CHAPTER 9

EFFECT OF THYROIDECTOMY DURING THE PREMIGRATORY PERIOD ON PREMIGRATORY HYPERLIPOGENESIS IN MIGRATORY BIRD, ROSY PASTOR (*STURNUS ROSEUS*)

Considerable work has been done on the effects of thyroid hormone on the carbohydrate, protein and lipid metabolism in mammalian body. Efforts have also been made to throw light on thyroid status and its effects on the intermediary metabolism in birds (Dodd and Matty, 1964; Sturkie, 1965; Raheja *et al.*, 1971; Snedecor *et al.*, 1972; Balnave, 1973; Thapliyal *et al.*, 1973, 1975). John *et al.* (1972) reported that thyroxin influences the rhythm of fattening response to prolactin in the pigeon. In the migratory birds also the thyroid is reported to play some role in premigratory fat deposition. George and Naik (1964a) and Pilo and George (1970) suggested that increased thyroid activity in Rosy Pastors during their premigratory period facilitates premigratory fattening and provides stimulus for migration. However, it is not clearly known that how thyroid gears up such metabolic activities in the migratory birds. It was therefore considered important to study the effect of thyroidectomy on the enzyme system

which could be correlated with physiological changes leading to fat deposition during the premigratory period.

MATERIALS AND METHODS

Rosy Pastors (Sturnus roseus) were captured from wild population in the third week of February (premigratory phase) and were caged in the out door aviary in a group of five per cage (2.5' X 4.5') with wire mesh on all the sides except the floor. The food (consisting mainly of fruits and a few cockroaches) and water were given ad libitum. After a period of one week of captivity when the birds were acclimatised to the captive condition, a group of birds was subjected to surgical thyroidectomy and an another was sham operated (which was treated as control), after recording their body weight. Equal amount of food was provided to both the groups of the birds. After one month, the birds of both the groups were weighed, sacrificed and tissues viz., liver, small intestine and pectoralis major muscle were quickly removed and processed for study as follows:

Liver: Quantitative estimations of Succinic dehydrogenase, Glucose-6-phosphate dehydrogenase and "Malic" enzyme and

lipid in the liver were carried out as per methods described in Chapters 5, 4 and 6.

Small intestine: Acid and alkaline phosphatases in the small intestine were estimated as per procedure described in Chapter 1.

Pectoralis major muscle: Succinic dehydrogenase and lipid contents were estimated in the muscle according to methods described in Chapters 5 and 6 respectively.

RESULTS

Body weight of control Rosy Pastors was significantly higher than that of thyroidectomized ones (Table 1). It was observed that food intake and the amount of abdominal fat was more in control birds compared to that in thyroidectomized ones. Alkaline phosphatase activity in the small intestine, SDH activity in the liver and muscle, G-6-PDH and "Malic" enzyme activities in the liver of athyroidic Rosy Pastors as compared to the control ones were significantly lower. However, acid phosphatase activity in the small intestine of thyroidectomized birds did not differ significantly from that of euthyroidic ones.

TABLE 1

Body weight, liver and muscle lipid content and activities of enzymes in small intestine, liver and muscle of control and thyroidectomized Rosy Pastor. Mean value ± S.D.

	Control	Thyroidectomized	*Significant at the level
Body weight	86.0 ±3.4	61.6* ±3.5	P<0.001
Small intestine: Acid phosphatase	0.599 ±0.018	0.558* ±0.029	NS
Alk. phosphatase	3.68 ±0.28	2.09* ±0.18	P<0.005
Liver: SDH	13.21 ± 0.79	10.09* ±0.79	P<0.05
Muscle: SDH	8.80 ± 0.23	4.14* ±0.95	P<0.01
Liver: G-6-PDH	15.80 ± 1.34	8.57* ±0.41	P<0.05
Malic enzyme	111.05 ±14.35	65.53* ±8.12	P<0.05
Liver lipid gm/100 gm wet liver	8.89 ±0.53	8.21* ±0.35	NS
Muscle clipid gm/100 gm wet muscle	17.43 ±2.38	6.35* ±0.79	P<0.01

*P values refer to differences between control and thyroidectomized birds. The Student's 't' test was used to analyze differences in means. NS = Difference observed is not significant. Activities of enzymes are expressed as mentioned in foregoing chapters.

