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Reproductive Involution in Male Hamsters Exposed to Naturally Increasing Daylengths after the Winter Solstice (40759)[1]

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Under controlled laboratory photoperiods, the reproductive systems of hamsters are maintained in a functional state only if the animals are exposed to 12.5 or more hours of light per day, i.e., long daily photoperiods (1). Exposure of hamsters to less than 12.5 hr of light daily (short photoperiods) induces reproductive involution. When hamsters are kept under natural photoperiodic conditions during the fall of the year when daylengths are both short and decreasing the gonads also involute (2, 3). As spring approaches the reproductive systems eventually regenerate to the mature state (4). The cause of the recrudescence of the gonads in the spring could be due to the increasing photoperiod lengths even though the days are still short, i.e., less than 12.5 hr in duration. In the present study sexually mature male hamsters were placed under natural photoperiods beginning on December 28 (6 days after the winter solstice) to determine how their reproductive organs would respond to short, but increasing daylengths.

Materials and methods. One-hundred-nine adult male Syrian hamsters (70–90 g) were purchased from Lakeview Hamster Colony, Newfield, New Jersey. During the period of acclimatization the hamsters were kept under light:dark (LD) cycles of 14:10. On December 28, 9 of the animals were necropsied and the testicular, accessory sex organ (seminal vesicles and coagulating glands) and anterior pituitary weights were recorded. Blood was collected in heparinized tubes and centrifuged, and plasma samples stored frozen for later hormone analyses. The remaining 100 hamsters were divided into two groups of 50 animals each. Half of the animals were caged under controlled long photoperiods, that is, LD cycles of 14:10 (in hours) and the remainder were maintained under natural photoperiods. At this time of the year the photoperiods were short but increasing in length (3). All animals were kept 5 per cage and given food and water *ad libitum*. During the treatment period subgroups of hamsters (10 each) were killed at roughly monthly intervals between February 1 and June 1. At each necropsy the organs mentioned above were weighed and plasma samples were collected.

Plasma and pituitary samples were assayed for immunoreactive luteinizing hormone (LH) and prolactin using the methods of Goldman and Porter (5) and Donofrio *et al.* (6), respectively. Reagents for the assays were provided by the Rat Hormone Distribution Program, NIAMDD. LH values are expressed in terms of NIAMDD-rat LH-I-4. Due to the lack of parallelism between rat and hamster prolactin inhibition curves, hamster prolactin values are expressed in terms of a pool of standard hamster anterior pituitaries (SHAP) (6). Statistical analyses of data were performed using an ANOVA and a t test.

Results. Even though the days were increasing in length, by February 1 the testes of the animals kept under natural photoperiods had undergone a highly significant ($P < 0.001$) reduction in weight compared to those in hamsters in LD 14:10 (Fig. 1). The regression was even more conspicuous on March 1 and April 3; however, by May 3 the testes had recrudesced to a near normal state. Total recovery of the testes was achieved on June 1. The accessory sex organs of the hamsters exposed to natural photoperiods exhibited the same pattern of regression and subsequent regeneration with the lowest mean weight being attained on April 3 (Fig. 1). By comparison, the gonads and accessory sex organs of the control animals in LD 14:10 remained at a constant weight throughout the experiment.

The hormonal changes in the pituitary

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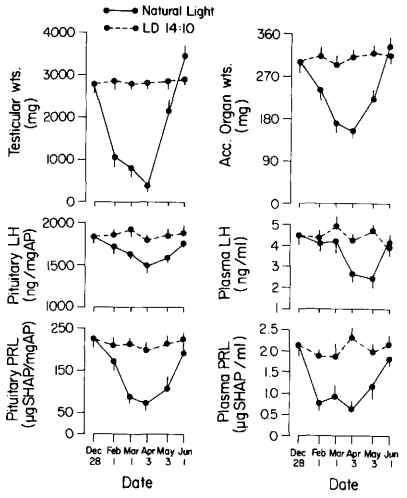

