larvae not yet metamorphosed. As stated, the effect upon the ovary is relatively insignificant.

Riddle and Flemion[7] administered fresh adult hypophysis and various extracts of beef hypophysis to young pigeons and obtained what was probably pronounced growth of the testes. However, the extreme range of variation of the controls and the very irregular response of the experimental individuals make it very difficult to estimate the degree of response or to be sure whether the response is specific. This is the only work known to the writer with results comparable to those reported here. Series of experiments are now in progress in which the parts of the hypophysis are transplanted separately, and different extracts of the hypophysis are injected.

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Development and Fate of Spermatozoa in the Epididymis and Vas Deferens in the Guinea Pig.

WILLIAM C. YOUNG AND FIORINDO A. SIMEONE.
(Introduced by A. M. Banta.)
From the Arnold Biological Laboratory, Brown University.

It is well known that spermatozoa in mammals attain what appears to be their full structural development while contained in the seminiferous tubules, but that they are not in a position to be discharged until they have passed through the long coiled ductus epididymidis and have reached the posterior end of the vas deferens.

There is no agreement as to the significance of this long passage through the epididymis. In earlier papers (Young[1, 2]), the suggestions were made: First, that the epididymis provides an environment in which spermatozoon development, not complete when these cells leave the testis, can continue until functional maturity has been attained, and (2) that once spermatozoa become mature, there is no influence which preserves them indefinitely in a condition for effecting fertilization.

Because this general idea has not been expressed previously, except possibly as isolated statements by different writers might be pieced together, supplementary experiments seemed desirable. In addition, the suggestion that spermatozoa age and become in-

[7] Riddle, Oscar, and Flemion, Florence, *Am. J. Phys.*, 1928, lxxxvii.

[1] Young, W. C., *J. Morph. and Physiol.*, 1929, xlvii, 479.

[2] Young, W. C., *Ibid.*, xlviii, 475.

capable of functioning interested us in the nature of the mechanism by which a constant supply of viable spermatozoa is maintained at the posterior end of the vasa deferentia in males which are not allowed to mate.

The suggestion that the epididymis is an organ in which spermatozoa may at one time be maturing and may at another time be aging was tested by 2 experiments.

In the first, 68 females selected during the oestrum were inseminated with spermatozoa removed from the proximal ends of the epididymides from normal males, and 69 were inseminated with spermatozoa removed from the distal ends of the same epididymides. The percentage of fertile inseminations was 32.4 in the former group and 71.0 in the latter group. The difference is sufficient to indicate the greater functional capacity of spermatozoa from the distal end.

In the second experiment this procedure was modified. The head of the epididymis and the vas deferens were ligated in such a manner that spermatozoa could neither enter the epididymis from the testis nor be discharged into the urethra. After 25 days spermatozoa from the proximal ends were used for inseminating 81 females and spermatozoa from the distal ends were used for inseminating 85 females.

If it is true that spermatozoa contained in the epididymis attain an optimum functional capacity and then age and become incapable of functioning, it would be expected that the younger spermatozoa confined in the anterior end would show an increased capacity for effecting fertilization and the older spermatozoa confined in the posterior end would show a decreased capacity for effecting fertilization.

The expectation was confirmed. The percentage of fertile inseminations with spermatozoa from the proximal ends rose to 53.1 and the percentage of fertile inseminations involving spermatozoa from the distal end decreased to 27.1.

This tendency of spermatozoa contained in the epididymis to age and become incapable of functioning suggests, (1) the existence of a constant current of spermatozoa through the epididymis even in the absence of copulations, and (2) the constant removal of old spermatozoa and their replacement by younger spermatozoa.

Both suggestions have been confirmed. When those males in which the heads of the epididymides and the vasa deferentia had been ligated were examined 25 days later, the confined spermatozoa were found tightly packed in the distal end of the tubule; a condition which must be attributable to neuro-muscular action. Any

pressure of fluid from the seminiferous tubules is precluded by the ligature of the epididymis head.

