7.4 The Critical Photoperiod in the Djungarian Hamster *Phodopus sungorus*

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1 Introduction

In many vertebrates the annual cycle of reproductive and other functions is regulated by photoperiod (Turek and Campbell 1979, Hoffmann 1981a). In some bird species it has been shown that once the photoperiod exceeds a critical duration, gonadal growth is stimulated, and the rate of growth is proportional to day length (Farner 1975, Follett and Robinson 1980). In mammals, the critical photoperiod has been determined in the golden hamster (Gaston and Menaker 1967, Elliott 1976). Twelve and a half h of light or more maintained gonadal activity or stimulated recrudescence, photoperiods of 12 h or less induced regression. Above or below this critical photoperiod, no influence of the length of the light period could be detected. Since the golden hamster is the only mammalian species in which the critical photoperiod has been determined precisely, we examined the reaction in different photoperiods in a related species, the Djungarian hamster *Phodopus sungorus*. This hamster also shows strong photoperiodic reactions (Hoffmann 1972, 1978a, 1981b). The results are in agreement with, and lend support to, the suggestion that the pineal is involved, not only in the transduction of the inhibitory effects of short photoperiods, but also participates in the stimulatory effects of long photoperiods (Hoffmann 1977, 1979a, 1981b, Hoffmann and Küderling 1975, 1977).

2 Material and Methods

*Phodopus* differs from the golden hamster in one important aspect: not only adults react to photoperiod, but development to puberty is also photoperiodically controlled (Hoffmann 1978b). In long photoperiods, first spermatozoa are found in the epidydimal cauda at about 35 days, while in short photoperiods testicular development is arrested for a considerable time. In order to strictly standardize the experiments, 35-day-old male *Phodopus* were used in the experiments. Breeding pairs were maintained in long photoperiods. Within 48 h after parturition, they were moved, with their litter, into long (LD 16 : 8) or short (LD 8 : 16) photoperiods. Temperature was kept at 20 ± 1°C, light intensity above the cages was between 40 and 600 lx, depending on position of cage in the
room. No differences in development, due to differences in light intensity, were observed within this range. The young were weaned at 21 days of age, and males were placed singly in plastic cages in the same room under the same conditions.

At 35 days, the hamsters were palpated for testis size. In LD 16 : 8, all animals had large testes. In LD 8 : 16, testes were not palpable in most cases, the few males with palpable testes were discarded (cf. Hoffmann 1978b). From each of the two light schedules, 16 animals were killed to serve as initial controls (IC). Other males were placed in one of the following light regiments: LD 1 : 23, 4 : 20, 8 : 16, 10 : 14, 11 : 13, 12 : 12, 13 : 11, 14 : 10, 15 : 9, 16 : 8, 20 : 4 or 24 : 0 (LL). Light-times were centered around local noon in all schedules. After 45 days in these conditions, the hamsters were killed. Body weight and fresh weight of testes and accessory glands (seminal vesicles, coagulating glands, ampullary glands) were determined. Testes were fixed in Bouin, embedded in Paraplast, sectioned at 10 μm and stained in Mayer’s haemalum and eosin. Tubular diameter in the left testis was determined from 10 measurements in each animal. Experimental groups consisted of 15-19 animals in each light schedule, a total of 460 young male Phodopus was used. For statistical evaluation, the two-tailed U-test was employed throughout. In addition, older males (6-8 months) which were in winter condition due to exposure to natural daylight, were placed in LD 8 : 16, 16 : 8 or 24 : 0 (LL) for 47 days, starting in early December. Otherwise, treatment was identical to that of 35 days old young males.

3 Results

Figure 1 shows testis weight of the young hamsters after 45 days in the different light schedules. In males coming from LD 16 : 8 (Fig. 1A), testes had significantly regressed in all groups that were exposed to photoperiods with 12 h light or less (in all groups p <0.002 versus IC). There was no significant difference between these groups. In some animals, testes did not regress in the short photoperiod. This also occurred in previous experiments with short days and seems to be a regular phenomenon (Figala et al. 1973, Hoffmann 1978b). In LD 13 : 11, there was regression in some animals only (p <0.01 versus all groups with shorter photoperiods; p <0.02 versus IC; p <0.002 versus all groups with longer photoperiods). In longer photoperiods, there was some further development compared to initial controls (p <0.01 for photoperiods with 15 h or more light per day).

No significant difference between hamsters maintained in LD 14 : 10, 15 : 9 and 16 : 8 could be detected. In even longer light periods, however, testicular weight was slightly higher (p <0.02 for LD 20 : 4 versus 14 : 10; p <0.02 to <0.002 for LD 24 : 0 versus LD 14 : 10, 15 : 9 or 16 : 8). In general, the data in animals coming from long photoperiods show that there is a marked critical photoperiod at around 13 h light per day. In addition, they suggest that very long photoperiods and constant light are somewhat more stimulatory (cf. also Fig. 2a).

In hamsters with initially small testes, coming from LD 8 : 16, the results are similar for short photoperiods (Fig. 1B). There was even some further regression compared to initial controls (p <0.05 for groups with 1 to 10 h light per day). In LD 11 : 13 and 12 : 12, slight development could be discerned in some animals (p <0.05 to <0.002 versus any of the shorter photoperiods), and development in LD 12 : 12 was slightly increased versus LD 11 : 13 (p <0.05). In LD 13 : 9, testis size was significantly higher than in