

SIMPLE EXPERIMENTS ON THE BEHAVIOUR OF BODY LICE
(SIPHUNCULATA)

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ALL the experiments to be described consist of the release of lice on or near to the human body and the search for them after an interval of time. The results show where and how far lice are likely to travel under certain circumstances and provide some information as to how readily a man may become infested.

Pioneer experiments of this kind were described by Lloyd (1919), who showed how readily lice will pass from one man to another sleeping in the same bed, especially if the primary host is in a febrile condition.

SERIES 1. NATURAL WANDERING AMONG UNDERGARMENTS.

Away from the body, and perhaps impelled by the desire to find a new host, the louse moves at a considerable speed: Buxton (1939) records 9 inches in a minute at 20° C. But, unless it is driven in one direction by unilateral lighting, the insect meanders about so that the distance covered from point to point is much less than would be expected.

There seems to be no recorded information about wandering under natural conditions of infestation, *i.e.* under the clothing. If one examines naturally infested underwear immediately after removal from the body, the insects do

not appear to be very active unless the garments are taken near to a window, when they will walk away from the light. A high proportion of the lice seem to have made a comfortable niche for themselves against one of the seams of the garments. Nevertheless, the presence of lice and eggs on outer garments proves that the insects must sometimes move away from their source of food, the skin.

The lice used in all the tests to be described were taken from a stock which had been reared in pill boxes for many generations. There is no reason to suppose that they would tend to wander more than "wild" lice.

Method A. A dozen adult lice were placed at a spot inside a fleecy woollen vest which lies against the skin of the small of the back when the vest is worn. The vest was put on, together with aertex short pants, a poplin shirt, flannel trousers and a laboratory overall. Three or four preliminary trials proved that putting on the vest did not dislodge the lice.

After two hours (during which the host mainly sat quietly) the garments were all quickly removed and a search made at once for the lice.

The figures in Table 1 give the *minimum* distances travelled during the experiments: the average is about a foot. In many cases the lice walked from the inner to the outer surface of the vest, and sometimes as far as the outside of the shirt. In the terms of MacLeod and Crauford-Benson, they had migrated from one "territory" to another.

It will be seen that the pubic hair was infested in three of the four tests and eggs were found to have been laid on this site. It is clear that body hair must not be overlooked in de-lousing operations.

TABLE 1.

Location of lice found 2 hrs. after release at the small of the back. Figures in brackets are minimum distances wandered in inches.

Test No.	Lice found	Lost	Average minimum distance, inches
1	2 on pants (12) (16), 2 inside shirt (25) (10), 3 on vest (10) (22) (6), 3 on pubic hair (15) (15) (15).	2	14.6
2	1 on pants (10), 1 on shirt (16), 7 on vest (18) (16) (16) (16) (16) (6) (3), 2 on pubic hair (15) (15).	1	12.0
3	1 on pants (18), 5 on vest (18) (12) (6) (6) (2), 3 on pubic hair (15) (15) (15).	3	12.0
4	3 on pants (16) (16) (10), 6 on vest (14) (8) (8) (8) (8) (1).	3	9.2

In these experiments the lice were liberated on uninfested under-garments; the results therefore only represent the start of an infestation, not an established case. Wigglesworth (1941) has shown that lice react favourably to the smell of other lice and to their excrement and suggests that this partly explains their aggregation at the seams of clothing. However, the following test indicates that even this attraction does not inhibit a great deal of wandering of the adults.

Sixty lice were confined beneath a three-inch square of bolting silk on the inside back of a vest. Knotted cord sewn to the vest gave them room to feed and provided a convenient resting place. After three days the bolting silk and lice were removed, leaving a contaminated patch round the knotted cord.

A liberation experiment was performed as above with a dozen adults from the box cultures. Two hours after they had been carefully placed on the knotted cord and the vest worn, they were found as follows: 1 outside pants (25), 2 on shirt (18 & 18), 6 on vest (0, 8, 10, 11, 12, 15), 1 on pubic hair, 2 lost. Average minimum distance 13 in.

Method B. These tests were similar to the foregoing except that the lice were released on a pleated cotton belt which discouraged wandering (because lice tend to settle down in folds and pleats). Nymphal as well as adult lice were used and in two cases the host carried out half an hour's physical exercise in thick clothing during the course of the experiment to promote sweating.

Ten adult and 10 second- or third-stage nymphs were released in each test, the results of which are shown in Table 2.

TABLE 2.

Amount of wandering from a cotton belt with and without exercise and sweating.

Test No.	Conditions.	Adults			Nymphs		
		No. wandered	Average distance wandered, inches	No. lost	No. wandered	Average distance wandered, inches	No. lost
1	} Sitting quietly } 2 hours	5	4.0	3	2	?	2
2		6	6.6	0	2	1.2	0
3	Exercise $\frac{1}{2}$ hour Sitting $1\frac{1}{2}$ hours	9	10.3	2	6	5.4	1
4		7	9.5	1	3	?	3

It will be seen that the physical exercise and sweating tended to increase the wandering of the lice. This had been suspected from observations on naturally infested men, and it is not a very surprising fact, for the increase in skin temperature would naturally increase the activity of the lice.

