Rica has been indebted for her educational and scientific life. One or more chapters are devoted to Germany, Argentina, Belgium, Colombia, Cuba, Chile, Spain, the United States, France, England, Italy, Mexico and Switzerland. The individuals of these countries who have visited and studied in Costa Rica, or who have described her natural productions, are discussed biographically and lists of their publications relating to the country are given. Pedagogical theories and methods proceeding from these different sources are considered with respect to Costa Rican schools and teaching. Four chapters (nearly 100 pages) are devoted to the United States, wherein 103 authors and travelers are named or discussed. The data on books and publications given in this volume constitute a fairly complete bibliography of foreign authors on Costa Rican pedagogy and natural science.

Senor Gonzalez's history is surely of great value to Americanists, Pan-Americans, naturalists and historians of science.

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SPECIAL ARTICLES

NOTES BY N. M. STEVENS ON CHROMOSOMES OF THE DOMESTIC CHICKEN

RECENTLY, in looking over a file of old research notes I came across a package of rough notes and drawings by Miss Stevens on the chromosomes of the domestic chicken, which had been given to me after her death. She had been working at this problem at odd times at the same time that Dr. Pearl and I had in 1914. We had sent her adult testis material from the Maine Agricultural Station, and she had also worked on embryos. The present interest in these notes lies in their bearing on T. S. Painter's paper on Reptilian Spermatogenesis (*Jour. Exp. Zool.*, 34, 281–327). Painter says that one object of his study was "to determine what light a study of reptilian spermatogenesis would throw on the spermatogenesis of birds since reptiles and birds are closely related phylogenetically." No one as yet has published any satisfactory results on bird chromosomes. The outstanding feature in the lizard spermatogenesis seems to be the arrangement of the chromosomes in the equatorial plate, a definite number of large chromosomes in a ring around a center group of small chromosomes, the number of which is sometimes difficult to determine. Miss Stevens's drawings show equatorial plates which exhibit a striking resemblance to those drawn from the lizard by Painter. She suggests that there may be a nebula of small chromosomes at the center of the group which clump readily in poor fixation and therefore have often been taken for several large chromosomes.

Her drawings show 12 large chromosomes forming the outer circle in the spermatogonia and usually 6 (occasionally 5 or 7) in the spermatocyte. The num-

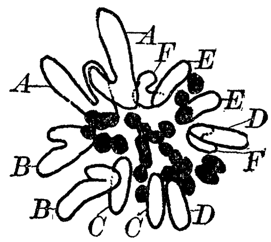

Fig. 1

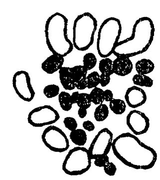

Fig. 2

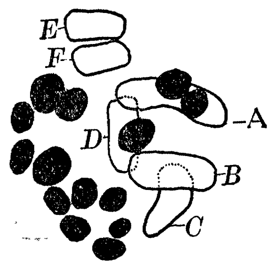

Fig. 3

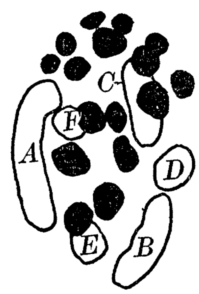

Fig. 4

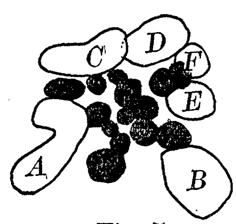

Fig. 5

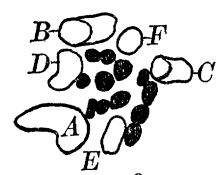

Fig. 6

ber of small chromosomes figured in the center varies, being usually 12 or 14 in the spermatocyte where they are of course easier to identify than in the spermatogonium. I include copies of six of her drawings. They were camera lucida drawings, but had not been finished as these were only fragmentary notes at the beginning of a study. Figures 1 and 2 are spermatogonia, each with 6 pairs of large chromosomes and a mass of small chromosomes. Figure 1 was marked "question as to how many small ones—too thick together." Figure 2 was marked "all rather mixed in the center." Figures 3 and 4 are prophases of the first spermatocyte division. Each shows 6 large chromosomes. Figure 3 has 14 small chromosomes, while Figure 4 has 16. Figures 5 and 6 are equatorial plates of the first spermatocyte division. Here we find 6 large chromosomes; in Figure 5, 14 small, while in Figure 6 there seem to be only 12 small. Some other drawings bear the following comments which show her uncertainty as to the number of small chromosomes: "Apparently 18, but number of small ones always uncertain"; "large ones all clear, small ones may be more"; "impossible to tell how many small ones."

