P. americana (table 1). It is clear that the synergistic effect of sulphoxide on the toxicity of dieldrin and malathion was higher than that of piperonylbutoxide and SKF 525A, particularly on resistant strain. It becomes evident that sulphoxide has a greater effect on resistant than on F_1 strain, may be due to greater amount of active degrading enzymes in resistant strain[4] which increases the toxicity probably by blocking of aliesterase enzyme. In the resistant strain, an additional particulate carboxylesterase has been observed which shows greater activity than the soluble enzyme. This enzyme is readily inhibited by the malathion and dieldrin. This is in accordance with the findings of Welling and Blaakmeer[5]. The blocking of such enzymes renders the availability of toxicant at the site of action. Similar observation was reported by Bigley[6] and Townsend and Busvine[7] for the blowfly *Chrysomya putoria*. It can be concluded that the pattern of synergism is a mixed phenomena which on the one hand is governed by variation in the enzyme activity of susceptible and resistant strain and on the other by the chemical structure of the compound. A correlation between the structure of synergist and that of the toxicant was earlier documented by Valdestra[8], Wilkinson[9] and Metcalf[10].

Further, the use of synergists with an insecticide as compared to its use alone, is more economical. Making use of one part of an insecticide in turn renders the same stock solution available for many individuals of the same species. This reduces the cost of application of the insecticide. This is in accordance with the views of Roberts *et al.*[11]. The above described correlation explains the long awaited answer why insecticides quickly show the effect when mixed with a synergist as compared to its use without it.

PNS is thankful to UGC, New Delhi for award of a scholarship.

19 May 1983; Revised 16 August 1983

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CONTROL OF TESTES FUNCTION IN BLACKHEADED BUNTING, *EMBERIZA MELANOCEPHALA*

P. D. TEWARY and VINOD KUMAR
Department of Zoology, Banaras Hindu University Varanasi 221 005, India.

CONSIDERABLE research work has been carried out during the past two decades to ascertain if photoperiodic birds use their circadian system to measure the photoperiodic time[1-3]. Yet, very little is known about the photoperiodic control systems in species that migrate between Indian subcontinent and south east Asia. However, it was recently demonstrated that the variations in daylength have direct effect on gonadal function in the black headed buntings (*Emberiza melanocephala*), an emberizid finch, which overwinters at Varanasi (India; 25°18'N, 83°01'E)[4]. Exposure of buntings to day lengths less than 12 hr causes gonadal regression and cessation of gonadal functions, while longer photoperiods induce growth and development of the testes[5]. The testicular response to day length in this species is mediated by circadian photoperiodic time measurement[6], similar to that of other birds[1,2]. The present study is aimed further to determine whether the gonadotropic hormone secretion induced by long days in buntings is dependent on the photoinducible phase.

Acclimatised male blackheaded buntings were kept on short day lengths (8L:16D) for eight weeks in the fall (combined testicular weight, CTW = ca. 5 mg). Groups of photosensitive birds were then exposed to interrupted-dark cycles, in which 1 hr light pulses (1 L) were introduced during scotophase of a 6L:18D cycle. Time of 'light-interruption' was changed from group to group to reveal the photosensitive phase, *i.e.* 6L:4D:1L:13D (Group G_{10}), 6L:6D:1L:11D

(G_{12}), 6L:8D:1L:9D (G_{14}), 6L:9D:1L:8D (G_{15}), 6L:11D:1L:6D (G_{17}), 6L:13D:1L:4D (G_{19}), and 6L:15D:1L:2D (G_{21}). Group G_6 was in 7L:17D, and served as control.

Birds were given food and water *ad libitum*. The basic photophase with an intensity of about 400 lux at the perch level always commenced at 06:00 hr. All the birds were laparotomized before and after a 6-week exposure to the interrupted-dark cycles. Gonadal growth was expressed as CTW, and assessed by comparing the size of the testes *in situ* with a standard series of fixed testes of known weights. The error by this method is less than (±) 20%. Statistical analysis was done using student's *t*-test.

Testes were stimulated in the birds in groups G_{12}, G_{15} and G_{17}, but not in those in groups G_6, G_{10}, G_{14}, G_{19} and G_{21} (figure 1). Further, the average CTW for buntings in G_{12}, G_{15} or G_{17} was significantly greater ($P<0.001$) than for birds in G_6, G_{10}, G_{14}, G_{19} or G_{21}.