In all cases the adults wandered much farther than the nymphs. This also is in harmony with observations on infested men by MacLeod and Craufurd-Benson (1941b), who found wandering lice on the outer clothing to consist of proportionately more adults than the populations on garments next the skin. It seems probable that new infestations are caused mainly by wandering adults.

SERIES 2. ACQUIRING LICE FROM A LOUSY BED.

Method: A cotton sleeping-bag was used measuring 6 ft. \times $2\frac{1}{2}$ ft. About 20 adult lice were put into the bag in the morning and the bag was rolled up and left with the opening directed towards a window to lessen the chances of escape (nevertheless, in some tests, several did escape during the course of the day!). In the evening the lice present were counted and a man wearing pyjamas slept in the bag during the ensuing night. The sleeping-bag was covered by two woollen blankets and a light eiderdown, as the weather was rather cold.

Next morning a careful search was made for the lice. The results are recorded in Table 3.

As might be expected, lice were more often picked up by the fleecy surface of the flannel than the smooth surface of the poplin pyjamas. It is interesting

TABLE 3.

Distribution of lice found after sleeping in an infested sleeping-bag.

Test No.	No. lice in bag in evening	Pyjamas worn	Percentage lice next morning				
			On pyjamas	On body	Inside bag	Outside bag	Lost
1	16	Flannel	50	6	6	13	25
2	20	Poplin	10	5	45	15	25
3	20	Flannel	40	5	20	15	20
4	20	Poplin	15	0	45	40	0

to note that 35% to 40% escaped during the night, which meant travelling a *minimum* distance of 6 ft. These lice often became entangled in the blankets in which they could only be discovered by a very careful search. This migrating habit of the lice seems to be the explanation of the observation of MacLeod and Craufurd-Benson (1941a), who remarked that casual beds become un-infested a few days after lousy individuals have slept in them.

SERIES 3. TESTS WITH AN ANTI-LOUSE TYPHUS PROTECTION GOWN.

A protective gown for medical and sanitary personnel (who may come in contact with typhus-infested lice) is described in the Ministry of Health Memorandum on louse-borne typhus fever 252/med. (1941). This garment gives complete protection except for the openings at the back, round the face and at the wrists. A zipp fastener is recommended for sealing the large opening at the back, but these fasteners do not well endure the continual sterilisations necessary. As an alternative, tapes are suggested, to be tied over an 8-in. overlap. Dr. Cosins, Medical Superintendent, Orsett Lodge Hospital (Essex C.C.), has proposed the following modification of the gown and suggested that insecticide treatment might be used in some way to enhance protective value. The two edges of the back opening are extended to form a flap which can be rolled up and the tapes tied across it. Round the face is introduced a double edging of gauze between which is a cotton-wool pad. A gown altered in this way was submitted to test with and without the application of Lethane 384, an effective anti-lice insecticide.

Method. The gown was put on by a man wearing ordinary clothes but no jacket and fastened in the prescribed manner. A known number of body lice were placed on the outside of the garment near the face opening and the rolled flap at the back. The wearer sat or walked about in a laboratory in daylight, not directly in the sun. After an hour a careful search was made to find if the lice had penetrated to the inner surface.

The protective effect of Lethane 384 was tested by lightly spraying the cotton gauze round the face opening and the edges of the back flap: about 2-4 c.c. of undiluted Lethane were used.

Results. Lice which crawled into the rolled flap were not considered to have penetrated the gown unless they passed right on to the *inner surface* of the two rolled edges. Their power of penetrating into recesses of garments is really extraordinary: in the first test one louse had found its way past the rolled edges, under the wearer's shirt, and as far as the armpit.

TABLE 4.

Intrusion of lice into protective clothing.

Test No.	Remarks	No. of lice released	Percentage of lice		
			Found outside	Found inside gown	Lost
1	No Lethane	36	72	14	14
4	No Lethane	24	46	17	37
2	Lethane used	22	91	0	9
3	Lethane used	24	67	0	33
5	Lethane used	24	71	0	29
6	Lethane used	24	88	0	12

Each test is fairly severe, for the attack of so many lice in the vicinity of the openings would correspond to many weeks' wear. Nevertheless it is rather alarming to find that a few lice were able to penetrate the untreated garment. The Lethane application gave complete protection as far as these tests went. This is because the lice which crawled into the vicinity of the two main openings were found afterwards to be stupefied by the insecticide and subsequently died.

It is evident that spraying the openings of anti-lice typhus gowns with Lethane will considerably increase their protective value. The spraying can be done with any small hand sprayer such as a "Flit" gun, a scent spray or an artist's pastel-fixing spray.

The insecticide is removed by laundering or heat sterilisation and should be applied every day immediately before putting on the garment. As only 2-4 cubic centimetres are used per application, a U.K. gallon of the Lethane 384 will suffice for one or two thousand treatments.

The insecticide is liable to cause stinging if it touches the face. Care was therefore taken not to spray the *inside* face gauze.

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