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Accompanying certain types of inflammation the heat-regulating mechanism of the body is disrupted so that heat accumulates and the body temperature rises. The individual is said to have a fever. Since the early work of Ledingham (1908) in which he showed that the rate of phagocytosis increased with a rise in temperature, a moderate fever has come to be regarded as a defense mechanism of the body. It is, therefore, of some significance that the normal and deviations from normal temperature be known for laboratory animals which are to be used to measure the response of an individual host to an artificial infection. Since mouse typhoid, a highly fatal disease occurring among mice and caused by the micro-organism *Salmonella typhimurium* has been likened in some respects to the typhoid of humans caused by *Eberthella typhosum,* it is all the more important that the temperature aspect of mouse typhoid be investigated. The present paper presents some preliminary results from experiments in which rectal temperatures were obtained for normal and inoculated mice of resistant and susceptible inbred strains.

Congdon (1912) measured changes in the rectal temperature of mice held at different room temperatures. Adult mice fell 3°C after a change of external temperature from 16°C to 5°C but apparently remained healthy. At a room temperature of 25°C the average rectal temperature was 35.3°C. At 5°C room temperature the rectal temperature was 31.2°C. Possibly the technical difficulties associated with the use of a clinical thermometer account for the lower temperatures compared to those reported by other workers using thermocouples. There is, however, general agreement in the literature that the mouse has a poor heat regulating mechanism. Larson and co-workers (1940) found that at 21°C the average temperature for their mice was 38.1°C and at a room temperature of 36.7°C the mice averaged about 40°C. Benedict and Lee (1936) reported the rectal temperature to vary between 36° and 39°C depending on the surrounding temperature.

Herter (1936) found that mice, which were placed on a temperature gradient, possessed the ability to choose their "thermotactic optimum" and this ability was inherited. He showed that the floor temperature and not the air above it was the deciding factor. Later, Herter and Sgonina (1938) showed that differences in skin thickness and density of fur of wild and albino mice accounted for the inherited temperature preference. Although the temperature of the

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fur on the belly differed, the rectal temperature of wild, albino, and waltzer mice was very nearly the same; viz., wild 37.39 ± 0.39, albino 37.68 ± 0.26 and waltzer 37.37 ± 0.41 (Herter 1936).

Seiffert et al (1928) used a specially constructed thermometer to study the temperature of mice which had been infected by stomach tube with mouse typhoid organisms. In their experiments the normal temperature of the mouse varied between 35.5°-38.0°C. The temperature induced by the disease fell within the normal limits but a slight increase was noted. Before death the temperature fell sharply. They concluded that temperature measurements are not reliable to predict the course of mouse typhoid.

Larson et al (1940) found that mice inoculated with pneumococci of type II and kept at room temperature did not show a rise in temperature as expected. On the contrary the temperature was depressed and continued to fall until death. A fall to as low as 28.9°C was frequently observed. Sulkin (1945) found that environmental temperature had little effect on mortality of the Swiss strain of mice infected with influenza, although the general course of the infection was modified.

Materials and Methods

A stock culture of *Salmonella typhimurium* of moderately high virulence, designated as 11 c, was used for the inoculations. The number of organisms in a saline suspension from an 18-hour growth on nutrient agar slants, was approximated by a Gates nephelometer and checked by poured agar dilution plates.

Rectal temperatures were recorded once daily, commencing the day after inoculation for mice so treated. A thermocouple especially designed for the purpose and accurate within less than 1/10 degree centigrade was employed. The best method for handling the mice proved to be to hold the animal by the tail and allow it to cling to the top of the cage. The thermocouple junction was fitted with a cork which acted as an insulator and insured the same depth of penetration in all cases.

Four inbred strains of mice were employed: two resistant strains, S and R.I., two susceptible strains, L and Ba. In addition, strains carrying waved-2, pugnose, hairless and shaker genes respectively, were employed.

Experimental Results

Since genetic differences between strains with regard to such things as character of the fur might be expected to affect body temperature, an experiment was conducted in which waved-2, pugnose, hairless, shaker, and wild type mice were compared. Rectal temperatures were recorded once daily over a 14-day period.

Table 1.—Comparison of Rectal temperatures of waved-2, hairless, pugnose, and shaker mice.

Description	No. of mice	Mean temperature
waved-2	9	37.08 ± .16
normal sibs	9	36.97 ± .11
Pugnose	9	36.74 ± .13
normal sibs	9	37.12 ± .12
waved-2 hairless	6	36.53 ± .13
shaker	9	36.89 ± .08
normal	10	37.11 ± .08

The results summarized in Table 1 indicate that the variation between strains was not great. The waved-2, hairless mice had a significantly lower temperature than waved-2 mice, and the pugnose mice were significantly lower than normal litter mates.

In an attempt to determine the fever picture during the course of mouse typhoid, mice of the highly susceptible Ba strain, the susceptible L strain and resistant R.I. and S strains were inoculated with 200,000 organisms of *S. typhimurium* of the moderately virulent 11 c strain. The survival of the mice is shown in Table 2.

