LIGHT RESPONSES OF THYROIDECTOMIZED COMMON WEAVER BIRDS, *PLOCEUS PHILIPPINUS*

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Increase in day length, in general, leads to development of the gonads and deposition of fat in the bodies of birds, particularly in migratory species (Farner 1959, 1964; Wolfson 1960; Thapliyal et al. 1961; Farner and Follett 1966). In the baby chick and duck (Kleinpeter and Mixner 1947; Radnot and Orban 1956) continuous light treatment stimulates the thyroid, and in canaries probably the output of the thyroid stimulating hormone increases with a concomitant decrease in the gonad stimulating hormones of the adenohypophysis (Kobayashi 1954, 1957). Severe hypothyroidism, on the other hand, is known to inhibit development of the gonads and to cause increase in the body weight of fowl and ducks, even when treated with stimulatory photoperiod (Benoit and Aron 1934; and see reviews by Chu 1938; Höhn 1961). Recently however, it has been shown that, in a number of tropical and sub-tropical finches whose gonadal cycles are not regulated by day length, surgical ablation of the thyroids leads to increase in the body weight and gonad size, which, after reaching a maximum, follow a plateau (Thapliyal and Pandha 1965, 1967a, b, c; Thapliyal 1968, 1969). Until now the effect of severe hypothyroidism on the gonadal development of a photoperiodic finch has not been studied. This paper reports results of such a study on the Common Weaver Bird, *Ploceus philippinus*.

MATERIAL AND METHODS

Ploceus philippinus is a non-migratory, seasonally dimorphic finch distributed over the whole of India and Pakistan. The annual gonadal cycle of this species, which breeds during summer months, is regulated by changes in the day length (Thapliyal and Saxena 1964). Under a long-day regime the testes increase in size and follow a plateau after reaching a maximum but with short photoperiods the gonads regress rapidly and do not redevelop (Saxena 1964). It has been shown that the annual body weight cycle, unlike the gonadal cycle, is not regulated by day length (Garg and Thapliyal 1967).

Nestling Common Weaver Birds were hand-fed over a month and were then allowed to feed naturally for about two weeks before being used in the present study. Adult females were collected locally and prior to use were allowed two weeks of rest in the department aviary.

Experiments with juveniles were started in December 1966 and with adults in January 1967. On the first day of each experiment, 16 female birds were thyroidectomized. Half of these birds were exposed to constant 9-hr days; the other eight birds were maintained as controls. Equal numbers of sham-operated females were also maintained as normal controls under both the photoperiods. The birds were kept in groups of four in wire cages ($10.5 \times 16.5 \times 9$ inches) with food (Kayun, *Setaria italica*) and water ad libitum. The cages of experimental birds were enclosed daily in a light-proof wooden box ($4.5 \times 2 \times 5.5$ ft) at 17:00, removed regularly at 08:00, and then placed under natural daylight alongside the control cages in the bird room ($12 \times 14 \times 18$ ft) in front of a north-facing window that receives unrestricted light. At Varanasi (25° 18′ N, 83° 1′ E) day length on 21 June is 13 hr, 34 min, and on 21 December, 10 hr, 26 min. All the birds remained in good condition on this regime. While daily temperature records were not maintained, the maximum temperature record for the last two years at Varanasi, as published by the Indian Meterological Department, is 114.5°F and the minimum is 38.0°F. In another series of light experiments in which daily temperature was recorded over a year, it was found that the difference between the bird-boxes and bird-room was never more than 3°F (Pandha and Thapliyal 1969).

Starting from the first day of the experiment the left sides of the birds were deplumed and regular monthly observations made of diameter of ovarian follicles, when 1 mm or larger, or appearance of the ovary to the eye (*in situ*) through a small incision placed between the last two ribs of the bird under aseptic condition and open ether anesthesia. The wound was closed by fine silk thread. In wild finches wound healing is rapid and complete within two weeks. Practically no scar tissue is formed at the site of surgery. This permits repeated surgery at the same place in these and other finches (Thapliyal and Saxena 1964; Thapliyal and Pandha 1965, 1967a, b). Birds were weighed and laparotomized regularly at monthly intervals until February 1968 when they were killed and the weights of the various organs recorded (table 2). The gonads were fixed in Bouin's fluid for microscopical study, and the thyroid areas of the thyroidectomized birds were checked by cutting serial sections. There was no regeneration of thyroid tissue in any of the operated birds. Statistical analysis of the data consisted of t tests. Since the stress due to surgery was the same in all the groups no special attempt was made to study and account for its effect.

