Chapter II

PINEAL-ADRENAL-THYROID INTERACTIONS IN TESTICULAR FUNCTIONS OF FERAL PIGEONS : STUDIES WITH EXOGENOUS CORTICOSTERONE ADMINISTRATION IN THE NON-BREEDING PHASE.

Previous studies on seasonal testicular cyclicity in the blue rock pigeon had revealed a parallel adrenal-gonad relationship and an inverse thyroid-gonad relationship (Patel, et al., 1985; Ramachandran and Patel, 1986; Ayyar, 1987; Ayyar et al., 1992). These inferences were supported by the recorded relatively higher corticosterone (CORT) level and relatively lower T_4 level in the breeding season and vice-versa in the non-breeding season (Patel, 1993). Since, it is revealed that the active testicular phase is paralleled by increased adreno-cortical activity and circulating CORT level, the present study was essentially conducted to see the possible influence of exogenous CORT in the non-breeding season on the histomorphology of adrenals, thyroid and testes and also on the serum levels of T_4 and CORT.

MATERIALS AND METHODS :

Procurement and maintenance of pigeons and preparation of CORT are as outlined in chapter I.

Experimental setups :

In the non-breeding phase (October), a total of 18 male pigeons were randomly divided into three groups. Two female birds were kept per group.

Group I (Control:C). These birds were given daily injections of 0.9% saline at 09.00h.

Group II (CV). These birds were given daily injections of the vehicle.

Group III (CORT). These birds were given daily injections of 2μg CORT in 0.1 ml vehicle at 09.00h.

All the above injections were given intraperitoneally (ip) at 09.00h for 15 days. However, none of the parameters studied presently showed any alteration between Group I and Group II and hence only data of Group I is presented.

Parameters and Methodology of evaluation :

Morphometry, histology and estimation of serum T_3, T_4 and CORT are as outlined in chapter I.

RESULTS:

Relative weight
(mg/100 g body wt)

Treatments	Testes	Adrenals	Thyroid
Control	16.42 ± 1.10	9.97 ± 0.48	9.06 ± 0.53
CORT	26.73* ± 1.90	8.71 ± 0.43	8.23 ± 0.81

Table IIa Changes in relative weight of testes, adrenals and thyroid of pigeons subjected to hypercorticalism in the quiescent phase.

(* Significant at $\underline{P} < 0.05$; values are $\bar{x} \pm$ SEM)