Concentration of hepatic lipids in both the groups of birds was almost same, while the lipid content of pectoralis major muscle of the birds with thyroid was significantly higher than that of the athyroidic birds (Table 1).

DISCUSSION

The present findings that the athyroidic birds had lower body weight and less amount of abdominal adipose tissue are suggestive of low rate of fat deposition in their body. It was observed that euthyroidic birds ingested more food than athyroidic ones. This is indicative of involvement of thyroid activity in development of hyperphagia during the premigratory period. The suggestion finds support from the work of Schildmacher and Rautenberg (1952) who reported that injection of thyroxine to Bramblings and Chaffinches resulted in an increased food intake and consequently an increase in the body weight due to fat deposition despite higher metabolic rate.

Alkaline phosphatase is an enzyme involved in absorption, secretion and thereby it plays an important role in the intestinal functions (Chapter 1). Higher intestinal alkaline phosphatase activity observed in the

control birds compared to that of the thyroidectomized ones points out the importance of thyroid in the expression of the intestinal functions. Present investigation confirms our presumption (Chapter 1) that increased thyroid activity during the premigratory period is responsible for the adaptive changes in the alimentary canal of these migratory birds. In the mammals too, the thyroid has been reported to have effect on small bowel structure and functions (Gelb and Gerson, 1969). Holliday et al. (1962) also reported that thyroid hormones facilitate increased absorption of carbohydrates.

Thyroid hormone not only influences the functional activity of the small intestine but also affects the metabolism of the ingested food as evident from the difference in levels of activities of different enzymes in various tissues of the thyroidectomized and control birds (Table 1). A low level of SDH activity in the liver and muscle of athyroidic Rosy Pastors is indicative of reduced rate of oxidative metabolism in these tissues as compared to that in those with intact thyroid. Thus the observations are in good agreement with those reported for other vertebrates wherein it has been suggested that several tissues share in the rise of oxygen consumption when animals are treated with thyroid or thyroid hormones

(Barker, 1955; Pitot and Yatvin, 1973; Hoch, 1974). Conversely, following thyroidectomy oxygen consumption is reduced in whole animal and its tissues (Bray and Goodman, 1968).

Compared to G-6-PDH and "Malic" enzyme activities in the liver of thyroidectomized birds, the activities of these enzymes in the liver of control birds were significantly high. Thus it becomes obvious that thyroid hormones influence the activities of G-6-PDH and "Malic" enzyme, in the liver of the migratory birds. Alterations in thyroid status are known to affect the activities of NADP-dependent enzymes. Bargoni et al. (1966) and Raheja et al. (1971) reported that "Malic" enzyme activity decreased in propylthiouracil-fed rats and chick respectively. Surgical ablation of thyroid in rats also decreased the "Malic" enzyme activity (Murad, 1968). Thyroid hormone is known to increase G-6-PDH and "Malic" enzyme activities in the liver of birds and mammals (Freedland, 1965; Reed and Tepperman, 1968; Chandrabose and Bensadoun, 1971b; Snedecor et al. 1972). There is a reason to believe that though thyroid is considered to influence G-6-PDH and "Malic" enzyme activities in the liver of migratory bird (Rosy Pastor), it could be one of the endocrine factors and not the only factor influencing

the activities of NADP-dependent enzymes and lipogenesis, because even in the thyroidectomized Rosy Pastors during the premigratory period the activities of G-6-PDH and "Malic" enzyme were found to be higher compared to their levels in the liver of Rosy Pastors bearing thyroid during their postmigratory period.

In the liver of euthyroidic birds, the higher rate of oxidative metabolism; by virtue of its making provision for more energy (ATP), and higher activities of NADP-dependent enzymes; which provide NADPH, pave way for higher rate of lipogenesis in their liver. Newly synthesized lipid is found to be stored in the adipose tissue. Inspite of the expected higher rate of lipogenesis in the liver of the control birds, the hepatic lipid concentration in these birds and that of athyroidic birds were almost same (8.5 gms/100 gms of liver). This could be due to a higher rate of removal of newly synthesized lipid from the liver to the site of storage in the case of control birds and comparatively lower rate of lipid synthesis in the thyroidectomized ones as there was poor lipid deposition in the fat depots in these birds. Higher level of lipid content in the muscle of euthyroidic Rosy Pastors compared to that of thyroidectomized birds, could be

perhaps due to higher rate of lipogenesis in the muscle as well as due to accumulation of lipids there transported from the liver.

