V.T.V.M. to that of the thermistor bridge. The lowest temperature is set on the zero of the scale by balancing the bridge, but the highest temperature is set at the full scale reading by adjusting the sensitivity of the V.T.V.M. The maximum setting control of the bridge serves to make the several bridges compare, but serves only as a fine control in matching the bridge to the V.T.V.M.

Calibration. (i) With the 20-point switch in the voltage-check position but with the battery voltage not applied, adjust the balance control of the V.T.V.M. so that the meter reads zero. (ii) With the 20-point switch in the check position and with the battery voltage applied, adjust the battery-adjust control to provide a predetermined reading on the V.T.V.M. This adjustment is important as a means of assuring reproducibility with changes in the age of the battery. The particular reading of the V.T.V.M. is not important as long as it allows adjustment when the battery ages, and providing the maximum adjust on the thermistor bridge can actually adjust for the maximum temperature desired. (iii) With the thermistors in a bath at the lower temperature limit, switch each of the thermistor bridges into the circuit in turn and adjust the minimum control of that bridge so that the meter reads zero. The bridge is now balanced. This adjustment is not disturbed by changes in the maximum control. (iv) With the thermistors in a bath at the upper temperature limit, switch each of the thermistor bridges in turn into the circuit and adjust the maximum control of that bridge so that the meter reads full scale. The scale of this thermometer is not linear, and either a special scale on the meter must be provided or a conversion graph must be prepared between the temperature and the meter reading. The instrument should now be in adjustment and ready for use.

15 November 1954.

Prolongation of Molting Period in the Canary by Long Days

Hideshi Kobayashi and Kiyonori Okubo

Zoological Institute, Faculty of Science* and *Branch Hospital, Faculty of Medicine, Tokyo University, Tokyo, Japan

The stimulating effect on avian gonads of lengthening daily light periods has been studied by many investigators, but little is known about its effect on molting periods. This paper describes the results of studies (*1*) of the effects of long days on the molting periods of the canary.

Beginning on 10 Sept. 1953, eight female canaries were subjected to 20-hr daily light periods. Artificial light was produced by a 100-w electric bulb, which was placed 1.5 m from the bird cages and was turned on from 4 A.M. until 12 P.M. every day. In addition, the birds received natural sunlight in daytime. Eight other female birds exposed to natural daily light periods served as controls. Four birds were kept in a cage. The structure of the cage used for the experiment has been described elsewhere (*2*).

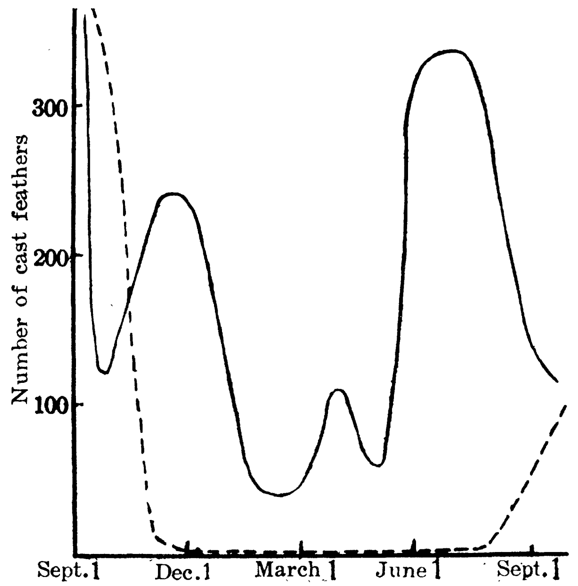

Fig. 1. Curves showing numbers of feathers cast off every 4 days by eight experimental canaries exposed to 20-hr daily light periods (solid line) and by eight control birds exposed to natural daily light periods (broken line).

All the birds were allowed to take water and food *ad libitum*. In order to examine the molting process of the birds, the feathers cast off on the floor of the cages were counted every 4 days, and at intervals the body and wing feathers that were being renewed were carefully observed in each bird.

The results of our experiment are summarized in Fig. 1. The molting of experimental birds was inhibited for about the first 20 days of the experiment. It has already been reported that the pituitary body and thyroid gland are concerned in the inhibition of molting following lengthening of the daily light periods (*3*). The molting became severe again toward December. During January and February 1954 the rate of refeathering was slowed. From March on, the loss of feathers was increased until the beginning of July; after this, a decrease again occurred. However, the birds continued to molt until 9 Nov., when the observation was stopped.

During the experimental period these birds were refractory to the stimulus of long days and did not show any sign of ovarian development. The cloacal region did not swell, and fat was not deposited subdermally. We had already observed that, in the canary, the cloacal region swells and the subdermal fat increases remarkably during the beginning of ovarian development (*4*). This refractoriness of the ovaries to long days observed in the experimental birds is in accordance with observations made by several investigators (*5*).

In control birds, the molting period was terminated at the beginning of November 1953, indications of ovarian development were observed in May 1954, and molting began at the end of July. Previously we reported that the development of gonads is a prerequisite to the inception of annual molting in the canary (*2, 4*).

