A CONTRIBUTION TO THE BIONOMICS OF *PEDICULUS HUMANUS* (*VESTIMENTI*) AND *PEDICULUS CAPITIS*.

By A. BACOT,

Entomologist to the Lister Institute of Preventive Medicine.

In its inception this work was planned with a view to supplement our present knowledge of the life history of *Pediculus humanus* (*vestimenti*, which we owe so largely to Warburton[1] (1909). The scheme was to work out in detail certain problems relating to sex and fertility and incidentally to obtain further evidence in support of what is already known concerning the laying and hatching of eggs. The success of an attempt to breed *P. capitis* under conditions that had already proved satisfactory with *P. humanus* suggested that it was worth while enlarging the scope of the scheme in order to include the head louse, as this insect seemed to be amenable to the same conditions of captivity.

These conditions, as nearly natural for *P. humanus* as were consistent with captivity and isolation, are admittedly more artificial when applied to *P. capitis*; it is necessary to keep this fact in mind when comparing the bionomics of the two insects as described in this paper.

The lower egg production of *capitis* is in all probability chiefly due to the smaller egg-containing capacity of its body; for, in spite of the fact that the eggs of the head louse are slightly smaller than those of the species associated with clothing, the body extension of the ♀♀ *P. humanus* still gives them a marked advantage with respect to the number of fully developed eggs that they can carry. The shorter life, and apparently lower vitality of *P. capitis* as compared with *P.*

[1] I was unaware of the publication of Sikora's (1915) excellent paper, which contains much fuller details than any hitherto published account of the biology of *P. humanus* (*vestimenti*), until the experiments detailed in this paper had been mapped out and half completed.

humanus, is probably due, at all events in part, to the method of feeding and other conditions of captivity.

Origin of the strains experimented with.

Lice were obtained from three separate sources; a London Borough Infirmary, one of the London County Council cleansing stations, and a Salvation Army shelter. I take this opportunity of recording my thanks to the Officials of these Institutions who so kindly assisted me by providing material.

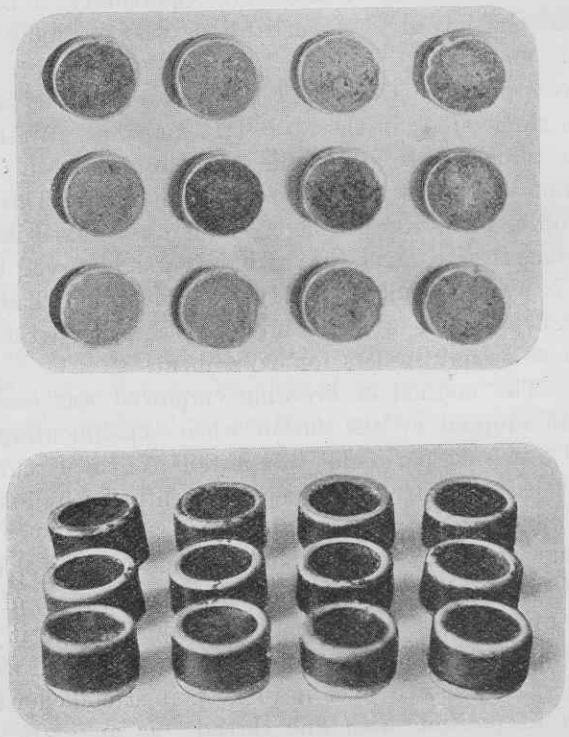
The insects obtained from these sources were placed together and treated as a single stock in the case of *P. humanus*. With *P. capitis*, however, two stocks were kept; one raised from nits on the hair and the other from active insects received with the hair. This course was pursued in order to avoid possible error due to a mixed infection, but as no difference in size, structure, or habits was observed between the two stocks, it was concluded, after several generations had been bred, that only *P. capitis* had been present. Subsequently either stock was drawn upon to supply insects for experiment.

Methods. The method of breeding employed was essentially the same as that adopted by the author when experimenting with fleas (Bacot 1914), in one particular adaptation to the circumstances it closely paralleled a feature of the method mentioned by Sikora (1915), the idea, however, was differently applied.

The insects were kept in glass-bottomed entomological boxes lined with a loose slip of cloth to give foothold. In the case of *P. capitis* a small tuft of hair was also generally added, although it was found not to be essential. The open top of the box was covered with chiffon, the lid being partly closed over it to keep it stretched while it was securely tied in position with fine thread; as an extra precaution against escape the box was nested in one of a larger size. Feeding took place readily through the chiffon when this was placed against a suitable skin surface. As it was necessary during the progress of the research to feed isolated individuals or families in as many as three dozen separate boxes at once, small ones of three quarters of an inch diameter were used. Holes punched in pieces of card into which the gauze covered boxes were inserted, enabled them to be kept in position against the body during sleep, with the aid of a flannel belt. The insects had the option of feeding at any time covering a period of six or seven hours during which the chiffon covered openings of the boxes were against the skin.

During the day the boxes were carried in the pockets of a waistcoat, the eggs laid being hatched in the same or similarly fitted boxes carried beneath the clothing.

The only section of the experiments in which this procedure was modified was in that dealing with the eggs of ♀♀ submitted to differential



Figs. 1 and 2.

Breeding method when a large number of segregated individuals or broods have to be fed at the same time.

feeding (Table VIII) and the trials conducted to test variability in hatching (Table IX), in which it was thought desirable to keep the eggs at a constant temperature. In both these instances the eggs were laid on cloth and placed in glass tubes plugged with cotton-wool, the tubes being kept in a humid incubator having a constant temperature of 31° C.

Habits of the insects noted when reared under the conditions mentioned above.

P. capitis is much the more active insect of the two. In egg laying either species can adapt itself to cloth or hair. *P. capitis* will sometimes lay eggs on cloth, although there are hairs in the box. *P. humanus*, on the other hand, seldom if ever lays on hair while there is cloth in the box and when compelled to do so the females of this species appear to

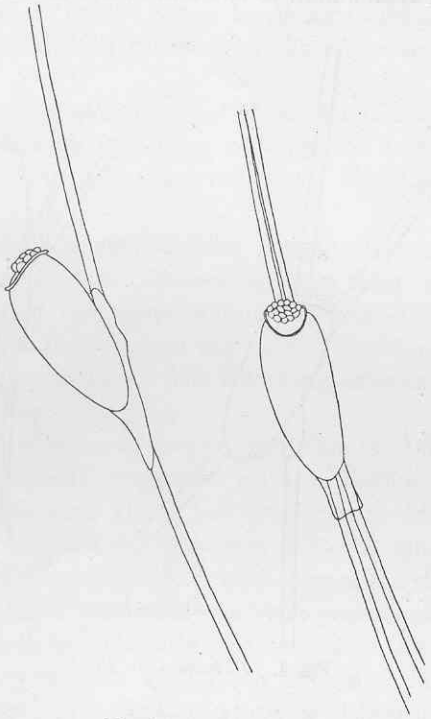


Fig. 3. *P. capitis* × 25.

be less skilful in cementing, or careful in getting the long axis of the egg into alignment with the hair. When forced to lay on hair they not infrequently attach the egg at an angle to the axis of the hair.

Two or three ♀♀ and ♂♂ of *P. humanus* were placed in a small box with human hairs of two or three centimetres long from the forearm. The insects were liberally fed for three days, during this period they laid 35 eggs. Of these one was attached to the side of the box and was also cemented to the hairs which clung together owing to eggs having

been fastened to two or more hairs at the angles of crossing. Nine eggs had been laid on the gauze cover of the box; only four eggs had been attached to the single hairs, while 21 (60 %) of the eggs were cemented to two or more of the hairs, the ♀♀ having apparently searched for positions where the hairs crossed or ran parallel to each other so as to avoid attachment to single hairs.

Several ♀♀ and ♂♂ of *P. capitis* were treated similarly, in this box—36 eggs were laid, all of them on hairs; 28 were attached to a single hair only; six had attachment to two and two to three hairs. A marked

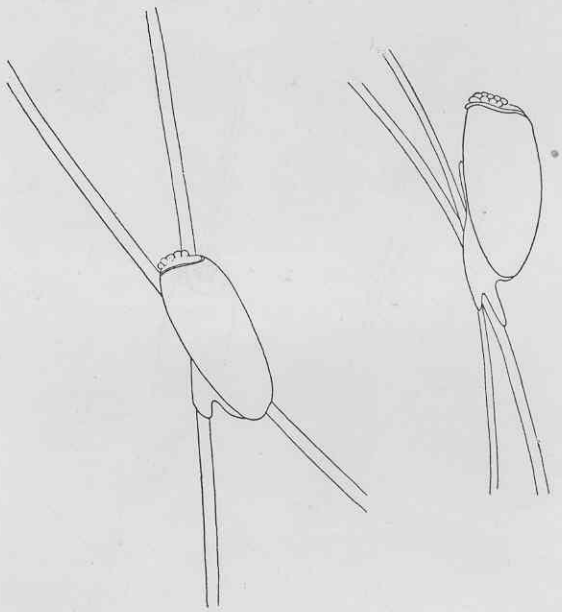


Fig. 4. *P. humanus* × 25.

difference was observable, also, in the selection of position for attachment in the case of the eggs having attachment to more than one hair. In every case the hairs chosen not only ran parallel for more than the length of the egg, but in most cases they were side by side. The parallel hairs affected by *P. humanus* were separated from each other by a well marked space, while in most cases hairs crossing each other at a wide angle had been chosen.

P. humanus ♀♀ in most cases exhibited what may be roughly called a homing instinct; that is to say they returned again and again to the same spot to lay their eggs. As this habit made counting difficult,

various methods of shifting the piece of cloth, turning it, so that the exposed surface went against the side of the box, the addition of a second piece of cloth, etc., were tried in an endeavour to get the eggs spread, instead of clustered. As a rule these attempts were unsuccessful, there seemed to be some attraction which led to the deposit of fresh eggs where others were already laid.

P. capitis ♀♀ occasionally exhibited the same tendency, but it was never so marked or "wilful" as with those of *P. humanus*. Another habit that was marked in the body louse and less noticeable but still to be observed with *P. capitis*, was a tendency to gregariousness shown by clustering, especially on the part of the larvae and nymphs when about to moult.

