CHAPTER 9

PHOTOPERIOD- ADRENAL INTERACTIONS: INFLUENCE OF HYPER. / HYPOCORTICALISM IN RIR PULLETS REARED UNDER LD 6:18 ON HISTOMORPHOLOGY AND HORMONES OF ADRENAL, THYROID AND OVARY AND GROWTH KINETICS OF LIVER AND LYMPHOID ORGANS.

The post-hatched growth phase, in birds, represents a phase of physical growth and physiological maturation leading to attainment of homeostatic mechanisms characteristic of adults. Dynamic alterations in the endocrine milieu can be envisaged to play a significant role in this. In this respect, the role of pituitary, thyroid and adrenal hormones has been inferred by the observed decrease in body weight gain in ducks and fowls when the chicks were either hypophysectomised, thyroidectomised or rendered hyper. or hypocortic (Blivaiss, 1947; Winchester and Davis, 1952; Howard and Constable, 1958; Baum and Meyer, 1960; Nagra *et al*, 1963; Nagra and Meyer 1963; Nagra *et al.,* 1965; Raheja *et al.,* 1971; King and King, 1973; Kallicharan and Hall, 1974; Carasia,1987; Bartov, 1982; Kuhn *et al.,* 1984;Akiba *et al.,* 1992; Hayashi *et al.,* 1994). Besides, in keeping with the well documented parallel or inverse thyroid-gonad and adrenal-gonad interrelationships in adult birds (Riddle *et al.,* 1924; Legait and Legait, 1959; Fromme-Bouman, 1962; Thapliyal and Pandha, 1967a,b; Jallageas and Assenmacher, 1973; 1974; Oshi and Konishi, 1978; Patel *et al.,* 1985;

Patel *et al.,* 1986; Ramachandran and Patel, 1986; Ramachandran *et al.,* 1987; Ramachandran and Patel,1988; Ayyar *et al.,* 1992), a previous study from this laboratory showed that, the growth and functional maturation of testes were retarded by hypercorticalism and stimulated by hypocorticalism in 30 days old white leghorn cockreals (Joseph and Ramachandran, 1993). Recently it was also reported that chronic mild hyper. or hypocorticalism during the first 90 days, in RIR pullets, has some modulatory influences on the features of normal cycle of lay and egg composition (Chapters,2,3,5,6). An attempt was also made to relate these consequential effects with the pattern of growth kinetics and histomorphology of adrenal, thyroid, ovary and oviduct and serum profiles of T_3, T_4, corticosterone and progesterone during the period of hypo. or hypercorticalism (Chapter,8).

Artificial rearing photoperiods have become the *modus operandi* as part of poultry practice and maintenance, to improve the laying performance (Dunn *et al.,* 1990; Lewis *et al.,* 1996a,b; Sandoval and Gernert, 1996; see Etches, 1996). Rearing Indian RIR pullets under SP (L:D 6:18) for 0-90 days and then shifting to a normal photoperiod (step-up schedule), has been shown to hasten sexual maturity and improve the laying performance significantly (Chapter,1). The effect of rearing under SP was also assessed in terms of growth kinetics, histological alterations in ovary, thyroid, adrenal and, serum profiles of T_3, T_4, progesterone and corticosterone during the period of maintenance under SP, so as to relate these alterations with the observed effects on laying performance (Chapter, 7). Since both SP and hyper. or hypocorticalism were shown to affect various aspects of laying performance of RIR hens, an attempt was made to study the interactive effects of SP and hyper. or hypocorticalism, which revealed both additive as well as antagonistic effects on sexual maturity and laying performance (Chapter, 3). It is presumable that the interactive influences and modulating effects of hyper. or hypocorticalism on laying performance could be a consequence of the changes induced by the combination effects of photoperiod and altered adrenocortical status on, the histomorphology of endocrine and reproductive organs and, the alterations in endocrine profile during the experimental period of rear. Hence in the present study, the growth kinetics of adrenal, thyroid, ovary and oviduct and serum levels of T_3, T_4, corticosterone and progesterone have been assessed during the 90 days of rear of hyper, or hypocoriticalic pullets under SP.

RESULTS

Body and organ weights :

The body weight of both HPR and HPO chicks was significantly higher at 90 days compared to the controls, though their weights were similar to that of the controls at 60 days (table 1A; fig. 1). Both the experimental groups of chicks showed significantly greater growth rates between 60 and 90 days (table 2), while in the control chicks the growth rate between 60 and 90 days was marginally more than those between 0 - 30 and 30 - 60 days. In the first 30 days, HPR chicks had a tendency to have reduced body weight, whereas HPO chicks had a tendency to have increased body weight. Similarly, the weights of adrenal, thyroid, ovary and oviduct were also significantly greater in both HPO and HPR groups of chicks compared to the controls at 90 days. The increase in the weights of these organs was manifested gradually between 30 and 90 days with, the difference becoming markedly pronounced between 60 and 90 days . The absolute and relative weights of liver of both HPR and HPO chicks showed an increment at 90 days as compared to the control. The absolute and relative weights of all the lymphoid organs (thymus, bursa and spleen) of HPR chicks was similar, and that of HPO chicks was increased at 90 days as compared to the control (table 1A&B; fig. 2A & B - 5A & B).

The overall growth kinetic ratio of thyroid, adrenal and ovary of HPR and HPO chicks, was significantly higher than that of control chicks. Whereas in the case of thyroid, it was mainly due to increments between 30 and 60 and 60 and 90 days, in both HPR and HPO chicks, in the case of adrenal, it was mainly due to a significant difference between 0-30 days in the HPR chicks and, between 0-30 and 60-90 days in the HPO chicks. While in the case of ovary, it was mainly due to increase between 60 and 90 days, in the case of oviduct the increased growth kinetic ratio was due to increments between 0-30 and 30-60 days in HPR chicks and, solely due to increase between 60-90 days in the case of HPO chicks (table 3; figs.6A&B - 7A&B).

Hormonal changes :

The serum CORT concentration showed a trend of significant decrease at 60 days with a steady level thereafter in all the three groups of chicks. However, the relative concentration appeared to be slightly more in HPR chicks and slightly less in HPO chicks. The SP control chicks showed an increase in serum T_3 and T_4 levels at 60 days followed by decrease at 90 days. In contrast, the HPR chicks showed significant decrement at 60 days followed by increment at 90 days, while the HPO chicks showed significant increment at 60 days with more or less a steady level thereafter. The relative concentration of T_3 was higher at 30 and 90 days and lower at 60 days in HPR chicks while, T_4 concentration was lower at both 30 and 60 days and significantly higher at 90 days. In the HPO chicks, the concentration of both T_3 and T_4 was significantly higher than the control chicks at all ages, except for a lower T_4 level at 30 days. Whereas the serum progesterone level showed a significant decrease in SP control chicks, there was significant decrement at 60 days followed by increase at 90 days in HPR chicks and, increase at 60 days and decrease at 90 days in HPO chicks. The relative concentration of the hormone was lesser in both HPR and HPO chicks at 30 days, while it was higher at 90 days, in HPR chicks and, higher in HPO chicks at 60 and 90 days as compared to the control chicks. (table 4; fig. 8 A-D).

Histological observations :

Thyroid :

The thyroid of SP control chicks showed fully colloid filled follicles with flattened epithelium at 30 days. A similar feature was seen even at 60 days though, some follicles depicted colloid depletion. At 90 days, the follicles were medium to large sized with full colloid content and very flat epithelium. In general, the thyroid of both HPR and HPO chicks showed small follicles with reduced colloid content and prominent cuboidal epithelium. At 60 days, there was generalized colloid retention more prominently in thyroid of HPR chicks. At 90 days, the follicles were larger and fully colloid laden with flat cuboidal epithelium (Plate 1).

Adrenal :

The adrenal of SP control chicks showed regressed less active cortical cords at 30 days and relatively less medullary cords. At 60 days, the medulla appeared well formed though, the cortical cords remained reduced in size with less active cells. However, at 90 days, the cortical cords were well formed with hypertrophied active cells showing extensive signs of secretory exhaustion in the form of vacoulization. At 30 days, whereas the adrenal of HPR chicks showed active cortical cords with prominent cells and prominent active medullary cords, the adrenal of HPO chicks showed reduced cortical cords though with hypertrophied cells and active medullary cells. At 60 days, the cortical and medullary cells in both HPR and HPO chicks appeared hypertrophied with differential secretory activity. The medullary cells appeared to be relatively more active in HPO chicks. At 90 days, the adrenal of HPR chicks showed less prominent medullary cords and prominent cortical cords but, with differential cortical cell activity. The adrenal of HPO chicks at 90 days showed prominent cortical and medullary cords and, the medullary cells appeared hypertrophied and active while, the cortical cells showed differential activity (Plate 2).

Ovary :

The 30 day old ovary of SP control chicks was characterized by many primary and primordial follicles with prominent granulosa cells. There were visible signs of thecal condensation. The histological appearance of ovary of HPR and HPO chicks at 30 days was similar to that of control, but with hypertrophied granulosa and stromal cells in the former and with prominent atretic changes in the latter. At 60 days, whereas the ovary of HPR chicks showed similar structure as that of control, that of HPO chicks showed hyperplasia of granulosa and stromal cells and less prominent thecal differentiation. At 90 days, the ovary of HPR chicks showed less active but hypertrophied stromal tissue and also less active thecal cells. The ovary of HPO chicks showed compact theca with less active granulosa cells with signs of stromal proliferation and stromal differentiation (Plate 3).

Control

The approximate follicular count reveals a temporal progression from 6-30 μm diameter follicles to 240-440 μm diameter follicles, from 30-90 days in the ovary of SP control chicks. Atretic follicles were evident at all periods but, the relative proportion was higher in 30 day old ovary than in 60 or 90 day old ovary. The follicular pool of 6-30 μm size was more or less the same even at 90 days as that seen at 30 days. The rate of transition of follicles into higher size hierarchy was slower, with transition from small to big and big to large follicles occurring only between 60 and 90 days (table 6).

