

THE EFFECT OF TEMPERATURE UPON THE  
HATCHING OF THE EGGS OF *PEDICULUS*  
*HUMANUS CORPORIS* DE GEER (ANOPLURA)

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(With 1 Figure in the Text)

SUMMARIES of the effects of temperature upon the time required for the hatching of the eggs of *Pediculus humanus corporis* given by Nuttall (1917) and by Buxton (1939) show that when kept at constant temperatures<sup>1</sup> the lower limit for hatching is between 22 and 25° and 16 days is given as the incubation period at 25°. The upper limit is stated to be between 38 and 40° (5 days at 37°).

The present work was begun to discover the period of exposure necessary to kill all eggs at a number of different temperatures.

In batches of eggs of *Pediculus* reared artificially the percentage hatching varies even when they are taken consistently from the same person. Eggs used in these experiments were therefore taken from several cultures reared in pillboxes on the legs of two, three or four persons. The age of the eggs was known to be less than 24 hr.

After the eggs had been counted, the pieces of black tape on which they were laid were placed (with the eggs still attached) in small Petri dishes (*not* in tubes). A piece of black material had previously been secured to the bottom of each dish to afford foothold for the newly emerged larvae. The Petri dishes were kept in closed desiccators over mixtures of sulphuric acid and water thus providing a constant relative humidity in each vessel. Temperatures were controlled electrically in the incubators containing the desiccators, recorded by thermographs and checked by mercury thermometers.

EGGS INCUBATED AT CONSTANT TEMPERATURES

By keeping newly deposited eggs at constant temperatures it was found that they would hatch between 24 and 37°. They would not hatch at 23° or lower, or at 38° or higher. The figures for these experiments are given in Table 1 and are plotted on the graph (Fig. 1). It is seen that at temperatures near the upper and lower limits the percentage of eggs successfully hatched is reduced; also that at low temperatures the incubation period is lengthened. Temperatures which could be considered as favourable are between 29 and 32°. At any one temperature, humidity did not affect the duration of the incubation period though extremely low or extremely high humidities reduced the percentages of eggs hatched (Table 2).

<sup>1</sup> The temperatures in this paper are given in degrees Centigrade.





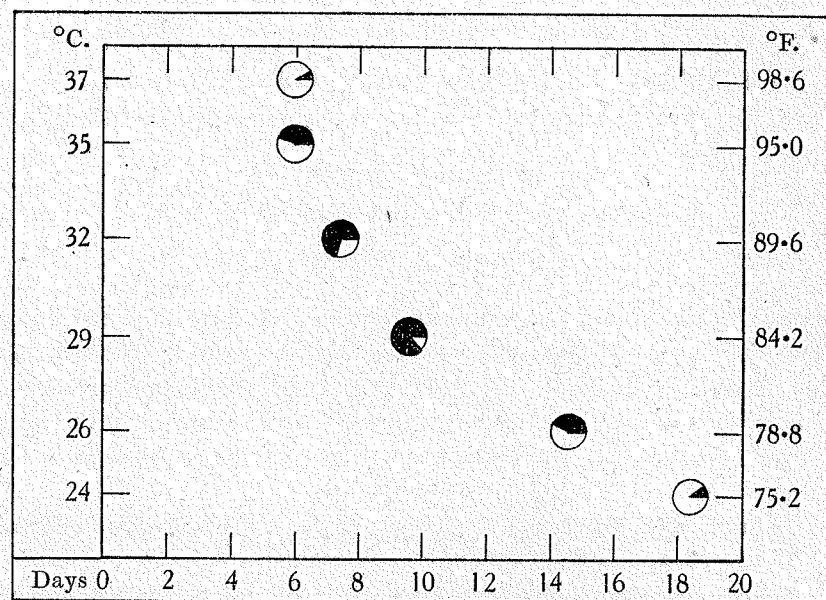


Fig. 1. Mean incubation period of eggs of *Pediculus* at constant temperatures. Black segments represent proportion hatched.

Table 1. Temperatures at which *Pediculus* eggs hatched

° C.	No. eggs used	No. eggs hatched	% eggs hatched	Duration of incubation period in days	Mean incubation period in days
37	269	24	9	6-7	6
35	379	170	45	5-7	6
32	471	342	73	7-9	7.5
29	438	386	88	9-11	9.5
26	381	168	44	13-19	14.5
24	120	14	11	17-21	18

Table 2. Hatching of eggs of *Pediculus* at different temperatures and humidities

° C.	% relative humidity	No. of eggs used	% eggs hatched	Duration of incubation period in days
37	10	89	0	—
	50	90	22	6-7
	95	90	4	6
35	10	56	25	6-7
	50	72	25	6-7
	75	106	72	5-7
	90	89	38	5-7
	95	56	50	5-7
32	45	92	75	7-9
	65	261	79	7-9
	85	118	57	7-9
	90	146	86	9-11
29	60	148	97	9-11
	90	144	80	9-11
	90	71	41	14-19
26	50	79	46	14-17
	75	80	62	13-15
	90	79	30	14-17
	95	72	39	14-18
24	90	120	11	17-21

#### EFFECT OF "UNFAVOURABLE" TEMPERATURES UPON HATCHING

Eggs were exposed to different "unfavourable" temperatures for definite periods and then transferred to a "favourable" temperature, 30, 31 or 32°, for hatching. A relative humidity of 65 % was used throughout the experiments.