Thus, on the basis of the present findings it could be deduced that increased thyroid activity in the migratory birds during their premigratory period is well involved in adaptive physiological changes in the intestine as well as in liver and other tissues. These adaptive changes influenced by thyroid could be summerized as follows (Fig. 1).

1) Hyperphagia
2) Increased digestion and absorption
3) Increased lipogenesis in the liver
4) Increased mobilization of fat from the liver
5) Increased deposition of fat in the adipose tissue
6) Hypertrophy and hyperplasia of tissues.

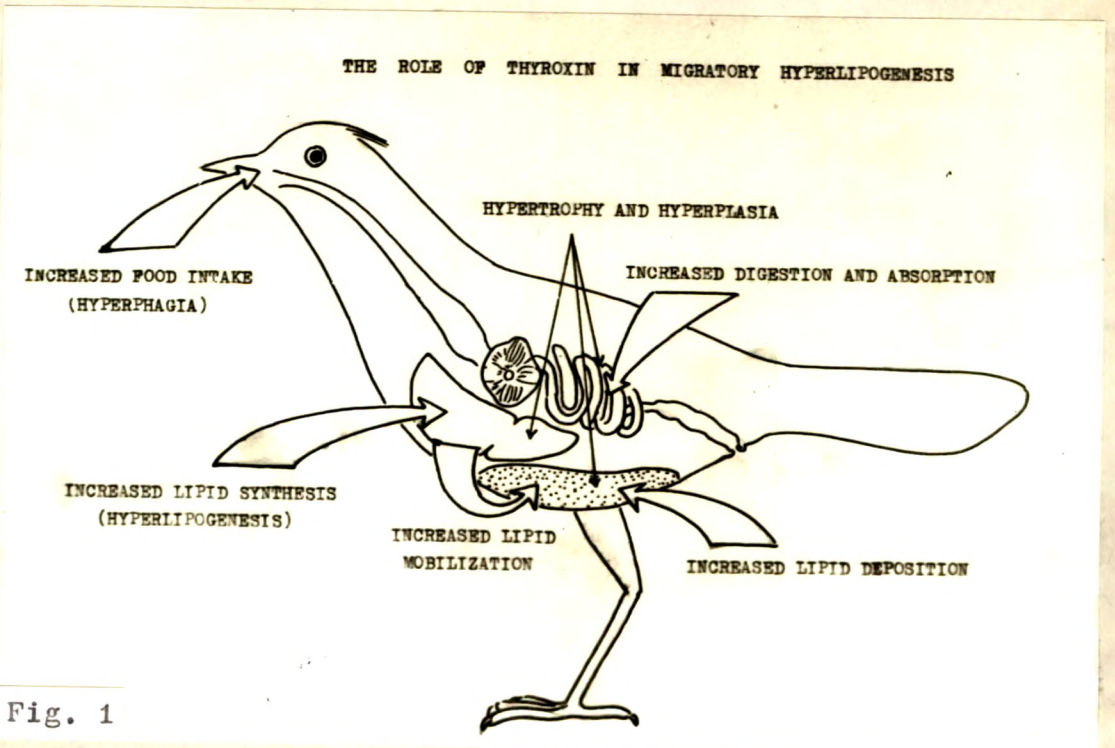
THE ROLE OF THYROXIN IN MIGRATORY HYPERLIPOGENESIS
HYPERTROPHY AND HYPERPLASIA
INCREASED FOOD INTAKE
(HYPERPHAGIA)
INCREASED DIGESTION AND ABSORPTION
INCREASED LIPID SYNTHESIS
(HYPERLIPOGENESIS)
INCREASED LIPID
MOBILIZATION
INCREASED LIPID DEPOSITION

Fig. 1