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Effects of Photoperiod Alterations on Adrenocortical, Pineal and Gonadal Activity in Nocturnal bird, *Athene brama* and Diurnal bird, *Perdica asiatica*

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ABSTRACT—Present study showed the influence of photoperiod alterations on adrenal gland weight, adrenal lipids and plasma corticosterone profiles (adrenocortical function), and pineal and gonadal weights of two Indian tropical male and female birds belonging to nocturnal (Spotted owl, *Athene brama*) and diurnal (Jungle bush quail, *Perdica asiatica*) habitats. Exposure of both sexes of nocturnal birds to long photoperiod (LP, 16L:8D, light between 6:00 to 22:00hr) and continuous illumination (CL) during reproductive recrudescence and active phases, respectively, increased adrenal weight, adrenal lipids, such as phospholipids, free and esterified cholesterol, as well as plasma corticosterone levels. Concomitantly, the LP treatment elevated the gonado-somatic index while decreased the pineal gland weight, however, the CL treatment was ineffective to alter gonadal and pineal activity. Exposure of both sexes of nocturnal birds to short photoperiod (SP, 8L:16D, light between 9:00 to 17:00hr) and continuous darkness (CD) during reproductive recrudescence and/or active phases inhibited adrenocortical function and gonadal activity while elevated the pineal gland weight. Exposure of both sexes of diurnal birds to SP and CD during the reproductive active phase produced similar changes on these variables like that of the nocturnal birds while the CL treatment was ineffective. These results indicated that adrenocortical function and gonadal weights are photoperiod-dependent in both sexes of birds, irrespective of their habitats and can be positively correlated. Pineal gland activity showed an inverse pattern of changes with adrenocortical function and gonadal activity when exposed to different photoperiod regimes, irrespective of the habitat or sex of birds. Present study together with previous reports further indicate that pineal gland may mediate photic signals. Direct evidence is, however, required to support this hypothesis.

INTRODUCTION

The importance of environmental factors such as photoperiod, temperature, rainfall, humidity and consequently food availability, in the control of annual reproductive cycle (Sakai and Ishii, 1986; Gwinner, 1989; Meijer, 1989; Cockrem, 1995) and role of pineal gland in this regard is suggested in avian species (Ralph, 1981; Vivien-Roels, 1985; Glass, 1988; Haldar and Ghosh, 1990; Chakraborty, 1993; Maitra and Dey, 1993). It has been suggested that the pineal gland may be one of the photo-neuroendocrine transducer to convey photic information via the daily pattern of melatonin secretion and whose primary effect is related to the suppression of the reproduc-

tive system (Arendt, 1988). Involvement of hypothalamic serotonin (5-HT) is indicated in photoperiod-dependent sexual mechanisms in birds (el-Halawani *et al.*, 1978). However, increasing evidences demonstrated that pineal or melatonin-mediated effects on reproduction implicate through the hypothalamic 5-HT system (Blask, 1981; Glass, 1988) and the effect being inhibitory (Ralph, 1981; Vivien-Roels, 1985; Chaturvedi, 1984; Haldar and Ghosh, 1990). In contrast, Simpson *et al.* (1983) reported no influence of pineal gland on luteinizing hormone secretion in male Japanese quail. Interestingly, Zeman *et al.* (1993) demonstrated an inhibitory role for melatonin in corticosterone secretion, behavioral and metabolic activity in the same species.

Compared to the reports on reproductive cycle (References as above), little attention has been paid to study the influence of environmental factors on adrenal cycle in birds (Silverin, 1979; Sudhakumari, 1995; Haldar *et al.*, 2000). However, the effects of temperature and traumatic stress had been addressed (el-Halawani *et al.*, 1973; Assenmacher *et al.*, 1975; Asthemier *et al.*, 1995). Although the inhibitory role of pineal

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gland on adrenocortical function is documented in birds (Zeman *et al.*, 1993; Sudhakumari and Haldar, 1997), very few studies (Sudhakumari, 1995; Haldar *et al.*, 2000) indicate that pineal gland mediate photic and environmental signals to implicate this phenomenon. Role of pineal gland in mediating the photic signals (Arendt, 1988; Glass, 1988) and its relationship with gonads (Ralph, 1981; Vivien-Roels, 1985; Glass, 1988; Chaturvedi, 1984; Haldar and Ghosh, 1990; Haldar and Rai, 1997) and adrenal (Zeman *et al.*, 1993; Sudhakumari and Haldar, 1997) is being considered. Hence, it may be worthwhile to study the changes in pineal and adrenal activity in combination with gonadal activity under changing conditions of photoperiod. However, studies comparing the environmental variables with annual variations on pineal and gonadal activity and to some extent with adrenal have been reported from our laboratory using avian species (Haldar and Ghosh, 1990; Rai, 1994; Sudhakumari, 1995; Haldar and Rai, 1997; Haldar *et al.*, 2000). To our knowledge, effects of different photoperiod regimes on pineal-adrenal-gonadal activity together in avian species are scarce. However, studies in mammals demonstrated the pineal-mediated effect of photoperiod on adrenal and gonadal activity (Reiter *et al.*, 1966; Reiter 1972; 1974; Vaughan *et al.*, 1972; Wurtman, 1975).

