The effect of temperature on the secretion of chloride by the rectal gland of *Squalus acanthias*

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The rate of most enzymatic reactions depends on the ambient temperature. In most systems the initial velocity of a reaction plotted against the inverse of the absolute temperature produces a linear relation (Arrhenius plots). The relationship of temperature and velocity is more complex in whole cells or epithelia, where numerous factors determine the response to temperature. On the other hand, in whole tissues, changes in ambient temperature can alter the generation or disposal of products such as reactive radicals that can either stimulate or inhibit the activity of a cell. In the present series of experiments we examined the secretory activity of the shark rectal gland over a range of temperature to determine whether changes in ambient temperature can modify the secretory activity of the gland.

Shark rectal glands were perfused as previously described[1]. The glands were perfused in a glass chamber at constant temperature. The temperature of the gland was maintained at 23°, 17°, or 10° C by continuously circulating water at the chosen temperatures. We chose 17°C because that is the normal temperature of the water and that of the sharks that swim in it; the temperature of 23°C was chosen because that is the temperature of the room where the experiments were done; the temperature of 10°C was chosen arbitrarily. Duct fluid was collected at ten-minute intervals in tared plastic centrifuge tubes, and the volume assessed by weight. The concentration of chloride in the duct fluid was measured by amperometric titration. All glands were perfused with shark Ringers containing 5 mM glucose. After three ten-minute periods to allow the gland to reach a steady state, a bolus of 3×10^{-8}M vasoactive intestinal peptide (VIP) was given over a period of one minute, and the experiment continued for another thirty minutes.

The effect of temperature on the secretion of chloride by the rectal gland of the shark is shown in Figure 1. Increasing the temperature from 17°C to 23°C did not alter the secretory activity of the gland in response to VIP. There was no increase or decrease in the rate of chloride secretion, suggesting that an inhibitory factor, as yet undefined, places a limit on the secretory response at higher temperatures. Decreasing the temperature of the perfused gland to 10°C significantly reduced the rate of secretion stimulated by VIP.

These experiments suggest that the optimal temperature for the secretion of chloride by the rectal gland is 17°C. Increasing the temperature of the gland does not increase the rate of the secretion of chloride. Decreasing the temperature results in a substantial reduction in the rate of secretion. These findings indicate that the secretion of chloride by the rectal gland of the shark is well adapted to the environmental situation of the shark that migrates throughout the year seeking waters of similar temperatures.

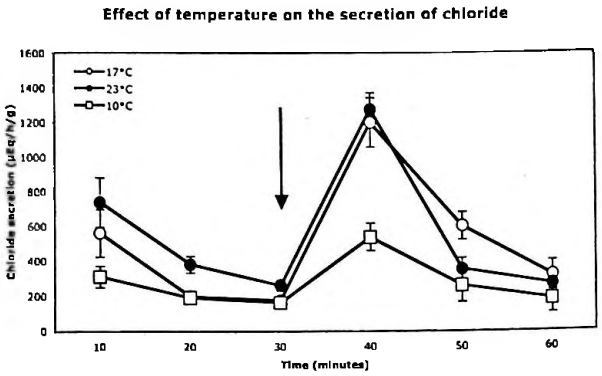

Figure 1. Effect of temperature on the secretion of chloride by the rectal gland. Rectal glands were perfused at 10°, 17°, and 23°C from the beginning of the experiments. Increasing the temperature of the gland from 17°C, the ambient temperature at which the fish live, to 23°C did not alter the response of the gland to a bolus of VIP. VIP was given at the time indicated by the arrow. Decreasing the temperature to 10°C reduced the response to VIP by 60% $p < 0.01$. Symbols are mean±SEM; n= 12 for 17°C, n=5 for 23°C and n=3 for 10°C.

1. **Silva P., R. J. Solomon, and F. H. Epstein**. Shark rectal gland. *Methods Enzymol.* 192:754-66, 1990.