A NOTE ON THE HEAT CHANGE IN HADDOCK MUSCLE DURING RIGOR MORTIS

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A Note on the Heat Change in Haddock Muscle during Rigor Mortis

By G.O. Langstroth

It is well known that heat is developed during the period of rigor in different types of muscular tissue. This heat, supposedly due to the formation of lactic acid from glycogen and it's consequent neutralization has been measured in the case of frog and the value obtained has been found to agree with that calculated from the heats of formation of the reactants.* The present report deals with an investigation to ascertain if possible whether this effect might not be large enough to change the temperature of a mass of chilled fish by an amount sufficient to materially increase the rate of bacterial action.

The method consisted in making a series of temperature time readings of a piece of fresh Haddock muscle. The muscle was kept in the calorimeter proper of a Richards adiabatic calorimeter to prevent great heat exchange with the surrounding Measurements showed the heat leak to be negligible. A fish which had been kept alive for several hours in a tub of water at a known temperature was killed and filleted, and the fillets were immediately placed in the calorimeter. One junction of a thermocouple was inserted directly into the tissue and the other was placed in the outer bath of the calorimeter-Beckmann readings of the temperature of the outer bath gave the temperature of the muscle. The calorimeter was in the bath in about fifteen minutes after the death of the fish but no readings could be made until about an hour after because of the thermal conditions within the calorimeter. The fish used had been handlined and had not been exhausted by "teasing"

* See, Ritchie,"Comparative Physiology of Muscular Tissue."

In the data given below some of the temperature readings have been omitted for the sake of brevity.

Fish No.1

Time of catching.....11.00 A.M.
Time of death ..... 3.15 P.M.
Weight of fillets.....215.4 gms.
Initial temperature of fish**..... 13.6° C.

Beckmann Temperature	Time	Beckmann Temperature	Time
2.143	4.12	2.732	11.00
2.207	4.24	2.749	11.25
2.269	4.50	2.760	11.53
2.460	6.38	2.773	12.51
2.590	8.21	2.784	1.47
2.652	9.25	2.790	3.01
		2.788	3.46

**This temperature is the temperature 57 minutes after death.

Temperature rise after the first 57 minutes.....0.64° C
Total heat liberated in rigor after the first 57 minutes.....138 cal.
Heat liberated per gram.....0.64 cal.

Fish No.2

Time of catching.....10.00 A.M.
Time death.....11.48 A.M.
Weight of fillets.....348.2 gms.
Initial temperature of fish**..... 14.4° C.

Beckmann Temperature	Time	Beckmann Temperature	Time
2.898	12.27	3.581	8.34
2.897	12.40	3.402	9.25
2.917	1.00	3.430	10.26
3.013	2.00	3.451	11.23
3.095	2.59	3.490	1.23
3.142	3.38	3.522	3.25
3.190	4.21	3.540	4.21
3.271	5.42	3.566	6.21
3.320	6.47	3.592	8.25
3.355	7.41	3.636	12.20
		3.752	11.10
		3.818	4.12

Many of the temperature readings have been omitted for the sake of brevity.