Present study was aimed to understand the effect of different photoperiodic regimes on adrenocortical function, pineal and gonadal activity in males and females of two economically important birds (Spotted owl, *Athene brama* and

Jungle bush quail, *Perdica asiatica*) inhabiting two different habitats (nocturnal and diurnal, respectively) in Tropical India. Adrenal, pineal and gonado-somatic indices, adrenal lipids and plasma corticosterone profiles were used as experimental variables.

MATERIAL AND METHODS

Birds of both sexes, belonging to nocturnal as well as diurnal habitats were purchased from local bird dealers of Varanasi (Latitude 25°C, 18°N, Longitude 83°E, 01'E), Uttar Pradesh State, India.

(A) Nocturnal adult birds, *A. brama* (strigiformes) of both sexes weighing 120–125g body weight (BW) were used in the present study. It is an omnivorous bird without any sexual dimorphism even during the reproductive active phase. Usually the males weigh lighter than females. The reproductive cycle of the bird can be divided into four phases, inactive (September–November), recrudescence (December–February), active (March–April) and regressive (May–August) phases. Diurnal adult birds, *P. asiatica* (Galliformes) of both sexes weighing 45–50g BW were used in the present study. It is a herbivorous and occasionally an omnivorous bird, showing distinct sexual dimorphism during recrudescence and reproductive active phases. Unlike the males, a dark patch below the neck is evident in female birds during gonadal recrudescence and active phases. The reproductive cycle of *P. asiatica* can be divided into four phases, inactive (November–December), recrudescence (January–April), active (May–June) and regressive (July–October) phases.

Interestingly, in the diurnal bird, both adrenal and gonadal cycles run in parallel while in the nocturnal bird the gonadal activity precede the adrenal. Both nocturnal and diurnal birds were kept separately in an open-air fenced aviary exposed to all changes in normal environ-

Athene brama

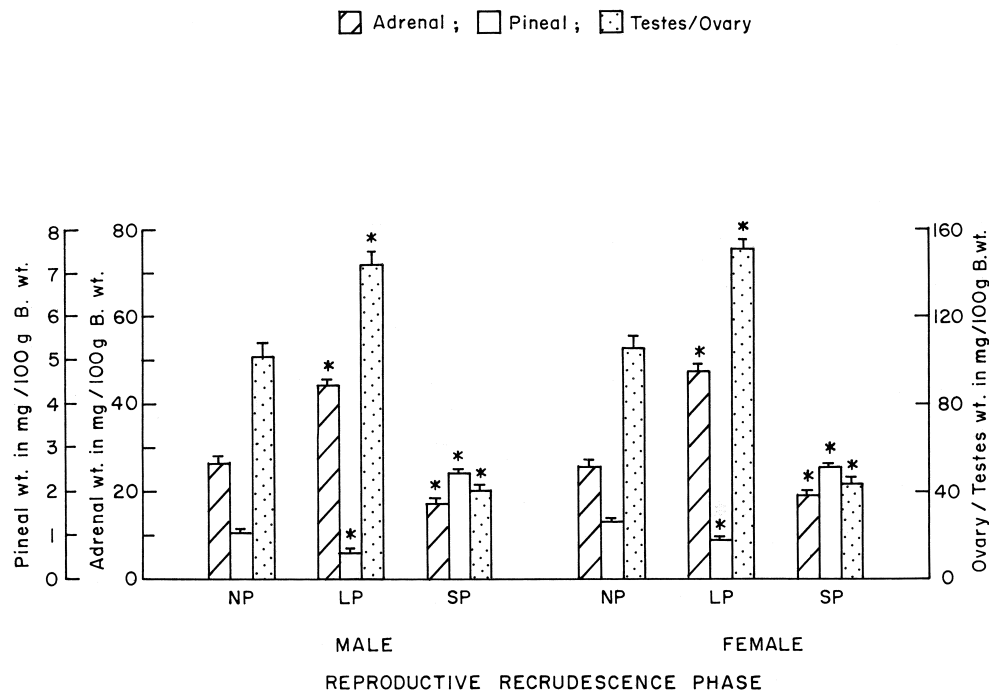


Fig. 1. Effects of long (LP, 16L:8D) and short (SP, 8L:16D) photoperiod on adrenal, pineal and gonadal weights of both sexes of the nocturnal bird *Athene brama* during the reproductive recrudescence phase. Vertical bars represent mean \pm SEM (n=10). All data were analyzed by one-way ANOVA followed by Kruskal-Wallis H test. *($P < 0.05$) means significantly different while NS means not significantly different from the normal photoperiod (NP) group.

mental conditions during acclimation. The nocturnal birds were fed with fresh meat, rodents while the diurnal birds were fed with millet seeds (*Pennisetum typhoides*) and provided water *ad libitum*. Similar type of feed was provided during the course of experiments too. The birds were acclimated for a fortnight before introducing to different photoperiod regimes. Feeding habits were quite normal and no mortality was observed in both sexes of both the species during acclimation and experimentation. A dim red light (0 Watt) was used to feed birds maintained in the darkness.