Pairing may be seen at any period of the day or night on the part of both species, the insects remaining together for a considerable time; periods of over an hour were observed, but I failed to ascertain what the limits were.

Both species show a very definite negative heliotropism, moving towards any shadow or dark coloured object in their vicinity. General observation suggested that their actions differed somewhat, however, according to whether they were at the time of exposure to light resting on a dark or a light surface. The following experiment was carried out with *P. humanus*:

Two eight inch squares of paper, one black and the other white, each having a sufficiently roughened surface to afford good foothold, were placed near together about two feet from a window. The lice at each trial being emptied out of a tube on to the centre of the paper.

Two batches of lice were used, each comprised five females and four males; eight trials were made on each paper—the batches being transposed from black to white and vice versa after each trial.

While these experiments strengthen the idea suggested by my general observations, viz. that there is a difference between the behaviour of the insects dependent upon their being on a light or dark surface when exposed to the light, their movements being less assured in the former case, the result is not so striking as I was led to expect. Had the papers been broader all the active insects would have reached the end farthest from the source of light, as all their tracks towards the sides were diagonals in this direction.

The sluggishness recorded is, with one exception, due to the inactivity of three ♂♂; of the 15 records 14 were due to the inaction of these three individuals.

No. of observation	Paper (black or white)	Distribution of lice on the paper	No. of observation	Paper (black or white)	Distribution of lice on the paper
1	Black	3 *a*, 0 *b*, 6 *c*	9	Black	1 *a*, 1 *b*, 7 *c*
2	White	0 *a*, 3 *b*, 6 *c*	10	White	0 *a*, 3 *b*, 6 *c*
3	Black	0 *a*, 1 *b*, 8 *c*	11	Black	0 *a*, 0 *b*, 9 *c*
4	White	0 *a*, 3 *b*, 6 *c*	12	White	2 *a*, 0 *b*, 7 *c*
5	Black	2 *a*, 2 *b*, 5 *c*	13	Black	3 *a*, 0 *b*, 6 *c*
6	White	1 *a*, 3 *b*, 5 *c*	14	White	0 *a*, 3 *b*, 6 *c*
7	Black	0 *a*, 1 *b*, 8 *c*	15	Black	0 *a*, 1 *b*, 8 *c*
8	White	1 *a*, 2 *b*, 6 *c*	16	White	2 *a*, 2 *b*, 5 *c*

Totals

Black	9 = 13 %	*a*
	6 = 8 %	*b*
	57 = 79 %	*c*
White	6 = 9 %	*a*
	19 = 26 %	*b*
	47 = 65 %	*c*

NOTE. *a* = lice sluggish and failed to crawl.
b = lice crawled to side of the paper.
c = lice crawled to edge of paper farthest from the source of light.

Length of life of unfed lice under different conditions of temperature.

Lice at all stages of growth were taken from a stock box carried in a vest pocket and submitted to the following conditions: in a room, the air of which is very dry owing to central heating, temperature 16°–18° C.; in a humid incubator at 24·5° C. constant; in a dry air incubator at 37° C. constant.

At 16°–18° C. most of the insects died within four days; two lived five days; one adult was still living on the seventh day.

At 24·5° C. all died within five days.

At 36·1° C. all died within three days.

Newly hatched lice that had not been fed lived less than 24 hours at 36·1° C. When kept unfed in a box in the vest pocket newly hatched lice lived but little more than a day; none survived a second day.

Adults kept in a box unfed in the side pocket of a coat lived five days.

Cold. Active lice in all stages were placed in a cloth-lined box and kept in a cold room at $-2{\cdot}3°$ to $-1{\cdot}1°$ C. for 48 hours; all were stiff and motionless when taken out, but after 24 hours in a vest pocket all revived; they were afforded ample opportunity of feeding, after which they were again kept in the cold room for seven days; all were dead on removal.

Feeding. Hungry lice do not as a rule wander, but settle down to feed at once if placed on a suitable skin area. When a number are placed on a small area of not more than a square inch, there is a considerable difference in the time taken to draw blood; many obtain it within half a minute to a minute, others within two or three minutes, while a few may be five minutes or over. Such delay seldom if ever occurs with bugs (*Cimex lectularius*) presumably owing to their more powerful pumping apparatus, or possibly the greater depth of the wound. Fleas not infrequently fail at the first attempt, in which case they usually shift and try again at another spot. Lice, however, rarely if ever shift, but wait patiently until, presumably, the irritation caused by the injection of saliva dilates the capillaries and brings the flow of blood to the wound. This reliance upon the salivary fluid fits in well with the fact of the more intense and lasting effect of the bite, as compared with that of either fleas or bugs (on the author). With insects having such a generally restricted range of operations there is a very fair chance of their feeding a second time on the same area and benefiting by the inflammation resulting from their previous attacks.

Experiment shows that there is much the same variation in the time required to obtain blood on the part of newly hatched larvae as with larvae in their second skin, nymphs and adults; and the speed with which they fill their crops also varies from about two to fifteen minutes.

Growth and moulting: Pediculus humanus (vestimenti).

Forty newly hatched lice were kept in a box in a vest pocket and afforded opportunity for feeding during six or seven hours each night; cast skins were found as under:

	Number of days after hatching													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of cast skins			1	17	22		6	29	5	2	1	22	13	2
			1st moult				2nd moult				3rd moult			
			3 %	42 %	55 %		15 %	72 %	13 %	5 %	3 %	55 %	32 %	5 %

TABLE I. *Fertility of* Pediculus humanus (vestimenti).

Insects in the larval stage were taken from a stock box and reared until maturity in separate boxes. The ♀♀ were kept (approximately 7 hours). The ♂ used for the first pairings matured on 23 Dec. 1915 and died on 24 January 1916 (life kept in separate boxes. None of them hatched.

The boxes containing the ♀♀ and eggs were carried in a waistcoat pocket during the day; at night they were in still closer

Reference No. of ♀	Date when ♀ matured	Date when the ♂ was added	Copulation observed	Date of removal of ♂	Days counting from maturity of the ♀ to that on which eggs														
					1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
1	23. XII. 15	23. XII. 15	—	24. XII. 15	—	—	—	—	8	10	4	6	5	6	7	7	4	10	4	10
2	23. XII. 15	24. XII. 15	—	25. XII. 15	—	—	—	—	5	7	4	7	3	7	8	8	3	7	7	6
3	23. XII. 15	25. XII. 15	26. XII. 15	26. XII. 15	—	—	*2*	—	6	4	5	5	7	4	10	6	7	3	7	6
4	23. XII. 15	26. XII. 15	—	27. XII. 15	—	—	*1*	—	—	11	5	7	6	3	11	8	5	7	3	8
5	23. XII. 15	27. XII. 15	—	28. XII. 15	—	—	*2*	—	*4*	1	—	—	—	—	—	—	—	—	—	—
6	24. XII. 15	28. XII. 15	—	29. XII. 15	—	—	—	*2*	*3*	5	6	5	6	7	10	3	6	7	10	5
7	24. XII. 15	29. XII. 15	29. XII. 15	30. XII. 15	—	—	—	*3*	*3*	*4*	4	5	6	6	5	8	5	6	7	4
8	25. XII. 15	30. XII. 15	—	31. XII. 15	—	—	—	*2*	*3*	*2*	3	4	3	6	2	6	3	2	3	2
9	26. XII. 15	31. XII. 15	1. I. 16	1. I. 16	—	—	—	—	*2*	*3*	3	6	4	5	7	8	6	**2**	5	9
10	26. XII. 15	1. I. 16	—	2. I. 16	—	—	*2*	*3*	*5*	*1*	*4*	6	1	5	5	3	6	5	1	4
11	28. XII. 15	2. I. 16	—	3. I. 16	—	—	*1*	*3*	*4*	*6*	5	6	6	5	9	9	2	6	5	8
12	28. XII. 15	3. I. 16	—	4. I. 16	—	—	—	*1*	*2*	*4*	*4*	3	4	3	7	4	5	3	2	6
13	30. XII. 15	4. I. 16	—	5. I. 16	—	—	*1*	*4*	*5*	*3*	7	8	5	8	4	6	10	7	3	7
14	1. I. 16	5. I. 16	5. I. 16	6. I. 16	—	*1*	*3*	*4*	*4*	5	6	8	5	6	8	7	6	7	10	3
15	6. I. 16	6. I. 16	6. I. 16	10. I. 16	—	—	—	5	3	4	7	2	10	3	8	4	7	8	5	10
16	10. I. 16	10. I. 16	10. I. 16	13. I. 16	—	—	—	3	3	7	8	5	6	6	10	4	6	9	4	7
17	13. I. 16	13. I. 16	—	15. I. 16	—	—	3	5	4	5	7	7	4	10	4	7	8	8	2	7
18	15. I. 16	15. I. 16	—	19. I. 16	—	—	—	5	7	6	7	8	4	8	6	10	8	6	8	6
19	19. I. 16	19. I. 16	19. I. 16	20. I. 16	—	—	—	3	5	5	7	7	4	8	7	6	10	2	10	**9**
20	20. I. 16	20. I. 16	—	22. I. 16	—	—	3	5	5	7	6	8	5	3	8	3	9	8	**6**	**7**
21	22. I. 16	22. I. 16	—	23. I. 16	—	—	1	4	5	6	7	6	7	7	6	10	—	9	6	7

NOTE. The figures in heavy type indicate that these eggs were kept in separate boxes from those laid earlier in
of laying before this test was made was progressively shortened in order that the opportunity

Particulars of pairing and egg laying.

and fed in these separate boxes, the ♂ being placed with each ♀ in rotation. Opportunity for feeding was given each night 32 days). Eggs laid before the introduction of the ♂ are italicised and were, in the case of ♀♀ Nos. 6, 7, 10, 12, 13 and 14,

relation to the human body.

