

Plasma Thyroxine and Testosterone Levels in the Red Fox (*Vulpes vulpes* L.) During the Annual Cycle

In the red fox, plasma thyroxine and testosterone levels show clearly marked seasonal variations. During winter (the breeding season) plasma testosterone concentrations are high while plasma thyroxine levels are low. In spring the thyroxine level rises at a high rate while testicular activity is decreasing. In autumn there is another peak in plasma thyroxine concentration and the plasma testosterone level remains low. The existence of these opposite relationships between the two cycles is considered in terms of possible thyroid-testicular negative interactions.

It is now well established that in numerous wild animals, there is a cyclic activity in endocrine expression, in particular the testicular and the thyroid function. The variations observed in the endocrine function of these glands have very often been related to environmental changes and principally the photoperiod and/or the temperature. More recently, it has been suggested that over and above the role of these external factors there are possible interrelations between the endocrine activity of the testis and the thyroid. In the Peking duck and the teal, Assenmacher *et al.* (1975) and Jallageas *et al.* (1978) have, on the one hand, shown the existence of very peculiar phase relationships between the seasonal profiles of testosterone and thyroxine plasma levels and, on the other hand, verified in the Peking duck that there were reciprocal interactions between the annual reproductive and thyroid cycles (Jallageas and Assenmacher, 1979).

At the present time there are few data concerning these possible interactions in mammals. In the badger we have shown (Maurel *et al.*, 1977) that there is a strictly opposite relationship between plasma thyroxine and testosterone levels, but in the hedgehog (Saboureaux and Boissin, 1978) these opposite relationships occurred only at the beginning of the summer.

In this study we have determined, in the

red fox, the plasma changes in thyroxine and testosterone levels during the annual cycle and researched the possible relationships between these two cycles.

ANIMALS AND METHODS

Sexually mature male foxes captured in the numerous burrows located in the area of the laboratory, Chizé forest, France (latitude, 46°19'N; longitude, 00°24'W), were housed in individual pens in the forest under natural temperature and photoperiod. They were fed daily with dead hens produced on a standard farm. Water was available *ad libitum*.

Monthly or twice monthly each animal was slightly anesthetized with ether and blood samples (10 ml) were collected from the radial vein in heparinized tubes. After centrifugation, the plasma was stored at -25° until assayed. The concentration of testosterone was measured by radioimmunoassay with the method described previously for the badger (Maurel *et al.*, 1980). After all validation tests, total plasma thyroxine was assayed by the isotopic competition technique used for the badger (Maurel and Boissin, 1979). For the two assays each plasma sample (0.8 ml for testosterone, 0.3 ml for thyroxine) was duplicated. All samples were collected between 9 and 11 AM.

The significance of the results was assessed by Anova's method.

RESULTS AND DISCUSSION

Figure 1 indicates the seasonal variations in the mean values (mean \pm SEM) of testosterone and total thyroxine concentrations. The plasma thyroxine level is minimal in December (10.9 ± 0.6 ng/ml, 1976; 12.9 ± 0.7 ng/ml, 1977) and always low

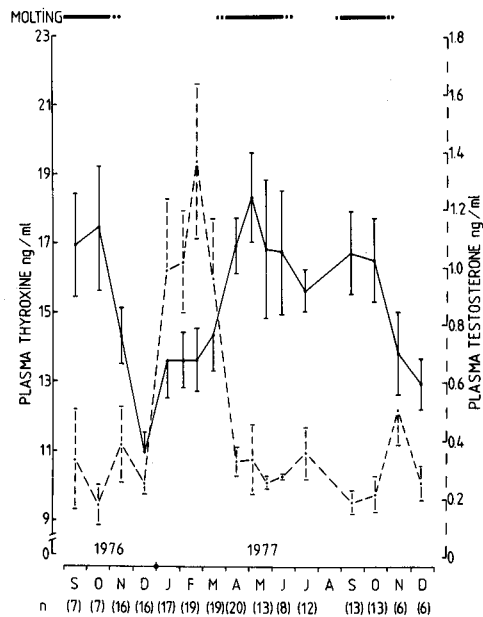


FIG. 1. Seasonal variations of thyroxine (solid line) and testosterone (dashed line) levels and molt in red foxes (mean \pm SEM). For each month, n is the number of animals investigated.

during the winter (13.6 ng/ml from January to March). Higher values are observed in spring (18.3 ± 1.3 ng/ml, April) and at the beginning of autumn (17.4 ± 1.8 ng/ml, October 1976; 16.7 ± 1.2 ng/ml, October 1977). These periods (spring and autumn) of high thyroxine values correspond to the periods of molt in foxes. In summer the values are higher than in winter, although there are no statistical differences between them. The plasma testosterone concentration shows a peak in winter (from January to March) with the highest value occurring in February (1.36 ± 0.27 ng/ml). From April to December the values are always low and fluctuate about a mean level of 0.27 ± 0.02 ng/ml. The plasma testosterone changes observed in the red fox confirm data published by Joffre and Joffre (1975). The high testosterone values observed in January and February correspond to the breeding season and territorial behavior observed for the red fox at this time in the Chizé forest (Maurel, 1980).

Maximal values of testosterone correspond to the minimal values of thyroxine, and high values of thyroxine (from April to October) correspond to the minimal values of testosterone. The period of increasing plasma thyroxine corresponds to the period of decreasing plasma testosterone (February to April). However, the decrease in the plasma thyroxine level occurred in November–December and during this time the plasma testosterone level still remained low; at this period of the year such an exact relationship does not exist, but it is possible that the increase of the endocrine testicular activity may start only after the decrease in the plasma level of thyroid hormones. Therefore, the existence of these opposite relationships at certain periods of the cycle allows us to consider that there are direct negative interactions between the two functions. Further experiments will be necessary to describe them more accurately.

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Accepted July 1, 1980*