The following photoperiodic conditions were subjected to the nocturnal bird, *A. brama* at two different reproductive phases:

Experiment I: This photoperiodic experiment was carried out during the reproductive recrudescence phase (February). Birds of both sexes were divided into three groups.

Group 1: Ten birds each for both sexes were exposed to normal photoperiod and ambient temperature conditions (NP, 11:18 hrs light, Temp: Max: 24.9°C; Min: 10.4°C; Humidity: 71%) and it served as the control. *Group 2*: Ten birds each for both sexes were exposed to long photoperiod (LP, 16L:8D, Light exposure between 6 AM to 10 PM; Darkness between 10 PM to 6 AM). *Group 3*: Ten birds each for both sexes were exposed to short photoperiod (SP, 8L:16D, Light exposure between 9 AM to 5 PM; Darkness between 5 PM to 9 AM).

Experiment II: This photoperiodic experiment was conducted during the reproductive active phase (April). Birds of both sexes were divided into four groups.

Group 1: Ten birds each for both sexes were exposed to NP (12:54 hrs light, Temp: Max: 39°C; Min: 19.5°C; Humidity: 32.1%) and it served as the control. *Group 2*: Ten birds each for both sexes were exposed to SP (8L:16D, light exposure and darkness duration are as mentioned above). *Group 3*: Ten birds each for both sexes were exposed to continuous illumination or light (CL). *Group 4*: Ten birds each for both sexes were exposed to continuous or total darkness (CD).

Similarly the diurnal bird *P. asiatica*, belonging to both sexes were subjected to following photoperiodic alterations. A single experiment was carried out during reproductive active phase (June). Birds of both sexes were divided into four groups.

Group 1: Ten birds each for both sexes were exposed to NP (13:08 hr light, Temp: Max: 41.2°C; Min: 25.5°C; Humidity: 49.4%) and it served as the control. *Group 2*: Ten birds each for both sexes were exposed to SP (8L:16D, Light exposure between 9 AM to 5 PM; Darkness between 5 PM to 9 AM). *Group 3*: Ten birds each for both sexes were exposed to CL. *Group 4*: Ten birds of both sexes were exposed to CD.

After the completion of experiments (20 days in all cases), birds were sacrificed by decapitation during 10:00–11:00 hrs and birds maintained in the CD were sacrificed in dim red light. Birds were weighed and BW was noted in grams. After sacrificing the bird, the ovaries/testes, adrenal and pineal glands were removed, freed from adherent tissues and blotted on a filter paper and weighed in micro-electrical balance to calculate the adrenal, pineal and gonado-somatic index, which is expressed as the mean glandular weight in mg per 100g BW.

The blood collected in heparinized tubes was centrifuged at 800xg at 4°C to separate out plasma. The plasma samples were stored briefly at -20°C until assayed for plasma corticosterone by RIA. The corticosterone RIA was followed by the method of Abraham (1974) and plasma extraction procedure were similar to the protocol described previously by Senthilkumaran and Joy (1994). Plasma corticosterone was estimated by using [1,2,6,7-³H (N)] corticosterone (Sp. Act. 70–100 Ci / mmol) purchased from NEN, Boston, MA, USA and the antiserum to corticosterone was obtained as a gift from Dr. J.K. Datta, formerly at NIHFW, New Delhi, India. The intra- and inter-assay variations of the RIA were 3.2% and 2.4% (n=10), respectively. The sensitivity of the RIA was 10 pg/ml. The recovery of standard in the RIA ranged between 87 to 90%. The antiserum to corticosterone did not

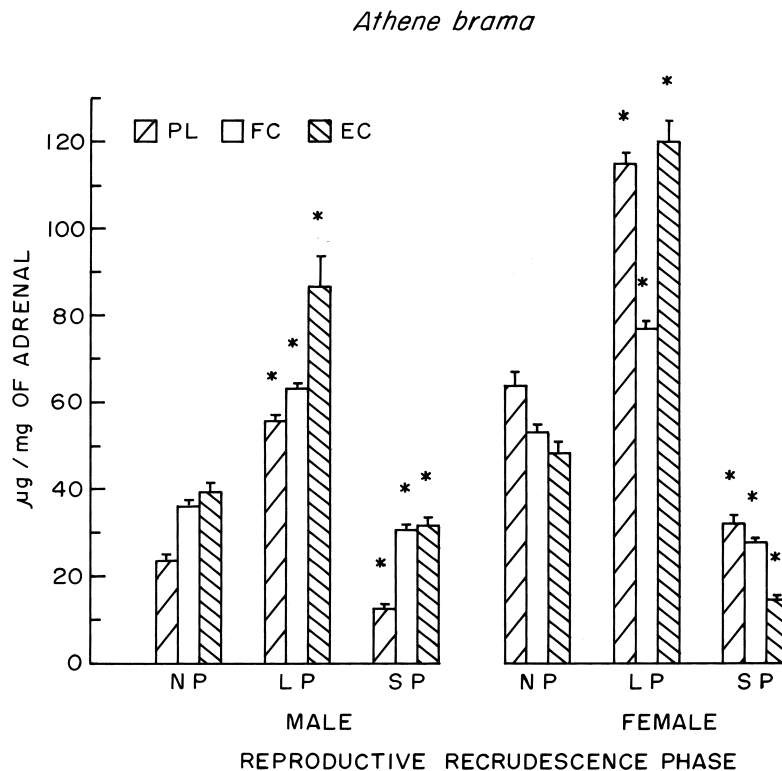


Fig. 2. Effects of long (LP, 16L:8D) and short (SP, 8L:16D) photoperiod on adrenal lipids such as phospholipids (PL), free (FC) and esterified cholesterol (EC) of both sexes of the nocturnal bird *Athene brama* during the reproductive recrudescence phase. Vertical bars represent mean \pm SEM (n=10). Other details are as in the Fig. 1.