At 39° experiments were done to discover how soon eggs were killed at this temperature. More than 100 eggs were used in each experiment. They were kept for periods of 1-7 days and then removed to 32°. Only eleven out of 105 eggs hatched; these had been kept for 1 day at 39°; six of them hatched on the sixth day after removal to 32° and the other five hatched on the seventh. The remaining eggs were kept for another 11 days but no more hatched. Thus 2 days or more at 39° killed all the eggs.

Eggs were kept at 24° for different periods and then transferred to 32°. As the period at 24° was lengthened the incubation period at 32° shortened. For example, eggs which spent 7 days at 24° commenced to hatch on the sixth day at 32°, but those which spent 14 days at 24° began hatching after only 2 days at 32°. Eggs kept continuously at 24° commenced to hatch on the seventeenth day and hatching continued until the twenty-first day. This was the lowest temperature at which eggs successfully hatched.

Eggs were exposed to 23° for periods ranging from 3 to 40 days. No eggs hatched at this temperature, though a number of eggs developed eye-spots. After the time spent at 23°, eggs were removed to 32°. The only hatching that occurred after the transfer was among eggs which had previously spent 11 days or less at the lower temperature. In each case hatching commenced on the sixth day at 32°. No eggs hatched at 32° among batches which had spent a previous period of 14 days or longer at 23° (Table 3).

Table 3. Eggs of *Pediculus* (under 24 hr. old at commencement) exposed to 23° and then to 32° until hatched

No. of eggs	Days at 23°	Days at 32°	Days to hatch at 32° and no. hatched	% eggs hatched at 32°
42	3	8	6 (10) 7 (7)	40
86	6	11	6 (13) 7 (3)	18
50	7	9	6 (15)	30
50	9	12	6 (5)	10
30	10	9	6 (14) 7 (4)	60
33	11	11	6 (4)	1
70	14	20	—	—
90	15	11	—	—
50	19	14	—	—
115	20	13	—	—
72	40	0	—	—

By exposing eggs to 22 and 20° it was found that eye-spots developed in some of the eggs though no hatching occurred. Some of the eggs hatched after removal to 32° before the eleventh day at 22° and the tenth day at 20°, but

they did not hatch if they were removed after 14 days at these temperatures. Short preliminary exposures to 22 and to 20° resulted in the subsequent incubation period at 32° being extended beyond the normal and long exposures reduced it (Table 4).

Table 4. *Eggs of Pediculus (under 24 hr. old at commencement) exposed to 22° for different periods and then to 32° until hatched*

No. of eggs	Days at 22°	Days at 32°	Days to hatch at 32° and no. hatched			% eggs hatched at 32°
102	4	14	9 (34)	10 (26)	11 (1)	60
93	5	13	8 (12)	9 (7)	10 (1)	22
107	6	13	8 (26)	9 (15)		38
105	7	12	7 (1)	8 (11)	9 (8)	19
45	8	10	7 (3)			7
115	9	11	6 (10)			9
100	10	11	6 (6)			6
66	14	9	—	—	—	—
100	15	13	—	—	—	—
103	16	12	—	—	—	—
100	17	11	—	—	—	—
143	22	16	—	—	—	—
104	41	7	—	—	—	—

Eggs were kept at 19 and 18° and moved to 32°; at 15 and moved to 30°; at 10 and moved to 31°; and at 8 and moved to 32°. No eggs hatched while they were at 19° or below. After the transfer to higher temperatures, no eggs hatched among batches which had spent 7 days or more at 19° or below. Among eggs which had spent 6 days or less at these low temperatures hatching occurred after the transfer to the higher ones. They commenced to hatch at each of the favourable temperatures in the minimum normal incubation periods as follows: at 32° in 7 days, at 31° in 8 days, and at 30° in 9 days. The percentages which hatched were lowest among those batches which had spent the longest periods at the preliminary low temperatures. To illustrate this the figures for 8 and 32° are given in Table 5.