HPR/HPO:

The total number of follicles in the ovary of HPR and HPO chicks were relatively more than that in the ovary of control chicks at 30 days. But at 60 and 90 days, the number of follicles in the ovary of HPR and HPO chicks was significantly lower than that counted in the ovary of control chicks. The rate of follicular atresia in the ovary of HPR chicks was maximal at 30 days and minimal at 60 days, while in the ovary of HPO chicks there was progressive increase in the rate of atresia from 30-90 days. The number of small follicles of 6-30 μm size which was significantly more in the ovary of HPR and HPO chicks at 30 days, was depleted significantly by 90 days. Transition into higher sized follicular hierarchy started between 30 and 60 days and was significantly higher in terms of small to big transition at 60 days in the ovaries of both HPR and HPO chicks compared to the controls. Additionally, the ovary of HPO chicks also showed transition from big to large follicles. In the 90 day old ovary, the transition from small to big follicle was of the same order in the HPR chicks as compared to the controls while, in the ovary of HPO chicks, it was significantly lesser. The transition from big to large follicles was greater in the ovary of HPR chicks and lower in the ovary of HPO chicks but, almost similar to that of control chicks (table 5).

DISCUSSION

The body weight of both HPR and HPO chicks was significantly greater than the control chicks at 90 days, of which, HPR chicks showing relatively greater weight than HPO chicks. However, whereas the HPO chicks showed continuously higher weight and increased growth rate throughout,

Table 1A: Body weight and organ weight of Control, HPR and HPO birds.

		30 days		60 days		90 days	
Body weight	***HPR***	94.16±15.23		324.00±18.02		692.50±16.32^{C}	
	CONTROL	122.50±19.25		322.00±13.03		533.33±15.87	
	HPO	156.60±23.37		353.30±16.23		656.00±14.23^{C}	
Organ weight		**Abs. wt**	**Rel. wt**	**Abs. wt**	**Rel. wt**	**Abs. wt**	**Rel. wt**
Thyroid	***HPR***	8.40±0.93	8.92±0.73	24.00±0.96^{C}	7.40±0.46^{a}	39.50±1.23^{C}	5.70±0.69
	CONTROL	10.50±0.86	8.57±0.60	15.50±1.44	4.81±0.75	23.03±1.47	4.31±0.49
	HPO	9.83±0.88	6.27±0.832	31.00±0.98^{C}	8.77±0.63^{b}	46.60±1.09^{C}	7.10±0.36^{b}
Adrenal	***HPR***	19.00±0.37	20.17±1.69^{b}	47.25±1.32^{b}	14.58±0.91	61.33±1.36^{C}	8.85±1.63
	CONTROL	17.00±0.80	13.87±2.32	41.50±2.01	12.88±0.70	48.00±1.47	9.00±1.09
	HPO	21.35±0.86^{b}	13.02±1.33	44.66±1.69	12.63±0.80	62.33±1.66^{C}	9.50±1.99
Ovary	***HPR***	36.00±4.33^{b}	38.23±1.93	110.00±4.36^{a}	33.95±1.04^{b}	212.00±2.31^{C}	30.65±1.32
	CONTROL	45.30±5.63	37.00±1.76	134.60±8.61	41.81±1.25	150.00±4.61	28.12±1.09
	HPO	52.50±2.63^{b}	33.51±1.88	141.33±2.93^{a}	39.99±1.93	201.00±3.11^{C}	30.64±1.98
Oviduct	***HPR***	23.25±2.37	24.69±1.08^{b}	71.50±1.22^{C}	22.06±0.69^{C}	84.33±1.11^{C}	12.17±0.73
	CONTROL	21.33±3.79	17.41±1.04	53.00±2.93	16.45±0.73	64.00±1.54	12.00±0.79
	HPO	18.50±2.22	11.80±1.22^{a}	52.50±3.61	14.85±0.83	78.00±1.23^{C}	11.89±0.83

Values : Mean, ±S.E, N= 12. **$^{a}P < .05$, $^{b}P < .005$, $^{c}P < .0005$**

Abs. wt : Absolute weight; Rel. wt : Relative weight; NLD: LD 12:12; SP: LD 6:18

PLATE I (figs. 1-9)

Photographs of sections of thyroid of Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP (320x).

Fig. 1 Thyroid of 30d HPR chick showing empty follicles with cuboidal epithelium.

Fig. 2 Thyroid of 30d SP chick showing follicles with flattened epithelium.

Fig.3 Thyroid of 30d HPO chick showing mixed population of colloid filled and empty follicles.

Fig. 4 Thyroid of 60d HPR chick showing colloid retention in the follicles.

Fig. 5 Thyroid of 60d SP chick showing colloid depletion from follicles.

Fig. 6 Thyroid of 60d HPO chick showing medium to big sized colloid filled follicles.

Fig. 7 Thyroid of 90d HPR chick showing colloid filled follicles with flattened cuboidal epithelium.

Fig. 8 Thyroid of 90d SP chick showing colloid filled follicles of medium to large size with flattened epithelium.

Fig. 9 Thyroid of 90d HPO chick showing large colloid filled follicles with flat cuboidal epithelium.

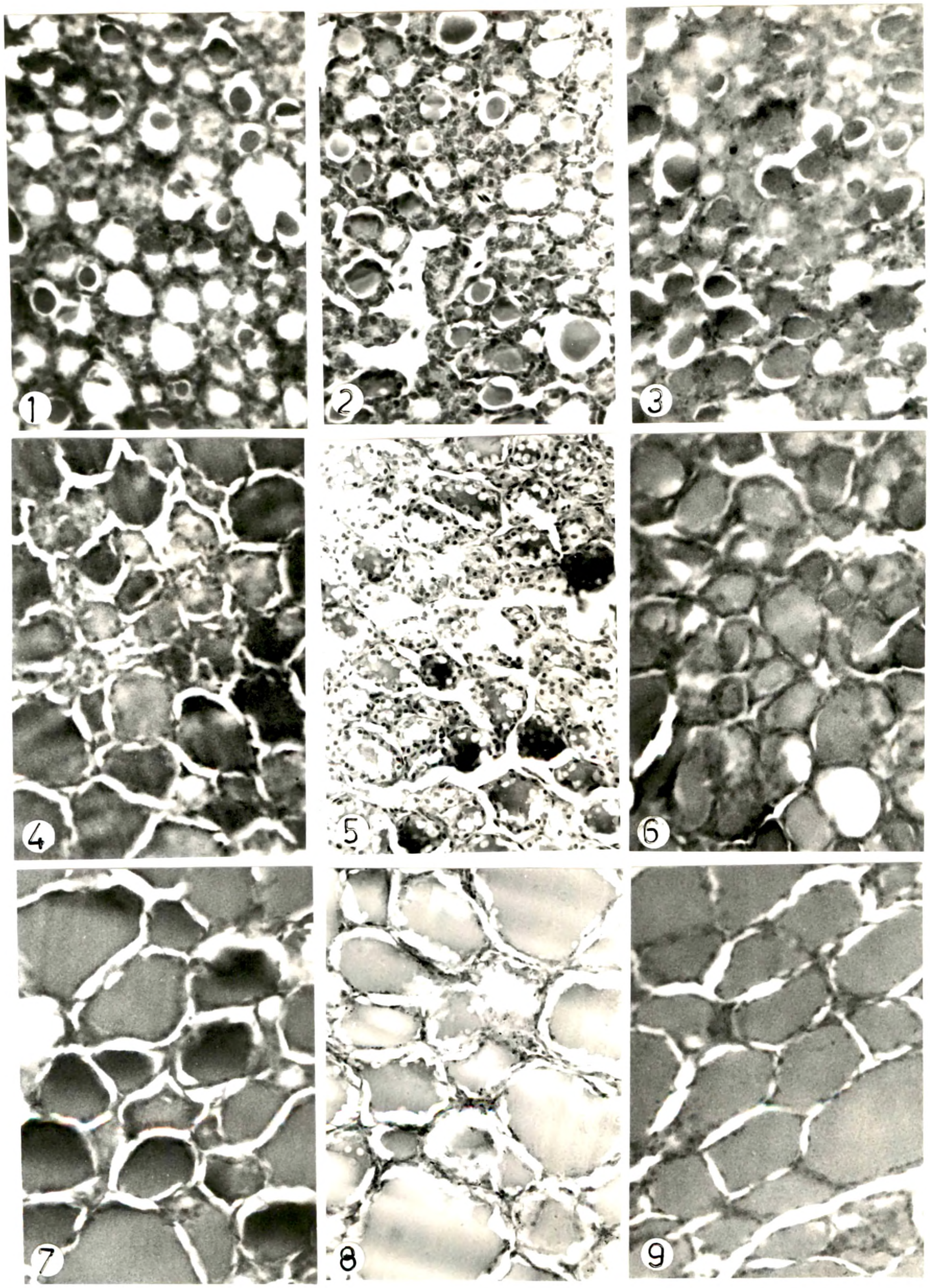
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PLATE II (fig. 10-18)

Photographs of sections of adrenal of Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP (320x).

Fig. 10 Adrenal of 30d HPR chick showing active cortical cords.

Fig. 11 Adrenal of 30d SP chick showing regressed cortical cords and less medullary cords.

Fig. 12 Adrenal of 30d HPO chick showing reduced cortical cords as compared to SP.

Fig. 13 Adrenal of 60d HPR chick showing active cortical and medullary cells.

Fig. 14 Adrenal of 60d SP chick showing well formed medullary cords.

Fig. 15 Adrenal of 60d HPO chick showing hypertrophied cortical and medullary cells with differential secretory activity.

Fig. 16 Adrenal of 90d HPR chick showing prominent cortical cells and less prominent medullary cells.

Fig. 17 Adrenal of 90d SP chick showing well formed cortical cords with hypertrophied active cells.

Fig. 18 Adrenal of 90d HPO chick showing prominent cortical and medullary cords.