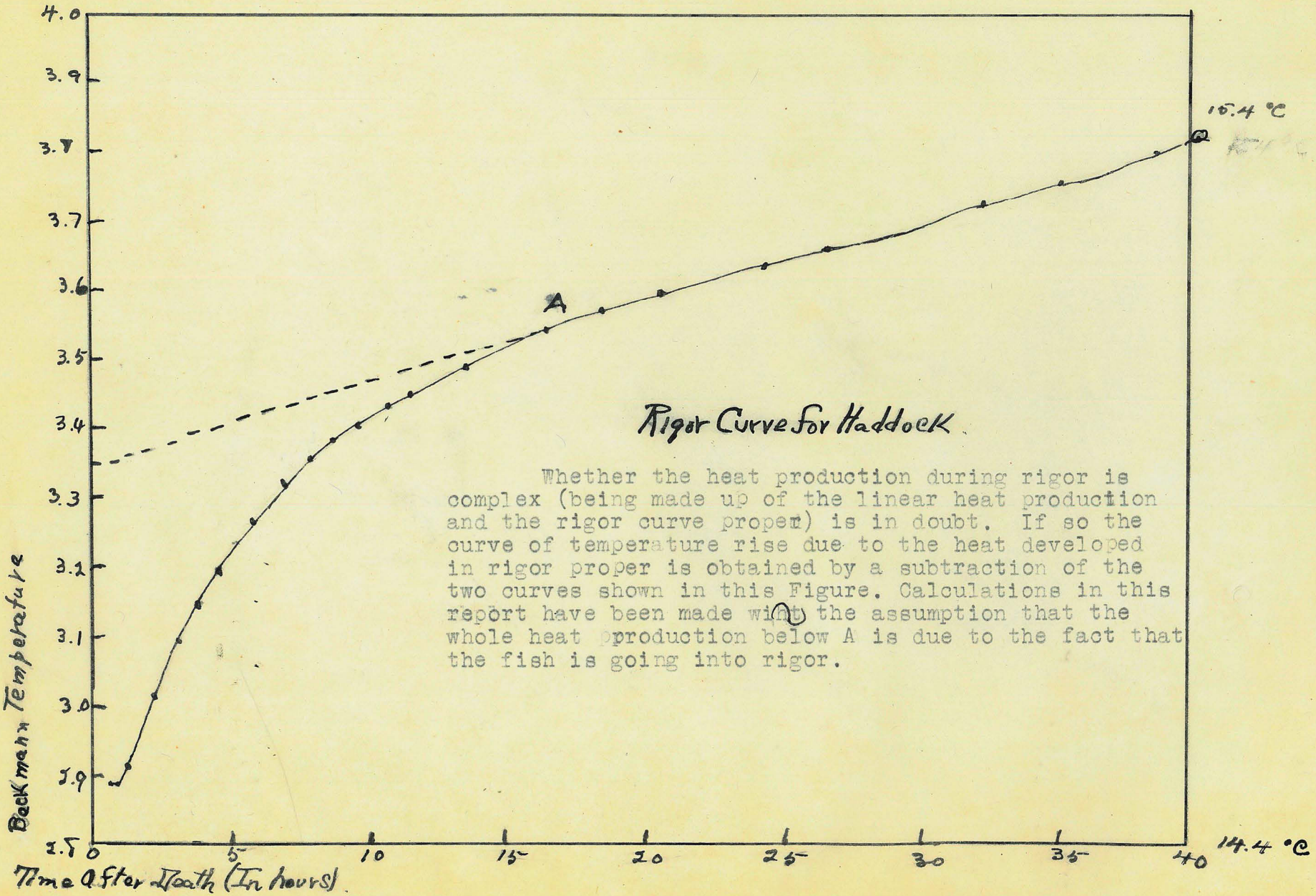
Temperature rise after the first hour.....0.63° C.
Total heat liberated after the first hour.....209. cal.
Heat liberated per gram.....0.60 cal.

If we consider as Ritchie does that the heat of lactic acid formation and it's neutralization is 390 cal/gm of acid formed, then we arrive at the conclusion that in the first fish 1.6 mg. were formed during rigor, and that in the second 1.5 mg. were formed, per gram of muscle. Ritchie gives the amount of lactic acid formed in fish muscle as varying from one to three milligrams per gram of muscle. Hence the theat produced by glycogenolysis seems to be the main factor in the temperature rise during rigor. This amount causes a rise of only 0.7° C in the pure fish muscle and this probably would not cause much increase in rate of growth of bacteria.

The objection that the reaction may have been far advanced before any measurements were made and that the actual temperature rise might have been quite large applies to both cases. The temperature of the bath in which the fish was

Kept alive was in the first case 12.5°C., and in the second case 13.0°C. Assuming that the ifsh was at the same temperature as the bath, (actually it probably was somewhat higher*) the temperature rise could not have been greater than 1.8° in the first case and 2.1° in the second. The actual time of rigor duration was for the first fish 12 hours and for the second 16 hours.

* Britton: Contributions to Canadian Biology Vol. 2 page 415. 1924.



Rigor Curve for Haddock

Whether the heat production during rigor is complex (being made up of the linear heat production and the rigor curve proper) is in doubt. If so the curve of temperature rise due to the heat developed in rigor proper is obtained by a subtraction of the two curves shown in this Figure. Calculations in this report have been made with the assumption that the whole heat production below A is due to the fact that the fish is going into rigor.