show any significant cross-reactivity (<0.01) with other corticosteroids. Adrenal samples were processed for the analysis of lipids, in which phospholipids (PL), free (FC) and esterified cholesterol (EC) were estimated by adopting the method of, Folch *et al.* (1957) using thin-layer chromatography (TLC). Recovery of lipid standards in the assay was more than 90%. Details of this method described previously by Kirubakaran and Joy (1995). Prior to TLC assay of adrenal lipids, the adrenal gland tissues were stored briefly at -20°C .

Statistical analysis

All data were expressed as means \pm standard error mean (SEM). One-way analysis of variance (ANOVA) followed by Kruskal-Wallis H test was employed to compare the experimental variables of NP with other photoperiod regime altered groups. Differences were considered significant at $P < 0.05$. F values were not shown to simplify results in the text, however, significance levels were indicated.

RESULTS

Birds belonging to both sexes of *A. brama* and *P. asiatica* maintained in the NP showed changes on adrenal, pineal and gonadal weights (Figs.1, 3 and 5), adrenal lipids (Figs. 2, 4 and 6) and plasma corticosterone (Tables 1 and 2) profiles in accordance to their breeding cycle or phases (see Discussion), during which experiments were conducted.

Effects of exposure of nocturnal birds to LP and SP during the reproductive recrudescence phase

A one-way ANOVA of the data followed by the Kruskal-Wallis H test ($P < 0.05$) of the data indicated that the LP and

Table 1. shows the changes in plasma corticosterone profiles (ng/ml) at normal and altered photoperiod regimes in the nocturnal bird, *Athene brama*.

Reproductive Phase	Photoperiod regimes	Male	Female
Recrudescence	Normal Photoperiod	42.5 \pm 2.3	45.4 \pm 1.7
	Long Photoperiod	61.2 \pm 1.2*	64.3 \pm 1.1*
	Short Photoperiod	28.7 \pm 0.9*	29.5 \pm 0.6*
Active	Normal Photoperiod	74.8 \pm 1.8	78.7 \pm 2.1
	Short Photoperiod	42.7 \pm 1.4*	45.3 \pm 1.6*
	Continuous illumination	94.1 \pm 1.7*	98.2 \pm 1.9*
	Continuous darkness	36.9 \pm 0.8*	38.7 \pm 0.9*

Data indicate mean \pm SEM (n=10). * means $P < 0.05$ significance level (one-way ANOVA followed by Kruskal-Wallis H test) when compared to the Normal Photoperiod group.

