frequencies upto 250 Hz and sometimes upto 500 Hz (figure, a), and could always be collided with an appropriately timed spontaneous spike (figure, a, c–h).

In agreement with previous reports[3–5], a distinct population of cells could be recorded in the zona compacta of the substantia nigra which had wide action potentials, slow firing rates and were antidromically invaded following striatal stimulation. Also, in agreement with previous observations[4] slight variations in SD latency were seen which reflected the excitability of the somadendritic membrane and hence the rate of axon-soma invasion[7]. However, in the present study slight variations in the IS latency were also observed in many cells. These variations could be attributed to changes in axon excitability following conduction of the previous orthodromic action potential, a phenomenon described in other unmyelinated central axons[8–11].

More noticeable were the latency jumps of the antidromic spike in response to a constant or altered stimulus. 1, or occasionally 2, latency jumps have been reported in certain hypothalamic neurones[8,12–15] and have been attributed to activation along different parts of branched or twisted axons. Multiple latency jumps of the extent observed in some neurones in the present study have not been reported before. However, the dopaminergic nigrostriatal pathway is highly branched[2] and this extensive branching may account for the multiple latencies seen. Presumably, with increasing stimulus strength the current spreads to faster conducting branches or to activation points closer to the cell soma.

Finally, the variations in antidromic latency reported here may explain in part failure of earlier workers to antidromically identify compacta neurones[16].


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## Diurnal variations in serum and liver zinc levels throughout the 4-day estrous cycle of the hamster


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*Summary.* Diurnal variations of serum zinc level and liver zinc level of the golden hamster were found throughout the 4-day estrous cycle, and on the different days of the cycle, the patterns of fluctuation differed.


It is well known that zinc metabolism in animals is regulated homeostatically[1]. Although the diurnal changes of zinc levels in serum have been noted in man and in other mammals[2–5], such changes in other organs or changes in relation to the reproductive cycle are scarcely known as yet. We therefore examined the serum zinc concentrations and liver zinc concentrations at selected times of the day throughout the 4-day estrous cycle in the golden hamsters *(Mesocricetus auratus)*.

Adult virgin female golden hamsters weighing 135±23 g (mean ±SD, n=133) were kept under controlled conditions of temperature (23±3 °C), relative humidity

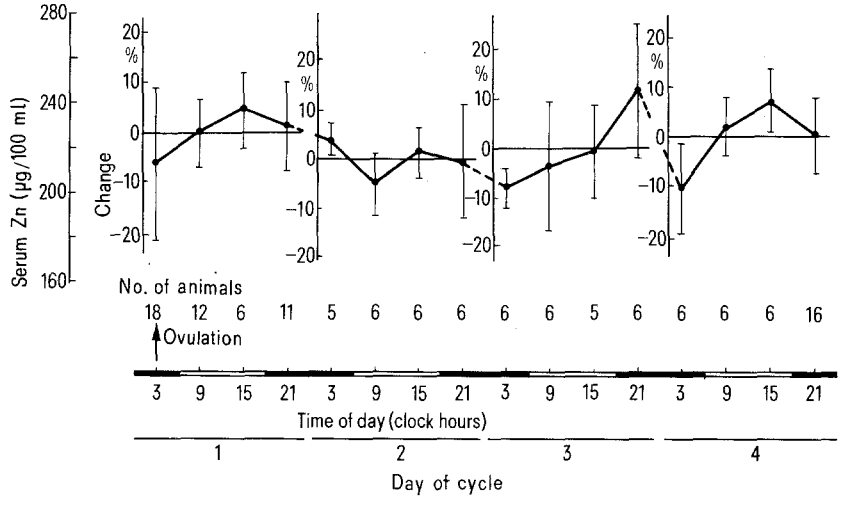


Fig. 1. Serum zinc concentrations of female hamsters throughout the 4-day estrous cycle. Points indicate the mean values ±SD in each group. The number of animals per group is shown in the figure. The analysis of variance revealed statistically significant diurnal changes on days 3 ($p < 0.05$) and 4 ($p < 0.01$) of the cycle. Also, significant changes with the day of the estrous cycle were observed at 09.00 h ($p < 0.05$) and 15.00 h ($p < 0.05$).