were laid. The number of eggs is indicated by the figure below																		Total eggs laid per ♀	Remarks
17th	18th	19th	20th	21st	22nd	23rd	24th	25th	26th	27th	28th	29th	30th	31st	32nd	33rd	34th	35th	
8	2	9	2	7	4	5	—	—	—	—	—	—	—	—	—	—	—	—	118	Died on the 23rd day.
5	4	9	5	8	5	6	7	2	5	4	3	5	1	—	1	4	4	—	150	Died on the 34th day.
5	8	7	5	5	4	5	5	7	3	6	4	4	5	3	6	4	6	2	166	See further entries after second pairing, Table II.
10	3	6	6	8	7	5	7	9	5	9	7	5	4	3	3	—	—	—	172	Died on the 32nd day.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	Died on the 11th day. Eggs infertile.
5	10	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	95	Lost on the 19th day.
4	6	6	3	4	5	2	9	—	4	4	3	6	—	1	—	—	—	—	123	Died on the 32nd day.
7	3	2	6	2	5	3	1	—	—	—	—	—	—	—	—	—	—	—	70	Accidentally killed on the 23rd day. Eggs infertile.
9	7	5	12	3	2	7	6	7	6	6	5	5	5	4	7	3	—	—	159	See further entries after second pairing, Table II.
4	6	6	5	3	8	5	2	1	6	4	1	—	—	—	—	—	—	—	102	Died on the 29th day.
4	9	7	11	14	7	9	8	6	5	5	7	3	10	—	—	—	—	—	180	Died on the 30th day.
4	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55	Died on the 19th day.
6	7	8	3	4	4	5	6	4	5	4	6	5	5	4	—	—	—	—	154	See further entries after second pairing, Table II.
7	7	6	6	6	2	3	10	9	6	6	10	6	4	3	7	—	—	—	181	,, ,, ,,
5	4	9	3	7	5	7	8	5	5	4	10	—	—	—	—	—	—	—	148	,, ,, ,,
6	9	8	5	5	6	7	6	7	—	—	—	—	—	—	—	—	—	—	137	,, ,, ,,
9	7	3	6	7	8	6	7	7	—	—	—	—	—	—	—	—	—	—	141	,, ,, ,,
8	5	9	8	8	9	9	7	—	—	—	—	—	—	—	—	—	—	—	152	,, ,, ,,
8	5	8	5	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	115	,, ,, ,,
8	7	6	8	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	117	,, ,, ,,
13	1	10	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	110	None of these eggs hatched, presumably this ♀ was not fertilized as she laid fertile eggs after pairing with another ♂, see entries on Table II.

order to test if the ♀♀ still retained the power of fertilizing them. It will be noted that with experience the period of a second pairing might take place before the ♀ was too old and feeble to profit by it.

Table I gives the record of 21 ♀♀ of *P. humanus* which were segregated in the larval stage and on reaching maturity were placed in rotation with a single ♂. Of these 21 ♀♀ 18 were more or less effectively fertilized by the one ♂. It will be noted that the ♀♀ invariably commenced oviposition irrespective of their having paired; probably egg development is entirely a question of nutrition and laying is completely automatic while feeding continues at a favourable temperature. In no case did eggs laid by virgin ♀♀ hatch.

As regards the three ♀♀ which laid only infertile eggs—it is probable that the death of No. 5 was connected with pairing, as she laid but one egg after the introduction of the ♂, and she died with the whole body and limbs as far as claws tinged with red. I suspect that death resulted from rupture of the alimentary canal due to violence during the sexual act. Deaths showing a similar post-mortem appearance are by no means uncommon. In the course of the experiments it was remarked that death frequently followed, if it did not actually occur during, the act of pairing if the ♀♀ were nearing their age limit.

In the case of No. 8 it is doubtful if pairing ever took place; this ♀ proved a poor egg layer, but the evidence available from the other ♀♀ which laid prior to pairing precludes any suggestion that low egg production resulted from infertility; it is possible, however, that both the failure to pair and small egg laying capacity were the outcome of a low vitality.

Probably the ♂ was too feeble to pair with No. 21, as he died the following day. Table V shows that there was no question in regard to the vitality of this ♀ as she laid fertile eggs after she had been placed with another ♂.

It was obvious early in the course of the experiment that ability of the ♀♀ to lay fertilized eggs after the removal of the ♂ did not continue for life (see Table IV). In order to test the period, the ♀♀ were removed to fresh boxes at a progressively shortened interval of time. The eggs laid in the second box are indicated by printing the figures in heavy type. By this means a general indication of the duration of fertility was attained; in the cases where eggs hatched which had been laid in the second box, showing definitely that fertility was still retained, the term "at least" indicates that the number of days might have been more. In several cases the number of days has been calculated by counting the number of eggs laid in sequence up to the number which hatched and reckoning the number of days from the removal of the ♂ up to the date of the last laid egg included in the total. ' In both cases it is probable that

TABLE II.

Pediculus humanus (vestimenti). *Particulars of egg laying after a second ♂ had been placed with the ♀♀.*

A ♂ that matured on the 1st January, 1916 was placed with ♀ No. 3 on the 26th January, he was afterwards placed with ♀♀ Nos. 9, 13, 14, 15 and 16, he was lost on the 5th February 1916. A ♂ taken from the stock box, of uncertain age, was placed with the later ♀♀ Nos. 17—21.

Reference number of ♀	Day, counting from maturity of ♀, when the second ♂ was introduced	Date on which the second ♂ was introduced	Day of copulation when observed	Day when ♂ was removed	Day, counting from maturity of ♀, on which eggs were laid after the introduction of the second ♂																															Total eggs laid per ♀	Remarks
					20th	21st	22nd	23rd	24th	25th	26th	27th	28th	29th	30th	31st	32nd	33rd	34th	35th	36th	37th	38th	39th	40th	41st	42nd	43rd	44th									
3	35th	26. I. 16	35th	36th	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	4	3	—	—	—	—	—	—								13	Died 38th day.
9	33rd	27. I. 16	35th	35th	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—								4	,, 35th ,, whilst paired.
13	31st	29. I. 16	—	34th	—	—	—	—	—	—	—	—	—	—	—	—	3	2	—	—	—	—	—	—	—	—	—	—	—								5	,, 33rd ,, eggs infertile.
14	32nd	1. II. 16	—	33rd	—	—	—	—	—	—	—	—	—	—	—	—	—	5	7	6	7	5	7	5	4	10	—	—	—								56	,, 41st ,, ,, ,,
15	28th	2. II. 16	—	29th	—	—	—	—	—	—	—	—	—	6	6	5	4	3	5	4	4	1	—	—	—	—	—	—	—								38	,, 37th ,, ,, ,,
16	25th	3. II. 16	—	27th	—	—	—	—	—	—	6	10	6	4	9	6	6	4	10	7	8	4	—	—	—	—	—	—	—								80	Placed with a third ♂ on 37th day and fertile eggs laid see Table III.
17	25th	6. II. 16	—	26th	—	—	—	—	—	—	7	9	3	10	8	7	4	8	4	7	6	2	7	3	—	10	3	5	5								108	Died 44th day.
18	24th	7. II. 16	—	25th	—	—	—	—	—	8	9	8	9	6	8	8	5	7	8	9	7	4	8	—	8	11	7	—	—								130	Placed with a third ♂ on 42nd day, see Table III.
19	21st	8. II. 16	21st	22nd	—	—	7	7	8	6	6	7	5	7	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—								58	Died 31st day.
20	21st	9. II. 16	—	22nd	—	—	7	6	8	5	6	4	10	7	8	7	9	7	6	3	3	6	4	2	—	—	—	—	—								108	,, 39th ,,
21	19th	10. II. 16	20th / 23rd	24th	—	7	7	3	11	4	6	11	5	5	7	10	10	8	—	—	—	—	—	—	—	—	—	—	—								94	,, 33rd ,,

TABLE III.

Pediculus humanus (vestimenti). *Particulars of egg laying after a third ♂ had been placed with the ♀♀.*

♂♂ taken from stock were used, age uncertain.

Reference number of ♀	Day, counting from maturity of ♀, when the third ♂ was introduced	Date on which the third ♂ was introduced	Day of copulation when observed	Day when ♂ was removed	Day, counting from maturity of the ♀, on which eggs were laid after the introduction of the third ♂								Total eggs laid per ♀	Remarks
					38th	39th	40th	41st	42nd	43rd	44th	45th		
16	37th	15. II. 16	—	not removed	3	1	—	—	—	—	—	—	4	Died 39th day.
18	42nd	25. II. 16	—	up to time of females death	—	—	—	—	—	2	8	3	13	Died 46th day, eggs infertile.

TABLE IV. *Fertility of* Pediculus humanus (vestimenti).

NOTE. There is no necessary relation between the lice emerging on any particular day and the eggs laid on other; they were kept in the box with the laying ♀ until she was transferred to a new box. The zero

Reference number of ♀	Date when ♀ matured	Date when the ♂ was added	Days counting from date on which the ♂ was																
			7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th
1	23. XII. 15	23. XII. 15	—	—	—	—	1	1	3	3	3	7	4	5	6	9	8	6	4	—	—
2	23. XII. 15	24. XII. 15	—	—	—	—	—	1	3	4	6	3	7	6	7	5	6	4	5	—	1
3	23. XII. 15	25. XII. 15	—	—	—	—	—	3	2	7	5	6	6	7	5	7	5	5	4	10	7
4	23. XII. 15	26. XII. 15	—	—	—	—	—	3	8	5	6	2	6	6	11	5	3	1	—	—	—
5	23. XII. 15	27. XII. 15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	24. XII. 15	28. XII. 15	—	—	—	—	—	2	4	6	4	8	12	7	8	3	2	—	1	—	—
7	24. XII. 15	29. XII. 15	—	—	—	—	1	3	3	5	4	6	5	8	2	4	9	6	8	—	1
8	25. XII. 15	30. XII. 15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	26. XII. 15	31. XII. 15	—	—	—	—	—	—	2	8	8	7	2	9	2	8	11	5	4	7	9
10	26. XII. 15	1. I. 16	—	—	—	—	2	3	1	—	3	2	6	3	3	1	—	—	—	—	—
11	28. XII. 15	2. I. 16	—	—	—	—	4	11	4	4	7	7	6	8	5	7	7	12	7	7	2
12	28. XII. 15	3. I. 16	—	—	—	—	—	1	5	4	3	9	3	1	1	1	—	1	—	—	—
13	30. XII. 15	4. I. 16	—	—	—	—	1	10	—	7	9	5	8	2	4	7	6	2	2	—	—
14	1. I. 16	5. I. 16	—	—	—	—	—	5	5	5	8	9	4	4	4	7	8	4	4	3	—
15	6. I. 16	6. I. 16	—	—	—	—	—	1	1	3	5	2	6	5	7	5	7	9	6	4	6
16	10. I. 16	10. I. 16	—	—	—	—	—	—	1	2	7	4	7	8	8	6	5	9	9	9	4
17	13. I. 16	13. I. 16	—	—	—	—	—	1	3	7	5	5	7	7	5	6	7	10	4	8	2
18	15. I. 16	15. I. 16	—	—	—	—	—	—	2	5	7	6	6	7	13	7	10	8	1	1	—
19	19. I. 16	19. I. 16	—	—	—	—	—	—	—	5	3	8	8	12	1	9	12	6	7	**3**	**1**
20	20. I. 16	20. I. 16	—	—	—	—	1	1	6	3	7	8	7	5	7	9	4	—	—	—	—
21	22. I. 16	22. I. 16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Figures in heavy type refer to cases in

