THE EFFECT OF AUDITORY STIMULATION ON THE SPERMATOGENETIC CYCLE OF THE MALE ENGLISH SPARROW

BY C. S. THORNTON AND S. B. CUMMINGS, JR.
ASSISTED BY FREDERICK GREELEY

IN recent years, many investigators have clearly demonstrated the importance of environmental factors in initiating and controlling the sexual cycle in a large number of fish, reptiles, birds, and mammals. According to the most widely accepted hypothesis (Bissonnette, 1936; Marshall, 1936) these environmental factors stimulate the anterior pituitary periodically to produce an increased amount of gonadotropic hormone which, in turn, causes seasonal changes in the sexual mechanism. These changes include hypertrophy of the gonads, active spermatogenesis and various secondary sexual changes in coloration and plumage. The question at issue is concerned with the factors which arouse the cyclic activity of the pituitary gland of the bird.

According to one theory (Bissonnette, 1931, 1932), an increase in the daily light ration is essential to the appearance of the seasonal sexual changes in birds. According to a second theory, the "activity" theory of Rowan (1938a, b), light rays are not directly responsible for, nor even essential to, the occurrence of these changes. Rowan's theory assumes that an increase in bodily activity produces metabolic and hormonal changes which, in their turn, stimulate the sexual mechanism. Accordingly, various environmental agencies, as long as they cause heightened activity in the animal, can be effective in producing the seasonal sexual changes.

As one line of evidence in support of this view, Rowan (1938b) reports some observations which indicate that London Starlings become sexually active several weeks in advance of country birds. He attributes this difference primarily to the sounds of city traffic which keep the birds in a state of prolonged wakefulness and agitation.

However, Bissonnette (1932), Riley (1940), and Kendeigh (1941) have proved without doubt that exercise has no effect on the avian sexual cycle. Rowan's explanation of the premature sexual activity of the city Starlings would consequently appear inadequate. Kendeigh (1941) has suggested that the enforced wakefulness of the city birds has allowed them to respond to the feeble illumination of the street lights.

Nevertheless, the possible effectiveness of the auditory pathway as a mechanism which may control sexual periodicity has not been systematically investigated. Such an investigation becomes all the more necessary in view of the fact that Whitaker (1940) has reported incidental observations indicating that white-footed mice become sexually active at a premature date in a noisy laboratory environment. Accordingly, we have undertaken experiments designed to test the effectiveness of sound in initiating and controlling the sexual cycle of the male English Sparrow. A preliminary report of the results of these experiments has already appeared (Cummings and Thornton, 1941).

PROCEDURE

Groups of male sparrows were captured in mid-November during their sexually quiescent period. They were housed in screened wooden cages, 3′ × 2′ × 16″ in size. All birds were maintained on a diet of scratch feed which had been passed through cod liver oil. They remained healthy and active during the experimental period, which lasted 40 days.

An experimental group of seven birds was isolated in a separate room and subjected to an intermittent noise from a small commercial buzzer throughout the 40-day period. The buzzer was connected to a circuit-breaker in such a way as to provide one second of sound stimulation followed by one second of silence. This form of stimulation continued for 15 hours each day for the duration of the experiment. The buzzer operated at a noise level of 50–60 decibels above the human auditory threshold. The experimental group of birds was allowed only the normal winter ration of daylight during the experiment.

Two control groups of sparrows were also observed over the same period. The first control group of four sparrows was subjected to 4.5 hours of artificial light in addition to the normal amount of daylight of the winter season, which was 9.4 hours in the latitude of Gambier, Ohio. Since it has been shown by other investigators (Kirschbaum and Ringoen, 1935; Riley, 1936) that the sparrow is responsive to light treatment, this control group served as a check on the physiological condition of the colony and also provided a basis of comparison for the sexual condition of the sound-stimulated group. These controls received no form of sound treatment and were kept in an isolated and quiet room.

A second small group of three sparrows was subjected to no added amounts of either sound or light. They represented birds in the normal quiescent condition and formed a second basis of comparison for the sound-stimulated group. While outside birds would probably have served just as well, it was thought best to take the precaution of using captive laboratory birds in case some unforeseen stimulating factor might be operative in causing spermatogenesis in the whole colony.

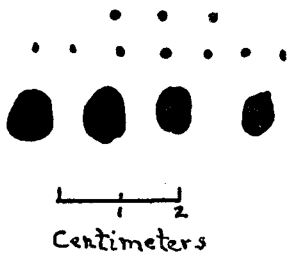
At the end of the 40-day experimental period the birds were sacrificed and their gonads removed. A testis of each bird used in the experiment was photographed *in toto* and then was sectioned and stained for histological examination.

RESULTS

The results of the experiment were clear-cut and consistent. No signs of gonadal hypertrophy or active spermatogenesis were found in any of the group of sound-stimulated birds nor in any of the control group which received only the normal amount of winter daylight.

In contrast, the birds of the control group which was given additional illumination were all well advanced in the sexual cycle. The testes were greatly enlarged, distinct lumina and mature sperm were observable in the seminiferous tubules. The usual seasonal secondary sex characters, such as darkening of the bill, were well marked.

