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Influence of Hydrogen Ion Concentration on Respiration Rate of Sperm.*

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Various authors[1, 2] have suggested that the respiration rate of sperm is influenced by the pH of the medium in which they are suspended, yet experimental evidence for this is lacking.† The optimum pH for sperm motility has been reported to be about 7.0 to 7.3[3] Motility is lost reversibly at about pH 4[3] and, despite contrary reports,† motility and respiration rate might be altered similarly by pH.

The problem is of interest from the point of view of cell metabolism as well as from that of the physiology of reproduction. We have attempted to answer the following questions: (a) Is there an optimum pH for sperm respiration? (b) Are there differences in the influence of pH on respiration of sperm of the various species? (c) Will small pH differences in buffered samples result in significant errors when comparisons are made of respiration rates?

All semen samples were obtained with the artificial vagina[4] by student assistants. The boars used were purebred and were of the following breeds and ages: one Poland China and 2 Chester White boars one year of age, and one Hampshire boar 2 years of age. The relatively concentrated early ejaculum of one boar was used in each trial. Nine purebred Ramboullet rams 3 to 4 years of age were used. Semen samples usually contained ejacula of 5 to 7 rams, and did not represent equal volumes from individuals.

Samples were adjusted to various pH levels by the addition to a given volume of semen of an equal volume of M/5 solution of phos-

* Contribution from the Department of Animal Husbandry, Missouri Agricultural Experiment Station, Journal Series No. 770.

1 Walton, Arthur, and Edwards, Joseph, *Am. Soc. An. Prod.*, 31st Annual Meet., 1938, 254.

2 Sergin, N. P., *Dokl. Akad. seljskohoz. Nauk.* (U. S. S. R.), No. 2/3, 1939, 60; *An. Brd. Abst.*, 1939, **7**, 181.

† Oxygen consumption rates of sperm of mammalia were measured at various pH levels by Windstosser, K., *Klin. Woch.*, 1935, **14**, 193. The results are contradictory. Windstosser concluded that no definite correlation exists between respiration rate, motility, or pH of sperm.

3 Allen, Edgar, *Sex and Internal Secretions*, Williams and Wilkins, Baltimore, Md., 1932.

4 McKenzie, Fred F., *The Cattleman*, September, 1939.

phate buffer (NaH_2PO_4, Na_2HPO_4, or Na_3PO_4). The pH of each mixed sample was determined at the beginning and end of each trial with a Beckman pH meter standardized daily with buffers at pH 4 or 7. Respiration rates were determined at 37°C with a modified Barcroft-Warburg respirometer.‡ [5] In each trial comparison was made between O_2 consumption rates of portions of a given sample which differed only in pH. The pH of the portion which exhibited the highest respiration rate is considered optimum, and respiration rates of the other portions are expressed as percentages of the highest rate. In boar samples, pH either did not change during the trials or increased up to 0.2 pH unit. The changes in pH of ram semen mixtures were towards the acid side and averaged less than those in boar semen. When the pH level changed during a trial, a mean value of the levels at the beginning and end of the trial was used in the calculations.

Results are given in Fig. 1. Each point represents a mean of 5 to 16 observations. The vertical lines from the points represent standard errors of the means.[6] Highest respiration rates were exhibited

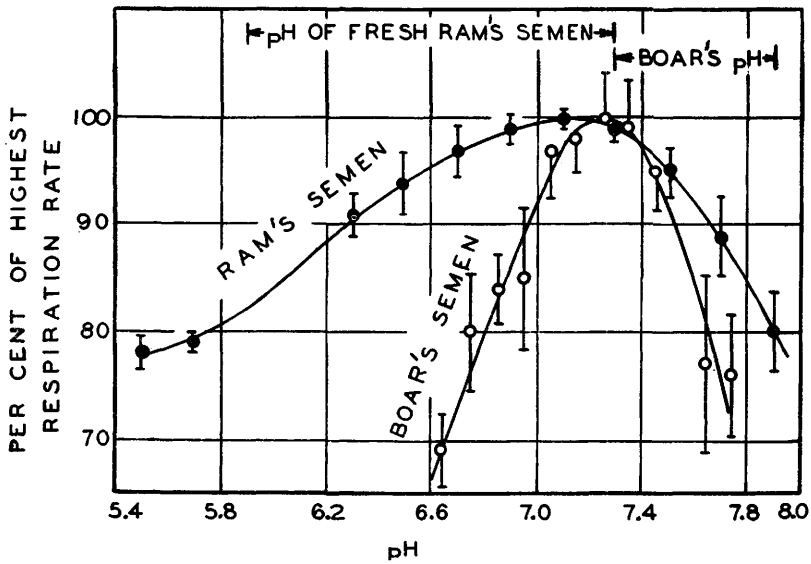

FIG. 1.

Influence of pH on respiration rate of sperm. Vertical lines from data points are standard errors of means. The pH values of fresh semen are those of McKenzie and coworkers.

‡ Accuracy of the apparatus was determined periodically by simultaneous respiration measurements of yeast suspension in each of the 6 manometer units. The error (mean deviation × 100/mean) was 2%.

[5] Dixon, M., *Manometric Methods*, Cambridge Univ. Press, London, 1934.

by boar semen at pH 7.2 to 7.3, by ram semen at pH 7.0 to 7.2; these may be considered optima for these species. At pH levels beyond the limits of those given in Fig. 1 the respiration rates tended to approach that of seminal plasma.[7]

The data given for boar semen consist of results obtained separately with ejacula of 4 boars. They were combined after comparisons had shown that differences in respiration rates of samples from a given animal were as great as those of samples from different animals. The pH ranges of fresh semen of the boar and the ram, given in Fig. 1, are those reported by McKenzie and coworkers.[8, 9]

Conclusions. (1) Hydrogen ion concentrations of the media in which sperm of the boar and ram are suspended definitely influence respiration rates of the sperm. (2) Optimum pH for respiration of boar semen is 7.2 to 7.3, and for ram semen 7.0 to 7.2. (3) As the pH is raised or lowered from the optimum the respiration rate progressively declines. (4) Unit change in pH has significantly less influence on respiration rate of ram sperm than on that of boar sperm. (5) Differences of 0.4 pH unit or more are accompanied by significant differences in respiration rates of boar and ram semen. Conditions for valid comparisons of different samples are presented.

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Retinal Pigment Distribution in Relation to a Diurnal Rhythm in the Compound Eye of Dytiscus.*

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In the higher Malacostracans one manifestation of a persistent diurnal rhythm is the periodic migration of retinal pigment. Therefore, the discovery of a diurnal rhythm in the electrical response from

[6] Snedecor, George W., *Statistical Methods*, p. 54, Iowa State College Press, Ames, 1940.

[7] Winchester, C. F., and McKenzie, Fred F., PROC. SOC. EXP. BIOL. AND MED., 1941, **46**, 455.

[8] McKenzie, Fred F., Miller, J. C., and Bauguess, L. C., *Mo. Agr. Exp. Sta. Res. Bul.* 279, 1938.

[9] McKenzie, Fred F., and Berliner, Victor, *Mo. Agr. Exp. Sta. Res. Bul.* 265, 1937.

* Aided by a grant from the Rockefeller Foundation for Work in Cellular Physiology.