Particulars of the hatching of the eggs.

any particular date. It was found impracticable to keep the eggs laid on different days separate from each date from which the number of days has been reckoned is the date on which the ♂ was placed with the ♀.

placed with the ♀										Total of eggs laid per ♀	Total of eggs hatched	Percentage of possible fertile eggs	Remarks
26th	27th	28th	29th	30th	31st	32nd	33rd	34th	35th				
—	—	—	—	—	—	—	—	—	—	118	60	51 %	Ability to fertilize eggs retained for *less* than 20 days.
1	—	—	—	—	—	—	—	—	—	150	59	39 %	,, ,, ,, ,, 24 ,,
4	7	5	1	—	1	—	—	—	—	166	97	59 %	,, ,, ,, *more* ,, 19 ,,
—	—	—	—	—	—	—	—	—	—	172	56	33 %	,, ,, ,, *less* ,, 19 ,,
—	—	—	—	—	—	—	—	—	—	7	0	nil	It is doubtful if any pairing took place.
—	—	—	—	—	—	—	—	—	—	95	57	63 %	Ability to fertilize eggs retained for *at least* 10 ,,
—	—	—	—	—	—	—	—	—	—	123	65	57 %	,, ,, ,, *less* than 21 ,,
—	—	—	—	—	—	—	—	—	—	70	0	nil	It is doubtful if any pairing took place.
9	3	2	4	5	5	4	—	—	1	159	115	75 %	Ability to fertilize eggs retained for *at least* 20 ,,
—	—	—	—	—	—	—	—	—	—	102	24	28 %	,, ,, ,, ,, 6 ,,
—	—	—	1	—	—	—	—	—	—	180	99	60 %	,, ,, ,, ,, 18 ,,
—	—	—	—	—	—	—	—	—	—	55	29	66 %	,, ,, ,, ,, 7 ,,
—	—	—	—	—	—	—	—	—	—	154	63	46 %	,, ,, ,, *not more* than 18 ,,
—	—	—	—	—	—	—	—	—	—	181	70	41 %	,, ,, ,, ,, 20 ,,
9	3	10	1	1	4	1	—	—	—	148	96	65 %	,, ,, ,, *over* 16 ,,
2	5	1	1	—	—	—	—	—	—	137	88	64 %	,, ,, ,, ,, 15 ,,
—	—	—	—	—	—	—	—	—	—	141	77	55 %	,, ,, ,, *not more* than 19 ,,
—	—	—	—	—	—	—	—	—	—	152	73	48 %	,, ,, ,, ,, 17 ,,
1	1	—	—	—	—	—	—	—	—	115	77	67 %	,, ,, ,, *about* 15 ,,
—	—	—	—	—	—	—	—	—	—	117	58	50 %	,, ,, ,, *not more* than 12 ,,
—	—	—	—	—	—	—	—	—	—	110	0	nil	It is doubtful if any pairing took place with this ♂, see entries under Table V.

which eggs laid in the second box hatched.

TABLE V.

Pediculus humanus (vestimenti). *Particulars of hatching of the eggs laid after the second ♂ had been placed with ♀♀.*

Reference number of ♀	Day counting from maturity of the ♀ when the second ♂ was introduced	Days counting from the date on which the second ♂ was placed with the ♀																Total of eggs laid per ♀	Total of eggs hatched	Percentage fertile	Remarks
		10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th	26th	27th				
3	35th	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	2	15 %	Died 38th day.
9	33rd	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	3	75 %	,, 35th ,, whilst paired.
13	31st	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	0	0	,, 33rd ,, eggs infertile.
14	32nd	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	56	0	0	,, 41st ,, ,, ,,
15	28th	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	38	0	0	,, 37th ,, ,, ,,
16	25th	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	0	0	Placed with a third ♂ on 37th day and fertile eggs laid subsequently, see Table VI.
17	25th	—	—	8	6	5	5	7	6	6	4	3	1	—	—	—	—	—	—	108	51	47 %	Died 44th day.
18	24th	—	6	10	6	6	8	6	6	7	8	3	8	5	6	4	3	—	—	130	92	71 %	Placed with a third ♂ on 42nd day, see Table VI.
19	21st	—	3	7	6	6	7	2	3	5	1	5	—	—	—	—	—	—	—	58	45	78 %	Died 31st day.
20	21st	—	4	5	9	6	4	7	6	8	4	8	6	4	5	3	5	1	2	108	87	81 %	,, 39th ,,
21	19th	—	1	5	7	7	6	3	5	3	3	7	5	5	4	5	3	4	—	94	73	78 %	,, 33rd ,,

TABLE VI.

Pediculus humanus (vestimenti). *Particulars of hatching of the eggs after the third ♂ had been placed with ♀♀.*

Reference number of ♀	Days counting from maturity of the ♀ when the third ♂ was introduced	Days counting from the date on which the third ♂ was placed with the ♀						Total of eggs laid per ♀	Total of eggs hatched	Percentage fertile	Remarks
		10th	11th	12th	13th	14th	15th				
16	37th	—	—	—	2	—	1	4	3	75 %	Died 39th day.
18	42nd	—	—	—	—	—	—	13	0	0	,, 46th ,, eggs infertile.

TABLE VII.

Pediculus humanus (vestimenti). *Summary of Tables I to VI.*

Reference number of ♀	Length of life in days	Number of days between maturity and pairing	Number of days between maturity and oviposition	Number of eggs laid before the introduction of a ♂	Number of eggs laid, pairing No. 1	Approximate period of fertility in days	Percentage of fertile eggs	Number of eggs laid, pairing No. 2	Approximate period of fertility in days	Percentage of fertile eggs	Number of eggs laid, pairing No. 3	Approximate period of fertility	Percentage of fertile eggs	Total number of eggs laid	Average number laid each day	Total number of eggs hatched	Percentage of *possibly fertile* eggs which hatched
1	23	1	1	3	118	less than 20	51 %	—	—	—	—	—	—	118	5·3	60	51 %
2	34	no choice	4	—	150	,, ,, 24	39 %	—	—	—	—	—	—	150	4·4	59	59 %
3	38	,,	2	2	166	more than 19	59 %	13	—	15 %	—	—	—	179	4·7	99	56 %
4	32	,,	2	1	172	less than 19	33 %	—	—	—	—	—	—	172	5·4	56	33 %
5	11	,,	2	6	7	infertile	nil	—	—	—	—	—	—	7	·6	nil	nil
6	19 (lost)	,,	3	5	95	at least 10	63 %	—	—	—	—	—	—	95	5·0	57	63 %
7	32	,,	3	10	123	less than 21	57 %	—	—	—	—	—	—	123	3·9	65	57 %
8	23 (killed)	,,	3	7	70	infertile	nil	—	—	—	—	—	—	70	3·0	—	nil
9	35	,,	4	5	159	at least 20	75 %	4	—	75 %	—	—	—	163	5·0	118	75 %
10	29	,,	2	15	102	,, ,, 6	28 %	—	—	—	—	—	—	102	3·5	24	28 %
11	30	,,	2	14	180	,, ,, 18	60 %	—	—	—	—	—	—	180	6·0	99	60 %
12	19	,,	3	11	55	,, ,, 7	66 %	—	—	—	—	—	—	55	2·9	29	66 %
13	33	,,	2	13	154	not more than 18	46 %	5	infertile	nil	—	—	—	159	4·8	63	43 %
14	41	,,	1	12	181	,, ,, 20	41 %	56	,,	,,	—	—	—	237	5·8	70	31 %
15	37	less than 1	3	—	148	over 16	65 %	38	,,	,,	—	—	—	186	5·0	96	52 %
16	39	,, ,, 1	3	—	137	,, 15	64 %	80	,,	,,	4	1 day	75 %	221	5·6	91	41 %
17	44	doubtful	2	—	141	not more than 19	55 %	108	at least 8	47 %	—	—	—	249	5·7	128	51 %
18	46	,,	3	—	152	,, ,, 17	48 %	130	,, ,, 13	71 %	13	infertile	nil	295	6·4	165	56 %
19	31	less than 1	3	—	115	about 15	67 %	58	,, ,, 7	78 %	—	—	—	173	5·8	122	71 %
20	39	doubtful	2	—	117	not more than 12	50 %	108	,, ,, 13	81 %	—	—	—	225	5·8	145	64 %
21	33	1	2	—	110	infertile	nil	94	,, ,, 11	78 %	—	—	—	204	6·2	73	36 %

Life of ♂ 32 days. Longest ♀ life 46 days. Average ♀ life 34 days. Number of ♀♀ fertilized by one ♂, 18. Eggs laid by unfertilized ♀♀ did not hatch. The period of fertility lasts about 12 to 21 days. The number of eggs fertilized during the period of fertility probably depends on the rate of egg laying, the highest record was 115 by ♀ No. 9. The egg laying capacity of normal ♀♀ is certainly conditioned by food (see Table VIII) and by temperature as pointed out by Sikora (1915). In the above experiment (omitting ♀ No. 5) the numbers range from 55 to 295 with an average of 177 and a daily average of 5·1.

TABLE VIII.

The influence of food supply upon (a) the number of eggs laid and (b) their fertility.