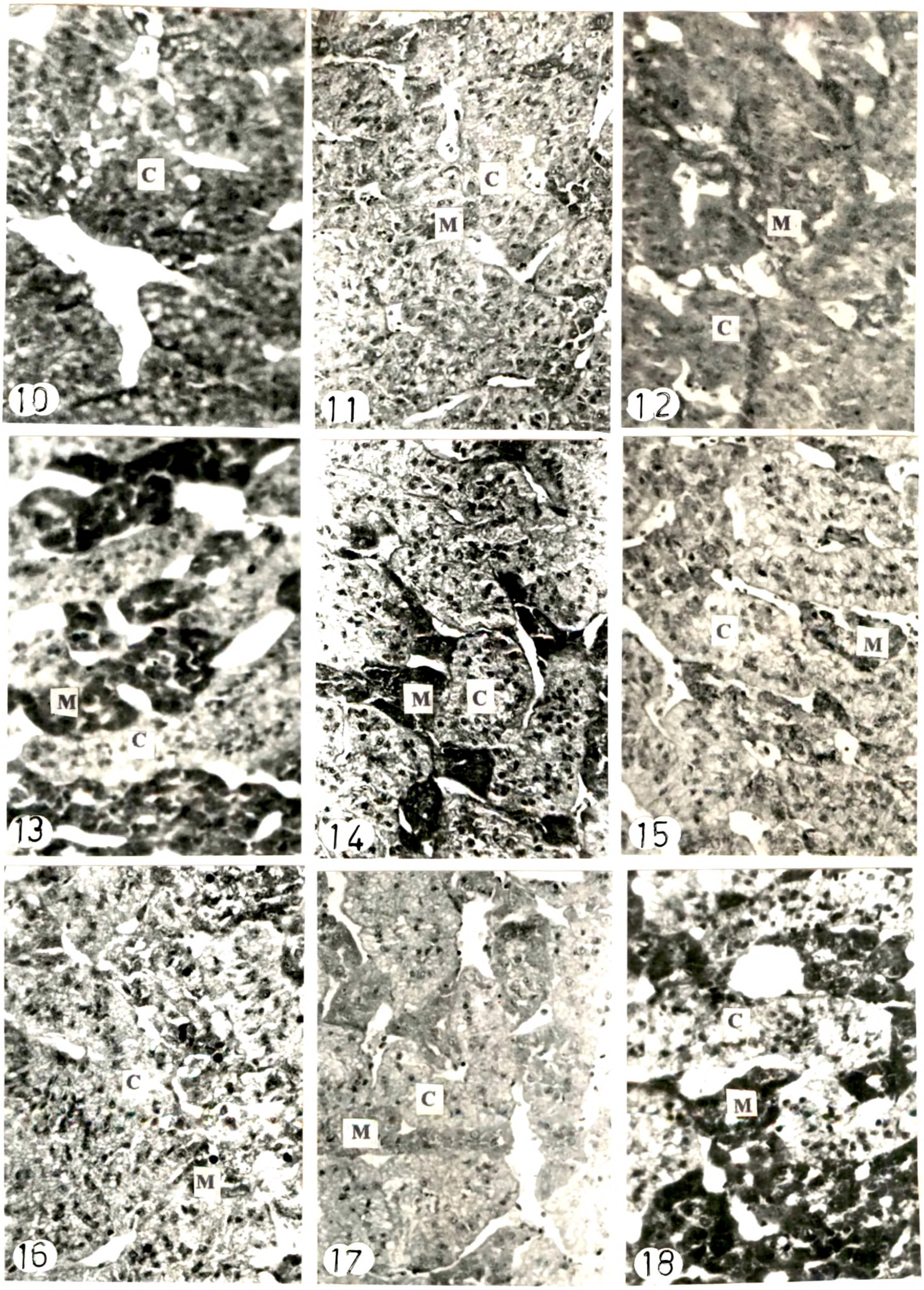
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PLATE III (figs. 19-24)

Photographs of sections of ovary of Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP.

Figs. 19 & 21: Sections of ovary of 30 d HPR & HPO chick showing increased number of primary and primordial follicles. (160 x)

Fig. 20: Section of ovary of 30 d control chick showing primary and primordial follicles. (160 x)

Figs. 22&24: Enlarged version of section of ovary of 30 d HPR & HPO chick showing hypertrophied granulosa in the former and compact stroma in the latter. (320 x)

Fig.23: Enlarged version of ovary of chick showing prominent theca. (320 x)

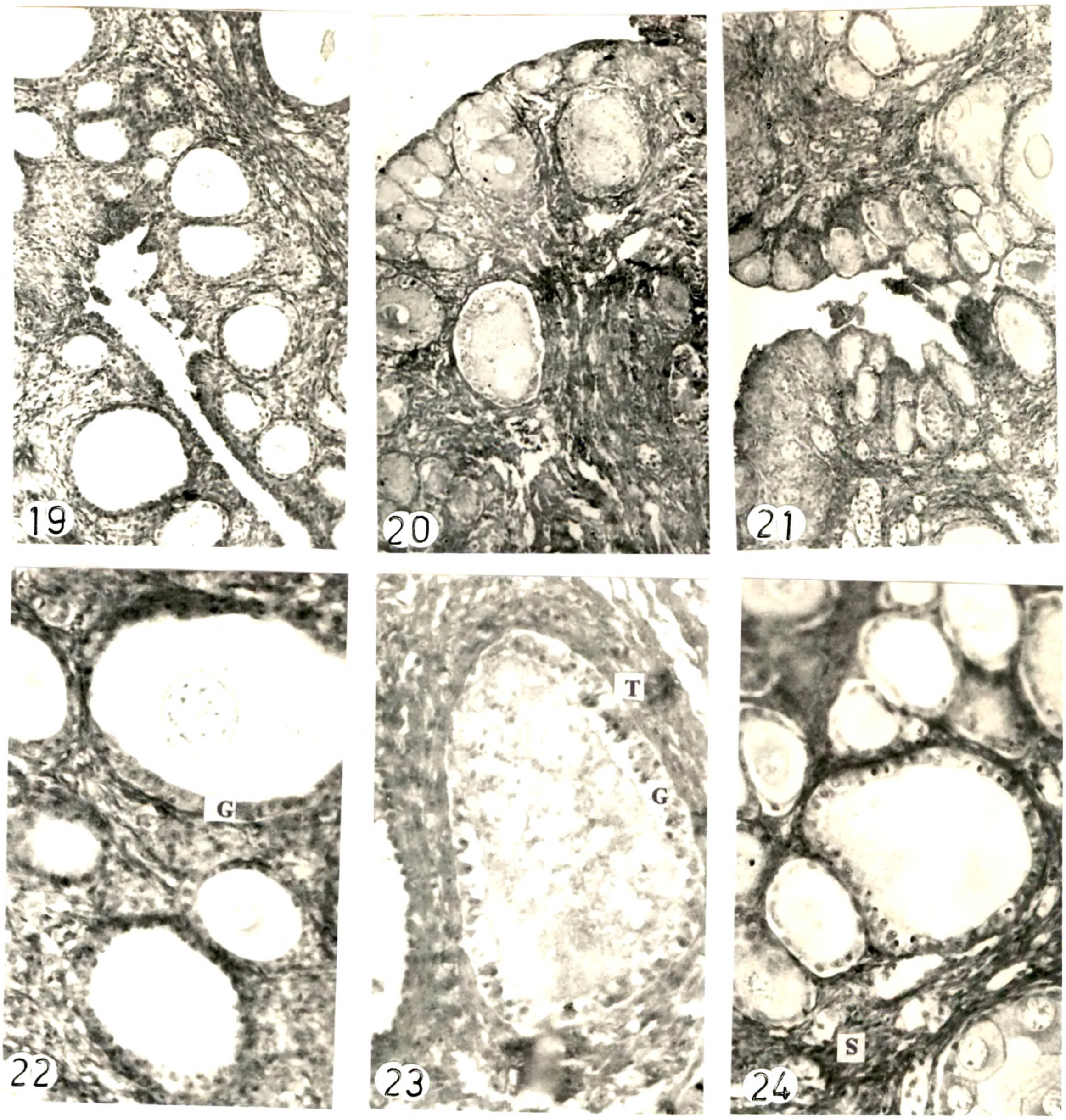
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PLATE IV (figs. 25-30)

Photographs of sections of ovary of Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP.

Fig.25: Section of ovary of 60 d HPR chick showing medium sized follicles. (160 x)

Fig. 26: Section of ovary of 60 d control chick showing medium and small sized follicles. (160 x)

Fig. 27: Section of ovary of 60 d HPO chick showing atretic changes in medium sized follicles. (160 x)

Fig.28: Enlarged version of ovary of 60 d HPR chick showing prominent granulosa. (320 x)

Fig.29: Enlarged version of ovary of 60 d control chick showing medium sized follicles. (320 x)

Fig.30: Enlarged version of ovary of 60 d HPO chick showing hyperplasia of granulosa. (320 x)


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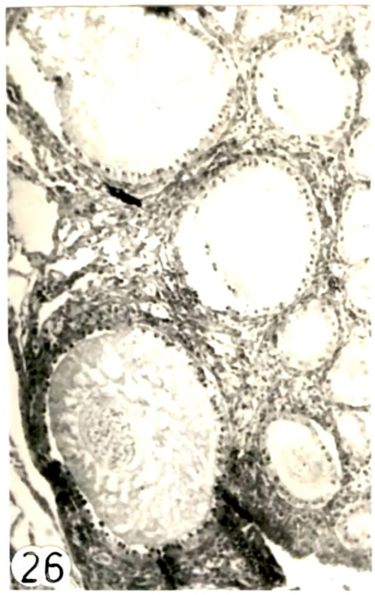
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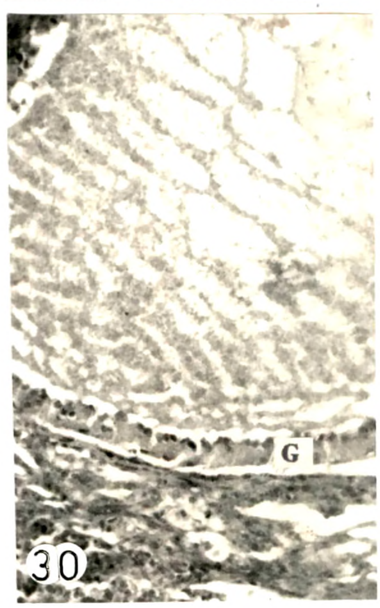
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PLATE V (figs. 31-39)

Photographs of sections of ovary of Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP.

Fig.31: Section of ovary of 90 d HPR chick showing medium follicles (80 x)

Fig.32: Section of ovary of 90 d control chick showing small to medium follicles. Note the atretic follicles (80 x)

Fig.33 Section of ovary of 90 d HPO chick showing medium follicles with loose stromal tissue. (80 x).

Fig.34 Section of ovary of 90 d HPR chick showing atretic follicles. (160 x).