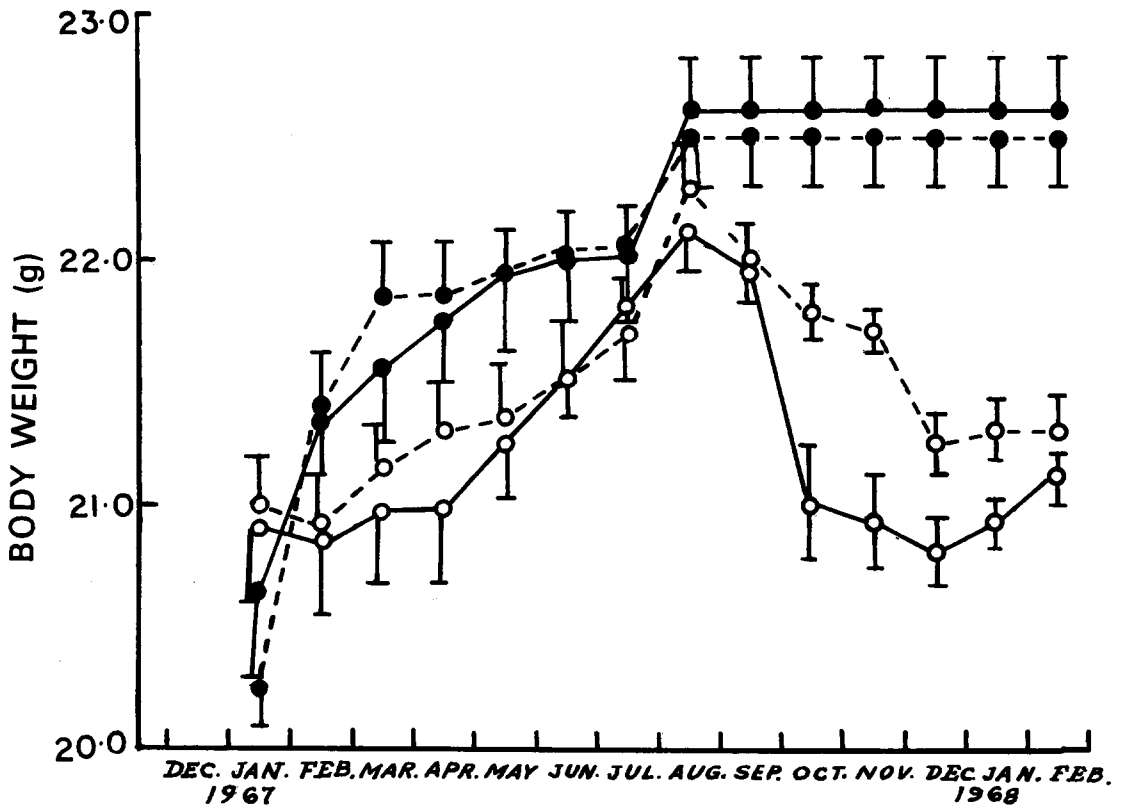

FIGURE 1. Mean body weight of thyroidectomized (solid circles) and sham-operated (open circles) adult female Common Weaver Birds under constant 9-hr (solid line) and natural photoperiods (broken line). Vertical bars represent the standard errors of the means. $N = 8$, except thyroidectomized 9-hr birds = 7, Aug. 1967–Feb. 1968.

OBSERVATIONS

BODY WEIGHT

Normal birds. Irrespective of the photoperiod, the weight of the normal adult females decreased slightly during the first month, then increased to a maximum in August, after which it declined. Minimum body weight was recorded in December; by February birds were once again gaining weight. While there was no significant change until September, from October to January the mean body weight of short-day birds was significantly less than that of birds receiving a normal photoperiod (fig. 1).

The sham-operated juveniles experienced a cycle of body weight essentially similar to that of the adult birds. Unlike the adults, however, they showed no decrease during the January–February period. Further, while the December 1967 body weight of the juveniles was significantly higher than that for December 1968, there was no significant difference between the mean body weights of January and February of 1967 and 1968 (fig. 2).

Thyroidectomized birds. The mean body weight of the thyroidectomized birds, irrespective of their age and the photoperiod, increased, first rapidly and then slowly, reached a maximum in August, and then followed a plateau. In February 1968, when the experiment was concluded, there was no significant difference due to age or photoperiod, but thyroidectomized birds weighed significantly more than sham-operated controls (figs. 1, 2).

