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 preliminary experiment was readily undertaken with honey samples provided by Everett Oertel (*7*) of the U.S. Department of Agriculture, using a magnetostriction oscillator, made available by V. Williams, tuned to 9 kcy/sec. The treatment lasted 30 min. The samples were examined microscopically immediately after the treatment, and also after storage periods of 1 and 4 wk at various temperatures from +39°C to −40°C, in order to observe the effect of storage temperatures on crystallization phenomena in general. The results were astonishingly successful in every respect. Although we found crystals of different sizes and numbers depending on the storage temperature, in the control samples, not one of the treated and stored samples showed any.

These results are not only important from the practical standpoint of preserving honey, but they also have theoretical significance in view of the fact that treatment with ultrasonic waves has hitherto been supposed to promote crystallization in general (*8*). Furthermore, the treated honey was limpid and had a slightly tart taste that made it superior to the controls that were opaque and generally less attractive. The *p*H of the treated samples was a little lower than the *p*H 3.9 of the controls, but the total acidity was 2.4 mg of NaOH per milliliter of honey in the treated samples and 3.0 mg in the controls. The redox potential was 406 mv in the treated samples and 346 mv in the controls.

Since yeasts are implicated in the spoilage of honey, we thought it advisable to make exploratory tests on the effects of ultrasonic waves on these microorganisms simultaneously with our tests of their effects on the crystallization.

A portion of untreated honey was plated out on acidified potato dextrose agar, and many yeast cells were detected. A portion of the same honey following treatment was similarly plated out, but no yeasts were detected. Microscopic examinations of the treated honey, however, disclosed some isolated yeast cells but very few in comparison with the number found in the untreated portion of the sample, which had a large number of actively budding cells. These results of the effect of ultrasonic waves on the microorganisms in general did not surprise us in view of the extensive literature on the subject (*9*). In order to obtain quantitative data, a more extensive experiment is being undertaken to study in more detail the specific effect of ultrasonics on these microorganisms.

Because the changes brought about in the honey by the ultrasonic waves cannot be attributed only to their mechanical action but possibly also to some chemical effect, probably on the sugar polymers present there and to other oxidation-reduction changes (*10*), a further study of these aspects of the problem is being carried out.

References and Notes

1. J. E. Dyce, *Cornell Univ. Agr. Expt. Sta. Bull. 538* (1931).
2. F. W. Fabian and R. I. Quinet, *Mich. State Coll. Agr., Agr. Expt. Sta. Tech. Bull. 92* (1928).
3. R. F. Jackson and C. G. Gillis, *Natl. Bur. Standards (U.S.) Technol. Paper 259* (1924).
4. R. A. Gorther, *Outlines of Biochemistry* (Wiley, New York, 1929), p. 13.
5. C. H. Lea and R. H. Hannan, *Food Science* (Cambridge Univ. Press, Cambridge, England, 1952), p. 230.
6. L. Bergman, *Ultrasonics and Their Scientific and Technical Application* (Wiley, New York, 1944.)

7. I wish to express my appreciation to Everett Oertel for his encouragement and the provision of the honey samples and to A. Colmer for his helpful cooperation in the bacteriological examination of the samples.

8. J. Alexander, *Colloid Chemsitry* (Reinhold, New York, 1944), vol. 5, p. 369.
9. W. B. Hugo, *Bacteriol. Revs.* **18**, No. 2 (1954); P. K. Stumph, D. E. Green, and F. W. Smith, Jr., *J. Bacteriol.* **51**, 487 (1946).
10. S. A. Kaloyereas, *J. Am. Oil Chemists' Soc.* **24**, 283 (1947).

26 November 1954.

Recorded Calls of Herring Gulls (*Larus argentatus*) as Repellents and Attractants

Hubert Frings, Mable Frings, Beverley Cox, Lorraine Peissner

Department of Zoology and Entomology, Pennsylvania State University, State College

Herring gulls and other sea birds may become pests by feeding on crops (*1*), on fish waste destined for chemical conversion, or by resting on airstrips (*2–4*) where they endanger airplanes. None of the attempts to rid these areas of the birds (*2, 4, 5*) has been entirely satisfactory.

The failure of mere noise to repel these birds (*2, 4, 5*) is probably owing to its lack of biological significance. It seems better to use sounds that have meaning to the species one wishes to repel. Starlings (*Sturnus vulgaris*), for instance, can be repelled from roosts by broadcasting to them the recorded distress call of one of their fellows, and the clearance thus achieved has some permanence (*6*).

Unfortunately, herring gulls do not have a distress call—that is, a call given by an individual when restrained or maltreated. Captive gulls are generally silent; even when buffeted they emit only vague grunts. Gulls, however, have an alarm call which they give when they see a captive gull or detect danger. This call causes other gulls that hear it to leave the region, not precipitously, as in the case of starlings, but by slowly circling away after initially drawing near.

The alarm call usually consists of two parts. The first is a set of two piercing cries in a descending sequence. This alone seems to be an attention call. There follows the alarm call proper, usually of three sharp cries. This has been variously represented in print by earlier workers (*7*) and sounds to us like "cut-cut-cut," with accent on the first note. It may have two, four, or five notes instead of three.

This call, as given by gulls free in the air, was recorded with a tape recorder (*8*). The usual recording consisted of the attention call with two sequences of the alarm call. This unit of about 5-sec duration was