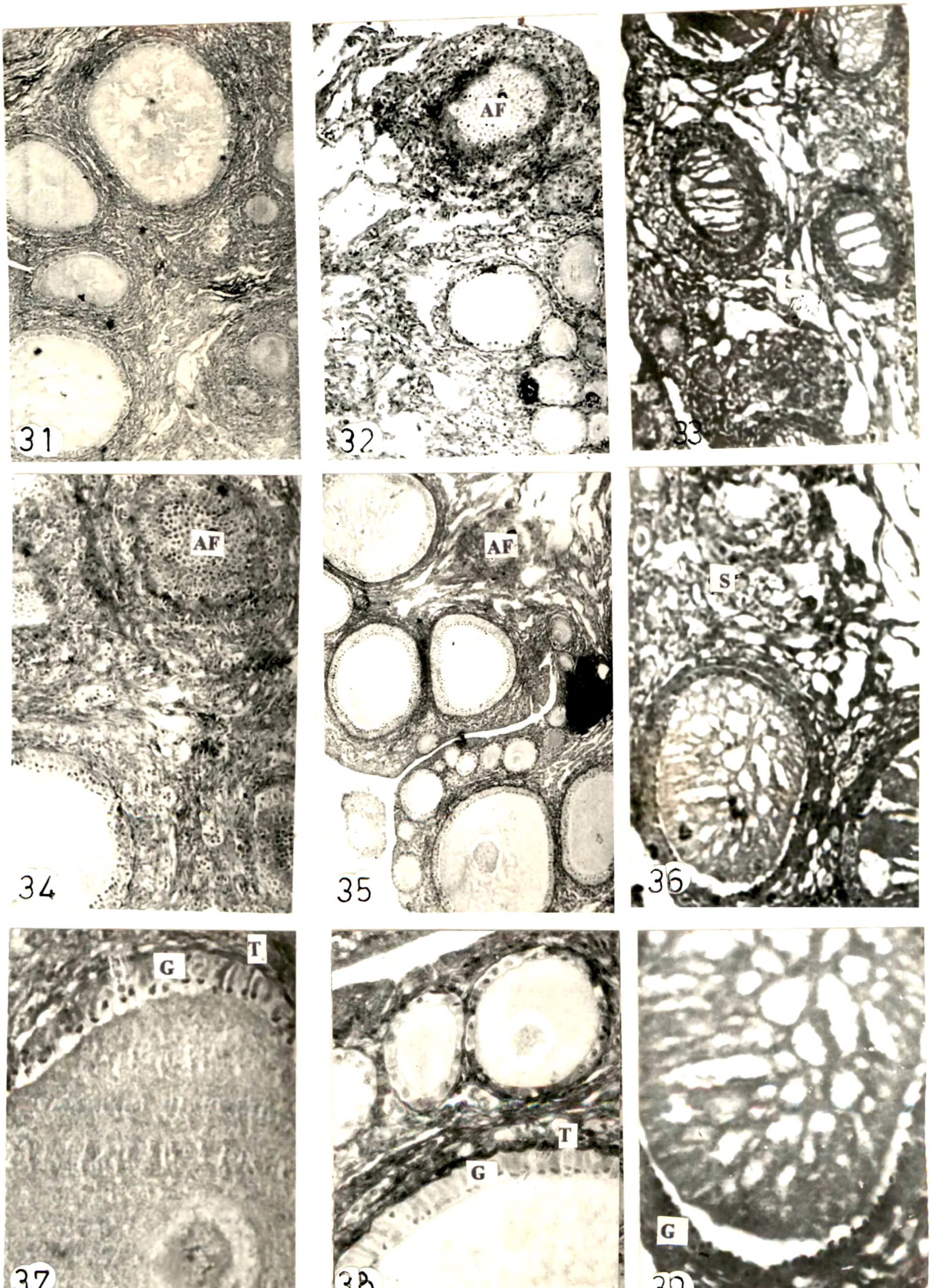
Fig.35 Section of ovary of 90 d control chicks showing presence of many intermediary sized follicles and an atretic follicle (160 x).

Fig.36. Section of ovary of 90 d HPO chick showing medium sized follicles and loose stromal tissue (160 x).

Fig.37: Enlarged version of section of ovary of 90 d HPR chick showing well formed granulosa and theca (320 x).

Fig.38: Section of ovary of 90 d control chick showing growing and intermediary sized follicles. Note the prominent granulosa and conspicuous thecal condensation (320 x).

Fig.39: Enlarged version of section of ovary of 90 d HPO chick showing compact theca and less active granulosa cells (320 x).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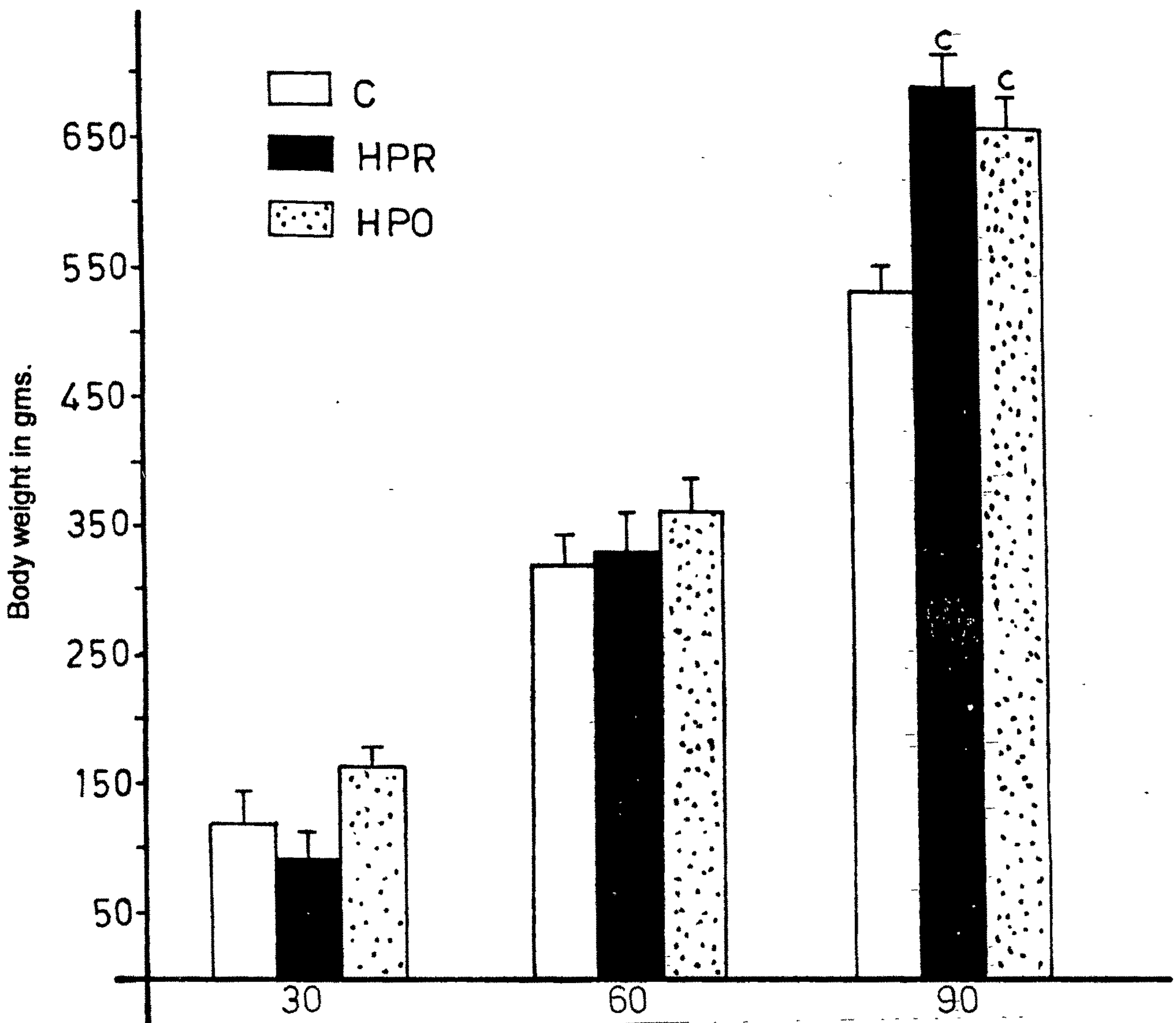

Fig.1 Body weight gain in Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP

Values : Mean, ±S.E, N= 12 SP - LD 6:18 °P < .0005.