OVARY

Normal birds. There was no change in the ovaries of the normal short-day birds until May, when they appeared to have developed slightly. There was further development during June and July, but measurable follicles were wholly absent. There was no further development over June (juvenile) and July (adult) until February 1968 when these birds were killed. During the same period, that is, from December 1966 to February 1968, the ovaries of the sham-operated birds receiving natural photoperiods experienced a complete cycle of change in the diameter of the follicles. Ovaries started developing during April/May, attained maximal development in August, and

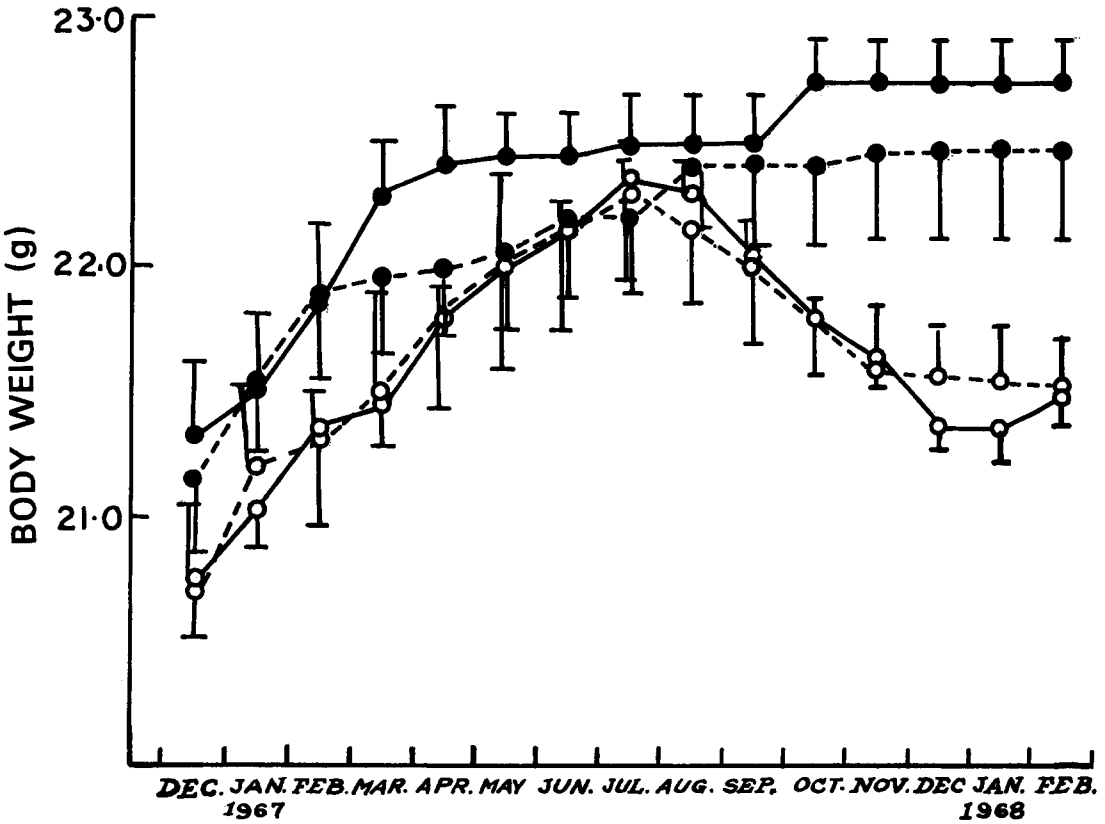

FIGURE 2. Mean body weight of thyroidectomized (solid circles) and sham-operated (open circles) juvenile female Common Weaver Birds under constant 9-hr (solid line) and natural photoperiods (broken line). Vertical bars represent the standard errors of the means. $N = 8$, except thyroidectomized birds = 7, Oct. 1967–Feb. 1968, and sham-operated, 9-hr birds = 7, Dec. 1967–Feb. 1968.

then started regressing. By the next February they had regressed to a small size (table 1).

In February 1968, when these experiments were concluded, while the mean weight of the oviduct was the same in all four groups of normal birds, ovaries of birds receiving the 9-hr photoperiod weighed significantly more than those of birds experiencing normal day length. Further, weights of the ovaries of the juveniles and adults subjected to the same photoperiod were not significantly different (table 2).

Thyroidectomized birds. The ovaries of the thyroidectomized adults started developing in February/March and those of the juveniles about a month later and in both cases followed a plateau after reaching a maximum in August. The February 1968 ovaries and oviducts of the athyroidic birds were significantly heavier than those of the normal birds. Further, irrespective of the difference in the age and photoperiod, there was no significant difference in the weights of the ovary and oviduct among the four groups of hypothyroid birds (table 2).

LIVER

The livers of the hypothyroid birds weighed significantly more than those of the normals, but otherwise there were no significant differences (table 2).