The process by which non-discharged spermatozoa are constantly being removed from the posterior end of the vas deferens would appear to be quite different from that which other investigators have described.

We have found no appreciable elimination in the urine as Oslund,[3] and others have claimed. Careful examinations twice daily were made of the urine collected from 5 males over a period ranging from 10 to 46 days without finding more than one or two spermatozoa. We noted the loss of spermatozoa from the epididymides of 4 males without finding more than one or two spermatozoa in the urine during the period of spermatozoa disappearance. Lastly, many other examinations of urine were made under varied conditions without finding more than an occasional spermatozoon.

No evidence for a phagocytosis of spermatozoa such as has been described by Morgenstern,[4] Nemiloff,[5] and Wegelin,[6] could be found in examinations of normal animals.

Careful examinations of the seminal vesicles revealed no disintegration of spermatozoa in this organ such as Königstein[7] has described.

What was found is that there is a continuous dissolution of spermatozoa particularly in the extreme posterior end of the vas deferens. Thousands of isolated, degenerate spermatozoa can be found in dilute suspensions. More striking are the numerous large, spindle-shaped to spherical masses of degenerate spermatozoa from the extreme distal end of the epididymis to the ejaculatory duct. These masses are larger and more numerous in the posterior end of the tract than they are a short distance anteriorly and they provide ample evidence for the wholesale destruction of spermatozoa which is occurring. Inasmuch as spermatozoa may become degenerate before they have passed into that part of the vas deferens which lies in the body cavity, we suggest that age may be a causal factor. It seems not unlikely, however, that the higher temperature encountered in the posterior end of the vas deferens may be a factor superimposed upon that of age.

As an outcome of the experiments described above we believe that a fairly complete account of spermatozoa history from the time they

[3] Oslund, R. M., *J. Am. Med. Assn.*, 1928, xc, 829.

[4] Morgenstern, Z., *Virchow's Arch. f. path. Anat. u. Physiol.*, 1924, ccl, 648.

[5] Nemiloff, A., *Zeitschr. f. ges. Anat.*, 1926, lxxix, 1.

[6] Wegelin, C., *Beitr. z. path. Anat. u. z. allg. Pathol.*, 1921, lxix, 281.

[7] Königstein, H., *Wiener klin. Wochenschr.*, 1924, xxxvii, 26.

leave the testis until they have reached the posterior end of the vas deferens can be given for at least one species. Spermatozoa are believed to be carried out of the testis into the ductus epididymidis while they are functionally immature. Much of the time consumed in passing through this 9 to 9½ foot tubule is necessary for the completion of their development. Once this is attained, however, there is no influence which preserves them in an optimal functional condition and they begin to age and ultimately to become liquified. There seems to be no general escape from the posterior end of the tract except during copulations and through dissolution.

To what extent these observations can be duplicated in other mammals, particularly those which are producing spermatozoa continuously, we do not as yet know.

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Biological Effects of Temperature Variations With High Frequency Oscillations.

JEAN MAC CREIGHT AND G. MURRAY MC KINLEY.
(Introduced by H. H. Collins.)

From the Zoological Laboratories of the University of Pittsburgh.

Since there is at present a premature trend toward the use of the vacuum tube high frequency generator in therapeutics, a study of certain extreme local heating effects in animals seems advisable. The following experiments were conducted in the hope of throwing some light on the exceedingly high temperatures generated in local tissues of which the general body temperature gives little or no warning.

When week old Albino rats were exposed to an electrostatic field obtained by an apparatus giving a frequency of 100,000,000 cycles per second, death was accompanied by a violent rush of blood to fore and hind limbs and tail. These appendages became severely congested and swollen, and so marked was this effect that it was believed possible to use the general macroscopic appearance as a basis for a comparative study of the effects of high frequency oscillations with external heat.

Christie and Loomis[1] in previous experiments with mice maintained that death occurred as a result of "pure" heat. They did not,

[1] Christie, R. V., and Loomis, A. L., *J. Exp. Med.*, 1929, xlix, 2.