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The Effect of Photoperiod on Sexual Development in Young Boars

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Summary and Implications

The effects of photoperiod in stimulating reproductive function in prepubertal boars was studied in 40 crossbred boars. One group of boars was exposed to a regimen where day length was increased from 12 to 14.5 h/d (from 8 to 20 weeks of age) and then decreased from 14.5 to 12 h/d (from 20 to 32 weeks of age); whereas, the other group of boars was exposed to a regimen where day length was decreased from 12 to 9.5 h/d and then increased from 9.5 to 12 h/d. Exposing prepubertal boars to a long photoperiod inhibited the development of the testis at 24 weeks of age. The inhibitory effect of long days on testis development at 24 weeks of age was overcome by decreasing the photoperiod. Short days reduced the level of sexual behavior at 25 and 26 weeks of age. The inhibitory effects of short days on sexual behavior was overcome by exposing boars to a longer period. This study implies that young boars reared during short days may need to be exposed to a longer photoperiod before expressing an adequate level of sexual behavior and young boars reared during long days may need to be exposed to shorter days to increase their sperm production capability.

Introduction

The role of photoperiod on reproduction in the male pig has been largely ignored. Most males destined for breeding are reared in some kind of testing facility, but the photoperiod regimen employed in the rearing area is rarely, if ever, considered. There is some evidence to suggest that long day length is inhibitory to steroid synthesis, sperm production and sexual behavior in mature boars but the effect of photoperiod on pubertal development in young boars is less clear. In general, reproductive performance of boars reared in a constant long-day of 15 hours of light has not been different from boars reared on a constant short-day of 8 hours of light. However, the effect of a step-wise light regimen that simulates a natural photoperiod over time on sexual development and behavior has not been studied in male pigs. In this experiment we examined the effect of two step-wise photoperiod regimens during rearing on the sexual and behavioral development of young boars.

Materials and Methods

A controlled-environment building with two similar rooms, each containing four pens was used in this experiment at the Western Australian Department of Agriculture Medina Research Center. Light in both rooms was provided by eight fluorescent tubes and the average light intensity 15.6 inches above the floor was 270 lux. Temperature was maintained as close as possible to 73.4°F in both rooms.

Two light regimens were created by providing different light:dark ratios in each room (Figure 1). At the start of the experiment, boars in both rooms received 12 hours of light and 12 hours of dark (12L:12D) with lights on at 6:00 a.m. and off at 6:00 p.m. In the long-day (LD) regimen the light phase was increased by 15 minutes per week for six weeks then by 10 minutes per week for a further six weeks to give a maximum light:dark ratio of 14.5L:9.5D in the week of summer solstice (longest day length). In the short-day (SD) regimen the light phase was decreased by 15 minutes per week for six weeks then by 10 minutes per week for a further six weeks to give a minimum light:dark ratio of 9.5L:14.5D in the week of the summer solstice. Afterwards, day length was increased (short-day) or decreased (long-day) by 10 minutes per week for six weeks and 15 minutes per week for a further six

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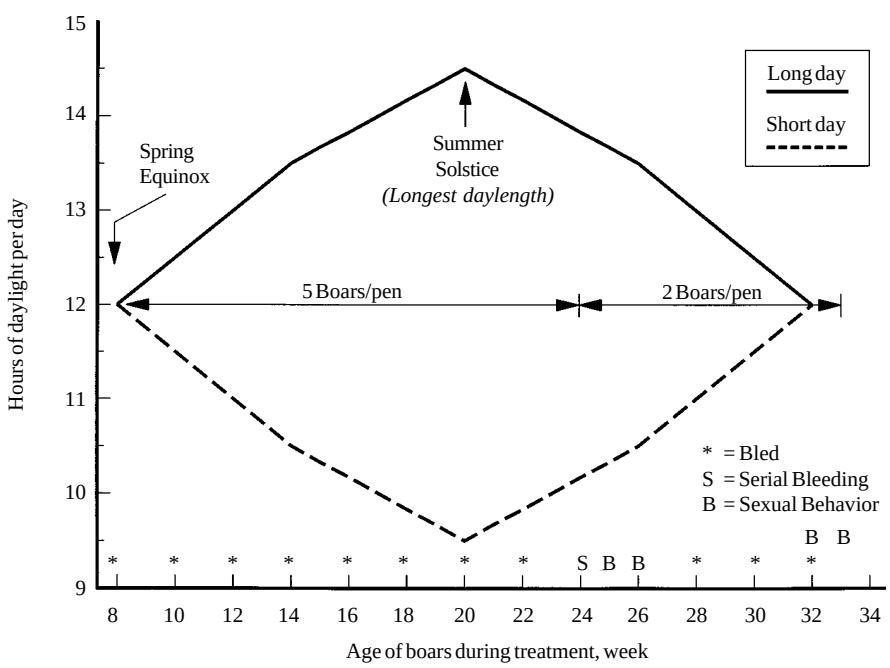

Figure 1. Light regimens and protocol for blood sampling and sexual behavior evaluations for long- and short-day treatments.

weeks so that the light:dark ratio returned to 12L:12D at the end of the experiment.