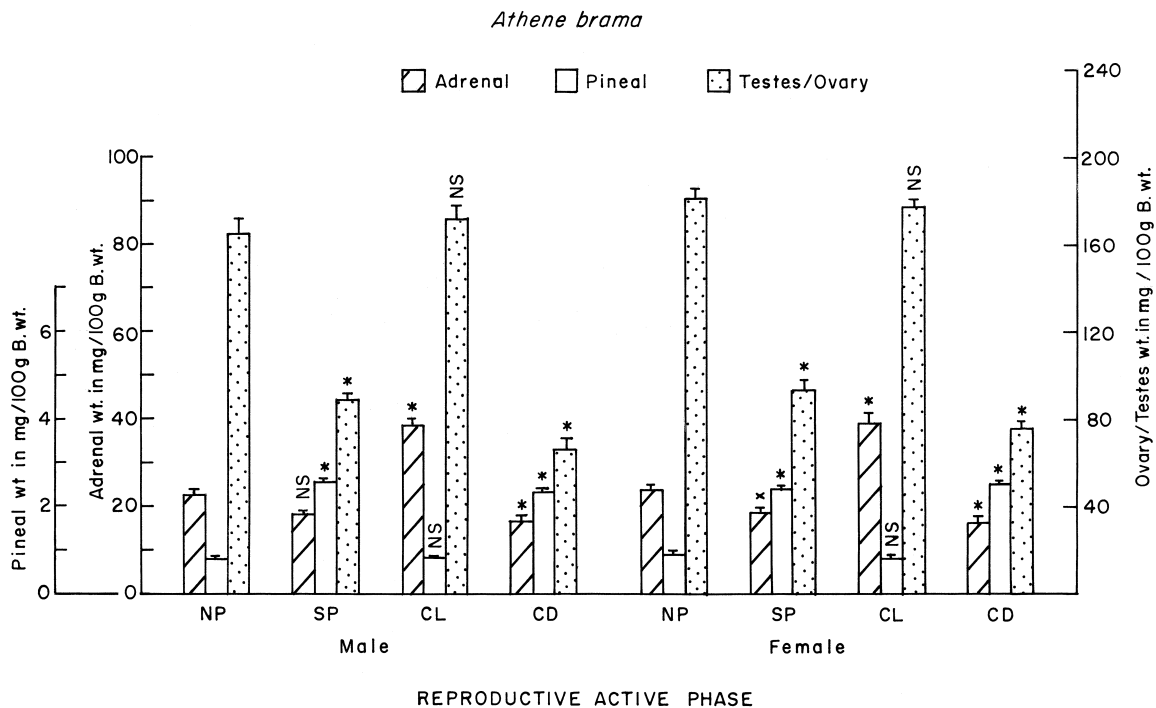


Fig. 3. Effects of continuous illumination (CL), continuous darkness (CD) and short (SP, 8L:16D) photoperiod on adrenal, pineal and gonadal weights of both sexes of the nocturnal bird *Athene brama* during the reproductive active phase. Vertical bars represent mean \pm SEM (n=10). Other details are as in the Fig. 1.

SP treatments significantly altered the experimental variables. Exposure of both sexes of nocturnal birds to the LP significantly increased adrenal and gonadal weights, while the pineal weight reduced significantly when compared to birds of the NP group (Fig.1). Adrenal lipid contents (PL, FC and EC) significantly elevated (Fig.2) concomitantly with plasma corticosterone (Table 1) when compared to the NP group. Whereas, exposure of both sexes of nocturnal birds to the SP significantly reduced adrenal and gonadal weights while the pineal weight rose significantly when compared to birds of the NP group (Fig.1). Adrenal lipids (Fig.2) and plasma corticosterone (Table 1) levels also decreased significantly in the SP exposed group.

Effects of exposure of nocturnal birds to SP, CL and CD during the reproductive active phase

A one-way ANOVA of the data followed by the Kruskal-Wallis H test ($P < 0.05$) of the data indicated that the SP, CL and CD treatments significantly altered the experimental variables except for the gonad and the pineal in the CL group. Exposure of both sexes of nocturnal birds to the SP significantly decreased adrenal and gonadal weights while the pineal weight elevated significantly when compared to birds of the NP group (Fig.3). Concomitantly, birds exposed to the SP, levels of adrenal lipids (PL, FC and EC; Fig.4) and plasma

corticosterone were significantly (Table 1) decreased when compared to the NP group. Exposure of both sexes of nocturnal birds to the CL significantly elevated the adrenal while pineal and gonadal weights were unaltered when compared to birds of the NP group (Fig.3). Adrenal lipids such as PL, FC and EC (Fig.4) and plasma corticosterone levels (Table 1) were elevated significantly in the CL exposed group. Exposure of birds to the CD completely reduced adrenocortical function (adrenal gland weight, adrenal lipids and plasma corticosterone; Fig. 4 and Table 1) and gonadal weight, while the pineal weight rose evidently (Fig.3).

Effects of exposure of diurnal birds to SP, CL and CD during the reproductive active phase

A one-way ANOVA of the data followed by the Kruskal-Wallis H test ($P < 0.05$) of the data indicated that the SP, CL and CD treatments significantly altered the experimental variables except for the CL group. Similar to nocturnal birds, exposure of both sexes of diurnal birds to the SP significantly decreased adrenal and gonadal weights while the pineal weight elevated significantly when compared to birds of the NP group (Fig.5). Concomitantly, birds exposed to the SP, levels of adrenal lipids (PL, FC and EC; Fig.6) and plasma corticosterone (Table 2) were significantly ($P < 0.001$) decreased when compared to the NP groups. Exposure of birds