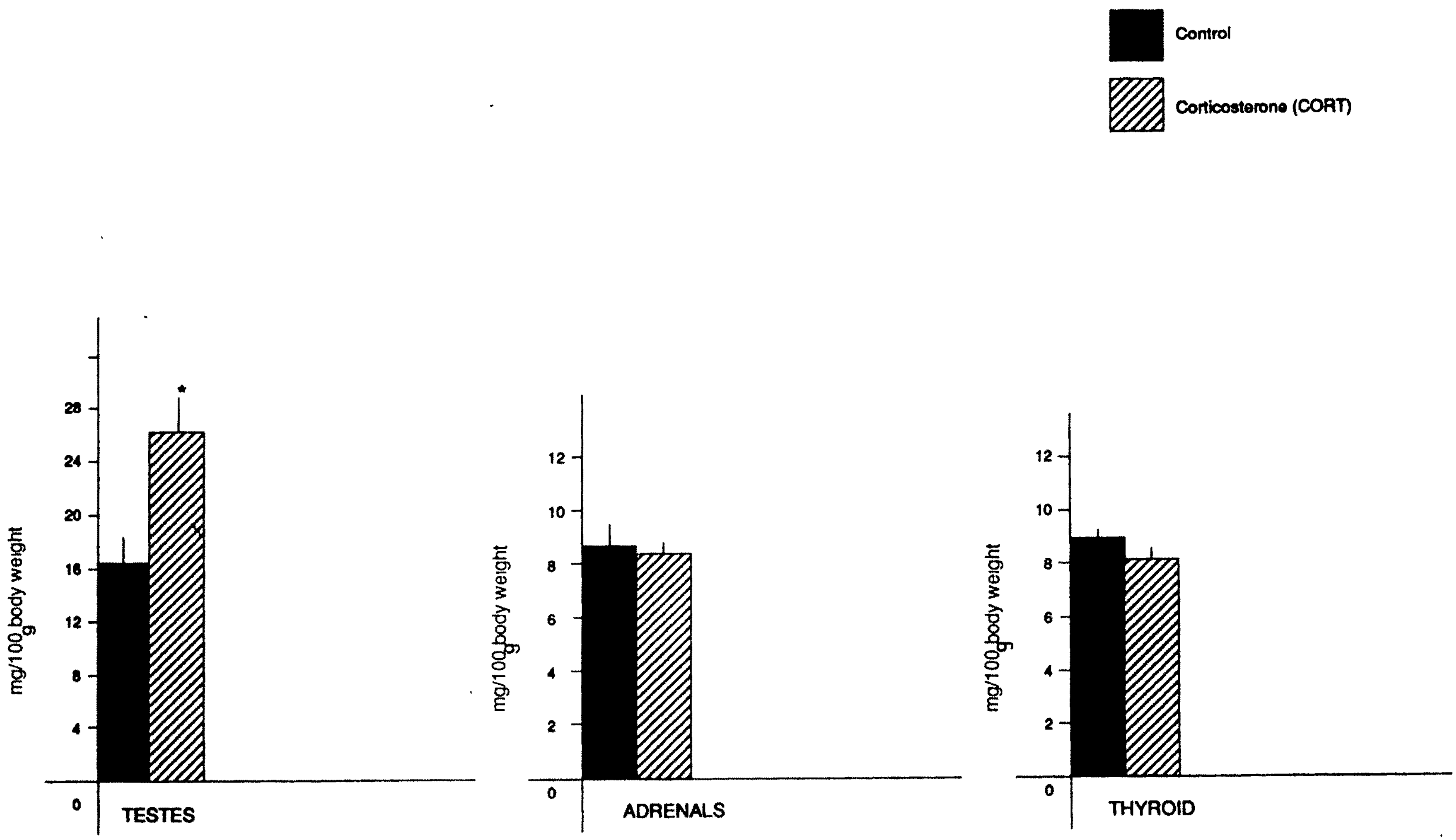


Fig. 2 A : Changes in relative weight of testes, adrenals and thyroid of pigeons subjected to hypercorticalism in the quiescent phase
(* Significant at $P < 0.05$, values are $\bar{x} \pm$ SEM).

Gravimetric changes:

The relative weight of testes was increased significantly after CORT treatment. The relative weights of adrenals and thyroid showed no significant alterations .(Table-IIa, Fig.2A)

Histology :

