kations, impermeable or less permeable for anions.

JACQUES LOEB,
REINHARD BEUTNER
DEPARTMENT OF EXPERIMENTAL BIOLOGY,
ROCKEFELLER INSTITUTE

THE PERMEABILITY OF THE OVARIAN EGG-MEMBRANES OF THE FOWL

I

VERY ordinary eggs have long been the subject of very much noise-making; the cackling hen, the cold-storage man, and the public each playing in this an individual, different and discordant part. One wonders therefore whether the quiet of the earth might be in any measure restored if *ordinary* eggs were made different; particularly if the egg were so much metamorphosed as to be born in a fully preserved and stable state. Would the noisily expressed solicitude of the persevering egg-maker then abate? Would the cold-storage man then "fold his tent like the Arabs, and as silently steal away"? Would the voiceful public then wait with less impatience "for its ships to come from sea"?

With something of this thought—of possibly contributing a modicum to the quiet of our planet—the undersigned, in an odd moment, set to the present task many months ago. Despite the generally rough exterior of the common barn-yard fowl, is it not possible to bring about some very nice adjustments between its blood and its growing ova, such as will effect the formation of eggs thus capable of maintaining themselves against the ravages of time and the decomposing influences of temperature?

To some veteran doubters, however, it may seem that the triumph of the experiment would bring no blessings whatever; and some there may be who would even assert that its success and utilization really but spells new calamity to egg-users. We do not know; we repose in our innocent intentions, in our wonder, and in our questions.

II

Can hexamethylentetramine leave the blood and penetrate the cells which guard the germ—the germ-plasm? Supposing that it can do so, will this substance decompose spontaneously within the egg—as it is known to do in some tissues—setting free formaldehyde? And will not the formaldehyde thus liberated exercise a preserving action on the elements of the egg? Again, can sodium benzoate pass through the egg-envelopes and enter the growing egg? If so, will it do duty as a preservative there? What will sodium salicylate do in a similar way?

The answer to these questions in so far as it is supplied by our experiments may be given at once; the details and the evidence being presented later.

When hexamethylentetramine (urotropin) is fed to laying hens it passes through the follicular and vitelline membranes surrounding the egg and is deposited in the egg. It undergoes decomposition there; formalin being set free. It acts as a preservative; *i. e.*, it lengthens the time which normally intervenes between the fresh and the unpalatable egg.

Numerous chemical tests have failed to demonstrate the presence of either benzoate or salicylate in eggs from birds fed with these substances. Whether the latter actually entered the egg, but in another form or combination, *e. g.*, as hippuric and salicyluric acids respectively, has not been determined; our supply of eggs having been exhausted in making other tests. Quite probably the benzoate would give rise to ornithuric acid, since it is known that this acid is formed when benzoate is excreted through the kidneys of birds. Some other evidence, however, is afforded by the eggs from birds fed with sodium benzoate and sodium salicylate that such eggs, particularly those supposed to contain salicylate, withstand the effects of summer temperatures better than do the untreated control eggs.

III

Something is intimated above as to reasons for the expectation that the feeding of urotropin to birds would result in its penetration and preservation of the growing egg. A

further word of similar effect may be stated concerning the benzoate and the salicylate. It seemed reasonable to expect that these substances would enter the egg, not only because there is a pronounced tendency of ring- and other compounds to appear in the egg, as my own previous, though unpublished, studies have taught me, but because it was known that these substances are normally not broken down, *i. e.*, not completely oxidized in the body, and even appear in other secretions than the urine; benzoic acid, for example, having been recovered from the saliva of dogs; and the salicylate likewise from milk, perspiration, bile and from synovial sacs.

If these substances should appear in the egg it seemed reasonable to expect them to exercise a preserving action there, since it is known that they retard both peptic and tryptic digestion; putrefaction of protein solutions being retarded or entirely prevented by the presence, even in small quantities, of these compounds.

The experiments were carried out in the following manner: Normally fed, laying hens were arranged in lots of five each. To one lot urotropin was fed; to another sodium benzoate, and to another sodium salicylate. The feedings were continued over a period of eight to ten days. All of the eggs laid during the week preceding the beginning of the dosing period, and all laid during the *second* week after the close of that period, were kept as control (those laid during the first week after the dosing stopped were discarded as being contaminated with the drug).

The dosage in each case was 0.4 G. administered in gelatin capsules twice per day; *i. e.*, the total dosage during each twenty-four hours was four-fifths of a gram. Two birds were not in good condition on the fifth day of the dosing and were withdrawn from the experiment.

Both control and dosed eggs were kept at moderate temperatures, *i. e.*, 12°–18° C., until the last of the control eggs were laid. Then all were placed at a temperature which fluctuated from 20°–32° C.; being left thus exposed for months in order to compare the "keeping" qualities of the various eggs.

