Influence of season and social environment on basal and thyrotropin releasing hormone-induced prolactin secretion in the adult domestic boar

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Abstract. Basal and TRH-induced PRL secretions were investigated for adult Landrace boars housed in two social environments. Socially nonrestricted boars (N = 4) were individually penned adjacent to ovariectomized gilts that were hormonally induced into estrus every 3 weeks, while socially restricted boars (N = 4) were individually kept in pens with solid walls. In February, May and August all boars were fitted with jugular catheters for serial blood sampling which took place 2 h prior to and 4 h following in iv injection of TRH (1 μg/kg). Mean pre-injection serum PRL concentration was not influenced by either month or social environment. The PRL response to TRH injection, however, was influenced by both factors. The magnitude of the PRL response (peak Δ value) increased (month, P < 0.01) progressively in both groups of boars from February through August and was greater (P < 0.05) in the nonrestricted versus the restricted boars in August. The total amount of PRL secreted was also maximal and greater in the socially nonrestricted boars in August (month × social group, P < 0.05). These results indicate that TRH-induced and not basal PRL secretion is influenced by both season and social interaction of boars.

Seasonal variations in PRL secretion have been documented for many species including sheep (Sanford et al. 1984) and goats (Howland et al. 1985). The primary environmental factor responsible for these variations is photoperiod (Howland et al. 1983; Lincoln et al. 1978), although ambient temperature is also involved (Sanford et al. 1978; Schillo et al. 1978). Environmental regulation of PRL secretion appears to be different for the pig. In comparison with other species (Raud et al. 1971), blood PRL concentration for the pig (Hoagland et al. 1981) changes very little in response to physical stress. PRL concentration relates positively to daylength changes in wild pigs of both sexes and in domestic female pigs, but not in domestic male pigs (Ravault et al. 1982). Although mean PRL concentration is similar for gilts following exposure to constant 8- or 16-h photoperiods for 1 month (Kraeling et al. 1983), TRH-induced PRL secretion is increased in the gilts maintained on short days. This is in marked contrast to sheep where the TRH-induced PRL response is greatest when photoperiod is longest (Howland et al. 1983). Sexual activity/inactivity influences PRL secretion in the ram (Sanford & Yarney 1983; Yarney & Sanford 1983) and the male goat (Howland et al. 1985) in a season-
dependent manner. Whether or not interaction with females influences blood PRL concentration in the boar is not known.

We examined the effects of two environmental factors on PRL secretion in the domestic boar. A study was designed to investigate the influence of season (naturally occurring changes in daylength and ambient temperature) and social environment on basal and TRH-induced PRL secretion in adult male pigs.

Materials and Methods

Animals and housing

Eight purebred Landrace boars approximately 12 months of age and 214 ± 3 kg in body weight were housed in one of two social environments for a 12-month period, beginning in mid-September. A detailed description of these environments has been reported (Trudeau & Sanford 1986). Briefly, boars in a socially nonrestrictive environment (N = 4) were individually penned adjacent to and allowed minimal physical contact with individually penned ovariecotmized gilts which were hormonally induced into estrus every 2 weeks. Boars in a socially restrictive environment (N = 4) were housed individually in pens with solid walls to eliminate visual and physical contact with other pigs, although olfactory and auditory communication was possible. All pigs were housed in the same building and exposed to the natural daylength changes of Southern Quebec (lat. 45°30', long. 73°26'); daylength ranged from ~8.5 h in December to ~15.8 h in June.

Blood collection and hormone treatment

During February, May and August, a jugular vein of each boar was catheterized. While animals were under general anesthesia, vinyl tubing (inner diameter 1.57 mm, outer diameter 2.08 mm; BoLab Inc, Lake Havasu City, AZ) was inserted 25 to 30 cm into the jugular vein. A small collar constructed of larger diameter vinyl tubing (inner diameter 1.78 mm, outer diameter 2.79 mm) was cemented to the catheter to allow sc attachment. Securing the catheter with absorbable suture aided in maintaining patency, especially for those boars housed near gilts. All catheters were removed nonsurgically at the completion of each bleeding period.