Method. A number of lice in the larval stage were reared until adult. 5 ♂♂ and 5 ♀♀ were then placed in each of two boxes. Those in box B were fed at night only, period for feeding available about 7 hours. In box A additional feeding time, 2 or 3 hours, was given by day. Boxes kept in a breast pocket by day. (A false start was made owing to a ♀ in one of the boxes escaping during the counting of the eggs; as the escape was not noticed until the 10th day a fresh start was made on the 11th day with four pairs in each box.)

Box A.

	Number of eggs laid each day. Figures at top indicate days in the life of the ♀								Number of eggs hatching, each day's laying treated as a separate batch							
	12	13	14	15	16	17	18	19	12	13	14	15	16	17	18	19
Number of eggs laid	32	25	66		34	35	34	30	30	23	62		32	30	30	26

Total 256 = a daily average of 8 per ♀ — Total 233

Percentage hatching = 91 %.

Box B.

	Number of eggs laid each day. Figures at top indicate days in the life of the ♀								Number of eggs hatching, each day's laying treated as a separate batch							
	12	13	14	15	16	17	18	19	12	13	14	15	16	17	18	19
Number of eggs laid	28	17	49		30	22	28	27	28	17	49		29	21	25	26

Total 201 = a daily average of 6·3 per ♀ — Total 195

Percentage hatching = 97 %.

Reverse order of feeding.

On the 20th and 21st days the insects in both boxes were treated alike as regards feeding (at night only) and no records of egg laying were made. On the 22nd and following days the insects were fed in the reverse order; A one period of about 7 hours at night, B two periods 7 hours at night and 2 or 3 hours during the day. On the 26th day a ♀ in box A died and one was also removed from box B. On the 28th day the insects in box B were not fed during the day and both boxes were removed from pocket during that day.

Box A.

	Number of eggs laid each day. Figures at top indicate days in the life of the ♀								Number of eggs hatching, each day's laying treated as a separate batch							
	23	24	25	26	27	28	29	30	23	24	25	26	27	28	29	30
Number of eggs laid	18	18	15	18	17	28		14	17	17	13	16	14	28		12

Total 128 = a daily average of 4·5 per ♀ — Total 117

Percentage hatching = 91 %.

Box B.

	Number of eggs laid each day. Figures at top indicate days in the life of the ♀								Number of eggs hatching, each day's laying treated as a separate batch							
	23	24	25	26	27	28	29	30	23	24	25	26	27	28	29	30
Number of eggs laid	32	30	28	25	23	28		21	31	30	24	23	20	27		21

Total 187 = a daily average of 6·6 per ♀ — Total 176

Percentage hatching = 94 %.

TABLE IX.

Hatching of eggs of Pediculus humanus *when kept at a constant temperature.*

The eggs laid by 10 pairs of newly-matured lice were taken from the boxes in which they were laid (on cloth) each day and kept as separate batches in a humid atmosphere at 30° C.

Number of days counting from the approximate date on which the insects matured	Total number of eggs laid	Record of hatching: Number of days reckoning from the date of laying												Total number of eggs which hatched	Percentage of eggs which hatched
		1	2	3	4	5	6	7	8	9	10	11	12		
1															
2	29	—	—	—	—	—	—	4	12	5	—	—	—	21	72 %
3	60	—	—	—	—	—	—	3	38	6	—	—	—	47	78 %
4	68	—	—	—	—	—	—	2	48	15	1	—	—	66	94 %
5	71	—	—	—	—	—	—	—	24	18	16	—	—	58	82 %
6	84	—	—	—	—	—	—	—	56	13	9	—	—	78	93 %
7 } 8	120	—	—	—	—	—	—	4	52	45	13	—	—	114	95 %
9	61	—	—	—	—	—	—	—	26	26	—	—	—	52	85 %
10	71	—	—	—	—	—	—	—	21	40	5	—	—	66	93 %
11	62	—	—	—	—	—	—	—	24	24	12	—	—	60	97 %
12	60	—	—	—	—	—	—	—	34	18	6	—	—	58	97 %
13	42	—	—	—	—	—	—	2	29	8	1	—	—	40	95 %
14 } 15	115	—	—	—	—	—	—	9	68	29	5	—	—	111	97 %
16	64	—	—	—	—	—	—	—	15	36	10	—	—	61	95 %
17	57	—	—	—	—	—	—	—	14	32	4	1	—	51	89 %
18	62	—	—	—	—	—	—	—	20	32	2	1	—	55	89 %
19	57	—	—	—	—	—	—	—	13	16	22	1	—	52	91 %
20 } 21 } 22	No record														
23	50	—	—	—	—	—	—	1	40	7	—	—	—	48	96 %
24	48	—	—	—	—	—	—	—	30	16	1	—	—	47	98 %
25	43	—	—	—	—	—	—	—	24	13	—	—	—	37	86 %
26	43	—	—	—	—	—	—	1	25	13	—	—	—	39	91 %
27	40	—	—	—	—	—	—	—	27	7	—	—	—	34	85 %
28 } 29	56	—	—	—	—	—	—	6	45	4	—	—	—	55	98 %
30	35	—	—	—	—	—	—	4	29	—	—	—	—	33	94 %
	1398							36	714	423	107	3		1283	92 %

Summary

3 % hatched on the 7th day
56 % " " 8th "
33 % " " 9th "
8 % " " 10th "
0·2 % " " 11th "

TABLE X. *Fertility of* Pediculus capitis.

Insects in the second larval skin were taken from a stock box and reared until maturity in separate boxes. Opportunity for feeding was given each night (approximately 7 hours). Owing to the early death of the ♂♂ indicated by the figures 1, 2, 3, 4 in the first column. ♂ No. 1 matured on the 5th January and died on the on the 25th January and died on the 9th February, life 15 days. The last ♂ No. 4 matured on the 9th February capacity of an unfertilized ♀. Eggs laid before the introduction of a ♂ are italicised. The boxes containing

Reference number of ♂	Reference number of ♀	Date when ♀ matured	Date when the ♂ was added	Copulation observed	Date of removal of the ♂	Days counting from the maturity of the ♀ to that on which the eggs															
						1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	19th	20th
No. 2	1	4. I. 16	17. I. 16	—	—	–	*1*	*2*	*3*	*2*	*5*	*2*	*4*	*2*	*3*	*2*	*2*	*4*	2	4	1	1	–	–
No. 1	2	5. I. 16	6. I. 16	—	9. I. 16	–	–	2	3	3	2	6	3	2	6	4	2	5	5	8	1	3	7	–
No. 1	3	9. I. 16	9. I. 16	—	died 12. I. 16	–	2	2	5	6	3	5	5	5	7	4	1	4	3	6	1	4	7	5
No. 2	4	13. I. 16	13. I. 16	—	16. I. 16	–	–	3	2	3	3	4	2	3	4	5	2	3	8	7	4	–	1	6
No. 2	5	16. I. 16	16. I. 16	—	died 17. I. 16	–	–	3	1	5	2	5	2	5	2	–	–	–	–	–	–	–	–	–
No. 3	6	27. I. 16	27. I. 16	—	31. I. 16	–	–	2	3	3	5	7	5	4	6	7	4	4	6	3	6	–	1	–
No. 3	7	31. I. 16	31. I. 16	—	5. II. 16	–	3	3	4	4	5	6	3	5	5	8	3	–	2	4	8	8	7	–
No. 3	8	5. II. 16	5. II. 16	—	8. II. 16	–	3	4	5	4	6	4	2	9	4	8	5	4	7	7	8	7	7	–
No. 3	9	8. II. 16	8. II. 16	—	died 9. II. 16	–	1	6	4	2	7	2	6	5	4	4	4	5	6	4	3	4	5	1
No. 4	10	8. II. 16	10. II. 16	—	11. II. 16	–	–	3	3	3	4	4	4	4	4	7	2	4	5	4	3	5	3	5
No. 4	11	11. II. 16	11. II. 16	—	12. II. 16	–	4	4	5	5	4	8	7	6	3	6	3	5	5	4	5	7	2	4
No. 4	12	12. II. 16	12. II. 16 15. II. 16	—	13. II. 16 16. II. 16	–	–	1	1	2	3	4	4	2	4	5	3	4	3	–	–	–	–	–
No. 4	13	13. II. 16	14. II. 16	—	15. II. 16	–	–	3	3	2	5	4	6	1	3	4	4	5	5	–	4	2	6	3
No. 4	14	16. II. 16	16. II. 16	—	18. II. 16	–	–	3	3	2	5	4	4	5	3	3	6	7	3	4	6	6	2	–
No. 4	15	16. II. 16	18. II. 16	—	19. II. 16	–	*3*	3	7	1	3	6	3	7	3	5	1	7	4	5	3	–	5	3
No. 4	16	19. II. 16	19. II. 16 25. II. 16	20. II. 16	21. II. 16 26. II. 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
No. 4	17	19. II. 16	21. II. 16	—	23. II. 16	–	–	–	2	3	4	4	4	–	5	3	6	5	3	2	7	1	6	5
No. 4	18	23. II. 16	23. II. 16	—	25. II. 16	–	–	5	1	5	4	4	2	2	2	6	6	5	6	5	–	7	3	2
No. 4	19	26. II. 16	26. II. 16	—	1. III. 16	–	2	4	4	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
No. 4	20	1. III. 16	1. III. 16	—	6. III. 16	–	1	3	3	3	3	2	6	5	2	3	–	–	–	–	–	–	–	–
No. 4	7	—	6. III. 16	7. III. 16	8. III. 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
No. 4	9	—	8. III. 16	—	9. III. 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
No. 4	10		9. III. 16	—	died 10. III. 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

NOTE. The figures in heavy type indicate that these eggs were kept in separate

Particulars of pairing and egg laying.

