4. These changes may account for some of the phenomena of xerophthalmia, particularly the drying of the cornea in the later stage of the condition.

184 (1931)

## Increased blood sugar coincident with ovulation in pigeons.

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The data of an earlier communication by one of us[1] have made it nearly certain that in healthy pigeons the suprarenals usually undergo extensive and regular enlargement at the period of ovulation. This result, in view of many facts which indicate an influence of the suprarenals on the mobilization of sugar, naturally leads to an inquiry as to whether the blood sugar also undergoes a similar and simultaneous increase in amount. The data reported here indicate that such an increase of blood sugar does also regularly occur.

Scott and Honeywell[2] concluded that in non-reproducing common pigeons of unknown sex the blood sugar amounts on the average to about 185 mgm. per 100 c.c. of blood as determined by MacLean's method. This same method was used in the present study and a similar amount of sugar was found for birds not actively ovulating. Ring doves in other than ovulation periods have, however, distinctly less blood sugar. Both of these kinds of pigeons, together with a third group—"scraggly" common pigeons—have been used by us. The "scragglies" are a mutational or aberrant form having a quite imperfect epidermal system (including the feathers) and bearing suprarenals earlier observed to show wide variation in size. Because of these variations it seemed desirable to include observations on this group. Males and females, both adult and young, of all the three groups have

[1] Riddle, Oscar, PROC. SOC. EXPER. BIOL. AND MED., 1922, xix, 122.

[2] Scott, E. L. and Honeywell, H. E., *Amer. Jour. Physiol.*, 1921, lv, 362.

been studied, but only figures obtained for adult reproducing females are here considered.

All samples were obtained by needle-puncture of the heart. Unfortunately, this procedure proved capable of producing occasional ovulations into the body cavity and also the resorption in the ovary of the nearly ripe ova. Since duplicate samples had to be taken from at least two different stages of ovulation it was possible to kill the bird only after the final sample was obtained. This circumstance and the disturbing effects of the puncture noted above unite to make it impossible to know in a few special cases at which stage with reference to ovulation the sample was taken. Such cases are indicated in the table. Nearly all figures of the table represent duplicate determinations made at intervals of one day to three weeks, and—in most cases—these determinations checked to within 10 mgms. Data were also obtained for suprarenal size at the time each bird was killed, but since only 8 of the 20 females used were entirely free from Ascaridia (none obviously tubercular) these data throw little further light on the relation of suprarenal size to ovulation; for, in the work referred to above[1] it was shown that the suprarenals of birds thus infested are usually continuously enlarged, are probably diseased, and do not show any definite hypertrophy at ovulation.

From 14 of the 20 females comparisons were obtained of the mid-ovulation stage with a stage more or less removed from ovulation. Of these 14 tests 12 show unquestionably higher values for the mid-ovulation stage than for stages more remote from the ovulation period. Moreover, both of the two exceptions proceed from samples taken at periods so far removed from both the previous and succeeding ovulations (see table) as to make it possible that instead of being really remote they may each represent a stage immediately preceding an ovulation which was suppressed by the heart punctures by which these samples were obtained. Again, in one of these two cases the comparison made is not with a mid-ovulation stage, but with stages 36 and 12 (?) hours preceding ovulation. For the remaining 6 of the 20 birds determinations are available from only one stage—these birds failing to survive the heart-punctures. In each of these six cases the

[1] Loc. cit.

amount obtained indicates that the mid-ovulation stage had the higher sugar value if the average values obtained for all birds of its kind be taken as a standard (see table).

If curves be formed from the individual determinations, by placing them at their exact intervals with reference to ovulation, and a separate curve made for each of the three groups, it is found that the highest points fall within the mid-ovulation period in all of the three curves. The curve for the "scragglies" departs most widely from the curve earlier obtained for suprarenal hypertrophy by Riddle.[1] If another curve be formed from

COMPARISON OF AMOUNTS OF BLOOD SUGAR OBTAINED WITHIN, AND APART FROM, OVULATION PERIODS.

| No. of Bird. | Periods 1 and 4 with Reference to Ovulation Amount of Blood Sugar. | | | |
|---|---|---|---|---|
| | Mid-ovulation | Within 36 Hrs. | More than 36 Hrs. | |
| V65..... | 215 | — | 175 | Common pigeons |
| M386.... | 228 | — | 158 | |
| V27..... | 185 | — | *228* (6–5)[1] | |
| V270.... | 235 | — | 180 | |
| Ave.... | *216* | | *185* | |
| V90..... | — | 143 | *165* ($4\frac{1}{2}$–5)[1] | "Scraggly" common pigeons |
| V241.... | 230 | — | 178 | |
| V299.... | 200 | 130 | 149 | |
| V288.... | 173 | 143 | 145 | |
| Ave.... | *201* | *139* | *160* | |
| T149.... | 178 | — | 153 | Ring doves |
| P715.... | 180 | — | 135 ($4\frac{1}{2}$–$5\frac{1}{2}$)[1] | |
| T320.... | 175 | — | 155 | |
| T171.... | 198 | — | 145 | |
| T153.... | 153 | — | 123 | |
| T289.... | 150 | — | 130 (6–5)[1] | |
| Ave.... | *172* | — | *140* | |
| V205.... | 220 | — | — | Common pigeon |
| V28..... | — | 120 | — | Scraggly common pigeon |
| V260.... | — | — | 160 | |
| T282.... | 185 | — | — | Ring doves |
| T390.... | — | 155 | — | |
| T226.... | — | 160 | — | |

These determinations made at intervals so far removed (4.5 or more days) from both earlier and later ovulations as to leave it uncertain whether ovulation was in fact far removed or quite imminent—and a resorption of the ovum produced by the heart-puncture employed to obtain the sugar sample.

[1] Loc. cit.

the data obtained from the five Ascaridia-free ring doves it is found to be the smoothest of the series and quite similar in its several parts to the curves for suprarenal hypertrophy and oviducal growth found in that earlier work. These several series of measurements therefore seem definitely to show that coincident with ovulation in the pigeon there occurs an increase of the blood sugar to 25 per cent. or more above the pre-ovulation value.

The results indicate: (1) That the stage with reference to ovulation is probably a factor influencing the values obtained for blood sugar in other animals and is probably too large a factor to be left out of consideration in dealing with samples taken from reproducing females. (2) That, the essential similarity of the curve expressing the rise of the blood sugar with the curve expressing the coincident hypertrophy of the suprarenals, as earlier reported by one of us, is a further evidence for the relationship of the suprarenals to carbohydrate metabolism on the one hand and to sexual functions on the other. (3) That the enforcement in pigeons of frequent and continuous ovulations throughout the year, as this has been practised and reported by Whitman and by Riddle—with important results on sex, viability, and longevity of offspring—is doubtless accompanied by an increased and nearly continuous mobilization of carbohydrate in the female parents.

185 (1932)

## Seasonal tide of blood phosphate in infants.

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In a previous communication it was shown that in infants the inorganic phosphate of the blood could be raised to the normal level by frequent exposures to the sun's rays.[1] The same result can be brought about by means of the carbon arc-lamp. The most effective radiation in bringing about this alteration are the ultraviolet rays. As has been shown by Dorno, the rays of the sun

[1] Hess, A. F., and Gutman, P., PROC. SOC. EXPER. BIOL. AND MED., 1921, xix, 31.