It is probably best to follow more specifically the eggs from the birds which were fed urotropin, since in these the experiment was the most successful. The eggs of the series were laid between June 30 and July 30. They belong, therefore, to the class of difficult-to-keep, summer eggs which cold-storage men designate as "dirties." Already on August 20 and on September 17 a comparison by taste and smell of control and dosed eggs left no doubt whatever that the dosed eggs were the more palatable. These tests repeated on October 12 and November 10 confirmed the earlier result. On the latter dates the control eggs almost without exception were quite unpalatable. The dosed eggs could be eaten even on the last named date. It can not be said, however, that these control eggs would ever be mistaken for really fresh eggs; nor that the consistency of the white or albumen was quite unchanged, for after a time the albumen of some of these eggs becomes rather more dense and elastic than is natural.

When tested for formaldehyde, by the Rimini and other tests, the eggs of this series yielded abundant quantities. Indeed it was found that such eggs were spontaneously giving off formaldehyde in quantities sufficient to be absorbed by, and detected in, some *control* eggs left in the same box. To my friend Professor Hugh McGuigan, of the Northwestern University Medical School, who is extensively studying the action and disposition of hexamethylentetramine in mammals, I am indebted for verifying these tests as well as for friendly and helpful conversations and suggestions.

It was made certain that the urotropin is excreted into both the white and the yolk of the egg. This was determined in the following manner: Eggs which were laid within twenty-four hours of a *first* feeding with urotropin were found to yield formaldehyde. Here the formaldehyde could not have entered the *yolk* while in the ovary, since such yolk must have left the ovary several hours before the feeding. It must, therefore, have

been excreted by the oviduct into, or with, the albumen. In the other case it was shown that urotropin can penetrate the follicular membrane and enter directly into the egg-yolk, since an egg which was laid five days after the *last* feeding with urotropin gave the test for formaldehyde. Two other eggs were laid by the same hen—two and four days previously—so that the above-mentioned egg could not have obtained its formalin from albumen stored in the oviduct. In this egg, therefore, only the yolk had been exposed to urotropin, and it only could have been the source of the formalin. Two other eggs of very similar history also gave positive tests for the presence of formalin in the yolk.

The eggs dosed with salicylate,[1] and less markedly those dosed with benzoate, besides appearing—somewhat inconstantly—to be better preserved, as judged by taste and smell, often showed certain other physical contrasts with the control eggs. For example, the yolks of the control eggs more often showed "adhesions" to the shell than did the dosed eggs. Of fifteen control eggs opened on October 12 and November 10, nine showed adhesions either to shell or to the membrane of the air cavity; whereas on the same dates ten eggs dosed with salicylate and eight dosed with benzoate furnished altogether only three adhesions. Too, the control eggs usually contained the more liquid albumen; a difference readily observed. Finally, it was often noted that there was present in the dosed eggs more of the dense whitish albumen of the chalazæ than in the control.

Obviously all these physical differences strengthen the not very conclusive evidence of taste and smell, that the eggs dosed with salicylate and benzoate had not undergone digestion and putrefaction to as great an extent as the normal untreated eggs.

Larger doses of these substances would probably yield more striking results. Doses of 0.2 G. of sodium benzoate were, however, occasionally seen to be regurgitated by pigeons.

[1] I am indebted to Mr. Valentine Petzold, an obliging poultryman of Chicago, for the privilige of dosing five of his birds with sodium salicylate.

I do not believe that any part of either of these drugs was so disposed of by the fowls. Actively laying hens—as these were—might withstand considerably larger amounts. Too, still other substances can doubtless be found which will yield as good or better results when applied by this method. But these questions and others are left to the labor of those who may be interested in the practical or economic possibilities of the matter.

OSCAR RIDDLE

LABORATORY OF
EXPERIMENTAL THERAPEUTICS,
UNIVERSITY OF CHICAGO

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Washington, D. C., during convocation week, beginning on December 27, 1911.

American Association for the Advancement of Science.—President, Professor Charles E. Bessey, University of Nebraska; retiring president, Professor A. A. Michelson, University of Chicago; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

Section A—Mathematics and Astronomy.—Vice-president, Professor Edwin B. Frost, Yerkes Observatory; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Robert A. Millikan, University of Chicago; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

Section C—Chemistry.—Vice-president, Frank K. Cameron, U. S. Department of Agriculture; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, President Chas. S. Howe, Case School of Applied Science; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor Bohumil Shimek, State University of Iowa; secretary, Dr. F. P. Gulliver, Norwich, Conn.

Section F—Zoology.—Vice-president, Professor Henry F. Nachtrieb, University of Michigan; sec-