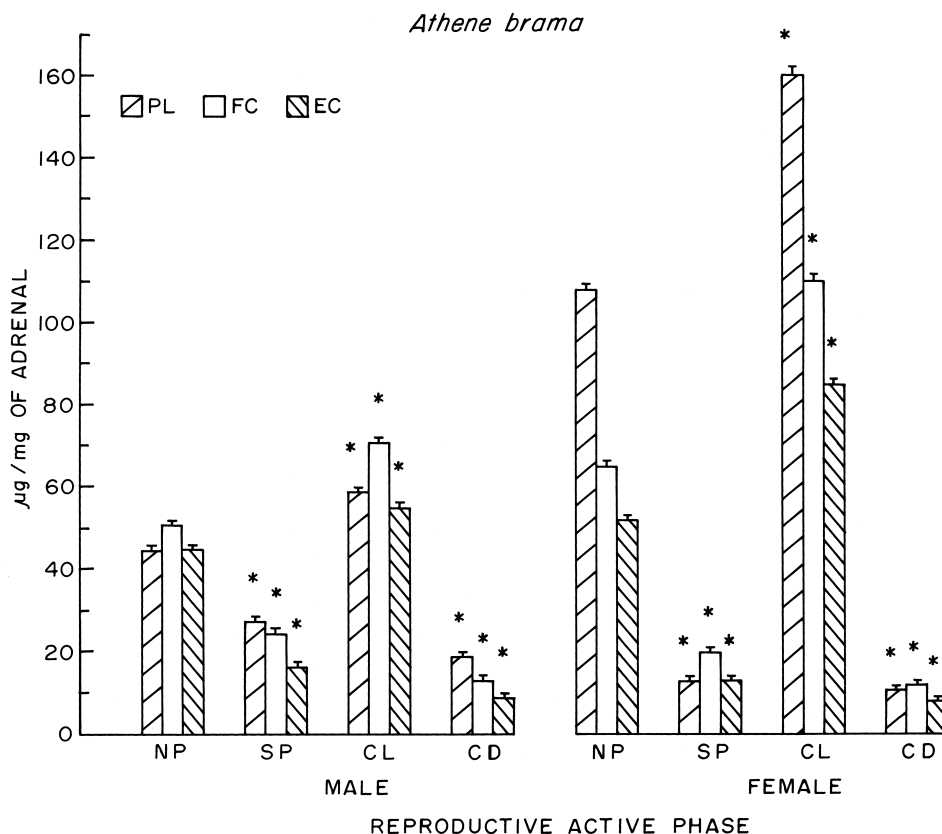


Fig. 4. Effects of continuous illumination (CL), continuous darkness (CD) and short (SP, 8L:16D) photoperiod on adrenal lipids such as phospholipids (PL), free (FC) and esterified cholesterol (EC) of both sexes of the nocturnal bird *Athene brama* during the reproductive active phase. Vertical bars represent mean \pm SEM (n=10). Other details are as in the Fig. 1.

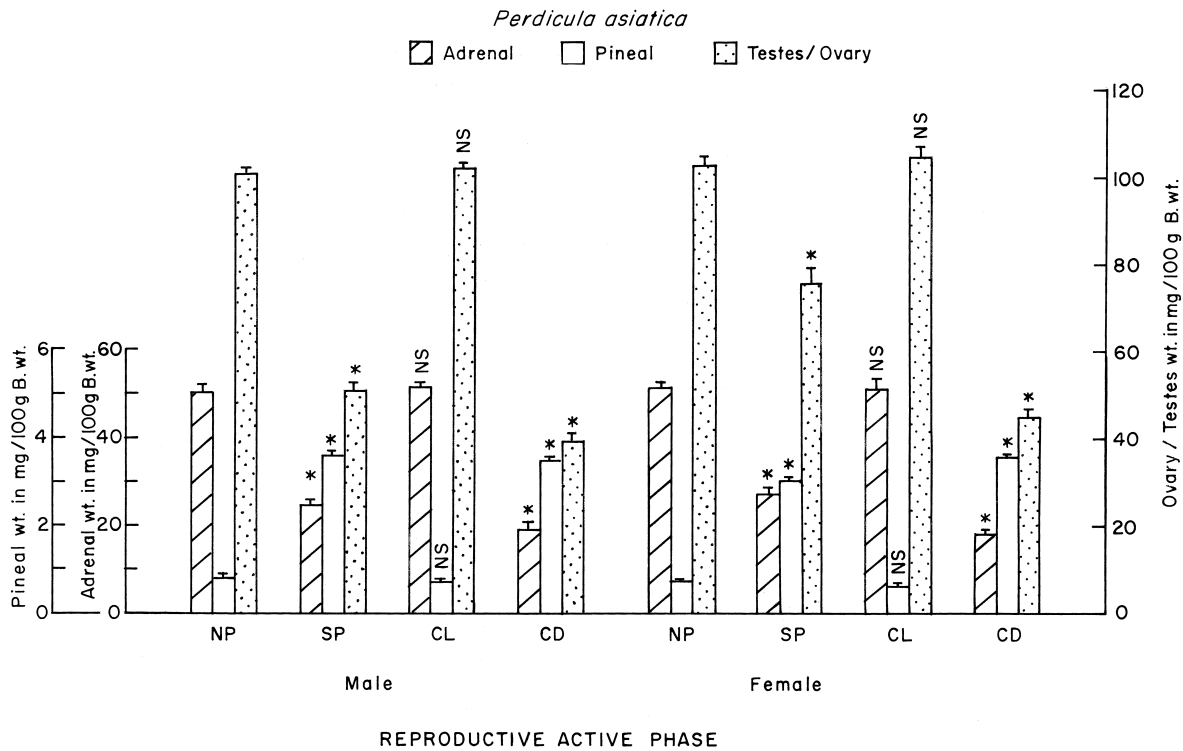


Fig. 5. Effects of continuous illumination (CL), continuous darkness (CD) and short (SP, 8L:16D) photoperiod on adrenal, pineal and gonadal weights of both sexes of the diurnal bird *Perdica asiatica* during the reproductive active phase. Vertical bars represent mean \pm SEM (n=10). Other details are as in the Fig. 1.