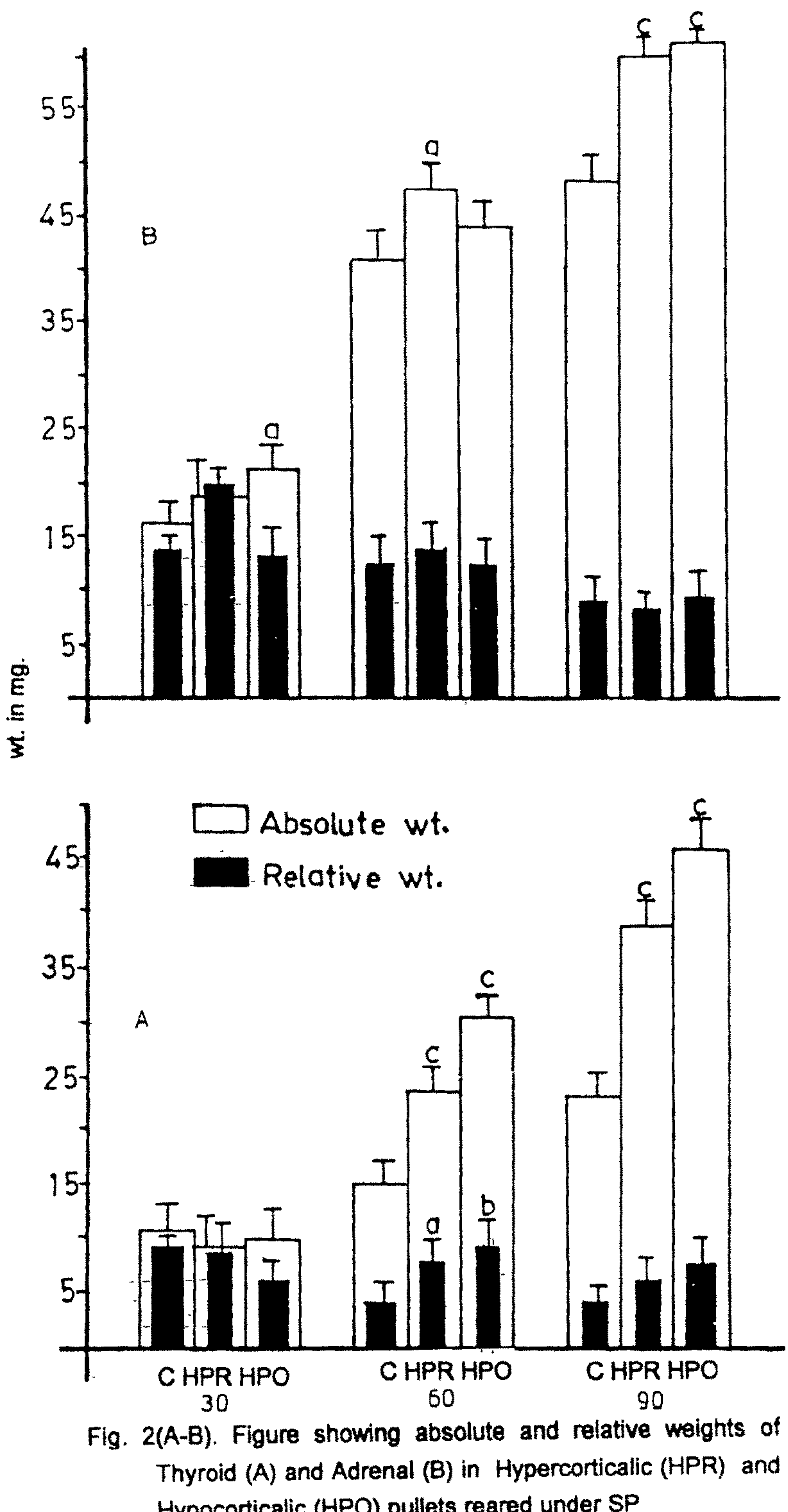

Fig. 2(A-B). Figure showing absolute and relative weights of Thyroid (A) and Adrenal (B) in Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP

Values · Mean, ±S E, N= 12 **^{a}P < .05, ^{b}P < .005, ^{c}P < .0005.**

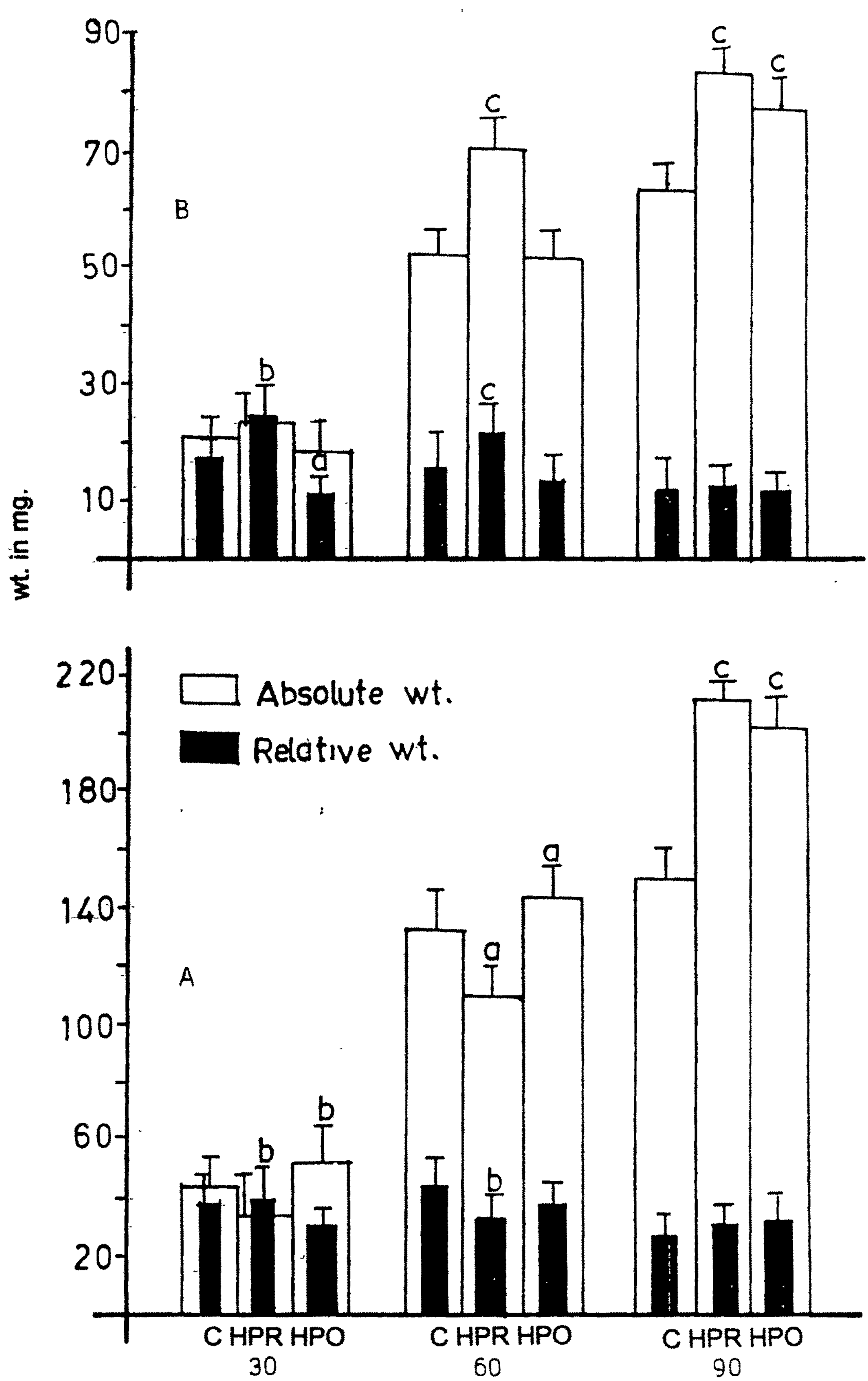

Fig. 3(A-B). Figure showing absolute and relative weights of Ovary (A) and Oviduct (B) in Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP

Values : Mean, ±S.E, N= 12 **[a]P < .05, [b]P < .005, [c]P < .0005.**

Table 1B: Table showing absolute and relative weight of lymphoid organs in Control, HPR and HPO birds.

		30 days		60 days		90 days	
Lymphoid organs		**Abs. wt**	**Rel. wt**	**Abs. wt**	**Rel. wt**	**Abs. wt**	**Rel. wt**
Liver gm	***HPR***	2.90±0.79	3.19±0.19[a]	7.52±0.27	2.32±0.37	15.14±0.19[b]	2.186±0.31[a]
	CONTROL	4.86±0.31	3.97±0.24	6.23±0.263	1.93±0.23	9.42±0.138	1.766±0.69
	HPO	4.87±0.37	3.07±0.17[a]	8.00±0.35	2.26±0.39	11.91±0.28	1.816±0.83
Thymus gm	***HPR***	0.278±0.31[a]	0.29±0.201	1.16±0.21	0.35±0.23	2.92±0.32	0.421±0.031
	CONTROL	0.467±0.023	0.38±0.303	1.10±0.19	0.34±0.108	2.20±0.201	0.412±0.022
	HPO	0.364±0.091	0.23±0.32	1.94±0.30	0.54±0.09[a]	5.06±0.109[C]	0.772±0.011[C]
Bursa gm	***HPR***	0.120±0.031	0.12±0.031	0.887±0.011	0.273±0.017	1.78±0.131	0.257±0.023
	CONTROL	0.170±0.010	0.13±0.012	0.670±0.014	0.208±0.014	1.37±0.138	0.258±0.013
	HPO	0.455±0.021 C	0.29±0.062	1.11±0.083[C]	0.314±0.013	2.66±0.210	0.406±0.062[C]
Spleen gm	***HPR***	0.156±0.032	0.165±0.062	0.283±0.009	0.087±0.012[a]	0.714±0.023	0.103±0.031
	CONTROL	0.175±0.021	0.142±0.018	0.359±0.008	0.111±0.013	0.728±0.037	0.136±0.019
	HPO	0.164±0.061	0.104±0.093	0.530±0.012[b]	0.150±0.019	1.26±0.031[b]	0.192±0.023

