ployed.⁵ All irradiated areas of skin extended well beyond the lymphatics visualized.

In the 10 different irradiated areas studied in the subjects who received doses varying from 220 r to 450 r the linear rates of lymph flow remained within normal variations. One subject received 370 r on the right side of the lower part of her abdomen and 1,187 r on a comparable area on the left. On the former side there were no detectable changes in the linear rate of lymph flow. Six weeks following the production of a first degree skin reaction on the left side there was a definite decrease in the rate of flow. During the course of 8 months the rate remained normal on the right side, while that on the left remained markedly reduced (Fig. 1). It was also observed that there was a great tendency for the dye to diffuse locally around the site of injection, rather than to form small streamers as occurs in normal skin.

Summary. The data tend to indicate that small doses of X-ray (220-450 r) to the skin of humans are not likely to disturb the linear flow of lymph in the cutaneous lymphatics, while large doses sufficient to produce a first degree skin reaction probably will reduce the rate of lymph flow.

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"Leg-Weakness" in Laying Hens on an Ascorbic Acid-Free (Vitamin C) Diet.*

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Since 1919 many workers^{1, 2, 3} have demonstrated the growth of chickens on a supposedly vitamin C-free diet. There are reports^{4, 5}

⁵ Burch, G. E., PROC. Soc. EXP. BIOL. AND MED., 1939, 40, 676.

³ Shorten, J. A., and Ray, C. B., Biochem. J., 1921, 15, 274.

⁴ Holst, W. F., and Halbrook, E. R., Science, 1933, 77, 354.

⁵ Beaudette, F. R., *Hints to Poultrymen*, 1923, 12, No. 2, The N.J. Agricultural Experiment Station.

^{*} Submitted by T. A. Bell in partial fulfillment for the degree Master of Science. 1 Hart, E. B., Steenbock, II., Lepkovsky, S., and Halpin, J. G., J. Biol. Chem., 1925, 66, 813.

² Plimmer, R. H. A., Rosendale, J. L., and Raymond, W. H., *Biochem. J.*, 1923, 17, 787.

indicating the possibility of a vitamin C requirement for the chicken.

In the course of an experiment to ascertain the influence of injections of ascorbic acid on the ascorbic acid content of blood, eggs, feces, and certain organs of laying hens⁶ a muscular weakness developed in the legs of 3 hens fed a vitamin C-free diet under laboratory conditions.

In this study 15 Barred Plymouth Rock hens, 3 groups of 6, 6, and 3, were fed the N. C. State College laying mash, scratch grain treated with 1% cod liver oil, and oyster shell.⁷ Fresh water was supplied daily. Each new supply of mash and grain was tested for its vitamin C content using the indophenol titration method,⁸ and all the samples were found to be devoid of vitamin C. The hens were confined to laying batteries in a room in a laboratory.

This study was started January 14, 1939, and was terminated June 13, 1939. Group A (test) hens were given injections of ascorbic acid throughout the experiment. The first week 2 injections of 100 mg of ascorbic acid in 2 ml of Ringer's solution⁹ were made subcutaneously. Thereafter, for the next 9 weeks 50 mg per injection were used twice weekly, then 4 injections were made weekly in the final 9 weeks of the experiment. A total of 246 injections of ascorbic acid were given to the 6 hens in group A which remained normal throughout the experiment. The hens in the control groups B and C, with the exception of those that developed "leg-weakness", received no ascorbic acid. The hens that developed this "leg-weakness", B3, C1, and C2, had been on the experimental diet 62, 67, and 68 days respectively.

The morbid condition of each of these 3 hens was similar: weakness and loss of action of one or both legs, inappetence, somnolence, inanition with loss of weight, definite fecal changes and a depression of the reproductive system.

Hen B3 presented the most pronounced morbid condition of the 3 cases. Inanition was progressive to the point of a weight loss of 469 g. All symptoms developed progressively worse in the 17 days from the time the first signs of the "leg-weakness" were noted to the time the first injection of ascorbic acid was made. Subcutaneous injections of 100 mg of ascorbic acid in 2 ml of Ringer's solution were made every second day. A total of 1000 mg of the vitamin C

⁶ Bell, T. A., Thesis, N.C. State College of Agr. and Eng., 1940.

⁷ Parrish, C. F., Maupin, C. J., and Brown, T. T., *Feed Formulas for Poultry*, N.C. Agr. Ext. Ser., Ext. Cir., 1940, No. 245.

⁸ Bessey, O. A., and King, C. G., J. Biol. Chem., 1933, 108, 687.

⁹ Guyer, M. F., Animal Micrology, 3d ed., 243.

in 10 injections were used. Recovery was dramatic. Hen B3 laid the first egg the day following the sixth injection which was on the tenth day subsequent to the first injection. Nineteen eggs were laid by Hen B3 in the following 36 days prior to its death (Table I). Death was due to a hemorrhage from a heart puncture made the preceding day.

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Hen No.	B3	C1	C2
Hen in confinement	1/7/39	1/7/39	1/7/39
Exper. started	1/14	1/14	1/14
Days on diet prior to "leg-weakness"	62	67	68
Total eggs 2d laying year prior to "leg-weakness"	123	163	117
1st day of "leg-weakness"	3/17	3/22	3/23
No. days "leg-weakness" prior to ascorbic acid inj.	17	7	5
Date 1st inj.	4/4	3/29	3/28
Date last inj.	4/20	4/16	4/15
Amt. ascorbic acid inj.	1000 mg	1000 mg	1000 mg
No. inj. weekly	4	4	4
Total No. inj.	10	10	10
Days between 1st inj. and 1st egg	10	6	14
Eggs laid after 1st inj. to disposition	19	3 6	25
Date of disposition of hen	Died	Trans-	Trans-
-	5/21	ferred	ferred
		6/8	6/8
Total eggs laid 1st yr	208	254	208
Total eggs 2d laying yr to date of disposition	144	205	157

TABLE I.

Hens C1 and C2 received the same treatment as hen B3 and they made the same rapid recovery (Table I).

A fourth case, a S. C. White Leghorn hen, Ex. 25, unrelated to the experiment just described had a case history almost identical to the 3 cases mentioned.

It is the opinion of the authors that certain hens, under the demands of heavy egg production and fed a diet deficient in vitamin C, develop avitaminosis C resulting in "leg-weakness", inanition and a depression of egg production.

Experiments should be conducted to ascertain whether the effect of the injections is due to the ascorbic acid alone, to the salts in Ringer's solutions or to both. Minimum vitamin C requirements of high egg-producing hens for the prevention of "leg-weakness" should be determined. A diet should be formulated incorporating vitamin C-containing foodstuffs fulfilling the necessary vitamin C requirements for the prevention of "leg-weakness", inanition and the depression of the reproductive system in hens bred for high egg production.

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