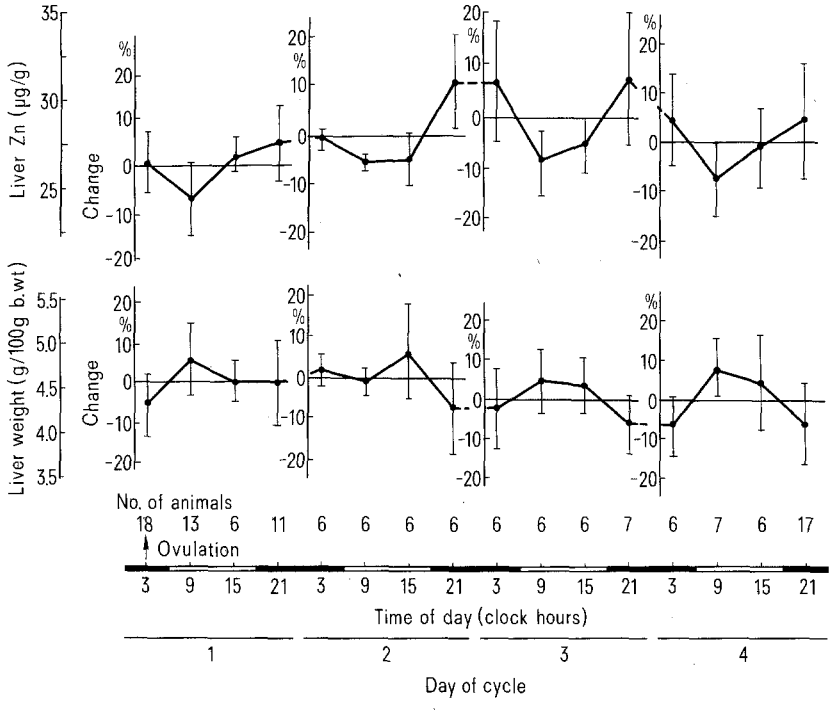


Fig. 2. Liver zinc concentrations and percent liver weights of female hamsters throughout the 4-day estrous cycle. Points indicate the mean values ± SD in each group. The number of animals per group is shown in the figure. By the analysis of variance, statistically significant changes in liver zinc concentrations with time of the day were seen on days 1 ($p < 0.001$), 2 ($p < 0.001$) and 3 ($p < 0.05$). Also, significant changes with the day of the estrous cycle were observed at 03.00 h ($p < 0.001$) and 21.00 h ($p < 0.05$).

(50 ± 10%) and lighting (light period, from 06.00 to 18.00 h) for at least 3 consecutive 4-day cycles before use. Day 1 of the estrous cycle was defined as the day of ovulation. Estrous cyclicity was monitored by the examination of the appearance of a sticky exudate in the vagina on the night of the day 4 of estrous period. Animals were anesthetized with sodium pentobarbital at selected hours (03.00, 09.00, 15.00 and 21.00 h) on each day of the cycle. Blood samples were withdrawn directly from the heart, and the whole livers were also removed and the wet weights were measured immediately. The samples were frozen at −20 °C until analyzed for zinc concentrations by atomic absorption spectrophotometry.

Figure 1 illustrates diurnal changes in serum zinc concentrations of female hamsters at 4 time points within each 24-h period throughout the 4-day estrous cycle. The zinc values in the serum fluctuated diurnally up to 10% of the average for each day on days 3 and 4. The patterns of fluctuations were somewhat different among the days of the cycle; on days 1 and 4, peaks were observed at 15.00 h, but, on day 3 of the cycle the highest level of serum zinc occurred at 21.00 h. These values of serum zinc concentrations in hamsters are much higher than the values observed in the human[6,7] and in rats[8,9]. This seems to represent a species difference. Figure 2 shows the sequential variations in zinc concentration in the liver, together with the variations in the relative weight of the liver (% weight to the b.wt) at 4 time points within 24 h throughout the 4-day estrous cycle. The liver zinc concentrations vary diurnally as much as 10% of the day average on day 2. The troughs of the liver zinc were observed at 09.00 h, and the peaks were observed at 21.00 h on days 1, 2 and 3. The observed fluctuations also did not repeat precisely the same rhythm on respective days of the cycle. As shown in figure 2, the relative weights of the liver fluctuate to the same extent as the liver zinc concentrations, apparently with a negative correlation to each other ($r = -0.75$, $n = 16$, $p < 0.001$). The change in liver zinc concentration seems rather secondary, due to variation of the relative weight of the liver.

Further, interrelationship between serum zinc levels and liver zinc content (zinc concentration × liver weight) was examined by partial correlation analysis keeping the body weight effect constant. There was a significant inverse relationship ($r = -0.696$, $n = 18$, $p < 0.01$) at 03.00 h on day 1 of the cycle. The observed alterations in serum zinc levels may be partially and negatively related to liver zinc fluctuations.

Because of the regularity of the 4-day estrous cycle, the golden hamster is one of the most widely used mammals in the field of reproductive physiology. Many papers on the dynamics of estrogen and progesterone in the blood of the female hamster have been reported recently[10,11]. These hormones are now considered as factors affecting serum zinc levels[6,7,12,13]. So, our findings of different patterns of the fluctuation of the zinc levels in the serum and liver on each day of the estrous cycle may relate to hormonal fluctuations during the reproductive cycle.

The diurnal fluctuation of the relative weight of the liver has been observed in rats as well[14]. Therefore, it may be proposed that this phenomenon must be taken into consideration when the contents of such chemicals as heavy metals in the liver are analyzed on a per-weight basis, especially when female animals are used.

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