The ♀♀ were kept and fed in the boxes in which they matured, the ♂♂ being placed with them in rotation. the first three attempts were of doubtful value and a fourth was initiated with better success. These ♂♂ are 12th, life 7 days. ♂ No. 2 matured on the 12th January and died on the 24th, life 12 days. ♂ No. 3 matured and died on the 10th March, life 30 days. ♀ No. 1 was purposely kept unpaired for 12 days to test the egg laying the ♀♀ and eggs were carried in a waistcoat pocket during the day, at night they were against the body.

were laid. The number of eggs laid is indicated by the figure below																	Total eggs laid per ♀	Remarks
21st	22nd	23rd	24th	25th	26th	27th	28th	29th	30th	31st	32nd	33rd	34th	35th	36th	37th		
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	Died on the 17th day.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	62	,, ,, 22nd ,,
5	–	2	6	3	3	3	3	3	3	3	–	–	–	–	–	–	109	Placed with another ♂ on the 32nd day, see entries in Table XII.
4	4	3	5	3	2	–	–	–	–	–	–	–	–	–	–	–	81	Placed with another ♂ on the 28th day, see entries in Table XII.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25	Died on the 11th day.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	66	,, ,, 20th ,,
6	6	5	4	4	6	–	4	4	4	5	3	2	5	–	2	–	138	Placed with ♂ No. 4 on the 36th day, see entries below.
–	4	–	4	5	–	–	–	–	–	–	–	–	–	–	–	–	107	Died on the 26th day.
5	4	3	2	4	–	3	–	7	–	–	–	–	–	–	–	–	101	Placed with ♂ No. 4 on the 30th day, see entries below.
5	6	–	4	6	5	–	–	6	3	–	–	–	–	–	–	–	102	,, ,, ,, 31st ,, ,, ,,
3	4	4	8	7	7	–	–	–	–	–	–	–	–	–	–	–	120	Died on the 29th day.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	36	Accidentally killed on the 14th day.
3	4	3	–	5	1	6	–	–	–	–	–	–	–	–	–	–	82	Placed with another ♂ on the 28th day ⎫ see further
7	4	3	2	3	–	–	–	–	–	–	–	–	–	–	–	–	85	,, ,, ,, 26th ,, ⎬ entries in
3	4	7	3	3	3	–	–	–	–	–	–	–	–	–	–	–	92	,, ,, ,, 27th ,, ⎭ Table XII.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	Died on 15th day, presumably malformed as she developed no eggs.
2	6	5	3	1	–	–	–	–	–	–	–	–	–	–	–	–	77	Died on the 25th day.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	65	Accidentally killed on the 20th day.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11	Died on the 14th day.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	Died on the 12th day. A stoppage of the oviduct was probably responsible for the death, her body became excessively swollen with eggs which she did not lay.
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	3	Died on the 38th day.
–	–	–	–	–	–	–	–	–	–	–	3	1	2	3	–	–	9	,, ,, 36th ,,
–	–	–	–	–	–	–	–	–	–	–	6	2	–	–	–	–	8	,, ,, 34th ,,

boxes in order to test if the ♀♀ still retained the power to fertilize.

TABLE XI.

Pediculus humanus (vestimenti). *Hatching of eggs at different temperatures.*

A large mass of eggs laid on a strip of cloth was taken from a stock box and divided into three portions, one of which was submitted to each of the following conditions: (*a*) in a room, the air of which was very dry owing to the central heating of the building at 15·6° to 18·4° C., (*b*) in a humid incubator at 24·5° C. constant, (*c*) in a dry air incubator at 36·1° C. constant.

Temperature	Day after removal from the stock box on which hatching occurred																							Totals
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	
at 15·6° to 18·4° C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	nil
at 24·5° C.	—	—	—	3	1	—	—	—	—	2	—	—	—	—	4	2	1	1	—	1	—	—	1	—	16
at 36·1° C.	—	—	—	21	32	53	25	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	143

NOTE. This table only shows the comparative time of hatching, the actual period would have been a few days longer. Prior to the removal of eggs from the stock box it would have contained some in an advanced stage of development. Probably the eggs on the verge of hatching would in some cases be killed or delayed by the sudden alteration in the conditions as the stage immediately preceding hatching seems to be a critical one.

TABLE XII.

Fertility of Pediculus capitis. *Particulars of egg laying after a second ♂ was placed with the ♀♀.*

Reference number of ♀	Day counting from maturity of ♀ when the second ♂ was introduced	Date on which the second ♂ was introduced	Date of copulation when observed	Date when the ♂ was removed	Day, counting from maturity of the ♀, on which eggs were laid after the introduction of the second ♂												Total eggs laid per ♀	Remarks
					26th	27th	28th	29th	30th	31st	32nd	33rd	34th	35th	36th	37th		
4	27th	8. II. 16	—	9. II. 16	—	—	—	3	1	—	—	—	—	—	—	—	4	Died 31st day.
3	32nd	9. II. 16	—	10. II. 16	—	—	—	—	—	—	—	2	1	—	—	—	3	,, 34th ,,
13	28th	10. III. 16	—	11. III. 16	—	—	—	2	3	2	2	2	2	—	—	—	13	,, 35th ,,
14	25th	10. III. 16	14. III. 16	17. III. 16	4	4	3	4	3	—	—	—	—	—	—	—	18	,, 31st ,,
15	27th	13. III. 16	15. III. 16	17. III. 16	—	—	—	2	3	5	2	5	3	3	2	—	25	,, 37th ,,

TABLE XIII.

Fertility of Pediculus capitis. *Particulars of the hatching of the eggs.*

NOTE. There is no necessary relation between the lice emerging on any particular day and the eggs laid on any particular date. It was found impracticable to keep the eggs laid on different days separate, they were allowed to accumulate in the box with the laying ♀ until she was transferred to a new box. The zero date from which the number of days has been reckoned is the date on which the ♂ was placed with the ♀.

Reference number of ♀	Date when the ♀ matured	Date when the ♂ was added	Days counting from the date on which the ♂ was placed with the ♀																				Total no. of eggs laid per ♀	Total no. which hatched	Percentage of possible fertile eggs	Remarks
			8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th	21st	22nd	23rd	24th	25th	26th	27th	29th				
1	4. I. 16	17. I 16	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	2	25 %	Eggs laid prior to the introduction of a ♂ all failed to develop.
2	5. I. 16	6. I. 16	–	–	–	–	1	–	–	4	2	3	2	4	6	1	–	2	1	2	–	3	–	62	31	50 %	Ability to fertilize eggs retained for at least 7 days.
3	9. I. 16	9. I. 16	–	–	–	–	–	1	1	2	3	1	1	2	1	1	1	1	1	–	–	–	–	109	16	15 %	,, ,, ,, ,, 3 ,,
4	13. I. 16	13. I. 16	–	–	–	–	–	–	1	2	4	1	1	1	5	–	5	7	5	3	4	5	–	81	44	54 %	,, ,, ,, ,, 12 ,,
5	16. I. 16	16. I. 16	–	–	–	–	4	1	3	2	2	3	2	2	2	–	–	–	–	–	–	–	–	25	21	84 %	,, ,, ,, ,, 8 ,,
6	27. I. 16	27. I. 16	–	–	–	–	–	1	4	–	4	6	–	8	4	6	3	3	4	1	–	–	–	66	44	67 %	,, ,, ,, ,, 8 ,,
7	31. I. 16	31. I. 16	–	–	–	–	1	4	3	5	2	4	6	3	5	5	5	3	5	3	3	4	–	138	61	44 %	,, ,, ,, ,, 11 ,,
8	5. II. 16	5. II. 16	–	2	–	1	1	6	3	4	3	5	8	4	4	6	3	3	8	7	–	2	–	107	70	65 %	,, ,, ,, ,, 12 ,,
9	8. II. 16	8. II. 16	–	–	–	–	2	1	6	3	2	5	4	1	6	6	3	5	–	1	–	–	–	101	45	45 %	,, ,, ,, ,, 11 ,,
10	8. II. 16	10 II. 16	–	–	–	–	–	4	3	1	6	3	3	2	6	1	3	1	4	1	–	1	–	102	39	38 %	,, ,, ,, ,, 10 ,,
11	11. II. 16	11. II. 16	–	–	–	–	–	2	3	3	2	4	3	5	7	4	1	1	–	–	–	–	–	120	35	29 %	,, ,, ,, ,, 7 ,,
12	12. II. 16	{12. II. 16 / 15. II. 16}	–	–	–	–	–	–	–	2	1	4	2	3	4	1	4	–	3	1	–	–	–	36	25	69 %	,, ,, ,, about 7 ,,
13	13. II. 16	14. II. 16	–	–	–	1	2	1	1	2	10	2	2	2	3	3	1	3	2	1	–	–	–	82	36	44 %	,, ,, ,, at least 11 ,,
14	16. II. 16	16. II. 16	–	–	–	–	–	–	1	–	2	1	1	2	2	1	4	2	2	3	1	1	2	85	25	29 %	,, ,, ,, ,, 7 ,,
15	16. II. 16	18. II. 16	–	–	–	3	4	2	2	1	3	5	2	2	4	3	3	4	3	3	1	1	–	92	46	50 %	,, ,, ,, ,, 10 ,,
16	19. II. 16	{19. II. 16 / 25. II. 16}	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	nil	nil	—	This female was presumably malformed, her ovaries failed to develop though she lived 15 days, fed vigorously and was observed to pair.
17	19. II. 16	21. II. 16	–	–	–	1	4	1	2	3	5	1	1	1	3	1	4	2	2	2	1	1	–	77	35	45 %	Ability to fertilize eggs retained for at least 9 days.
18	23. II. 16	23. II. 16	–	–	–	–	1	2	–	3	5	3	1	1	6	2	3	7	5	2	1	3	1	65	46	71 %	,, ,, ,, ,, 12 ,,
19	26. II. 16	26. II. 16	–	–	–	–	–	3	3	3	1	–	–	–	–	–	–	–	–	–	–	–	–	11	10	91 %	
20	1. III. 16	1. III. 16	–	–	–	–	–	–	1	1	1	–	3	1	–	–	4	–	–	–	–	–	–	31	11	35 %	
7		6. III. 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	nil		
9		8. III. 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	nil		
10		9. III. 16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	nil		

TABLE XIV.

Fertility of Pediculus capitis. *Particulars of hatching after a second ♂ was placed with the ♀♀.*

Reference no. of ♀	Day, counting from maturity of the ♀, when the second ♂ was introduced	Days counting from the date on which the second ♂ was placed with the ♀						Total eggs laid per ♀	Total of eggs hatched	Percentage fertile	Remarks
		11th	12th	13th	14th	15th	16th				
4	27th	1	—	—	—	—	—	4	1	25 %	died 31st day
3	32nd	1	—	—	—	—	—	3	1	33 %	,, 34th ,,
13	28th	—	—	—	—	—	—	13	nil	—	,, 35th ,,
14	25th	—	—	—	—	—	—	18	nil	—	,, 31st ,,
15	27th	—	1	—	1	3	1	25	6	24 %	,, 37th ,, *

* Although no more eggs hatched the balance had mostly been fertilized, the larvae developed but died just prior to hatching.

