

EXPERIMENTAL MODIFICATION OF THE PLUMAGE  
CYCLE OF THE MALE EUROPEAN STARLING  
(*Sturnus vulgaris*)<sup>1</sup>

BY J. WENDELL BURGER

WHILE considerable experimental work has been done on the genetic and hormonal factors which determine the character of avian plumage, very little has been published on the factors which determine the seasonal periodicity of plumage changes. Witschi (see Witschi '35 for a summary) in a fine series of studies has shown for some birds, especially the weaver finch, *Pyromelana franciscana*; that cyclic behavior of the pituitary is responsible for the alternation of mating and eclipse plumage. He found moreover, that the time of year when plumage changes occurred in this African weaver finch was the same for birds caged in Iowa City as it was for birds in Africa. For this species at least, conditions of the external environment different from those of the native habitat were without effect on the plumage cycle.

A somewhat different result was secured by Miyazaki ('34, '35) for the "white-eye", *Zosterops palpebrosa japonica*. He induced three sexual maturations in a year by artificially lengthening the days. After each sexual maturation the daily lighting was reduced, whereupon, molting ensued. He found further, that increasing the length of day during the refeathering process caused this refeathering to become irregular and deficient. No relation was found between testicular states as such and the time of molt. Miyazaki's results indicate that the plumage cycle of the "white-eye" can be influenced by changes in the external environment. The purpose of the present investigation was to extend this type of work to the starling.

METHODS AND MATERIALS

Two experiments of similar nature were performed. Twenty-four adult male starlings were given daily, fifteen hours solely of artificial illumination, beginning February 18. The birds were thus put through a precocious sexual cycle. All birds were kept on this light ration until April 19 when sexual regression had reduced the testes to a size approaching that found in sexually inactive birds. On April 19, twelve of the starlings were further kept on fifteen hours of daily light until June 15. The remaining twelve had their daily light reduced to nine hours until May 16 when a fifteen hour daily ration of light was resumed. These latter birds were also maintained until June 15.

Sixteen male starlings who had gone through a natural sexual maturation were given experimental lighting beginning June 24.

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Seven birds were kept on natural day-lengths until June 28, whereafter, their daily light ration was sixteen hours. Nine birds had their daily light reduced to nine hours until July 28, whereafter, their ration was raised to sixteen hours daily. All birds were maintained until September 7.

The undue complication of light changes described was due to the fact that these experiments were designed as well for a problem other than that here discussed.

#### RESULTS AND DISCUSSION

The starling shows no readily observed sexual dimorphism in its plumage. There is only one molt a year. This occurs in the summer and fall (Kalmbach and Gabrielson '21, Witschi and Miller '38). New feathers on the under surface of the bird are easily observed because of their white tips. Developing feathers can be readily noticed when the birds are handled.

In both these experiments, the birds whose light ration was constantly around 15-16 hours daily, molted. In the spring experiment, the first signs of new feathers were found about May 26. In the summer experiment, these signs were found about July 25. In both experiments, many new feathers were developing at the terminations of these experiments on June 15 and September 7. In fact, the bulk of the refeathering occurred closer to these end dates than to May 26 and July 25. The refeathering involved all the feather types, and certainly, the great majority of the feathers. In two birds, one in each experiment, little signs of molting were found. The testes of all the above starlings were inactive sexually.

The starlings which experienced a reduction to nine hours in their daily light ration molted more early and refeathered more quickly than did the birds which experienced no reduction in their daily lighting. In the spring experiment, the first signs of refeathering were found about May 9, roughly fifteen days earlier than these signs appeared in the birds whose light was not reduced. The refeathering moreover, was completed by May 29. In the summer experiment, the first signs of refeathering were found about July 8, seventeen days earlier than these signs were observed in the birds which received no reduction in their daily lighting. The refeathering was completed by July 28.

This short period of about twenty days, in which a complete refeathering occurred, is in contrast to the 45 days in the summer, when the starlings whose daily lighting was about sixteen hours, failed to complete their refeathering. In one bird in the spring experiment and in two in the summer experiment, only scattered new feathers were ever found.

It should be emphasized that in each experiment the refeathering (of the birds whose light ration was reduced) was completed by the

time refeathering reached its peak in the starlings on long days.

The testicular states involved in these experiments where reduced lighting was used were first, sexual inactivity at the beginning of the experiments, and second, a recrudescence of the testes for *some* of the birds in the last three weeks of the experimental period. Since this sexual maturation occurred only after the refeathering process was practically completed, no data are available as to whether or not the plumage cycle is at all related to the sexual cycle. The only information for the starling is that given by Witschi and Miller ('38) who find injections of sex hormones are without influence on the plumage of *Sturnus*.

In each experiment, conditions of food and temperature were the same for lots of birds to be compared with each other. While these factors are conceivably important, it is hard to see how they had any influence on the results described.

These experiments indicate that molting in the male starling can occur independently of the changes in length of day. Birds in nature molt when the days are growing shorter. In the laboratory, starlings molted when the days were constantly maintained at a length near that of the longest day of the year at the latitudes of New England. This much agrees with Witschi's findings on the African weaver finch.

A reduction in day-length however, was accompanied by a molt which appeared earlier than that of the starlings kept on long days. This earlier molt was also followed by a more rapid refeathering. It would appear that molting and subsequent refeathering will occur no matter what the day-length, but that a reduction in day-lengths favors or reinforces these processes. This situation is similar to that found by Miyazaki for the "white-eye" and by Bissonnette ('35) for the hair cycle of the ferret. The "white-eye" however, seems to be more influenced by light changes than is the starling. The full interpretation of the relation of the plumage cycle to the external environment requires work more elaborate than that of this preliminary investigation.

#### LITERATURE CITED

- BISSONNETTE, T. H. 1935. Relations of hair cycles in ferrets to changes in the anterior hypophysis and to light cycles. *Anat. Rec.*, 63: 159-168.
- KALMBACH, E. R. and GABRIELSON, I. N. 1921. Economic value of the starling in the United States. *U. S. Dept. of Agri., Bull.* No. 868.
- MIYAZAKI, H. 1934. On the relation of the daily period to the sexual maturity and to molting of *Zosterops palpebrosa japonica*. *Sci. Reports of the Tohoku Imp. Univ., 4th Series Biology*, 9: 183-203.
1935. Notes on the relation between the molting, the sexual maturation and the light period in *Zosterops palpebrosa japonica*. *Ibid.* 9: 427-429.
- WITSCHI, E. 1935. Seasonal sex characters in birds and their hormonal control. *Wilson Bull.*, 47: 177-188.
- WITSCHI, E. and MILLER, R. A. 1938. Ambisexuality in the female starling. *Journ. Exp. Zool.*, 79: 475-487.

Department of Biology, Trinity College, Hartford, Connecticut.