Boars were bled on the sixth day post-surgery while restrained in their own pens in portable cages resembling farrowing crates. Only walking was restricted and boars had been habituated to this procedure. Gilts were not in estrus during the bleeding periods. Initially, blood sampling involved withdrawal of 5 ml every 20 min for a period of 2 h, starting at 09.00 h. Following collection of the seventh sample, a single iv bolus of TRH (1 µg/kg ; Sigma Chemical Co, St. Louis, MO) in 0.85% saline was administered via the catheter. Blood sampling continued at 10-min intervals during the first hour post-TRH injection and then at 20-min intervals for the next 3 h. Handling of blood samples and serum collection and storage were as reported (Sanford et al. 1984).

Prolactin assay

Serum samples (100 µl) were assayed in duplicate in a single assay for PRL concentration using a double-antibody radioimmunoassay procedure (van Landeghem & van de Weil 1978). This assay employed the pPRL preparation IVO-19-1-79 as reference standard.

Table 1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Social group</th>
<th>Date of assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>February 21</td>
<td>May 23</td>
</tr>
<tr>
<td>Basal concentration (µg/l)</td>
<td>Nonrestricted</td>
<td>3.5 ± 0.4a</td>
</tr>
<tr>
<td></td>
<td>Restricted</td>
<td>3.4 ± 0.5a</td>
</tr>
<tr>
<td>Peak Δ value (µg/l)</td>
<td>Nonrestricted</td>
<td>50.1 ± 9.8a</td>
</tr>
<tr>
<td></td>
<td>Restricted</td>
<td>50.2 ± 10.6a</td>
</tr>
<tr>
<td>Area under response (mg/l × min)</td>
<td>Nonrestricted</td>
<td>1.9 ± 0.5a,b</td>
</tr>
<tr>
<td></td>
<td>Restricted</td>
<td>1.9 ± 0.4a</td>
</tr>
</tbody>
</table>

Means (± SEM) represent four boars.

a,b,c,d For a given characteristic, means with the same superscript(s) are not significantly (P > 0.05) different.
Serum PRL responses to TRH injection (1 µg/kg) for socially nonrestricted (N = 4) and restricted (N = 4) adult Landrace boars throughout the year. Time 0 values represent 2-h basal concentrations. Daylengths at the time of assessment and mean monthly daytime high ambient temperatures are given in the inset. ●●● Nonrestricted boars. ○○○ Restricted boars.

Data and statistical analyses
The PRL response to TRH treatment was characterized in the following manner. The mean of the seven pre-injection PRL values was considered to represent basal concentration. Peak height was the highest value associated with the response curve; subtraction of basal concentration from peak-height estimate yielded a delta value (Sanford et al. 1984). The area under the response curve above basal concentration was calculated from a series of time and PRL concentration coordinates (Normand & Fortier 1970) to assess relative differences in total secretion.

Data were statistically analysed using the least-squares method of analysis (SAS 1979). All data were fitted to a model that include the main effects of social group and month. The group effect was tested using the boar-within-group mean square, while the effects of month and the group × month interaction were tested with the residual mean square. Comparisons were made between months and groups using the PDIF option of least-squares means.
Results

Basal PRL secretion (pre-TRH injection concentration) did not change appreciably throughout the year and was similar for both socially non-restricted and restricted boars during each month of assessment (Table 1). However, TRH-induced PRL secretion was influenced by both month and social environment (Table 1, Fig. 1). Although the peak PRL response always occurred within 10 min, the magnitude of the response (peak Δ value) increased (month, \( P < 0.01 \)) progressively between February and August; social environment had a secondary effect on peak magnitude in that in August, peak delta values for non-restricted boars were greater (\( P < 0.05 \)) than those for restricted boars. The total amount of PRL secreted following TRH treatment, as measured by area under the response curve, differed in a manner similar to that for peak delta value. In the latter instance though, variances in the patterns of seasonal change led to more definitive differences between the two social groups (group \( \times \) month, \( P < 0.05 \)). Progressive increases in the PRL response between February and August were closely associated with concurrent increases in ambient temperature (mean daytime highs for each month) and to a lesser extent with increases in photoperiod (Fig. 1).

Discussion

The present results indicate that TRH-induced PRL secretion, but not basal secretion, is influenced by both season and social environment. Throughout the study, pre-injection PRL concentration remained relatively low and constant, thus confirming previous reports on the pig (Ravault et al. 1982; Kraeling et al. 1983). Photoperiod-related changes in the PRL response to TRH have been reported for sheep (Schanbacher 1980; Howland et al. 1983) with the greatest response occurring during the longest days. Our results on the boar are in general agreement with these data, although the greatest PRL response was seen in August approximately 6 weeks following the onset of decreasing daylength. It may be that any stimulatory effect of long days is persistent for some time. In contrast, the PRL response to TRH injection was greatest in ovariectomized gilts maintained on 8 h of daylength, rather than on 16 h (Kraeling et al. 1983). The discrepancy in these results may relate to differences in the physiological states of the animal models and (or) in the photoperiodic programs employed.