A total of 40 Large White x Landrace boars were reared together from weaning under natural daylight until transfer to the controlled environment rooms at an average age and weight of 56 ± 5 days and 43.3 ± .7 lb, respectively. There were four pens per room with five boars per pen. The experiment started when natural light:dark ratio was 12L:12D (spring equinox). The boars were weighed and blood sampled every two weeks from eight until 24 weeks of age. At 24 weeks of age three boars from each pen were removed from the controlled-environment rooms. The boars were removed to: (1) prevent damage to the indwelling catheters that were surgically inserted into the jugular vein of two boars in each pen, (2) prevent physical interaction between boars in a pen on the day sexual behavior was evaluated, and (3) to avoid overcrowding during the remaining weeks of the experiment.

During the time when the catheters were inserted in the eight boars, the size of testicles was measured using calipers. Total testicular volume was estimated from the formula for a right ellipsoid ($4/3\ \pi\ h\ r^2$, where $\pi = 3.14$, h = height, and r^2 = radius squared).

Boars were evaluated for sexual behavior at 6 and 7.5 months of age. During the 10-min (600 seconds) sexual behavior tests when the boar had direct contact with an estrous gilt, the following sexual behavior traits were recorded to the nearest second: nosing head area of gilt (DNH), nosing side and flank area of gilt (DNS), nosing ano-genital area of gilt (DAG), time to first mount (TFM), time to first extension of penis, duration of mounts without penis exposed (DMNP), duration of mounts with penis exposed (DMWP), time to first intromission (TI), and duration of copulation. Number of mounts and copulations were also recorded. A sexual behavior index score (SBI) was calculated for each boar by the following formula: SBI = (600 - TFM) + DNH + DAG + (2 x DNS) + DMNP + (3 x DMWP) + [5 x (600 - TI) ÷ 600)]. The boars were not given assistance with copulation. Estrous gilts were prepared by priming prepubertal gilts about 170 to 190 days of age with 1.2 mg of estradiol benzoate four to five days before the behavior testing of boars.

The testicles were collected at slaughter to estimate daily sperm production. The right epididymis and testis were separated and weighed. Three samples of one gram each from the proximal, mid, and distal regions of the testis were used to determine daily sperm production. The three grams of tissue were homogenized and the number of homogenization resistant sperm nuclei was counted in duplicate for each sample with a hemacytometer.

Results and Discussion

Average daily gain and average concentration of testosterone from 8 to 24 weeks of age were not different between the two photoperiod regimens (average daily gain: LD, 1.85 lb/d and SD, 1.98 lb/d; average testosterone concentration: LD, 3.9 ng/mL and SD, 4.4 ng/mL). The following results are only for the 16 boars that remained in the controlled-environment rooms until 33 weeks of age. The average concentration of testosterone in SD boars increased ($P < .01$) from 3.3 ng/mL at 24 weeks of age to 8.1 and 12.7 ng/mL at 28 and 30 weeks of age; whereas, in the LD boars the concentration of testosterone changed less dramatically from 3.7 ng/mL at 24 weeks of age to 5.7 ng/mL and 6.9 ng/mL at 28 and 30 weeks of age. Testosterone concentration differed ($P < .05$) between treatments at 30 weeks of age.

Testis volume was larger in SD than LD boars at 24 weeks of age (Table 1). At 33 weeks of age the SD boars had numerically but not statistically greater average values than LD boars for testes weight, sperm per gram of testis, and total sperm per testis.

The sexual behavior traits of boars at weeks 25 and 26 of age are illustrated in Table 2. Boars kept in the long-day photoperiod regimen mounted more ($P<.02$) times than did boars kept in the short-day photoperiod. The LD boars also tended ($P < .07$) to spend a greater sum of time courting gilts and being mounted on gilts than SD boars, thus LD boars tended ($P < .06$) to have higher SBI scores than SD boars. Although SD boars tended to have larger testis and a greater concentration of testosterone, we speculate that the higher level of sexual activity in LD boars is due to their having more daylight hours to mount, ride and interact with each other. It was noted that when the lights went off, the SD boars soon laid down to sleep.