TABLE XV.

Pediculus capitis. *Summary of Tables X, XII—XIV.*

Reference number of ♀	Reference number of ♂	Number of days between maturity and pairing	Number of days between maturity and oviposition	Number of eggs laid before the introduction of a ♂	Number of eggs laid, pairing No. 1	Approximate period of fertility in days	Percentage of fertile eggs	Number of eggs laid, pairing No. 2	Percentage of fertile eggs	Total number of eggs laid per ♀	Average number laid each day	Total number of eggs hatched	Percentage of possible fertile eggs which hatched
1	2	no choice	2	32	40	1	25 %	—	—	40	2·5	2	25 %
2	1	doubtful	3	nil	62	at least 7	50 %	—	—	62	3·9	31	50 %
3	1	,,	2	,,	109	,, ,, 3	15 %	3	33 %	112	3·6	17	15 %
4	2	,,	3	,,	81	,, ,, 12	54 %	4	25 %	85	3·3	45	53 %
5	2	same day	3	,,	25	,, ,, 8	84 %	—	—	25	3·1	21	84 %
6	3	doubtful	3	,,	66	,, ,, 8	67 %	—	—	66	4·1	44	67 %
7	3	,,	2	,,	138	,, ,, 11	44 %	3	nil	141	4·0	61	43 %
8	3	,,	2	,,	107	,, ,, 12	65 %	—	—	107	4·7	70	65 %
9	3	same day	2	,,	101	,, ,, 11	45 %	9	nil	110	3·5	45	41 %
10	4	no choice	3	,,	102	,, ,, 10	38 %	8	nil	110	3·8	39	36 %
11	4	1	2	,,	120	,, ,, 7	29 %	—	—	120	4·4	35	29 %
12	4	probably 3	3	,,	36	about 7	69 %	—	—	36	3·0	25	69 %
13	4	no choice	3	,,	82	at least 11	44 %	13	nil	95	3·1	36	38 %
14	4	doubtful	3	,,	85	,, ,, 7	29 %	18	nil	103	3·8	25	24 %
15	4	,,	2	3	92	,, ,, 10	50 %	25	24 %	117	3·7	52	44 %
16	4	1	...	nil	nil	...	...	—	—	nil	nil	nil	nil
17	4	doubtful	4	,,	77	at least 9	45 %	—	—	77	3·7	35	45 %
18	4	,,	3	,,	65	,, ,, 12	71 %	—	—	65	3·8	46	71 %
19	4	,,	2	,,	11	3	91 %	—	—	11	2·2	10	91 %
20	4	,,	2	,,	31	at least 6	35 %	—	—	31	3·1	11	35 %

Longest ♂ life 30 days. Longest ♀ life 38 days. Average ♀ life 27 days. Number of ♀♀ fertilized by one ♂ 10. Eggs laid by unfertilized ♀♀ did not hatch. The period of fertility lasts about 7 to 12 days. The greatest number of eggs fertilized by a ♀ after separation from a ♂ was 70 (♀ No. 8). The egg laying record in the above experiment ranges between 25 and 141 with an average of 88 and a daily average of 3·7. It is probable that owing to the unnatural conditions of the experiment that these figures are too low as an estimate of the egg production of wild lice.

the real period of fertility exceeded that calculated, it being improbable that there would be no failures among the early laid eggs. As soon as the ♀♀ ceased to lay fertile eggs some of them were given the opportunity of a second pairing. Particulars of the egg laying subsequent to the introduction of a second ♂ are set out in Table II, and of the hatching of the eggs in Table V. It will be seen that a number of the ♀♀ regained fertility after a second pairing, while two were afforded the option of a third. One of these (No. 16) apparently missed the second opportunity, but availed herself of the third and laid a few fertile eggs; the other (No. 18) survived long enough to lay a few more eggs, but none of them hatched. Details are given in Tables III and VI[1].

Although the ♀♀ are stated to have no receptaculum seminis it will be seen that they are able to lay fertile eggs as long as 20 days after the removal of the ♂. This does not compare so unfavourably with fleas, in which the receptaculum is well developed. The ♀ of *Pulex irritans* requires to pair several times if all the eggs she is capable of laying are to be fertilized.

Table VII summarises the previous ones.

Table VIII shows the results of an experiment in differential feeding. Owing to the escape of a ♀ from Box A, it was necessary to remove one from Box B, and to discard observations made prior to this reduction in numbers. Consequently, the experiment covers the later, instead of the earlier, two-thirds of the insects' lives, as was intended. It is probably owing to this that there is a marked falling off in the average number of eggs laid during the reversed order of feeding, when the lice in Box B were fed twice a day and those in Box A only once. Nevertheless, the result shows clearly how dependent egg laying is on food supply—the fertility of the eggs remaining unaffected.

Hatching of eggs. Table IX shows details of the hatching of a number of eggs laid by 10 pairs of *P. humanus* from the date of their maturity until the 30th day. The eggs were placed in an incubator at a constant temperature of 31° C., the air being kept humid by a pan of water with slips of filter paper dipping into the water and hanging over the side of the pans. The high percentage hatching suggests that the conditions were not unfavourable. The variability shown in hatching may have been somewhat enhanced by the fact that the time of examination

[1] It is of course obvious that the percentage of eggs hatching in these Tables, as well as those in the parallel series for *P. capitis* Tables X and XII, has no real relation to the natural fertility of the eggs in the correct sense of the term; the figures are only inserted as a convenience.

occasionally varied by three or four hours. It would be possible for the three records of hatching on the 11th day to be due to an earlier examination than usual on the previous day.

Table XI gives the record of an experiment of the hatching of batches of eggs taken from a stock box and placed under varied conditions. None of the eggs hatched at room temperature, 15·6° to 18·4° C., but a few lice emerged from eggs kept at 24·5° C.

The widely distributed dates of hatching, in some instances after a long interval of time, of these eggs is in marked contrast to the uniformly rapid hatching of eggs kept at 36·1° C. and reminds us of the instance recorded by Warburton (1909), although the period of delay is far shorter.

Although the eggs were not counted, there is no doubt that many died when maintained at 24·5° C.; the batch submitted to cool conditions, 15·6° to 18·4° C., was smaller than the one placed at 36·1° C. but the number must have been upwards of 100.

Pediculus capitis. The attempt with this species to parallel the series of breeding experiments carried out with *P. humanus* were less successful. Possibly the former constituted a chance observation that it would be difficult to repeat without numerous failures, but more probably the conditions were less favourable for the head than for the body louse. There is, however, probably a real difference in the length of life and fecundity of the two insects even if this appears somewhat exaggerated in the protocol.

From Table X it will be seen that four ♂♂ were used in fertilizing the series of 20 ♀♀, the first three ♂♂ dying early in their career, but the fourth fertilized 10 ♀♀ and certainly paired once at least with a malformed ♀ that developed no eggs. A shortage in the supply of virgin ♀♀ was responsible for the fewer opportunities afforded to this ♂ than to the *P. humanus*. The fact that the ♂♂ in many instances were left longer with the ♀♀ than the one day which was usual in the parallel experiment with *P. humanus* probably accounts for there being no failures in fertilization. Similarly the periods during which the ♀♀ retain the power to lay fertile eggs may have been understated since they have been reckoned from the date upon which the male was removed.

Table XIII shows details regarding the hatching of the eggs recorded in Table X. Owing to the earlier loss of the power to lay fertile eggs in this species, the period is less clearly defined as regards its upper limit than in the case of *P. humanus*, but there is little doubt but that it is really shorter by about one-third.

Tables XII and XIV show the distribution in time of egg laying and hatching for the ♀♀ of the series which were afforded the opportunity of pairing with a second ♂.

Although the evidence obtained with regard to *P. capitis* is not so full as for *P. humanus*, it is sufficient to show that the habits of pairing, egg laying and fertilization are similar in both species.

Hybridization.

An attempt was made to hybridize the two insects with a view to obtaining evidence bearing upon the debated question of their right to specific rank. It was found that when single pairs were confined in the same box, the ♂♂ of *capitis* and ♀♀ of *humanus*, or vice versa paired freely. In half the attempts, however, the ♀♀ of *P. capitis* were killed in the act of pairing or died within a day or two, presumably as the result of renewed attempts. It was found necessary, if any number of eggs was required, to remove the ♂ *P. humanus* after the pairing had been consummated. No such precaution was needed in the case of the reverse pairing, and although some of the ♂♂ of *P. capitis* used died early, they succeeded in fertilizing the eggs.

A noticeable feature of the pairing between *P. capitis* ♂ and *P. humanus* ♀ was the disparity of the sexes in the F. 1 generation of some of the crosses. The first trial gave 71 ♂♂ (= 74 %) against 25 ♀♀ (= 26 %), three specimens being killed in the nymph stage. There was considerable mortality in the egg state, which possibly accounted for the small number of ♀♀, although it affords no satisfactory explanation of the disparity of the sexes. No deaths were observed in the larval or nymph stage.

Pairing No. 2 of this cross gave 130 ♂♂ (= 86 %) and 22 ♀♀ (= 14 %), 44 of the ♂♂ had matured before the first ♀♀ developed.

Pairing No. 3 gave 51 ♂♂ (= 51 %) and 49 ♀♀ (= 49 %).

Pairing No. 4 gave 76 ♂♂ (= 68 %) and 35 ♀♀ (= 32 %).

In the F. 2 and F. 3 generations arising from cross pairing No. 1 the number of ♂♂ and ♀♀ appeared normal in all the boxes whether they contained single pairs or the eggs resulting from a number of individuals laid in a stock box. A considerable number of specimens were preserved without selection and an examination of these insects shows the following result:

F. 2 generation, 211 ♂♂ (= 54 %) and 181 ♀♀ (= 46 %).

F. 3 generation, 93 ♂♂ (= 46 %) and 110 ♀♀ (= 54 %) also 80 nymphs.

With the F. 1 generation of reverse cross, *P. humanus* ♂ and *P. capitis* ♀, the disparity was not so obvious.

The first trial failed owing to the death of the ♀ whilst pairing.