In the present experiment, the molting of the experimental birds was in progress during January and February, and it became severe in March, although the ovaries had not developed in the birds. Therefore, it seems highly probable that the molting which occurred in 1954 was not a regular annual molting, which should always occur after the gonadal development, but a continuation of the molting of the preceding year. Thus, long days prolong the molting period of the bird. The reason why the rate of molting was slowed during January and February is not clear, but the observation (*2*) that, in the canary, it requires more thyroxin to induce the molt in winter than in summer, may partly account for the fact.

Burger (*6*), Miller (*7*), and Wolfson (*8*) have reported that long days prolong the refractory period of avian gonads to light stimuli. It has been suggested elsewhere that physiological conditions, especially in the pituitary body, accompanied by the continuation of molting period induced by long days, may be responsible for the prolongation of the refractory period in avian gonads (*4*).

References and Notes

1. We wish to thank Kiyoshi Takewaki for his helpful criticism and kind encouragement.
2. K. Takewaki and H. Mori (Kobayashi), *J. Fac. Sci. Imp. Univ. Tokyo* Sec. 6, **6**, 547 (1944).
3. H. Kobayashi, *Annot. Zool. Japon.* **27**, 19 (1954).
4. ———, *ibid.* **27**, 128 (1954).
5. W. Rowan, *Proc. Boston Soc. Nat. Hist.* **39**, 151 (1929); G. M. Riley, *Proc. Soc. Exptl. Biol. Med.* **34**, 331 (1936); A. Wolfson, *Condor* **47**, 95 (1945); J. W. Burger, *J. Exptl. Zool.* **105**, 259 (1947); A. H. Miller, *ibid.* **109**, 1 (1948).
6. J. W. Burger, *Wilson Bull.* **61**, 211 (1949).
7. A. H. Miller, *Auk* **68**, 380 (1951).
8. A. Wolfson, *J. Exptl. Zool.* **121**, 311 (1952).

15 November 1954.

Preliminary Report on the Effect of Ultrasonic Waves on the Crystallization of Honey

Socrates A. Kaloyereas

Department of Agricultural Chemistry and Biochemistry, Louisiana State University Agricultural Experiment Station, Baton Rouge

Despite the common belief to the contrary, honey is a perishable product. The yearly loss of honey in a 2-yr storage experiment (*1*) averaged 13 percent. Crystallization is the first step in honey deterioration, which may be followed by fermentation. Honey consists mainly of a mixture of three sugars: levulose 40.5 percent, dextrose 34.0 percent, and sucrose 1.9 percent, all dissolved in water, the amount of which averages 17.7 percent. Honey also contains some other substances, such as dextrines, gums, organic acids, proteins, coloring substances, aldehydes, esters, superior alcohols, rare sugars, and enzymes.

Dextrose, the most easily crystallizable of the three sugars, is the first to form crystals when crystallization occurs. Since dextrose hydrate crystals contain only 9.09 percent of water, when partial crystallization occurs the remaining liquid honey is diluted, and thus offers a better medium for the growth of the osmophilic yeast that is always present in honey (*2*).

Water at ordinary temperatures can dissolve about its own weight in dextrose. Figures are not available to show the extent to which saturation of dextrose is affected by the presence of levulose and other substances except that at 30°C a solution of levulose and dextrose is saturated in respect to dextrose when each of these sugars is present in the solution to the amount of 34.85 percent (*3*). It appears from this that honey is more or less a supersaturated solution of dextrose. But it is also possible that other substances, probably dextrines and proteins, play some role in the dextrose saturation since there are special types of honey, such as the "Tupelo" type, that never or very seldom crystallize. The size of the crystals is considered very important. Large crystals seriously affect the quality (taste and aroma), whereas very small crystals seem to have a rather beneficial effect on the quality.

Assuming that the crystal growth in honey follows the Noyes-Nernst formula (*4*),

$$V = \frac{\Delta}{1} S(C - L),$$

where V is the rate of crystal growth, Δ in the diffusion coefficient, 1 is the length of the diffusion path, S is the surface area of the disperse phase, C is the concentration of the solution, L is the solubility of the disperse phase of a given size, and $C - L$ is the absolute supersaturation, we can see from the formula that the easiest way to retard the process of crystal growth is by changing S, which depends on the number of primary nuclei in honey. These nuclei can be small dextrose crystals, colloidal particles, mesotropic crystals of beeswax, or even minute air bubbles occlused during centrifugation. The prevailing practice of heating honey to retard crystallization by more or less eliminating the existing primary nuclei seems to be well founded in this respect. However, the heating is not a practical operation since honey has a high viscosity. There also are other serious disadvantages, the most important of which is the great acceleration brought on by the heat to the browning (Maillard reaction), the thermal coefficient of which is very high ($Q_{10} = 5.4$) (*5*). Heating must be discarded as a treatment for crystallization because it impairs the flavor and aroma, and later leads to the formation of large objectionable crystals.

In view of the fact that ultrasonic waves have been used to degas liquids to destroy microorganisms and for other purposes (*6*), we thought that they might be used to prevent crystallization in honey. A pre-