Values : Mean, ±S.E, N= 12. **[a]$P < .05$, [b]$P < .005$, [c]$P < .0005$**

Abs. wt : Absolute weight; Rel. wt : Relative weight; NLD: LD 12:12; SP: LD 6:18

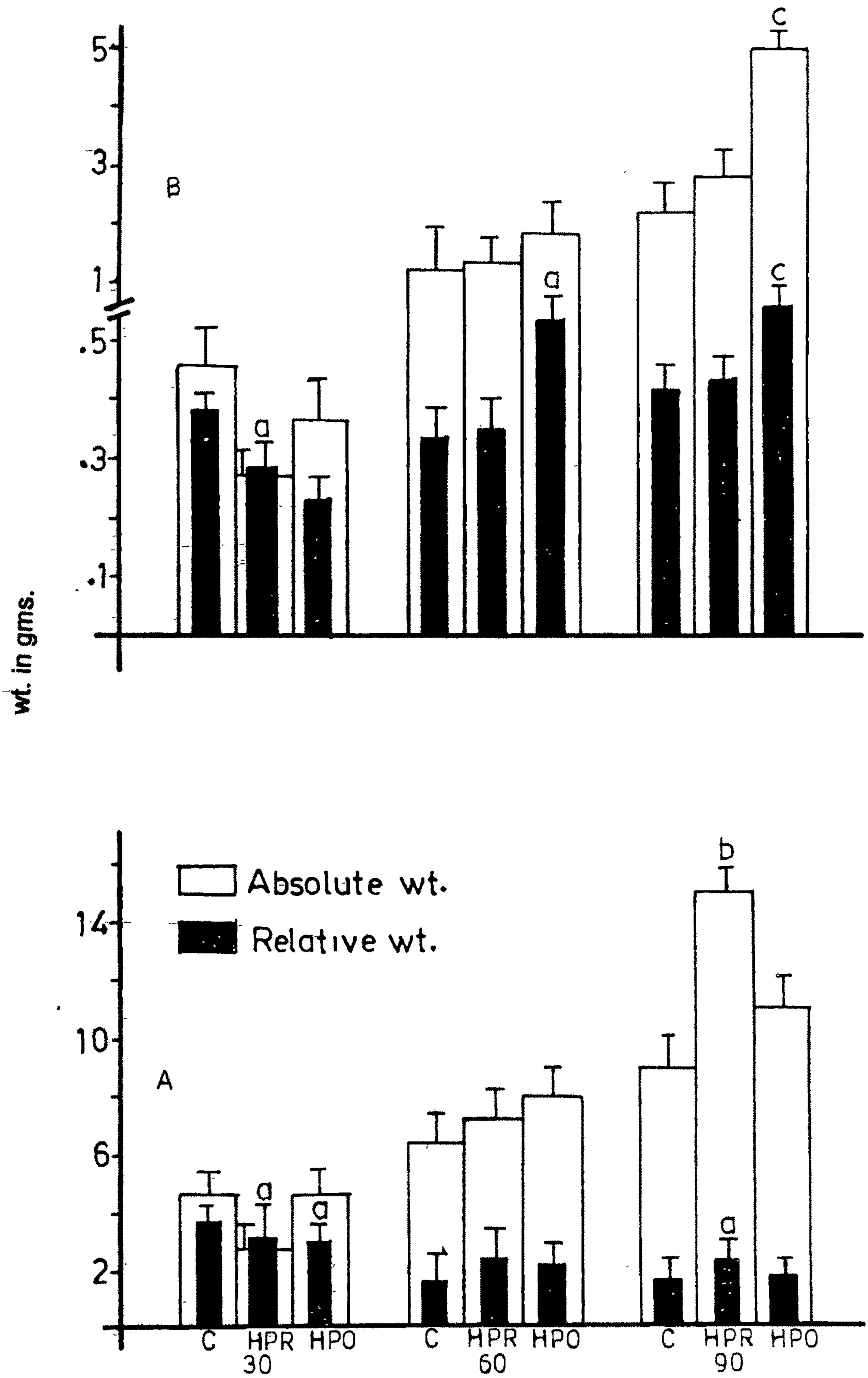

Fig. 4(A-B). Figure showing absolute and relative weights of Liver (A) and Thymus in Hypercorticalic(HPR)and Hypocorticalic (HPO) pullets reared under SP

Values : Mean, ±S.E, N= 12 $^{a}P < .05$, $^{b}P < .005$, $^{c}P < .0005$.

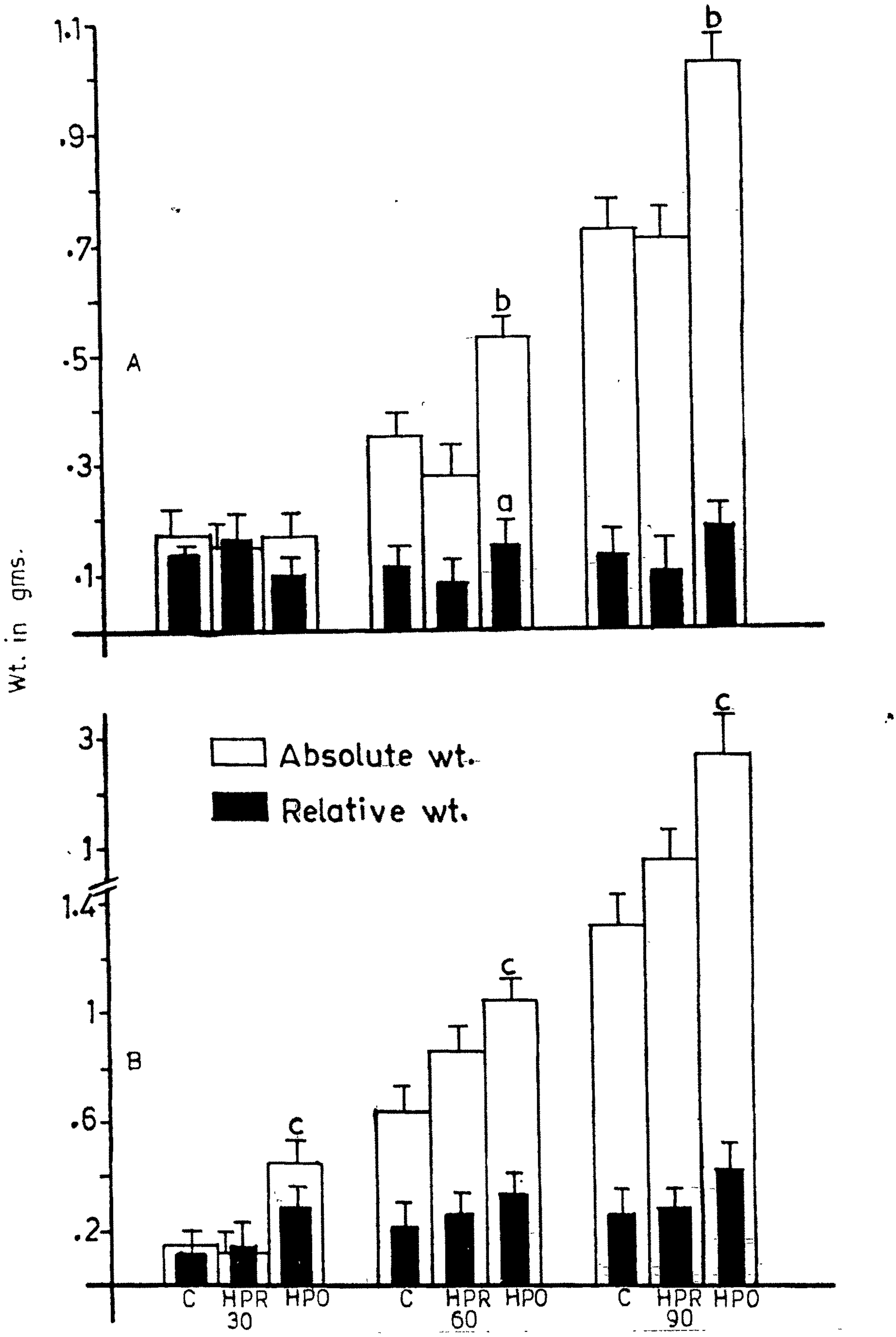

Fig. 5 (A-B). Figure showing absolute and relative weight of spleen (A) and Bursa (B) in Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP

Values : Mean, ±S.E, N= 12 **[a]P < .05, [b]P < .005, [c]P < .0005.**

Table 2: Per day growth rate in Control,HPR and HPO pullets.

		0-30	30-60	60-90	Overall
Body weight	*HPR*	2.25	7.66	12.28	7.39
	CONTROL	3.19	6.65	7.04	5.62
	HPO	4.33	6.55	10.08	6.99
Thyroid	*HPR*	0.135	0.520	0.516	0.390
	CONTROL	0.205	0.166	0.251	0.207
	HPO	0.183	0.705	0.520	0.469
Adrenal	*HPR*	0.208	0.941	0.469	0.539
	CONTROL	0.141	0.816	0.216	0.391
	HPO	0.286	0.777	0.589	0.550
Ovary	*HPR*	0.444	2.46	3.4	2.10
	CONTROL	0.755	2.97	0.511	1.41
	HPO	0.994	2.96	1.98	1.98
Oviduct	*HPR*	0.650	1.60	0.427	0.895
	CONTROL	0.586	1.05	0.366	0.699
	HPO	0.491	1.13	0.850	0.828
Liver	*HPR*	0.094	0.153	0.267	0.167
	CONTROL	0.132	0.048	0.106	0.103
	HPO	0.157	0.106	0.130	0.131
Thymus	*HPR*	0.0020	0.029	0.058	0.030
	CONTROL	0.0091	0.021	0.036	0.022
	HPO	0.0050	0.051	0.104	0.054
Bursa	*HPR*	0.0010	0.025	0.029	0.018
	CONTROL	0.0029	0.016	0.023	0.014
	HPO	0.0120	0.021	0.051	0.028
Spleen	*HPR*	0.0002	0.004	0.014	0.006
	CONTROL	0.0008	0.0061	0.0123	0.0064
	HPO	0.0004	0.012	0.024	0.012

Values : Mean

Table :3 Growth Index in Control,HPR and HPO pullets

		0-30	30-60	60-90	Overall
Thyroid	***HPR***	0.060	0.067	0.042	0.052
	CONTROL	0.064	0.024	0.035	0.036
	HPO	0.042	0.107	0.051	0.067
Adrenal	***HPR***	0.092	0.122	0.038	0.072
	CONTROL	0.044	0.122	0.030	0.069
	HPO	0.066	0.118	0.058	0.078
Ovary	***HPR***	0.197	0.321	0.276	0.284
	CONTROL	0.236	0.446	0.072	0.250
	HPO	0.229	0.451	0.196	0.283
Oviduct	***HPR***	0.288	0.208	0.034	0.121
	CONTROL	0.183	0.157	0.051	0.119
	HPO	0.133	0.172	0.084	0.118
Liver	***HPR***	0.041	0.019	0.021	0.022
	CONTROL	0.041	0.007	0.015	0.018
	HPO	0.036	0.016	0.012	0.017
Thymus	***HPR***	0.0008	0.003	0.004	0.004
	CONTROL	0.002	0.003	0.005	0.0039
	HPO	0.001	0.007	0.010	0.007
Bursa	***HPR***	0.0004	0.003	0.002	0.002
	CONTROL	0.0009	0.002	0.003	0.0024
	HPO	0.0002	0.003	0.005	0.004
Spleen	***HPR***	0.00008	0.0005	0.001	0.0008
	CONTROL	0.0002	0.0009	0.001	0.001
	HPO	0.00009	0.001	0.002	0.001