It may be of interest that part of the notes dated September include some sketches with only 9 chromosomes, and therefore assumed that those with 18 or 20 chromosomes were spermatogonia; while sketches dated November figure the spermatocytes with 18 or 20 chromosomes. One note for November reads "looks as though these were first spermatocytes with about 18 chromosomes." Then come drawings of spermatogonia with many more than 20, such as those copied here.

It has seemed worth commenting on these notes and drawings for the scientific public, now that Painter's careful study of chromosomes in a group phylogenetically close to birds has clearly shown a similar grouping on the equatorial plate, and therefore adds significance and plausibility to Miss Stevens's observations on material evidently more difficult to handle. If she had lived, the processes of bird spermatogenesis would probably have been satisfactorily cleared up before this. But it is hoped that publishing these notes may stimulate some one to continue work on this material and try to settle the matter.

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THE PRODUCTION OF EPINEPHRIN BY THE ADRENAL CORTEX

Cramer[1] concluded from the histological study of adrenals fixed with osmic acid that the cortex participates in the functional activity of the medulla. He found fine black granules similar to the epinephrin granules of the medulla.

We have obtained further evidence that epinephrin is produced by the cortex. The adrenal of a cat recently killed was carefully removed and then frozen with CO_2. Some of the outer portion of the cortex was sliced away with a razor. This material gave a positive test for epinephrin by the Folin, Cannon and Denis[2] reaction. It likewise caused inhibition of a piece of kitten's intestine contracting in Ringer's solution.

The cortex of an adrenal, the medulla of which had been completely destroyed by cautery thirty days previously, gave a positive test for epinephrin by the Folin, Cannon and Denis method. The destruction of the interior of the gland was so thorough that only a thin shell of live cortex remained. Cortex of another adrenal prepared in a similar fashion gave a good inhibition of contracting intestine. By the use of the exercise test[3] we have also obtained an indication of epinephrin production by the cortex. One iris had been made sensitive to epinephrin by the removal of the superior cervical ganglion on that side. One adrenal had been removed and the medulla of the other had been thoroughly destroyed by cautery. After complete recovery, exercise in the treadmill caused dilatation of the sensitive pupil.

Whenever there seemed to be a possibility of the presence of good medulla we have studied microscopically sections of the gland fixed with formaldehyde and potassium bichromate.

Finally, we have used the completely denervated pupil[4] in order to determine whether the cortex produces epinephrin. The excitement caused by shutting off the air from the lungs for 40 seconds rarely fails to produce an increased secretion from the adrenals. Moreover, it produces perhaps the most marked effect among stimuli which are harmless. Our method has been to destroy the medulla of one adrenal by electric cautery several days before the experiment. The reaction to shutting off the air from the lungs was observed, the denervated pupil being measured by a smaller caliper square. The good adrenal was then removed. After recovery from the anesthetic the pupil response to shutting off air from the lungs was again determined. The cauterized adrenal was next removed, a final test of the denervated pupil being made after recovery from anesthesia. The cauterized adrenal was fixed and examined microscopically for the presence of medulla, the whole gland being sectioned (sections of 25μ). Approximately every fifth and sixth sections were saved, the others being discarded.

To be more certain of medullary destruction much of the cortex was destroyed.

Experiments on fourteen cats were completed. A small portion of the medulla remained in five; medullary tissue was absent in nine; but four of these had the cortex almost completely destroyed. The five cats possessing healthy cortex and no medulla in the cauterized adrenal gave good denervated pupil reactions to shutting off the air after removal of the uncauterized adrenal. After removal of the cauterized adrenal the denervated pupil gave a much smaller reaction or no response at all to a similar test.

All of our evidence indicates that the adrenal cortex produces epinephrin.

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1 Cramer, W., *J. Physiol.*, 1918, LII, viii–x, xiii–xv.

2 Folin, O., Cannon, W. B. and Denis, W., *J. Biol. Chem.*, 1913, XIII, 477.

3 Hartman, Waite and Powell, *Am. J. Physiol.*, 1922, LXII, 225.

4 Hartman, McCordock and Loder, *Am. J. Physiol.*, 1923, LXIV, 1.