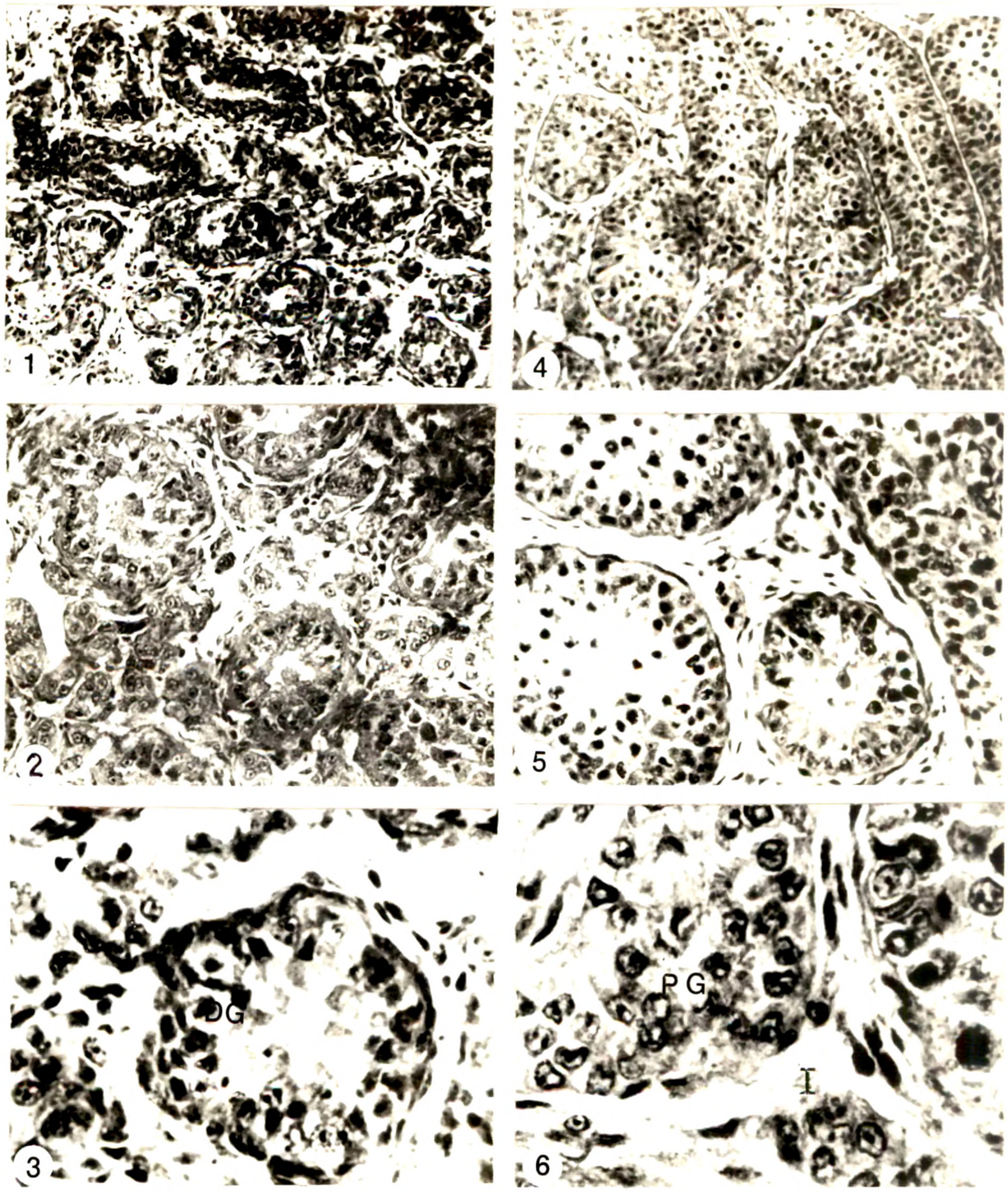
Testes : The testis of control birds showed totally regressed tubules with a single layer of gonial cells. The interstitial cells were also regressed. The testis of CORT. treated birds also showed regressed tubules, however many of the tubules showed activation in the form of gonial proliferation with the result many of them showed more than one layer of germ cells. The interstitial cells did not show any change. (Plate 1)

Adrenal : The adrenal of control birds showed reduced cortical area consisting of regressed hypoactive cortical cells. The overall cortico-medullary ratio was 1:1. Corticosterone treatment induced cortical activation as marked by enlarged cortical cells with prominent nucleus and nucleolus. The medulla was also prominent. (Plate 11)

Thyroid : Thyroid of control birds showed folicles with depleting or depleted colloid content and the follicular epithelium was low cuboidal and also appeared hyperplastic.