Alternatively, a factor(s) other than photoperiod may be centrally involved in the regulation of TRH-induced PRL secretion in the boar. The influence of ambient temperature on PRL secretion in pigs is not known. Boars in the present study were exposed to moderate increases in maximum daytime temperature which averaged approximately 15°C in February, 19°C in May, and 24°C in August. These increases were not associated with changes in rectal temperature (Trudeau & Sanford 1986), but showed a striking similarity to the pattern of increases in the magnitude of the PRL response. Perhaps as for the sheep (Sanford et al. 1978; Schillo et al. 1978), increases in PRL secretion can occur in the boar in response to exteroceptorally detected increases in ambient temperature without increases in rectal temperature. It is known that treatment of intact male rats with pharmacological doses of estradiol benzoate increases the PRL response to TRH (Delean et al. 1977). Since testosterone concentration was highest in our boars in August (Trudeau 1986) and since increases in estrogen concentration would also be expected (Claus et al. 1985), it is conceivable that enhanced pituitary responsiveness to TRH related to changes in steroidal feedback on the pituitary.

PRL secretion in the pig is under tonic inhibition by dopamine (DA) (van de Wiel et al. 1985); and in the ewe, the suppressive effects of DA on PRL are greatest in the fall (Deaver & Dailey 1982). Seasonal increases in the responsiveness of the pituitary to hypothalamic PRL-releasing factors (e.g. TRH) may be required to counteract increases in DA inhibition and maintain basal PRL secretion in the boar. PRL is involved in the regulation of LH release and ovarian steroidogenesis in female pigs (van de Wiel et al. 1985) and is important for the maintenance of testicular LH receptors in golden hamsters (Klemcke et al. 1984). Similar actions of PRL in the boar may contribute to the increases in testosterone secretion noted in late summer and the fall (Claus et al. 1985; Trudeau 1986).

The presence or absence of female pigs influenced TRH-induced PRL secretion in the boars; a major group difference was noted in
August when the PRL response was maximal. Differences in gonadal steroid concentrations were probably not involved since both groups had similar serum testosterone values at this time (Trudeau 1986). PRL secretion is acutely increased in the male goat at most times of the year in response to a series of frequent matings (Howland et al. 1985) and in the ram in the breeding season in response to repeated mounting of ewes without intromission (Yarney & Sanford 1983). In this study, all boars were sexually active in that semen was collected weekly using the gloved-hand technique and a 'dummy sow' (Trudeau & Sanford 1986). Since gilts were never in estrus at the time of bleeding and boars were not involved in mounting and copulatory activity within 2 days of a scheduled sampling period, it is probable that the effect of social environment on the PRL response was mediated via the presence or absence of the visual and limited physical contact between boars and gilts. Exteroceptive stimulation is known to induce an elevation in PRL secretion in the lactating rat (Grosvenor et al. 1981) and sexual stimulation elicits changes in a number of hypothalamic neurotransmitter systems and stimulates PRL secretion (Gunnnett & Freeman 1983). Whether changes in the neurotransmitters involved in the regulation of PRL secretion (Kato et al. 1985) are responsible for the different PRL responses for the social groups warrants investigation.

In conclusion our results demonstrate that TRH-induced PRL secretion, but not basal secretion, in the adult domestic boar is influenced by both season and social environment. How these effects are mediated is not certain, but changes in photoperiod, ambient temperature and in the extent of physical and visual contact between boars and gilts appear to be involved.

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References

Deaver D R & Dailey R A (1982): Effects of dopamine, norepinephrine and serotonin on plasma concentrations of luteinizing hormone and prolactin in ovariec-
Gunnnett J W & Freeman M E (1983): The mating-induced release of prolactin: a unique neuroendo-
Howland B E, Sonya D, Sanford L M & Palmer W M (1983): Influence of photoperiod on thyrotropin relea-
Klemcke H G, Bartke A, Borer K T & Hogan M P (1984): Regulation of testicular prolactin and lutein-
izing hormone receptors in golden hamsters. Endo-
crinology 114: 594–603.

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