Table 5. *Eggs of Pediculus (under 24 hr. old at commencement) exposed to 8° and then transferred to 32° until hatched*

No. of eggs	Days at 8°	Days at 32°	Days to hatch at 32° and no. hatched			% eggs hatched at 32°
120	1	13	7 (85)	8 (18)		86
103	2	12	7 (36)	8 (11)		46
80	3	11	7 (4)	8 (10)	9 (1)	19
113	4	10	7 (24)	8 (9)		27
103	5	11	7 (1)	8 (1)		2
44	6	13	7 (2)			4
104	7	12	—	—	—	—
104	8	11	—	—	—	—

#### EGGS NEARLY READY TO HATCH

Batches of eggs were incubated for 6 days at 32° and then transferred to 23°. They were kept at this temperature for 1, 3, 5 and 7 days and then restored to 32° unless they had already hatched. In all the batches hatching com-

menced on the first day at 23° and continued for two more days. Therefore, eggs in an advanced stage of development will hatch at 23° though, as we have seen, newly deposited eggs kept at this temperature do not.

Eggs incubated at 32° for 6 days were exposed to 19° for 6, 7 and 8 days and then returned to 32°. Some eggs hatched at 19° on the fourth day and others on the seventh and eighth days. A larger number of eggs hatched after they were put back to 32°. A temperature of 19° is therefore not low enough to prevent the more advanced embryos completing their development.

Similar experiments were carried out with eggs incubated at 32° for 6 days and then at 18°. Some eggs hatched at 18° every day from the second to the ninth. Also, a considerable proportion hatched after being restored to 32°, except when the period at 18° was 8 days or more.

Eggs incubated for 7 days at 31° were stored at 15°. No eggs hatched at 15° and none hatched after being replaced at 31° if the period at 15° had been more than 9 days (Table 6).

Table 6. *Eggs of Pediculus incubated at 31° for 7 days, exposed to 15° for different periods and then transferred to 31° until hatched*

No. of eggs	Days at 31°	Days at 15°	Days at 31°	Days to hatch at 31° and no. hatched			% hatched at 31°
29	7	1	6	2 (20)	3 (6)		90
40	7	3	8	2 (22)	3 (7)		73
50	7	5	9	1 (8)	2 (20)	3 (4)	64
27	7	6	12	1 (7)	2 (8)	3 (3)	66
28	7	7	12	1 (8)	2 (8)	3 (2)	64
53	7	8	12	1 (5)	2 (30)		66
30	7	9	30	—	—	—	—
53	7	10	29	—	—	—	—

In a rather similar way, eggs were incubated at 32° and then exposed to 8° just before they were expected to hatch; they did not hatch, but they were not killed unless the period at 8° was over 9 days.

Table 7. *Minimum times of exposure to constant temperatures which ensure that eggs of Pediculus are killed*

° C.	Newly deposited eggs		Older eggs
	days	days	
8	7		9 days
10	7		9 days
15	7		9 days
18	8		} Some eggs will hatch
19	9		
20	10		
22	12		
23	14		

## PARTIALLY DEVELOPED EGGS

A few experiments were done with eggs incubated at 30° for periods of 2-5 days and then exposed to 15° for 1-10 days. No eggs hatched while they were at 15°. When they were replaced at 30° larvae hatched in those batches in which the period at 15° had been from 1 to 7 days. Longer periods at 15° were fatal.

## CONCLUSION

It has been shown that eggs of lice are killed by short exposure to high temperatures (39° and over) but medical officers and others interested in the control of lice will gather from these experiments that the eggs may also be killed by exposing them to low temperatures (23° and below). The period of exposure necessary varies of course with the temperature and with the stage of development of the eggs. The minimum periods required are shown in Table 7. It will be seen that in dealing with a mixed collection of eggs the temperatures should not be above 15° and the exposure should be not less than nine days.

## SUMMARY

The hatching of the eggs of *Pediculus humanus corporis* De Geer is influenced by temperature.

High temperatures accelerate and low temperatures delay development.

The lowest constant temperature at which eggs will hatch is 24° and the highest 37°.

At 24° eggs begin to hatch on the seventeenth day and continue hatching until the twenty-first. At 37° eggs hatch on the sixth and seventh days. The temperature at which eggs hatch in the shortest time is 35° and the time 5 days. At these extremes many eggs are killed so that the percentages of successful hatches are very low. Eggs are killed by 2 days' exposure to 39°.

Temperatures at which the maximum number of eggs hatch lie between 29 and 32°. In this range of "favourable" temperatures, up to 97 % of successful hatches may be recorded. The incubation period is from 7 to 11 days. This is a convenient range of temperatures for laboratory purposes and gives largest numbers in a reasonably short time.

Newly deposited eggs will not hatch if kept for 14 days at 23° or for shorter periods at lower temperatures, until at 8° exposure for 7 days is sufficient to ensure that all eggs are dead.

If partially developed eggs are exposed to temperatures of 15° or lower, development ceases. If they are restored to a favourable temperature within 7 days, development is resumed and some of the eggs will hatch.

Older eggs which have almost reached hatching point at a "favourable" temperature hatch if transferred to temperatures as low as 18°. They do not hatch at 15° or lower if kept at such temperatures for at least 9 days.

## REFERENCES

- BUXTON, P. A. (1939). *The Louse*. London: Edward Arnold and Co.  
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