The main reasons why the boars did not copulate during the mating tests at 25 and 26 weeks of age were

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Table 1. Comparison of testicular characteristics of boars reared in either a long- or short-day photoperiod regimen (mean ± SE)

Item	Treatment		P[c]
	Long day[a]	Short day[b]	
Age at measurement, wk	24	24	
No. of boars	8	8	
Testis volume, cm^3/lb BW	3.58	5.64	.01
Age at slaughter, wk	33	33	
No. of boars	8	8	
Body wt, lb	368 ± 4.6	365 ± 12.8	
Epididymal wt, g	126 ± 8.3	122 ± 5.3	.71
Testis wt, g	512 ± 47.0	547 ± 31.0	.53
Sperm/g testis, 10^6	115.24 ± 6.1	132.19 ± 10.2	.18
Total sperm/testis, 10^{10}	5.85 ± .6	7.08 ± .3	.08

[a]Long day = increasing from 12 h to 14.5 h day length from 8 to 20 wks of age then decreasing from 14.5 h to 12 h day length from 20 to 32 wks of age.
[b]Short day = decreasing from 12 to 9.5 h day length from 8 to 20 wks of age then increasing from 9.5 to 12 h day length from 20 to 32 wks of age.
[c]P = probability of difference between light regimens.

Table 2. Comparison of sexual behavior traits of boars reared in either a long- or short-day photoperiod regimen (eight boars per treatment)

	Sexual behavior test				Probability	
Item	1	2	3	4	LD vs SD[a]	Time
Age at evaluation, wk	25	25	26	26		
Sum of all time spent courting and mounted, sec						
Long-day boars	154.4	219.3	193.5	194.4	.07	.20
Short-day boars	92.9	121.6	89.5	128.3		
Number of mounts						
Long-day boars	3.9	7.5	5.6	6.3	.02	.07
Short-day boars	.5	.9	.6	1.3		
SBI score[b]						
Long-day boars	.74	1.16	1.19	1.12	.06	.04
Short-day boars	.32	.52	.37	.57		
Proportion of tests with a copulation						
Long-day boars	0	0	0	0		
	(37.5)[c]	(62.5)	(62.5)	(62.5)		
Short-day boars	0	0	0	0		
	(12.5)	(12.5)	(12.5	(25.0)		

[a]LD = long day and SD = short day.
[b]Sexual behavior index (see text for details).
[c]Proportion of boars mounting.

Table 3. Comparison of sexual behavior traits of boars reared in either a long- or short-day photoperiod regimen (eight boars per treatment)

	Sexual behavior test				Probability	
Item	1	2	3	4	LD vs SD[a]	Time
Age at evaluation, wk	32	32	33	33		
Sum of all time spent courting and mounted, sec						
Long-day boars	170.0	170.1	290.9	341.9	.72	.01
Short-day boars	147.4	196.9	274.9	272.1		
No. of mounts						
Long-day boars	5.4	4.4	7.8	2.8	.45	.21
Short-day boars	2.0	3.3	4.4	4.7		
SBI score[b]						
Long-day boars	1.00	.82	2.29	2.45	.29	.03
Short-day boars	.75	1.31	1.23	1.10		
Proportion of tests with a copulation						
Long-day boars	0	0	25.0	37.5[c]		
Short-day boars	0	0	12.5	0		

[a]LD = long day and SD = short day.
[b]Sexual behavior index (see text for details).
[c]Copulation rate was greater ($P < .05$) for LD boars at the fourth evaluation.

that SD boars expressed a very low level of mounting behavior and LD boars lacked mating dexterity. Since the LD boars did mount the rear of the gilt for an average of 59.6 $\pm$ 11.9 seconds, they probably would have mated if given assistance with copulation. It is not uncommon to see young, inexperienced boars have difficulty with intromission. The average duration of time the two SD boars were mounted on the rear of the gilt was 79.6 $\pm$ 36.7 seconds.

The detrimental effects of short days on sexual behavior at 25 and 26 weeks of age were not observed when the boars were 32 and 33 weeks of age (Table 3). There was no difference at 32 and 33 weeks in the sum of all time spent courting and mounted, number of mounts, or sexual behavior index score. There was no difference in the proportion of tests with a copulation between SD and LD boars during sexual behavior tests 1, 2, or 3. However, LD boars copulated more ($P<.05$) times during the fourth evaluation.

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