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Relation of the Antirachitic Factor to Reproduction in Birds.

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Some years ago it was shown that hen's eggs are especially rich in the antirachitic factor, an observation which has been confirmed repeatedly. We have since found that the eggs of other animals, for example those of various fish and of serpents, likewise contain a large amount of this specific factor, the concentration varying considerably. In the hen the concentration is greater in the egg than in the liver. Several investigators¹ have shown that the content of the antirachitic factor in hen's eggs varies according to their diet and the degree of exposure to ultra-violet rays, and furthermore than when this factor is notably deficient a marked lack of hatchability results. This failure to hatch has been attributed to defective absorption of calcium from the shell into the yolk.

From last summer until this spring one group of hens has been placed on a diet devoid of the antirachitic factor (a grain mixture, including yellow corn, also meat scrap and 1 part of sodium chloride) but otherwise complete, whereas another group has been given daily supplements of cod liver oil. Our experience may be summarized by the statement that the group on the deficient diet laid comparatively few eggs even during the productive period of March and April, that these eggs contained very little of the antirachitic factor, that fertile eggs failed to hatch, and that the livers of these hens were also lacking in this substance. It should be added, however, that the blood serum of both groups of hens was found to contain a high percentage of calcium in the spring, that is during the productive season, in spite of the fact that one of the groups was laying and hatching normally, whereas the other was almost inactive in this respect.

The relation of the antirachitic factor to the development of the chick was studied from another aspect. Tests were made to ascertain whether this factor, which is so rich in the egg, is consumed

¹ Hart, E. B., Steenbock, H., Lepkovsky, S., and Kleitzien, S. W. F., *J. Biol. Chem.*, 1925, lxxv, 579; Hughes, J. S., Payne, L. F., Titus, R. W., and Moore, J. M., *J. Biol. Chem.*, 1925, lxxvi, 595; Bethke, R. M., Kennard, D. C., and Sassman, H. L., *J. Biol. Chem.*, 1927, lxxii, 595.

in the course of the development of the embryo. It was found that the liver of the newly-born chick is practically devoid of this factor. Furthermore, a composite ethereal extract of the entire bodies of 50 newly-hatched chicks was found lacking in this factor when tested quantitatively on rats. These results would seem to give new significance to the function of what is commonly termed the antirachitic factor. The failure to hatch, associated with this nutritional deficiency, is a phenomenon due to the lack of development of the embryo. Complementary experiments, a report of which follows, were carried out on fish in connection with this study of reproduction.

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Relation of the Antirachitic Factor to Reproduction in Fish.

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In a recent communication it was reported that in the cod there is a definite relationship between the percentage of calcium in the blood and the maturation period, the calcium rising to a markedly high level at the spawning season.¹ It was found likewise, in agreement with the investigations of others, that there is an inverse relationship between the size of the liver and the size and development of the roe, the liver becoming smaller as the ovary fills up and grows larger. At this time the liver may lose 50% or more of its fat. In many instances the weight of the fully matured ovary far exceeds that of the liver; for example in 3 fish, the ovary weighed 400, 345, and 270 gm. respectively, whereas the liver weighed 29, 105 and 60 gm. On testing the roe for antirachitic potency it proved in every instance to be active; this held true for the roe of the cod, sheepshead, flounder, carp, buffalo fish and smelt. The milt of the cod and of the carp had similar protective value. When the respective weights of the organs, of the liver and the ovary, were taken into consideration it was found that the latter contained quite as much as, or even more, of the antirachitic factor than the liver. In

¹ Hess, A. F., Bills, C. E., Weinstock, M., and Rivkin, H., *PROC. SOC. EXP. BIOL. AND MED.*, 1928, xxv, 349.