SPLEEN

The weights of the spleens were not significantly different for any two groups of birds (table 2).

DISCUSSION

BODY WEIGHT

The body weight of the non-migratory wild Spotted Munia is independent of the gonadal hormones and gonad-stimulating hormones of the adenohypophysis (Chandola and Thapliyal 1968a), but it is influenced by the pituitary metabolic (luteotrophic and somatotrophic) and the thyroidal hormones (Chandola and Thapliyal 1968b). In the Spotted (*Lonchura punctulata*), Lal (*Estrilda amandava*), and Chestnut-bellied (*Munia atricapilla*) Munias, body weights of thyroidectomized birds increase and follow a plateau (Thapliyal and

TABLE 1. Mean diameter (mm) of the largest ovarian follicles or visual condition[a] of the ovary of normal and athyroidic Common Weaver Birds under natural and 9-hr photoperiods.

Months	No. birds	Juvenile				Adult			
		Photoperiod				Photoperiod			
		Normal		Thyroidectomized		Normal		Thyroidectomized	
		Natural	9-hr	Natural	9-hr	Natural	9-hr	Natural	9-hr
1966									
Dec.	8	NS	NS	NS	NS				
1967									
Jan.	8	NS	NS	NS	NS	NS	NS	NS	NS
Feb.	8	NS	NS	NS	NS	NS	NS	NS	NS
Mar.	8	NS	NS	NS	NS	NS	NS	Sti	Sti
Apr.	8	NS	NS	SS	SS	NS	NS	Sti	Sti
May	8	SS	SS	Sti	Sti	SS	SS	0.90[c]	Sti
June	8	Sti	Sti	Sti	Sti	Sti	SS	1.09	0.81
July	8	1.09	Sti	1.15	1.09	0.94	Sti	1.28	1.05
Aug	8	1.22	Sti	1.37	1.28	1.20	Sti	1.30	1.32[b]
Sept.	8	Sti	Sti	1.37	1.28	0.88	Sti	1.30	1.32[b]
Oct.	8	Sti	Sti	1.37[b]	1.28[b]	Sti	Sti	1.30	1.32[b]
Nov.	8	SS	Sti	1.37[b]	1.28[b]	SS	Sti	1.30	1.32[b]
Dec.	8	NS	Sti[b]	1.37[b]	1.28[b]	NS	Sti	1.30	1.32[b]
1968									
Jan.	8	NS	Sti[b]	1.37[b]	1.28[b]	NS	Sti	1.30	1.32[b]
Feb.	8	NS	Sti[b]	1.37[b]	1.28[b]	NS	Sti	1.30	1.32[b]

[a] NS = not stimulated (follicles not visible to naked eye).
SS = slightly stimulated (follicles observed but not very distinctly).
Sti = stimulated (distinct follicles visible but diameter < 1 mm).
[b] Groups having seven birds only.
[c] Less than 1 mm mean diameter indicates that not all birds examined had follicles that measured 1 mm or more across; i.e., follicles of six birds measured 1 mm, the seventh only 1.2 mm. The diameter of the follicles of the eighth, being less than 1 mm, could not be measured. The average for this group of eight birds is therefore $= (1 \times 6 + 1.2)/8 = 0.90$ mm.

TABLE 2. Mean weights of body (g ± SE), ovary, oviduct, spleen, and liver (mg ± SE) of normal and thyroidectomized juvenile and adult female Common Weaver Birds under natural and 9-hr photoperiods.

Status	No. birds	Organs	Natural photoperiod	No. birds	9-hr photoperiod
Juvenile					
Normal	8			7	
		Body	21.52 ± 0.20		21.49 ± 0.13
		Ovary	9.98 ± 0.74		14.55 ± 1.19[a]
		Oviduct	6.22 ± 0.72		7.73 ± 1.13
		Spleen	29.50 ± 2.39		22.71 ± 3.11
		Liver	676.25 ± 44.30		599.30 ± 22.51
Thyroidectomized	7			7	
		Body	22.43 ± 0.25		22.74 ± 0.17
		Ovary	24.71 ± 1.74		25.41 ± 1.11
		Oviduct	14.80 ± 0.71		14.05 ± 0.81
		Spleen	24.43 ± 2.95		28.57 ± 3.03
		Liver	903.71 ± 30.28		923.40 ± 107.14
Adult					
Normal	8			8	
		Body	21.51 ± 0.19		21.12 ± 0.09
		Ovary	11.61 ± 0.84		14.60 ± 0.84[b]
		Oviduct	7.95 ± 1.12		8.65 ± 1.32
		Spleen	27.50 ± 2.29		22.37 ± 2.24
		Liver	675.25 ± 39.98		685.37 ± 44.83
Thyroidectomized	8			7	
		Body	22.61 ± 0.22		22.32 ± 0.16
		Ovary	26.07 ± 1.78		25.97 ± 1.24
		Oviduct	13.35 ± 1.92		14.08 ± 0.78
		Spleen	24.62 ± 4.84		26.00 ± 1.51
		Liver	862.20 ± 43.21		839.00 ± 56.95