Values : Mean

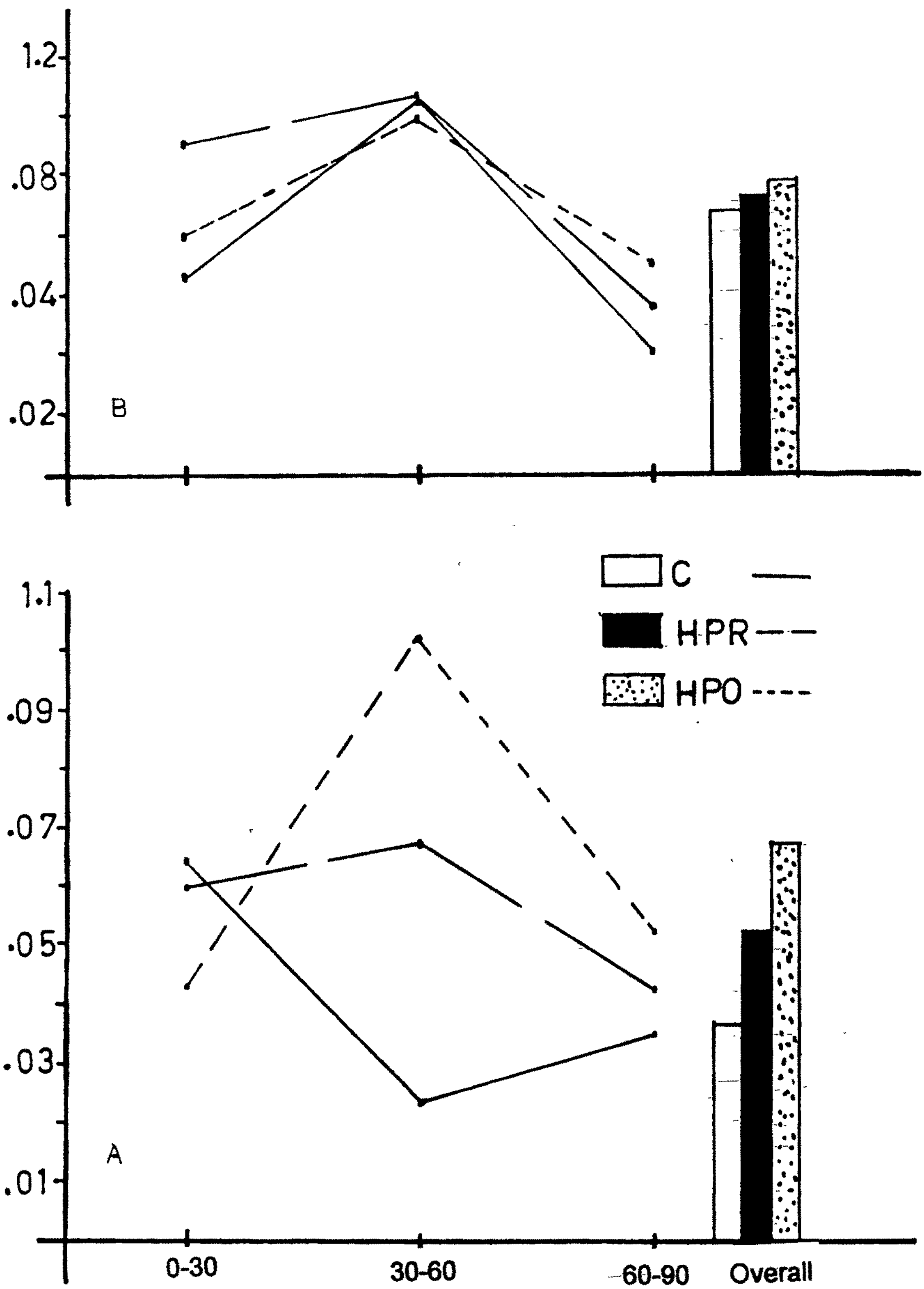

Fig. 6 (A-B). Figure showing growth index of Thyroid (A) and Adrenal (B) in Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP

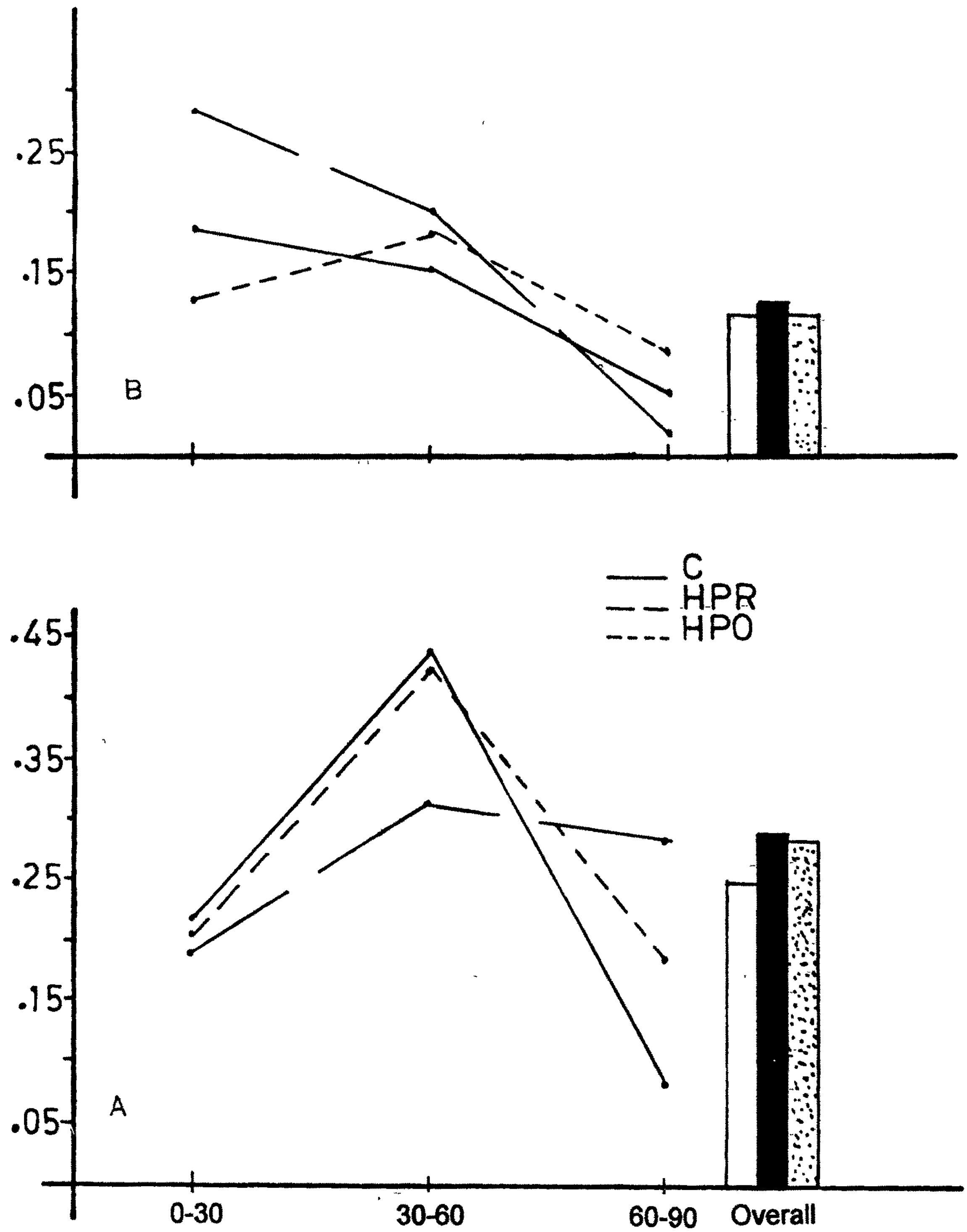

Fig. 7 (A-B). Figure showing growth index of Ovary (A) and oviduct (B) in Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP

Table : 4 Serum hormone levels of Control, HPR and HPO pullets

		0-30	30-60	60-90
Corticosterone (ng/ml)	***HPR***	3.75±0.39	1.70±0.11	1.70±0.83
	CONTROL	3.78±0.34	1.57±0.09	1.36±0.94
	HPO	3.06±0.219	1.49±0.17	1.05±0.74
T_3 (ng/ml)	***HPR***	0.608±0.03[c]	0.354±0.032	0.511±0.012[c]
	CONTROL	0.389±0.062	0.428±0.022	0.305±0.017
	HPO	0.459±0.091	0.787±0.076[c]	0.758±0.019[c]
T_4 (µg/dl)	***HPR***	2.30±0.41	1.52±0.043	4.17±0.09[c]
	CONTROL	2.59±0.39	2.90±0.32	1.37±0.06
	HPO	1.60±0.62	3.51±0.76	3.04±0.02[c]
Progesterone (ng/ml)	***HPR***	0.270±0.019[a]	0.065±0.021[a]	0.211±0.007[c]
	CONTROL	0.573±0.029	0.180±0.031	0.070±0.008
	HPO	0.159±0.31[c]	0.299±0.038[c]	0.205±0.004[c]

