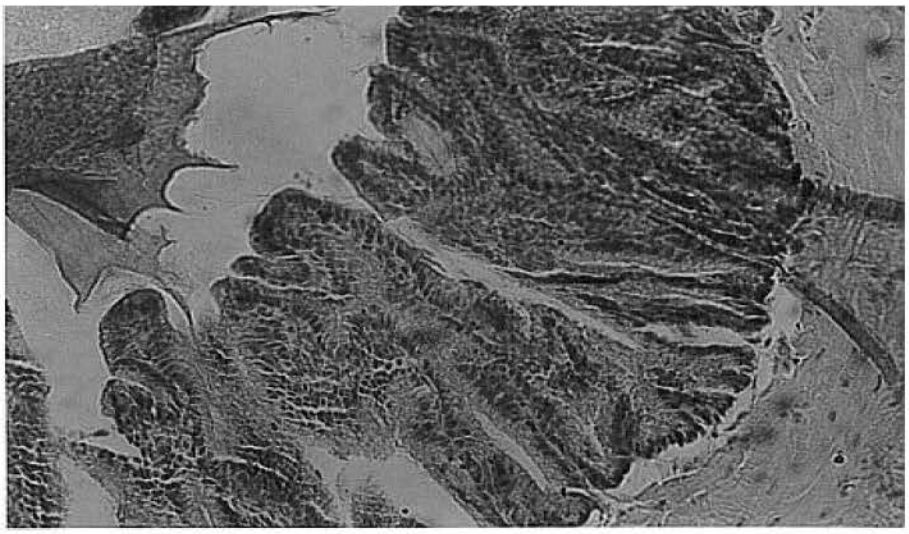

Fig. 4: Epithelium of a seminal vesicle from a gerbil exposed to a long (14L:10D) photoperiod. Note the presence of tall columnar cells and secretion in the lumen(x400)

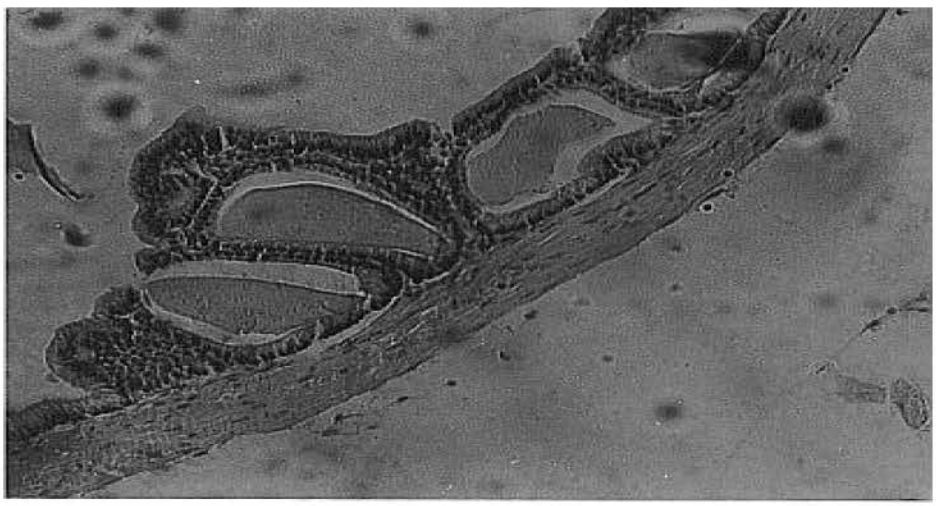

Fig. 5: Epithelium of a seminal vesicle from a gerbil exposed to a short (8L:16L) photoperiod. Note the presence of low columnar and cuboidal cells and absence or small amount of secretion in the lumen. Seminal vesicles from gerbils exposed to 24L and 0L photoperiods have a similar histological appearance (x400).

reduced in size and changed from columnar to cuboidal appearance. The secretory activity of the epithelial cells was also reduced (Fig. 5).

Discussion

The male Mongolian gerbils are sensitive to photoperiodic changes as far as their male reproductive systems are concerned. Testes and seminal vesicles were significantly influenced by photoperiod. This conclusion contrasts with that of some other studies (Reiter *et al.*, 1980; Sinhasane and Joshi, 1997) which found no or poor effect on reproductive parameters of exposure to short (8L) or long (14L) photoperiod manipulations during adulthood. On the other hand, present observation is paralleled by finding in our previous work (Karakaş and Gündüz, data to be published).

The response of reproductive system to changes in photoperiod employed was both interesting and difficult to explain. Males which remained in 14L maintained their reproductive activity but males which were transferred to other photoperiods (24L, 8L, or 0L) showed atrophy of testes and reduced activity of seminal vesicles.

This type of responses of the reproductive system to photoperiod in Mongolian gerbil may have a selective basis. Gonadal regression during exposure to short and very long photoperiods would result in a cessation in breeding at the harshest time of the year for gerbils. This hypothesis is supported by field data indicating that most reproduction occurs between February and September (Benimettskii, 1975).

What is (are) the mechanism(s) by which animals can measure the lenght of the daily photoperiod and respond to it? In mammals it has been suggested that the influence of photoperiod on the neuroendocrine-reproductive axis is mediated by the pineal gland (Reiter, 1991). Studies concerning the effects of light factor on testis histology in Mongolian gerbils are not available. At present it is not possible to compare our finding with other studies, but on the basis of accumulated data on reproductive responses we suggested the following hypothesis. Short photoperiods ($\leq$8L) and very long photoperiod (24L; constant light) in adult male Mongolian gerbils might be responsible for the inhibition of spermatozoan production (due to the absence of testosterone). Therefore, the role of pineal gland and melatonin hormone (a product of pineal gland) must be throughly studied at the level of hypothalamic-pituitary-reproductive axis.

Because Mongolian gerbils are exquisitely sensitive to photoperiod and that each photo-sensitive trait can respond independently to change in photoperiod, perhaps photoperiod-related differences in the daily melatonin release profile might dictate the physiological response to photoperiod.

Acknowledgments

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