[a] $P < 0.01$
[b] $P < 0.05$

Pandha 1965, 1967a, b; Thapliyal 1967, 1968, 1969; Thapliyal and Garg 1967). Our results show that the relationship between hypothyroidism and body weight in the female Common Weaver Bird is of a similar type. Thyroidectomy, as in other finches (Thapliyal 1969), leads to a permanent increase in the body weight. The body weight of the female Common Weaver Bird, however, appears to be independent of day length, unlike that of the migratory birds (Farner 1959; Wolfson 1960; Benoit 1961, 1964; Thapliyal et al. 1961; Farner and Follett 1966). This probably indicates that in the non-migratory birds, unlike the migratory birds, light does not influence the factor(s) that leads to alteration in the body weight (King and Farner 1956, 1963; Farner 1959, 1964; Wolfson 1960; Meier and Farner 1964).

Alternatively, it would be of interest to investigate whether severe hypothyroidism will lead to increase in the weight of migratory birds, as in the non-migratory finches. The nature of the factor(s) (hormonal or metabolic) that can cause gain in the body weight of a bird, whether migratory or sedentary, is not known with certainty (Chandola and Thapliyal 1968a, b). Further, since no special efforts were made to study the accumulation of fat at various regions within the bodies of these birds, it is difficult to state whether the increase in the weight of the hypothyroid weaver birds occurred as a consequence of fat deposition or protein synthesis (nitrogen retention). Experiments are being planned to examine the above question biochemically.

OVARY

The annual reproductive cycle of the Common Weaver Bird, as that of a number of the temperate zone birds (Wolfson 1960; Marshall 1961; Farner 1964; Farner and Follett 1966), is regulated by fluctuations in day length (Thapliyal and Saxena 1964; Garg and Thapliyal 1967). Gonadal development in both sexes is stimulated by long, and inhibited by short, photoperiods (Saxena 1964; Garg and Thapliyal 1967). However, when treated with long days, gonads of the Common Weaver Bird, unlike those of the other photoperiodic birds, develop and follow a plateau after reaching a maximum (Thapliyal and Saxena 1964; Garg and Thapliyal 1967). Results of present experiments indicate that the influence of severe hypothyroidism on the development cycles of the ovary of the Common Weaver Bird is similar to that induced by long photoperiods. This is the first report showing that gonadal stimulation in a photoperiodic bird may be augmented by severe hypothyroidism under constant, short photoperiods.

Further, since the light-induced development is blocked by l-thyroxin (Thapliyal 1969), it seems reasonable to suggest that, as in the Lal Munia (Thapliyal 1969), in the female Common Weaver Bird reduction in the activity of the thyroid may be essential before the hypothalamo-hypophysial-gonadal axis will respond fully to photostimulation.

LIVER

Our results agree with those reported for Black-headed (*Munia malacca*) (Thapliyal and Pandha 1967a) and Chestnut-bellied Munias (Thapliyal and Garg 1967). The increased weight probably reflects disturbed metabolism due to the hypothyroidic condition (Thapliyal 1969). Estimation of liver protein, lipid, and glycogen content would be of considerable help in understanding the nature of the metabolic disturbance.

SPLEEN

Changes in the weight of spleen, it has been reported, may be taken as a measurable sign of alteration in the endocrine factors (Oakeson 1953). Further, while l-thyroxin has no influence, weight of the spleen is affected by metabolic hormones of the adenohypophysis (Chandola and Thapliyal 1968b). The absence of any change in the mean weight of the spleen probably indicates that neither light nor hypothyroidism has any influence on those factors that influence its weight.

CONCLUSIONS

When the photoperiodic female Common Weaver Bird is made severely hypothyroidic, the body weight and the diameter of the ovarian follicles increase and remain elevated even under a constant 9-hr photoperiod. Further, while thyroidectomy leads to increase in weight of the liver, weight of the spleen is not affected significantly. It is suggested that thyroid activity may be related in an important way not only to the annual gonadal and body weight cycles, but also to the light-responding mechanism(s) of the female Common Weaver Bird.

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