Values : Mean, ±S.E, N= 12. **[a]P < .05, [b]P < .005, [c]P < .0005**

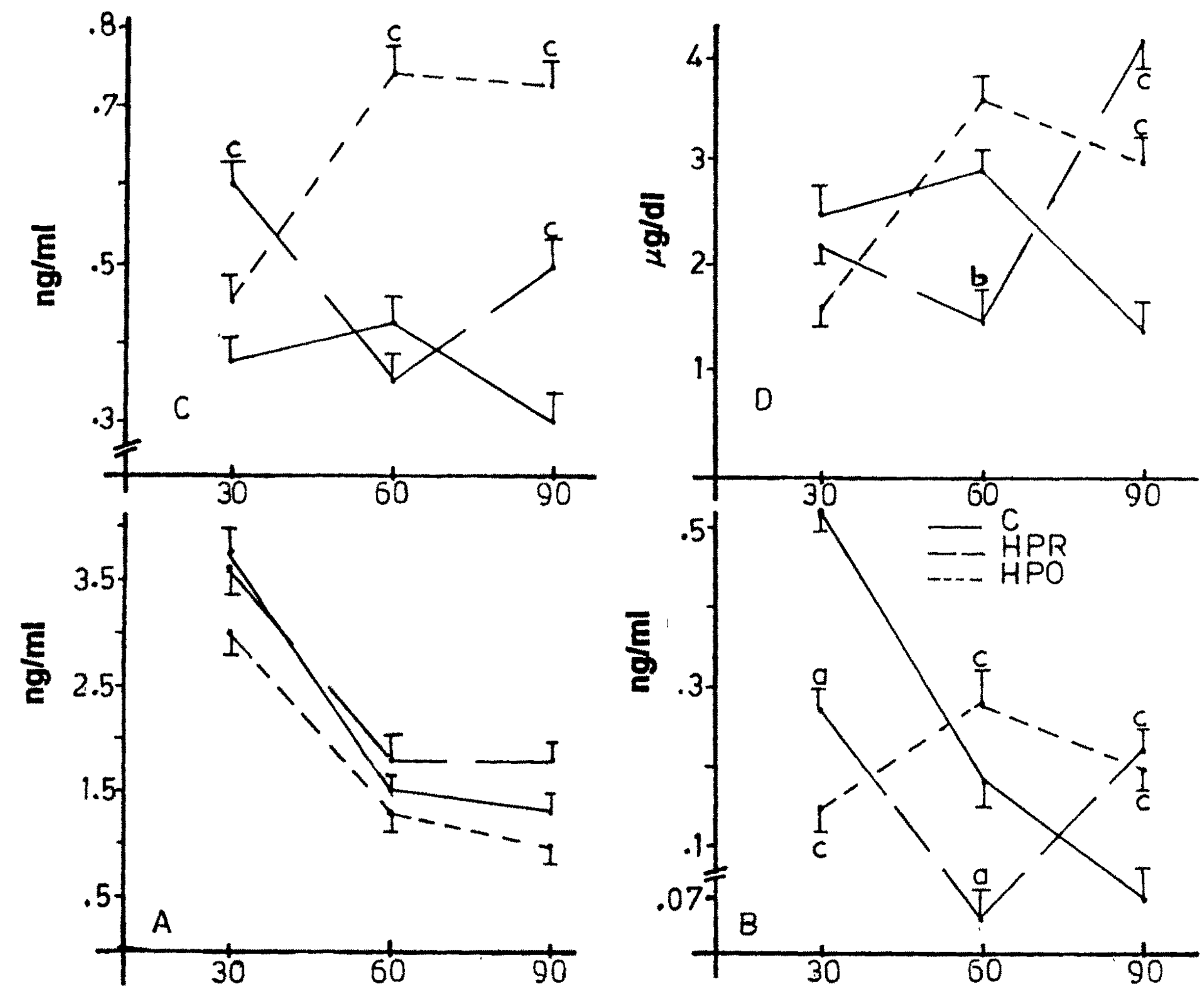

Fig. 8 (A-D). Serum hormone levels of corticosterone (A), Progesterone (B), T_3 (C) and T_4 (D) in Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP

Values : Mean, ±S.E, N= 12 **[a]P < .05, [b]P < .005, [c]P < .0005.**

Table : 5 Table showing histometric data of ovary of Control,HPR and HPO pullets. Values : mean (*A.F : Atretic follicles*)

			Small[1] <30μm	Small[2] 31-90μm	Small[3] 91-120μm	Big[1] 21-240μm	Big[2] 241-440μm	Small 6-200μm	Big 200-300μm	Large >300μm	Total
30day	**HPR**	*Total*	32 (32%)	51 (52%)	13 (13%)	3 (3%)	---	98	---	---	98
		A.F	7 (22%)	22 (43%)	6 (46%)	---	---				35 (36%)
	CONT	*Total*	22 (28%)	42 (52%)	12 (15%)	4 (5%)	---	80	---	---	80
		A.F	4 (18%)	17 (40%)	2 (17%)	1 (25%)	---				24 (30%)
	HPO	*Total*	52 (58%)	28 (31%)	7 (8%)	2 (2%)	---	89	---	---	89
		A.F	3 (6%)	5 (18%)	2 (29%)	---	---				10 (11%)
60day	**HPR**	*Total*	17 (26%)	14 (21%)	13 (20%)	18 (27%)	4 (7%)	50	16	---	66
		A.F	1 (6%)	1 (7%)	1 (8%)	2 (11%)	---				5 (7%)
	CONT	*Total*	28 (35%)	40 (51%)	4 (6%)	5 (6%)	2 (3%)	77	2	---	79
		A.F	4 (14%)	5 (12%)	2 (50%)	---	---				11 (14%)
	HPO	*Total*	9 (20%)	11 (25%)	9 (20%)	9 (21%)	6 (14%)	29	11	4	44
		A.F	---	3 (27%)	2 (22%)	2 (22%)	---				7 (16%)
90day	**HPR**	*Total*	2 (3%)	23 (33%)	20 (29%)	13 (19%)	11 (16%)	47	14	8	69
		A.F	---	5 (22%)	2 (10%)	1 (8%)	---				8 (11%)
	CONT	*Total*	18 (20%)	31 (35%)	12 (14%)	20 (23%)	7 (8%)	65	18	5	88
		A.F	1 (6%)	4 (13%)	5 (42%)	4 (20%)	---				14 (15%)
	HPO	*Total*	11 (18%)	17 (22%)	19 (31%)	10 (16%)	5 (8%)	50	9	3	62
		A.F	2 (18%)	5 (29%)	6 (32%)	2 (20%)	---				15 (24%)

T able 6. Table showing percentage rate of transition from small (0-120μ) to big (121-240μ) and big to large(>300μ) follicular hirearchy in Hypercorticalic (HPR) and Hypocorticalic (HPO) pullets reared under SP

	30d		60d		90d	
	S⇒ B	B ⇒ L	S ⇒ B	B ⇒ L	S ⇒ B	B ⇒ L
HPR	---	---	24.2%	---	20.3%	11.6%
Control	---	---	2.5%	---	20.5%	5.7%
HPO	---	---	25%	9.1%	14.5%	4.8%

Values: Mean, N=12

the HPR chicks showed increased weight and growth only between 60 and 90 days with, lesser weight and reduced growth rate during the1st month. The absolute weight and growth rate of liver and lymphoid organs, in general, showed a similar trend as that of body weight. In terms of relative weight at 90 days, whereas the HPR chicks had a higher liver weight, the HPO chicks had higher lymphoid organ weights. This suggests a favourable influence of HPR on growth of liver, and that of HPO, on growth of lymphoid organ. This is well corroborated not only by the relative growth rates of these organs in the three groups of chicks, but also by the growth index which is significantly higher with respect to liver in HPR and, significantly higher with respect to lymphoid organs under HPO. Previous chapters as well as few studies from other laboratories, had shown favourable influence of corticosterone on hepatic growth (Garren and Barber, 1955; Garren, 1957; 1961; Davison *et al.,* 1979;Joseph and Ramachandran, 1992;Chapter,8). Based on the present observations of increased growth of liver in HPR chicks, it can be presumed that the influence of corticosterone on hepatic growth in domestic fowl is a generalized one and photoperiod independent. It has been established that corticosterone has a suppressive effect on lymphoid organ growth (Siegel, 1961; Freeman *et al.,* 1966), which had been confirmed in growing chicken by corticosterone implantation (Davison *et al.,* 1985). However, in the previous study, mild HPR by corticosterone implantation showed a favourable influence on lymphoid organ growth and based on these differential observations it was inferred that the effect of corticosterone and lymphoid organs is dose dependent, and that, within an optimal range corticosterone infact has a favourable influence (Chapter,8). But presently, HPR, though within the optimum range, did not have any favourable influence on the growth of lymphoid organs. In contrast, mild insignificant HPO in the present study had a significant positive influence on the growth of lymphoid organs. Such an influence of HPO has been demonstrated only under significant reduced corticosterone levels (Chapter,8). Apparently, small decrease in corticosterone levels within an optimal range, which is without any influence on lymphoid organs, can be potentiated by short photoperiod. Conceivably, prevailing melatonin levels may have bearing on the action of corticosterone on lymphoid organs. Though the ovary and oviduct showed an increase in absolute weight in both HPR and HPO chicks, in terms of relative weight and growth index, there is no difference between the three groups, suggesting no influence of HPR or HPO. Same was the case with reference to the adrenal as well. However, the thyroid gland showed relatively greater relative weight and growth index in both HPR and HPO chicks, more pronouncedly in the later group.

The increased relative weight and growth indices of thyroid gland seen in HPR and HPO chicks, are paralled by increased T_3 and T_4 levels in these two groups of chicks. Though the corticosterone levels did not show much difference between the three groups, thyroid hormone levels were significantly elevated in the experimental groups, more pronouncedly in the HPO group of chicks.

Previously,an early maturation of HHG axis by rearing of chicks under a short photoperiod (SP) from 0-90 days was inferred, on the weight and histoarchitecture of the ovary and initiation of egg laying and total number of eggs laid (Chapter,1). Present observations on weight, growth rate, growth index and histological features of the ovary in the three groups of chicks, suggest no effect of HPR or HPO on the favourable influence induced by SP. A comparison of the histometric data of ovary, reveals the presence of only small follicles of less than 200μm in all the three groups of chicks. Obviously, the transition in terms of follicular size hierarchy from small to big follicles, is slowed down due to short photoperiod, as has been inferred earlier (Chapter,7). From the above study, it was inferred that, slower initial pace of follicular progression may provide the follicles more time for maturational changes and, ultimately result in an augmented stimulatory response to the increased hypothalamo-hypophyseal output in response to a step-up photoperiod after 90 days, resulting in faster progression through white and yellow follicular hierarchy as characteristic of hens closer to sexual maturity and oviposition (Sharp, 1993; see Etches, 1996; Chapter,7). Apparently, mild HPR or HPO condition, seems to have no influence in this respect on the SP induced favourable changes. However, on a comparative basis, the transition from small to big follicles occurring during the 2nd month and, big to large follicles occurring during the 3rd month, is relatively higher in the HPR chicks compared to the control chicks, along with relatively lesser rate of follicular atresia. These changes are well reflected in the higher yield of eggs in the SP+HPR chicks as compared to SP control chicks (Chapter,3) Apparently, mild HPR has a further favourable effect on the SP induced increased egg yield by influencing the intra-ovarian regulatory mechanisms of folliculogenesis and atritia. The slightly reduced egg yield in the SP-HPO chicks compared to SP-C chicks seems to be essentially due to an earlier transition of follicles from big to large during the 2nd month and a dampened transition from small to big and big to large follicles during the 3rd month, coupled with increased follicular atresia (Chapter,8). Apparently, a regulated and synchronized hierarchial transition in terms of follicular size on a temporal basis and, the rate of follicular atresia, could be the determining factors in attainment of sexual maturity and total egg yield. Another aspect which finds identity in SP control and SP+HPR chicks, is the serum progesterone titre which showed a dramatic decrement during the 3rd month. It is likely that this dramatic decrease in the progesterone level which occurs about 30 days prior to the initiation of lay may have some bearing on initiation of egg laying and the, establishment of LH surge. It is reported that, transfer to a long day, provides photostimulation and, consequently, the concentration of LH rises and egg production increases (see Etches 1996). From the data, it is clear that this dramatic decrease in progesterone level is delayed in HPO chicks, which may be correlated with the earlier reported delayed initiation of egg laying by 10 days (Chapter,3)

From the present sets of observations, it can be concluded that, SP in rearing phase has a favourable influence on, the HHG axis, the intra ovarian events and, overall egg lay and, that, HPR or HPO may exert a certain subtle modulatory influence on SP induced intra-ovarian molecular mechanisms.