PLATE I

Figures 1-6	Photomicrographs of section of control and CORT treated birds in the quiescent phase.
Fig.1	Testis section of control birds showing highly regressed tubules. (200 X)
Fig.2	Enlarged version of the same (400 X)
Fig.3	A higher magnification showing a single tubule. Note the degenerated state of the germ cells (DG). (640 X)
Fig.4	Testis section of corticosterone (CORT) treated birds (200 X).
Fig. 5 & 6	Higher magnification of the same 400 X and 640 X respectively. Note the active state of the tubules in the former and the proliferating gonial (PG) cells in the latter.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2
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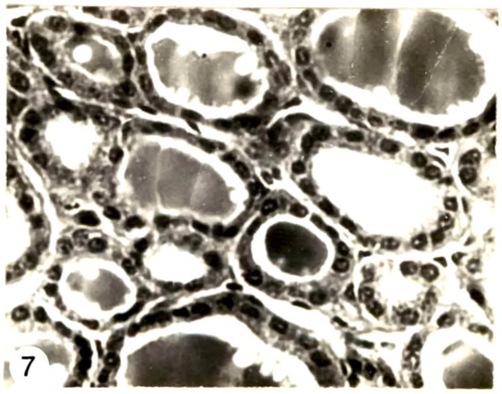
PLATE II

Figures 7-10	Photomicrographs of section of thyroid and adrenal of control and CORT treated birds in the quiescent phase
Fig.7	Thyroid of control bird showing a mixture of colloid filled and colloid depleted follicles. Note the increased cell height of the follicular epithelium. (260 X)
Fig.8	Thyroid of CORT treated bird showing reduced cell height and increased colloid content in the follicles. (260 X)
Fig.9	Adrenal of control birds showing the regressed inactive cortical cords (C) and prominent medulla (M) (200 X)
Fig.10	Adrenal of CORT treated bird showing hypertrophied cortical cords and active state of cortical cells (200 X)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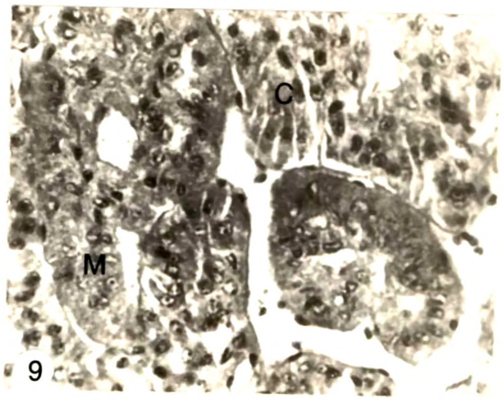
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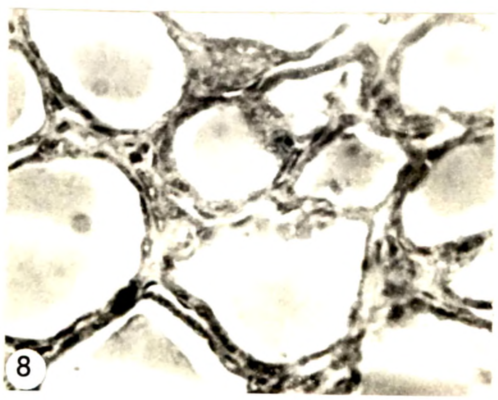
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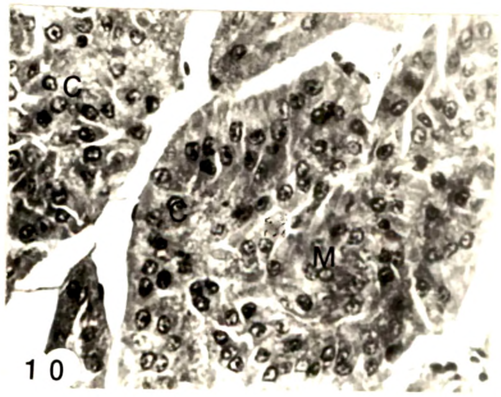
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Serum Hormone

Treatments	T_4 (ng/ml)	T_3	CORT (µg/dl)
Control	22.64 ± 2.18	2.98 ± 0.17	7.50 ± 0.63
CORT	17.61* ± 1.18	2.42* ± 0.32	8.93* ± 0.98