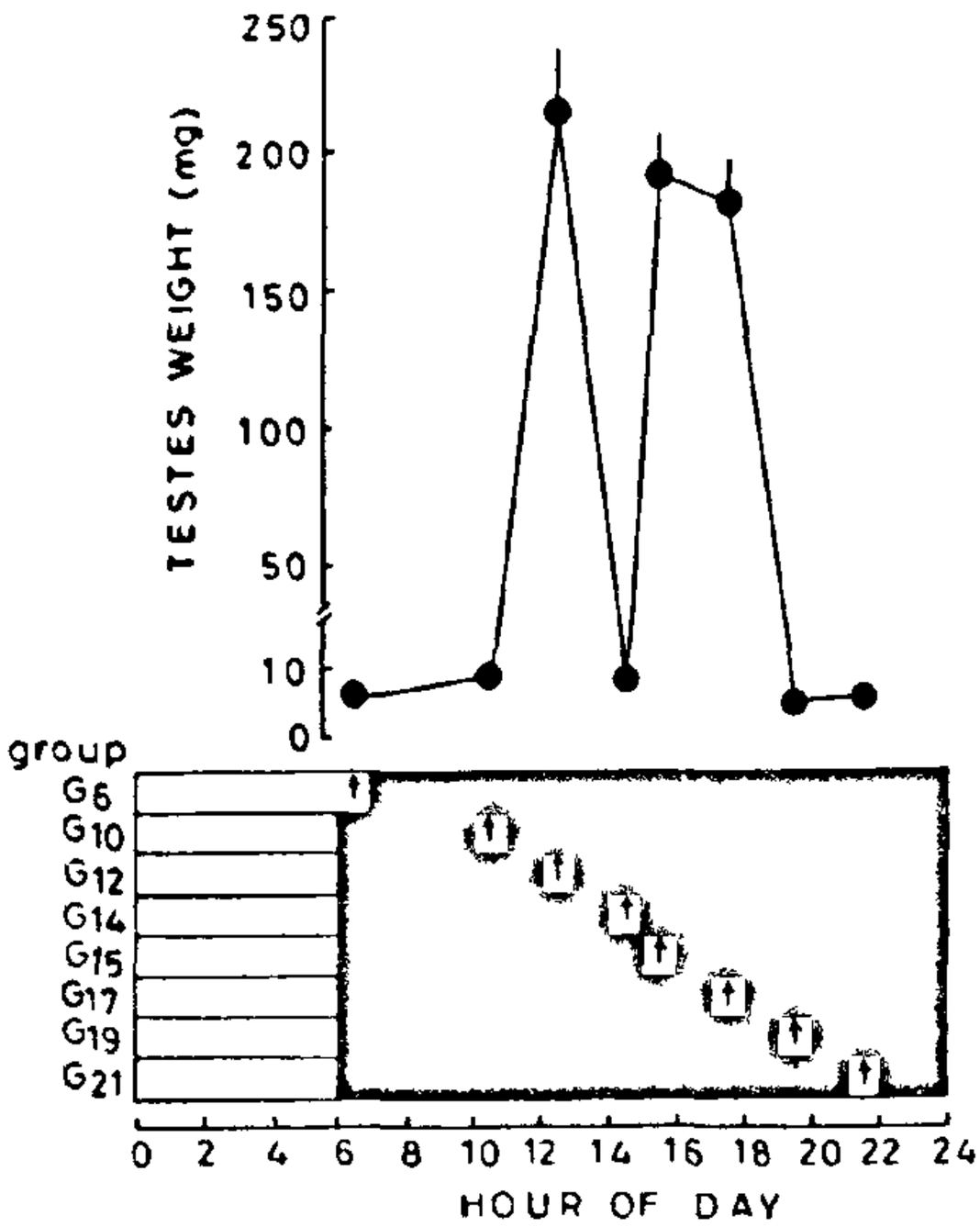

Figure 1. Effect of interrupted-night photoschedules to testes in male blackheaded buntings. Photosensitive birds were exposed for six weeks to one of seven interrupted-night photoschedules (arrow) for 1 hr. Shaded areas in the diagram indicate dark periods. Closed circles indicate means of combined testes weights for groups of five or six birds indicated on the left side. Standard errors are represented by the vertical bars.

However, no significant difference in testicular response among the photostimulated groups was observed.

These results clearly indicate that there is a photoinducible (light-sensitive) phase for gonadotropin release in the buntings, and that buntings are sensitive to light twice a day, between 12 and 14 hr and 15 to 17 hr after the dawn (a bimodal pattern). The bimodality in the photoperiodic responses appears to be due to phase shift and entrainment to light pulses, during the late hours in the scotophase, as a false dawn, so that the so-called photoinducible phase is illuminated by the basic photoperiod of the following day[1,7–10]. Support for this hypothesis is found in Japanese quails where the measurable circadian rhythm of motor activity is phase shifted by certain light pulses during the night[9].

Our data on buntings are consistent with those on other species[1,2] where testes are stimulated if the scotophase of a short LD cycle is interrupted by a light pulse at certain hr. Since there is no data on motor activity, it is premature to comment on the length of the photoinducible phase in buntings. Figure 1 however, demonstrates it to be of approximately 2 hr (between 12 and 14 hr) if second peak of gonadal growth is due to reentrainment of the endogenous circadian rhythm by 1L pulses. It must nonetheless be noted that the location of the photoinducible phase is dependent on the length of the basic photophase[9–11]

This study was financially supported by the UGC.

4 June 1983; Revised 27 September 1983

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