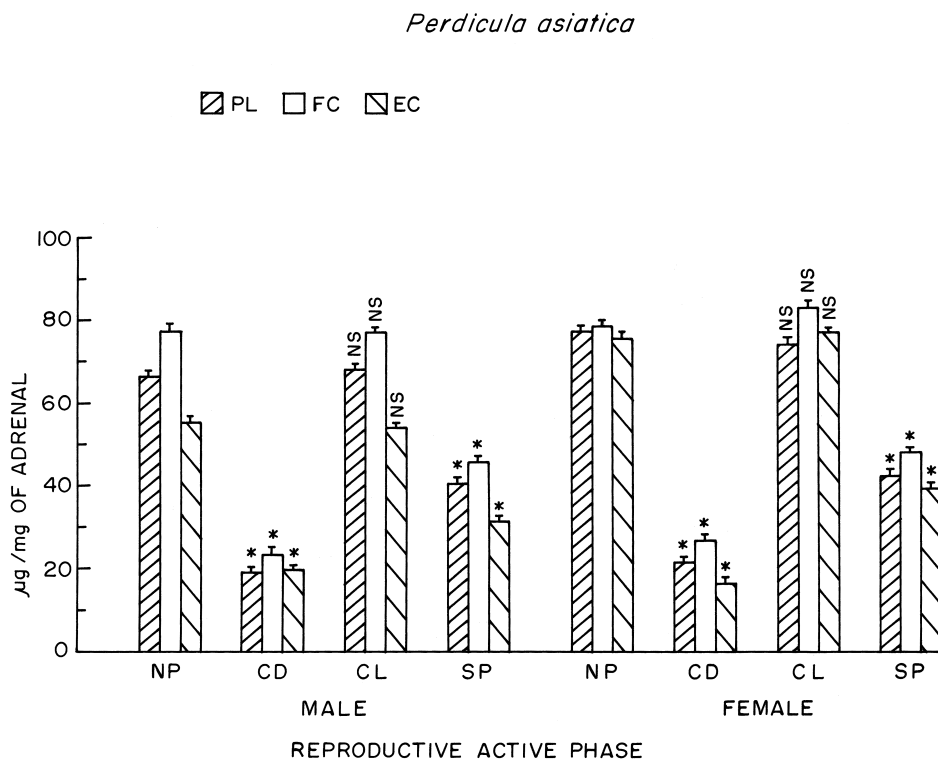


Fig. 6. Effects of continuous illumination (CL), continuous darkness (CD) and short (SP, 8L:16D) photoperiod on adrenal lipids such as phospholipids (PL), free (FC) and esterified cholesterol (EC) of both sexes of the diurnal bird *Perdica asiatica* during the reproductive active phase. Vertical bars represent mean \pm SEM (n=10). Other details are as in the Fig. 1.

Table 2. shows the changes in plasma corticosterone profiles (ng/ml) at normal and altered photoperiod regimes in the diurnal bird, *Perdicula asiatica*.

Reproductive Phase	Photoperiod regimes	Male	Female
Active	Normal Photoperiod	60.7 ± 1.4	64.8 ± 1.7
	Short Photoperiod	35.2 ± 0.9*	36.4 ± 1.1*
	Continuous illumination	62.3 ± 1.9 ^{NS}	66.9 ± 2.1 ^{NS}
	Continuous darkness	28.5 ± 0.7*	29.4 ± 0.8*

Data indicate mean ± SEM (n=10). * means $P < 0.05$ significance level (one-way ANOVA followed by Kruskal-Wallis H test) when compared to the Normal Photoperiod group. ^{NS} means not significantly different from the Normal Photoperiod group.

to the CD completely reduced the adrenocortical function (adrenal gland weight, adrenal lipids and plasma corticosterone (Fig.6 and Table 2) and the gonadal weight, while the pineal weight increased significantly (Fig.5). In contrast to nocturnal birds, exposure of both sexes of diurnal birds to the CL did not alter adrenal activity (Fig. 5) when compared to birds of the NP groups. Concomitantly, adrenal lipids such as PL, FC and EC (Fig.6) and plasma corticosterone (Table 2) levels showed no changes. The CL treatment did not alter pineal and gonadal weights as that of the nocturnal bird (Fig. 5).

DISCUSSION

In the present investigation, photoperiod-induced changes in experimental variables such as adrenal, pineal and gonadal weights, adrenal lipids and plasma corticosterone profiles were showed for the first time in males and females of nocturnal and diurnal bird species on a comparative basis. In general, the experimental variables enumerated above, responded to different photoperiodic regimes in the nocturnal bird. In the diurnal species, CD and SP treatments had pronounced effects.

The changes in adrenocortical function, pineal and gonadal weights in nocturnal and diurnal birds exposed to NP were in accordance to the annual data on these variables in the respective bird species, reported previously (Haldar and Ghosh, 1990; Sudhakumari, 1995; Haldar *et al.*, 2000). Exposure of the nocturnal bird to LP and CL in reproductive recrudescence and active phases, respectively, increased adrenal and/or gonadal weight and/or decreased the pineal gland weight significantly in both sexes. The CD and SP treatments had opposite effects. These results support each other and further indicate that the nocturnal birds are photo and scoto periodic species like that of the diurnal birds (Haldar and Ghosh, 1990; Chakraborty, 1993; Rai, 1994; Haldar *et al.*, 2000). Similar to the adrenal gland weight, adrenal lipids and plasma corticosterone showed corroborative changes. All the three lipid fractions elevated significantly in LP and CL exposed birds with a concomitant rise in the plasma corticosterone level. Increased level of EC and FC probably denote steroidogenic and adrenocortical hyperactivity, which is also evident from the elevated plasma corticosterone level. Elevated PL level might have some function associated with adrenal catecholamine release and such a relationship had been pro-

posed in birds (Chakarabarti and Ghosh, 1998) and mammals (Chakarabarty *et al.*, 1998). Conversely, both sexes of nocturnal birds exposed to CD and SP had diminished adrenocortical function evident from decreased adrenal lipids and plasma corticosterone level. Our studies on annual variations on these variables also indicated that increasing day length favored adrenal-gonadal activity and decreased the pineal activity while the reverse is true during decreasing day length (Sudhakumari, 1995; Haldar *et al.*, 2000).