Table II b : Changes in serum levels of T_4, T_3 and CORT of pigeons subjected to hypercorticalism in the quiescent phase.
(* Significant at $P<0.05$; values are $\bar{x} \pm SD$)

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Corticosterone treatment showed retention of colloid with the result most of the follicles were full of colloid and the cell height was decreased and appeared flat. The epithelial cells depicted prominent hyperplasia. (Plate II)

Serum T_4 ,T_3 and CORT levels :

The control pigeons showed 22.64 $\pm$ 2.18 ng/ml T_4, 2.98 $\pm$ 0.17 ng/ml T_3 and 7.50 $\pm$ 0.63 µg/dl CORT in the non-breeding period. Birds treated with CORT showed a significant decrease in both serum T_4 and T_3 levels and a marginal increase in serum CORT level (Table-II b).

DISCUSSION :

The results of the present study indicate stimulatory influence of CORT on spermatogonial proliferation however, CORT was without any effect in inducing enlargement of seminiferous tubule nor activation of interstitial cells. The elevated CORT level induced colloid retention in thyroid follicles, and decreased the circulating level of T_4,indicating the ability of CORT to exert an inhibitory influence on the Hypothalamo-Hypophysial-Thyroid (HHT) axis. Such an action of CORT on HHT axis was shown in an earlier study also (chapter I). However, the influence of CORT was found to be indirect through potentiation of the inhibitory action of melatonin on the HHT axis. This was deduced from the observation that CORT was ineffective in bringing about colloid retention and lowering of circulating T_4 level in PX pigeons, as compared to intact birds (chapter I). Reduced thyroid activity coupled with increased adrenocortical activity seemed to be the appropriate conducive state for breeding activities while the reverse holds true for the non-breeding phase. Such a conclusion was drawn from the previous studies from this laboratory (Patel *et al*.,1985; Patel *et al*., 1993). As has been inferred from the earlier studies, the breeding phase of the sub-tropical feral blue rock pigeon occurring in the summer months (March-May) coincides with decreasing melatonin level and the non-breeding phase coincides with increasing melatonin levels in the post summer solstice periods (Patel, 1993). Viewed in this context, the lower T_4 level required for the testes to remain active in the breeding phase seems to be induced by the potentiating influence of CORT on the inhibitory action of melatonin on the HHT axis. The higher T_4 level in the non-breeding phase is apparently due to the decreased potentiating influence of CORT, (due to the lower CORT level) even though the melatonin level is purportedly higher. This is confirmed by the earlier observation of colloid depletion and increased serum T_4 level in pigeons due to adrenocortical suppression in the breeding phase (chapter I).

In the present study though, exogenous CORT administration in the non-breeding season brought about a higher serum CORT and lower serum T_4 level, a condition akin to that of the breeding season, neither enlargement of seminiferous tubules nor establishment of spermatogenic and steroidogenic functions could be induced. This is clearly due to the inactive state of the Hypothalamo-Hypophysial-Gonadal (HHG) axis. It would therefore suggest that though high CORT : low T_4 ratio is conducive for testicular functions, neither higher CORT level nor a lower T_4 level or even a combination of the two per se has any ability to activate the HHG axis in the non breeding season, probably due to the refractory state of the HHG axis. This was also inferred from the earlier study by the inability of photostimulation to induce testicular recrudescence when tried two months earlier than the expected gonadal recrudescence though the favourable CORT : T_4 level was established (Patel, 1993). The present study however reveals that CORT has a stimulatory influence on gonial proliferation as could be made out from the histological observations.

Overall, the present study has revealed that increased adrenocortical activity can potentiate the inhibitory influence of melatonin on the HHT axis and thereby bring about a higher CORT: lower T_4 ratio conducive for testicular functions and that the HHG axis is refractory to this favourable milieu in the non-breeding phase.