FIG. 1. Testicular, accessory sex organ (seminal vesicles and coagulating glands), pituitary and plasma luteinizing hormone (LH), and pituitary and plasma prolactin levels in male hamsters kept under either naturally short, but increasing, or controlled long photoperiods (light:dark cycle of 14:10 in hours) between December 28 and June 1. are shown. Hamsters under the natural photoperiods experienced involution of their reproductive organs and a drop in hormone levels with a subsequent return of these parameters to preexperiment levels.

glands and plasma were very similar to the weight fluctuations of the reproductive organs. Pituitary LH values were significantly depressed ($P < 0.001$ vs hamsters in 14:10) in animals kept under natural photoperiods on March 1, April 3, and May 3, while plasma LH values were depressed ($P < 0.001$) on April 3 and May 3. The prolactin changes were even more dramatic in the hamsters exposed to natural lighting conditions. The mean pituitary prolactin contents were highly significantly depressed ($P < 0.001$) on March 1, April 3, and May 3. Plasma prolactin levels were also lower ($P < 0.001$) during the same interval. As with the organ weights, pituitary and plasma levels of LH and prolactin in hamsters kept in LD 14:10 remained uniformly high throughout the experimental period.

Discussion. The present results indicate that the reproductive organ atrophy and the drop in pituitary and plasma hormone levels are just as pronounced in hamsters exposed to short, but increasing, daylengths as in animals kept under short, but decreasing, photoperiods (3). At the time of the winter solstice the daylength was slightly over 10 hr in duration. When the hamsters were placed in the natural photoperiods, i.e., December 28, daylengths were increasing roughly 0.7 min daily. On and around the vernal equinox, March 22, the mean daylength was increasing by approximately 2 min daily. Yet, neither the gonads nor the associated hormones exhibited any evidence of recovery. Indeed, on April 3 the testes and accessory sex organs reached their lowest weight (Fig. 1).

Of some note is that after April 3 the gonads grew rapidly such that by May 3 they had attained nearly their normal size. On April 3 the daylength reached 12.5 hr light daily, the minimal amount of daylight normally required to maintain testicular function in male hamsters (1). Thus, the rapid regrowth of the sexual organs and the restoration of the hormone levels were occurring simultaneously with what would normally be considered to be stimulatory photoperiods. However, whether the recrudescence of the reproductive system was exclusively a consequence of the long days is unknown since the gonads of hamsters under short photoperiods eventually spontaneously regenerate (4). This could have happened in the present experiment as well.

An examination of Fig. 1 reveals that the testes atrophied in advance of a significant reduction in plasma LH titers. This was not altogether unexpected since gonadal regression has been reported in male hamsters with normal or near normal circulating LH values. Of major importance in the maintenance of testicular size and function in the hamster is prolactin. This hormone has been shown to be important in stimulating testicular growth in hamsters suffering from darkness-induced gonadal atrophy (7). In the present study there is also a strong correlation between testicular regression and the drop in plasma prolactin levels. Also, during gonadal recrudescence testicular size was more positively correlated with prolactin than with LH. Since follicle stimulating hormone was not measured, its role in the observed responses could not be assessed.

It seems clear from this study that increasing, but short, daylengths do little to promote growth of the reproductive organs of male hamsters. Indeed, it appears the major feature involved is the length of the photoperiod since even though the days were increasing in length the gonads underwent involution. Inasmuch as hamsters placed in natural photoperiods in September and October become sexually competent the following March (8), it appears that this restoration is endogenous as originally suspected (4), rather than being related to the increasing photoperiods in the spring of the year.

Summary. Exposure of adult male hamsters to short (<12.5 hr light/day) but increasing daylengths beginning on December 28 was followed by involution of the testes and accessory sex organs. These changes were accompanied by a drop in pituitary LH and prolactin and by a depression in circulating levels of these hormones. The reproductive organs and hormone levels remained depressed until about May 3 at which time there was evidence of restoration of the weights of the sex organs and a reestablishment of normal hormone levels. By June 1 all reproductive parameters that were measured had returned to preexperiment levels. It is apparent from these results that absolute daylength rather than increasing photoperiod is more important in maintaining the functional capacity of the neuroendocrine–reproductive axis of male Syrian hamsters.

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