Table 2.—Survival of Ba, L, R.I. and S mice inoculated with 200,000 organisms, 11 c strain *S. typhimurium*

Strain	Ave. age in days	Alive	Dead	% Survival
Ba	166	0	20	0
L	173	7	13	35
R.I.	175	20	0	100
S	162	20	0	100

None of the susceptible Ba and all of the resistant R.I. and S mice survived. The temperature fluctuated from day to day, and this corresponded with variations in room temperature. The correlation between rectal temperature and room temperature was highly significant.

(S strain, r = .86 d.f. = 12; R.I. strain, r = .84 d.f. = 12)

The results of this experiment are in accord with those of other investigators indicating that the mouse has a poor temperature regulating mechanism. (Congdon, 1912, Benedict and Lee, 1936, Larson et al, 1940).

A comparison of the four strains for the period before any of the mice died is shown in Table 3.

Table 3.—Comparison of temperatures of Ba, L, R.I., and S strains for 3 days following inoculation with 200,000 organisims of *S. typhimurium*, strain 11 c.

Strain	No. of readings	Mean rectal temp. °C
Ba	59	37.44
L	60	37.22
R.I.	60	36.92
S	60	37.34

Comparison of 20 R.I. and 20 S mice over a 14-day period.

R.I.	280	36.40	
S	280	36.79	$t = 4.42$

The R.I. mice were significantly lower in temperature, which may be associated with their large size.

Although the mice could not be said to have developed a typical fever during the course of the disease, a small rise in temperature during the early part of the disease was observed in all strains. On the other hand, the fall in temperature before death was unmistakable.

Table 4.—Comparison of rectal temperatures of Ba and L mice inoculated with 11 c strain of *S. typhimurium*. Dose 200,000 organisms.

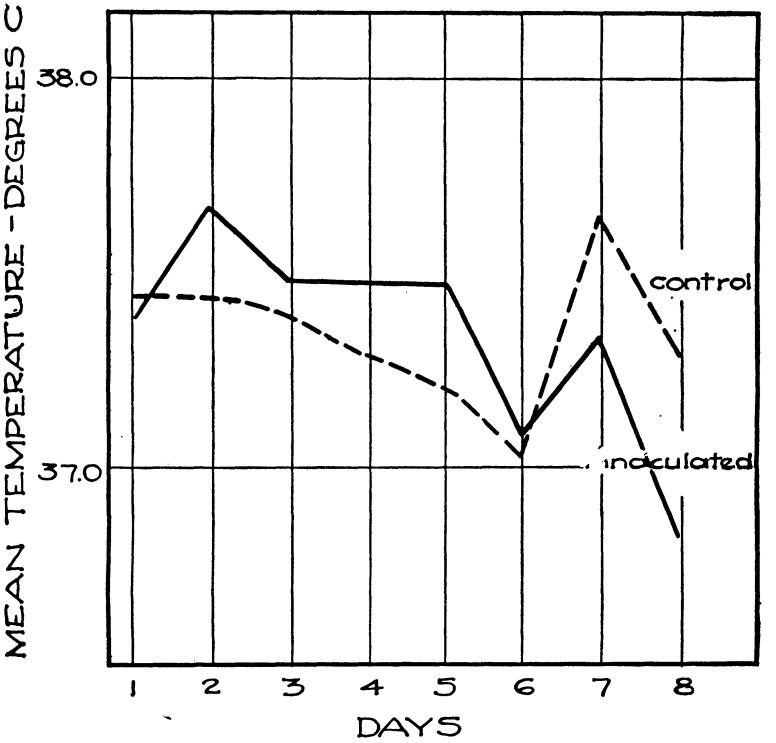
	Last Recorded Temperature of mice which died.		All Other Temperature readings.	
	No.	Ave. temp. °C	No.	Ave. temp. °C
Ba	20	33.87	83	37.39
L	13	32.66	209	36.92

Since a slight rise in temperature was regularly observed during the early part of the disease, an experiment was designed to compare normal and inoculated sib pairs inoculated with a heavy dose of organisms (1,000,000).

Table 5.—Mean temperatures of S controls and sibs inoculated with 1,000,000 organisms.

	Days After Inoculation							
	1	2	3	4	5	6	7	8
Inoculated	37.38	37.67	37.47	37.46	37.47	37.07	37.33	36.81
Control	37.44	37.43	37.38	37.28	37.20	37.04	37.63	37.29
Diff.	−.06	+.24	+.09	+.18	+.27	+.03	−.03	−.48

The rise in temperature was significant.



Mean temperatures of inoculated and control sib pairs. Inoculation dose—11c *S. typhimurium* 1,000,000 organisms.

Summary and Conclusions

At a room temperature of 20°C the rectal temperature of the mouse is approximately 37°C. Mice artificially infected with mouse typhoid show a slight increase in temperature during the early part of the disease, and before death the temperature falls sharply. Apparently fever is not one of the mechanisms contributing to the survival of mice which are genetically resistant to mouse typhoid.

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