A second attempt was more successful and about 50 eggs were laid, the ♀ dying on the 17th day.

The F. 1 generation consisted of 27 ♂♂ (= 55 %) and 22 ♀♀ (= 45 %).

In the third trial the ♀ died after laying one egg.

A fourth attempt was made; two ♀♀ of *P. capitis* being confined with one ♂ of *P. humanus*. One of the ♀♀ died within a day or two and the other was left with the ♂, she laid about 30 eggs, but died within 10 or 12 days.

The F. 1 generation from this pairing consisted of 17 ♂♂ (= 71 %) and 7 ♀♀ (= 29 %).

One or two other attempts were made which resulted in the death of the ♀♀.

Of the subsequent generations reared from the F. 1 generation of the second pairing, a large number of specimens were reared and killed as they reached maturity. They consist of a portion, not the whole, of the offspring of two single pairings and a number of pairs left together in a stock box.

The specimens of the F. 2 generation are

143 ♂♂ (= 57 %), 109 ♀♀ (= 43 %) and 6 nymphs.

The specimens present of the F. 3 generation are

63 ♂♂ (= 50 %), 64 ♀♀ (= 50 %).

In size the specimens of the F. 1 and F. 2 generations of both crosses are generally intermediate between those of *P. humanus* and *P. capitis*, but in the F. 3 generation considerable disparity was noticeable—some very large ♂♂ and some very small ♀♀ being observed.

In the F. 2 generation, observations were made in regard to the egg laying habit, both hair (human) and cloth having been placed in boxes with a few selected pairs of hybrids of the F. 2 generation of the cross *P. capitis* ♂ and *P. humanus* ♀. I noticed that the ♀♀ laid on hair for choice, only a few eggs being attached to the cloth, but the lice showed the instinct to cluster their eggs, a few only being generally scattered along the hairs as is the case with eggs of *P. capitis*[1].

[1] The F. 1 generation of this cross, resulting from a later pairing, show a marked preference for laying on cloth; out of four pairings three ♀♀ laid their eggs on cloth, while one selected hair and laid nearly all her eggs upon it. Unfortunately I was too busy to note the egg laying habit of the F. 1 generation of the earlier pairing.

The ♀♀ of the F. 2 generation of the cross, *P. humanus* ♂ and *P. capitis* ♀, laid their eggs on both cloth and hair, but they showed a preference for laying on hair; clustering was not so noticeable a feature as in the case of the ♀♀ of the reverse cross.

An examination of the eggs laid by these hybrids showed that on the whole they were clearly intermediate in size between those of the species. The eggs are, however, variable in size, both as regards those of the species and those of the hybrids, so that it was easy to match eggs of either *capitis* or *humanus* from the hybrid batch.

No signs of unhealthiness, mortality in moulting or shortening of life in the hybrid insects was observed; the usual life was 30 to 40 days. One pair of the F. 1 generation of the *P. capitis* ♂ and *P. humanus* ♀ cross lived 45 days and their fecundity appeared to be on a par with that of *P. humanus*. They throve just as well under the artificial conditions of rearing as did this species. Although *P. capitis* can be successfully reared in the boxes, the colonies do not show the same rapid and vigorous growth.

There was no noticeable increase of mortality in the eggs laid by the hybrid insects.

No attempts were made to carry the hybrid races beyond the F. 3 generation; they were then in all respects healthy and fertile, probably they could be continued indefinitely. The variability in size referred to above may, however, have been the beginning of a segregating process which would eventually result in the hybrid races being forced back to the specific norm.

Summary.

General comparative note on the two species.

Pediculus humanus (*vestimenti*) is a larger, more robust and less active insect than *P. capitis*,—the ♀♀ having a relatively greater egg-carrying capacity than those of the head louse. The eggs are larger and the number laid (under the conditions of these experiments) is greater, while the habits associated with egg laying differ, although placing the ♀♀ of *humanus* under conditions applicable to *capitis* or vice versa may induce a considerable degree of uniformity. Cross pairings between the insects are easily brought about and the offspring are fertile *inter se*. Hybrid strains were maintained until the F. 3 generation and there seemed no reason, judging from breeding results, why such strains should not be continued indefinitely. Nevertheless

the marked disparity in the sexes of the F. 1 generation of some of the crosses between *P. capitis* ♂ and *P. humanus* ♀ suggests that the parents are specifically distinct.

No such obvious disparity occurred between the sexes of the F. 2 and F. 3 hybrid generation, or of either of the pure stocks[1].

Habits. The body louse exhibits some of the habits of a gregarious animal especially during the moulting phases, also a preference for returning to the same spot for oviposition, which leads to the clustering of its eggs. These habits are shown, though in a less marked degree, by *P. capitis*, and it is possible therefore that they are to some extent the outcome of confinement. Pairing within both species took place at any time during day or night, and was very frequently observed after feeding. ♂♂ with but little food in their alimentary tract were, however, often seen in coitus. The period during which the insects remained paired was frequently observed to be over an hour, but no upper limit was defined.

A ♂ of *P. humanus* fertilized 18 out of 21 ♀♀ placed with him in succession. Four attempts with *P. capitis* were less successful; one ♂ fertilized ten ♀♀ and very possibly might have equalled the *P. humanus* record but for a scarcity of virgin ♀♀ while the experiment was in progress. The longest period during which a ♀ of *P. humanus* retained the power to lay fertile eggs in the absence of a ♂ was 20 days, usually it would seem to be from 16 to 18 days. In the case of *P. capitis* the period was shorter; 12 days being the longest ascertained period, while it was more usually from seven to eleven days.

The greatest number of eggs laid by any one ♀ of *P. humanus* was 295, an average of 6·4 per day—the daily average of a number of ♀♀ being 5·1. *P. capitis* ♀♀ showed a lower fecundity, the highest record being 141 with a daily average of 4—the general average being 3·7. These figures are probably exceeded under natural conditions. An experiment in differential feeding with *P. humanus* (Table VIII) shows clearly that fecundity is dependent on feeding. When extra feeding time over and above seven hours per day was given the average for four ♀♀ was eight per day. It is reasonable to suppose that the average for *P. capitis* would also be increased by unrestricted feeding.

[1] Since the above went to press I have reared two broods of *P. humanus* from crosses between pale and dark forms of this species with a view to discovering if the melanic race shows Mendelian inheritance. In the case of a pairing between a pale ♂ and a dark ♀ there resulted 15 ♂♂ and 54 ♀♀, while from the reverse cross 102 ♂♂ and only 15 ♀♀ were bred. This result qualifies the above suggestion and necessitates further breeding experiments which are now in progress. (See p. 259, paper by Hindle.)

The fertility of the eggs laid was not affected by increased feeding. The greatest number of fertilized eggs laid by a ♀ *P. humanus* after the removal of the ♂ was 115 (♀ No. 9), with a ♀ showing a higher daily laying average this might well be exceeded. With *P. capitis* the parallel figure is 70 (♀ No. 9). The ♀♀ of both species, after arriving at maturity, started oviposition irrespective of their having paired or not, but eggs laid by virgin ♀♀ were invariably infertile.

Length of life. The life of the ♂ *P. humanus* used in the experiment recorded in Table I was 32 days; the longest ♀ life was 46 days, with an average of 34. For *P. capitis* the figures were: ♂ life 30 days; ♀ life 38 days, with an average of 27 days. Whether or not the average lives of the insects would be extended by unrestricted feeding is an open question.

The life of the hybrid insects was not noticeably shorter than that usual for *P. humanus*, and they seemed to thrive better than *P. capitis*.

Tests made with *unfed P. humanus* showed that the longest lives were at a medium temperature of 16° to 18° C., many of the insects living from three to four days, while two lived five and one lived seven days. At 24·5° C. all died within five days. At 36·1° C. all died within three days.

Newly-hatched larvae, unless fed, lived less than 24 hours at 36·1° C., and when kept in a box in the vest pocket they lived but little more than a day; none survived a second day.

Adults kept in a box in the side pocket of a coat lived five days without food; this was in March.

Moulting. 40 young lice were reared in a box carried in a vest pocket and particulars of their moulting recorded.

1st moult: 3 % moulted on the 3rd day; 42 % on the 4th and 55 % on the 5th day.

2nd moult: 15 % moulted on the 7th day; 72 % on the 8th and 13 % on the 9th day.

3rd moult: 5 % moulted on the 10th day; 3 % on the 11th, 55 % on the 12th, 32 % on the 13th day, while 5 % took 14 days to reach maturity.

The ♂♂ usually mature rather earlier than the ♀♀.

Cold. Active specimens of *P. humanus* survived two days at a temperature of − 2·3° C. to − 1·1° C., but none recovered after exposure to these conditions for a week.

Hatching of eggs. Table IX shows that under humid conditions at 31° C. 3 % of the 1300 eggs tested hatched on the 7th day; 56 % on

the 8th; 33 % on the 9th; 8 % on the 10th and ·2 % later on the same day or on the 11th.

A test of batches of eggs taken from a stock box, some of which must have been laid several days previously, showed that none hatched at 15·6°–18·4° C., while at 24·5° C. there was considerable egg mortality, and the hatching period was spread over a longer period than usual, though not to the extent mentioned by Warburton (1909); at 36·1° C. hatching was spread over five days and the mortality was not excessive.

To give some idea of the possible rate of multiplication of *P. humanus* we may estimate the egg period as 12 days and a further 12 days to the maturity of the ♀♀. Allowing an average of eight eggs per day, spread over a fertility period of 40 days, we find that, during her life, a single ♀ may have 4160 offspring.

REFERENCES.

Bacot (I. 1914). A Study of Bionomics of the Common Rat Fleas, and other species associated with human habitation, with special reference to the influences of Temperature and Humidity at various periods of the Life History of the Insect. Plague Supplement III., *Journal of Hygiene*, pp. 464–465.

Sikora (25. viii. 1915). Beiträge zur Biologie von *Pediculus vestimenti*. *Centralbl. f. Bakt., Parasit. u. Infektionskrankh.*, Jena, lxxvi, pp. 523–537.

Warburton (1909). Report to the Local Government Board on a preliminary Investigation on Flock as a possible distributor of Vermin, and on the Life History of the Body Louse, *Pediculus vestimenti*. *Reports to the Local Government Board*, New Series, No. 2.