Similar to the nocturnal bird, exposure of both sexes of diurnal birds to SP and CD diminished the adrenocortical function and the gonadal weight while elevated the pineal gland weight. However, the CL treatment did not induce any response. It is interesting to note that the CL was ineffective in the diurnal bird as it was for the nocturnal bird, except for the adrenal activity. The reason could be due to their specific sensitivity and habitat (Quay, 1970), or else it may be amenable that adrenal and gonadal activity might have reached its maximum and pineal activity to its nadir in the diurnal bird. It can also be attributed to their difference in the annual cycle of adrenal and gonadal activity in nocturnal and diurnal birds (Silverin, 1979; Haldar and Ghosh, 1990; Chakraborty, 1993; Rai, 1994; Sudhakumari, 1995; Haldar *et al.*, 2000). In other words, gonadal cycle override adrenal cycle in the nocturnal bird (Sudhakumari, 1995; Haldar *et al.*, 2000), while it coincides in the diurnal bird (Sudhakumari, 1995).

Taken together, photoperiodic alterations influenced adrenocortical function and pineal and gonadal activity in both sexes of nocturnal and diurnal birds. LP and CL are stimulatory for the adrenocortical function and/or gonadal activity only in nocturnal birds while SP and CD are inhibitory to experimental variables in both the species. The reverse is true for pineal gland weight. These observations are further supported by annual cyclic studies on these variables of the bird species from our laboratory (Haldar and Ghosh, 1990; Rai, 1994; Sudhakumari, 1995; Haldar *et al.*, 2000). These studies further indicated a role for pineal in mediating photic and other environmental factors to entrain reproductive and adrenal cycles.

The effects of increasing day length on initiation of gonadal growth (Lofts, 1975; Turek and Campbell, 1979; Wingfield and Farner, 1980) and pineal mediation in this regard is suggested (Glass, 1988; Haldar and Ghosh, 1990; Chakraborty, 1993; Rai, 1994; Haldar and Rai, 1997; Haldar

et al., 2000) in birds. Most of the reports suggested an inhibitory role for pineal on adrenal and gonadal activity in birds (Haldar and Ghosh, 1990; Chakraborty, 1993; Zeman *et al.*, 1993; Sudhakumari and Haldar, 1997; Haldar and Rai, 1997; Haldar *et al.*, 2000). However, the reviews of Ralph (1981) and Vivien-Roels (1985) concerning the influence of pineal gland on avian reproduction, favored inhibitory role but remarked some inconsistent results too. As suggested by Vivien-Roels (1985) this contradictory phenomenon may be due to species specific as well as sex dependent response of birds to the photic stimuli, also the impact of the zoogeographical positions. In contrast, Simpson *et al.* (1983) showed lack of pineal gland influence on photoperiodic clock in male Japanese quail. However, Zeman *et al.* (1993) demonstrated the influence of dietary melatonin on various endocrine and metabolic parameters including adrenal in the same species. Nevertheless, increasing evidences demonstrated the pineal or melatonin mediated effects on reproduction and sexual mechanisms in birds. (Blask, 1981; Glass, 1988). In mammals pineal-mediated photoperiod effects on adrenal and gonadal activity is documented (Reiter *et al.*, 1966; Reiter, 1972; 1974; Vaughan *et al.*, 1972; Wurtman, 1975; Arendt, 1988). In addition, specific receptors for melatonin have been identified in adrenal and gonads of avian species (Brown *et al.*, 1994; Murayama *et al.*, 1997). Considering all these observations and the photoperiod-induced changes in the pineal activity in the present report may indicate a role for the pineal gland to mediate the photic stimuli. However, in the present study, photoperiodic or traumatic stress, induced by CL and CD, can also be considered as a factor, at least, for changes in the adrenocortical function. This contention acquires very less support, as the diurnal birds exposed to the CL showed no change in the adrenal gland activity. Additionally, CD and SP treatments in nocturnal and diurnal birds diminished the adrenocortical function, indicating little or no photoperiod-induced traumatic stress. Under these conditions pineal gland activity responded in an opposite manner. Therefore, it is possible that the changes in photoperiod utilize pineal gland to mediate (Arendt, 1988; Glass, 1988; Haldar and Rai, 1997), as explained above or an endogenous circadian rhythm to entrain photoperiodic response in birds (Ravikumar *et al.*, 1995) may be operative or else these two together mediate the photic stimuli (Glass, 1988). This phenomenon has to be explored further. Nevertheless, the present study at least warrants the effect of photoperiod on adrenocortical function, pineal and gonadal activity in birds for the first time, though mechanisms remain unclear, but preliminary evidences indicate for pineal mediation.

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