These results are most clearly presented in Text-figure 1, which rep-



TEXT-FIGURE 1.—Testes of male English Sparrows. Top row, testes of normal controls; middle row, testes of sound-stimulated birds; bottom row, testes of light-stimulated birds.

resents tracings from the photographs of a testis taken from each of the birds used in the experiment. In the top row are shown the sizes of the testes of the birds which received only the normal winter ration of daylight (9.4 hours). These testes are typical for the normal male sparrow in the sexually quiescent condition of the late fall and winter. From histological sections of these testes, it was observed that the seminiferous tubules were at their minimum diameter, containing only spermatogonia.

The middle row of Text-figure 1 shows the testes of the sound-stimulated birds. All are small and indistinguishable in size from those of normal birds in the sexually inactive state. The histological picture of the testes in this group was practically indistinguishable from that of the testes of the unstimulated control group. Seminiferous tubules were small and contained only spermatogonia. In not a single instance was there the slightest evidence of spermatogenesis.

The bottom row of Text-figure 1 shows the testes of the birds stimulated with 4.5 hours of light in addition to the normal winter ration. All are enlarged considerably and contain fully mature sperm, indicating that the conditions under which the colony was maintained did not in any way interfere with the reactivity of the pituitary to appropriate stimulation.

Conclusions

These results present clear evidence that, under the conditions of the present experiment, sound unlike light is ineffective in initiating seasonal sexual changes in the male sparrow. These results, therefore, are in direct conflict with the observations of Rowan (1938b) and Whitaker (1940) who originally suggested the possibility of the effectiveness of sound for sexual stimulation. It should be pointed out, however, that Whitaker's observations were made on the white-footed mouse and that the situation in this mammal may not be strictly comparable to that found in the sparrow.

The only environmental variable which has clearly been demonstrated to control the avian sexual cycle is light. The failure of temperature (Miyazaki, 1934; Scott and Payne, 1937; Suomalainen, 1937) and bodily activity (Bissonnette, 1932; Riley, 1940; Kendeigh, 1941) to influence sexual periodicity in the bird is well established. The experiments reported in the present paper would seem to eliminate sound as well, at least within the audible range used here.

References Cited

Bissonnette, T. H.

1931. Studies on the sexual cycle of birds. IV. Experimental modification of the sexual cycle in males of the European Starling (*Sturnus vulgaris*) by change in the daily period of illumination and of muscular work. Jour. Exp. Zool., 58: 281–319.

1932. Light or exercise as factors in sexual periodicity in birds. Science, 76: 253–255.

1936. Sexual Photoperiodicity. Quart. Rev. Biol., 11: 371–386.

Cummings, S. B., and Thornton, C. S.

1941. The effect of auditory stimulation on the sexual cycle of the sparrow. Psych. Bull., 38: 532. (Abstract.)

KENDEIGH, S. C.
1941 Length of day and energy requirements for gonad development and egg-laying in birds. Ecology, 22: 237–248.

KIRSCHBAUM, A., AND RINGOEN, A. R.
1935. Seasonal sexual activity and its experimental modification in the male sparrow, *Passer domesticus* Linnaeus. Anat. Rec., 64: 453–474.

MARSHALL, F. H. A.
1936. Sexual periodicity and the causes which determine it. Phil. Trans. Roy. Sci. London, B226: 432–456.

MIYAZAKI, H.
1934. On the relation of the daily period to the sexual maturity and to the molting of *Zosterops palpebrosa japonica*. Sci. Rep. Tohoku Imp. Univ., 4th ser., 9: 183–203.

RILEY, G. M.
1936. Light regulation of sexual activity in the male sparrow (*Passer domesticus*). Proc. Soc. Exp. Biol. Med., 34: 331–332.
1940. Light versus acitvity as a regulator of the sexual cycle in the House Sparrow. Wilson Bull., 52: 73–86.

ROWAN, W.
1938a. Light and seasonal reproduction in animals. Biol. Rev., 13: 374–402.
1938b. London starlings and seasonal reproduction in birds. Proc. Zool. Soc. London, A 108: 51–77.

SCOTT, H. M., AND PAYNE, L. F.
1937. Light in relation to the experimental modification of the breeding season of turkeys. Poult. Sci., 16: 90–96.

SUOMALAINEN, H.
1937. The effect of temperature on the sexual activity of nonmigratory birds stimulated by artificial lighting. Ornis Fennica, 14: 108–112.

WHITAKER, W. L.
1940. Some effects of artificial illumination on reproduction in the white-footed mouse, Peromyscus leucopus noveboracensis. Jour. Exp. Zool., 83: 33–60.

Department of Biology
Kenyon College
Gambier, Ohio

THE EUROPEAN STARLING IN GASPÉ

BY STANLEY C. BALL

Plates 6, 7

IN its radiation from New York City where it was established in 1890, the European Starling (*Sturnus vulgaris* Linn.) was first recorded in Canada at Halifax, Nova Scotia, on December 1, 1915 (Tufts, 1926), and in southern Labrador in the spring of 1917 (Lewis, 1922: 513). For its early history in Ontario, the reader is referred to the excellent account by Dr. Harrison F. Lewis (1927). He has since followed the spread of this pioneer through Ontario, Quebec, and