193

FOR OFFICIAL USE.

REPORTS

TO THE

LOCAL GOVERNMENT BOARD

ON

PUBLIC HEALTH AND MEDICAL MATTERS.

(*NEW SERIES No.* 2.)

Mr. Warburton's 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*).

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY DARLING & SON, LTD., 34-40, BACON STREET, E.

And to be purchased, either directly or through any Bookseller, from
WYMAN AND SONS, LTD., FETTER LANE, E.C.; or
OLIVER & BOYD, TWEEDDALE COURT, EDINBURGH; or
E. PONSONBY, 116, GRAFTON STREET, DUBLIN.

1909.

Price Twopence.

194

TO THE RIGHT HONOURABLE JOHN BURNS, M.P.

SIR,

In 1908 you authorised an inquiry into the condition of flock beddings, and Dr. Farrar, a Medical Inspector of the Board, was detailed for the purpose. In connection with this enquiry, it became necessary to ascertain the limits of vitality of the vermin with which the materials used in manufacturing inferior flock bedding are sometimes infested. This investigation was undertaken by Mr. Warburton, M.A., F.Z.S.

It has been thought desirable to publish at once the results of his investigations into the life-history of the vermin in question; the report on the entire subject by Dr. Farrar will appear at a later date.

The summary on page 5 embodies the main results of the investigations up to date.

I am, Sir,
Your obedient Servant,
ARTHUR NEWSHOLME.

March 9th, 1909.

(12778—21.) Wt. 33622—450. 500. 4/09. D & S.

A Preliminary Investigation on Flock as a possible Distributor of Vermin, and on the Life History of the Body-louse (*Pediculus vestimenti*), by Cecil Warburton, M.A., F.Z.S., Christ's College, Cambridge.

Flock as a possible Distributor of Vermin.

In order to determine whether flock, manufactured from verminous clothing, might act as a distributor of vermin when used for bedding, two lines of investigation were clearly indicated. It was necessary (1) to ascertain, if possible, the presence of living vermin in flock; but it was also important (2) to obtain an accurate knowledge of the life-history of the creatures concerned in order to estimate the probability of their surviving, in any stage, the operation of converting cloth into flock.

(1.) A large amount of flock of different grades was examined for vermin with a negative result. It seemed unsafe, however, to draw any conclusion from this fact, for the search is difficult and tedious, and a considerable number of living vermin might easily escape observation in a sack-full of flock. It was arranged, therefore, that some clothing known to be verminous should be passed through the machine, and the resultant flock examined. In this case, though no living lice were found in the flock, there was evidence that some had survived the tearing process, for dead specimens were found adhering to the sacking in which the sample of flock was enclosed, and they must, therefore, have crawled out of the flock after it was packed. The presence of various foreign bodies such as buttons and small fragments of bread in the flock made it evident that lice might easily pass through the machine uncrushed, and the position of the dead lice in the flock obtained from verminous cloth indicated that they had lived for a time, at all events, after undergoing the ordeal.

The possibility of the flock acting as a distributor of vermin therefore clearly depended upon the ability of such creatures to live for a considerable time without food in one or other of the stages they pass through in the course of their development, and an accurate acquaintance with their life history was a necessary preliminary to settling this question.

The Life-History of the Body-Louse.

Pediculus vestimenti.

An extensive research into the literature of the subject revealed the fact that all the statements concerning length of life, the number of eggs laid and the periods occupied in incubation and development were more or less hap-hazard inferences from observations of the insects in the bulk. There was no evidence that anyone had observed throughout the life-history of a single louse and it was clear that until this was accomplished our acquaintance with the bionomics of the Pediculi must remain unsatisfactory.

The difficulties in the way of such a research arise from the fact that, unlike many creatures of parasitic habit such as ticks, which are highly resistent to starvation and to variation of temperature, lice are extremely sensitive to any change in the conditions under which they normally live. When verminous clothing is sent from a distance, most of the lice are dead or moribund on arrival, and a very close approximation to their natural conditions is necessary if the attempt to rear them is to be successful. Several experiments made before these facts were fully realised resulted in failure. For example, specimens kept in an incubator at a steady body-surface temperature and fed at intervals on rats quickly succumbed. Success only seemed possible by keeping the insects constantly about the person and allowing them to feed frequently in as natural manner as possible, and it was determined to undertake this experiment.

The species best adapted for the purpose was obviously the body-louse, *P. vestimenti*, for not only does it survive longer under adverse conditions than the head-louse *P. cervicalis* (= *P. capitis*), but it habitually passes much of its time in the clothing and not actually in contact with the skin of its host, and it was with this species that success was finally attained by the method here described.

Examples of *P. vestimenti* were imprisoned, together with a small piece of cloth, in a glass tube about 3 ins. by ·5 ins., plugged with cotton wool. The glass tube was enclosed in a metal case open at one end, to guard against possible accidents. The whole was kept close to the person, night and day, except when feeding was necessary, which was at least twice in twenty-four hours. The tube was then opened and the small piece of cloth, with the lice adhering to it allowed to fall upon the back of the hand. The adult *P. vestimenti* is very reluctant to let go its hold on the clothing, and prefers to feed while still clinging to it, so that little trouble was caused by attempts to wander over the skin, and the captives usually settled down to feeding almost immediately.

As soon as it was found that in this manner lice could be kept alive in a fairly healthy condition, the specific experiment was entered upon. A single female *P. vestimenti*, apparently only recently mature, was placed in the tube, and lived there for a month, its death being to all appearance natural. A male was admitted to it on the second day of its captivity, and remained in company with it for seventeen days when it died. Copulation was not observed until the pair had been together for five days. It took place afterwards at frequent intervals and lasted for hours. The first egg was laid shortly after the insects were first observed pairing, and during the remaining twenty-five days of her life the female laid 124 eggs, averaging about five in twenty-four hours. After the death of the first male a second male was admitted to the tube and survived the female, with which it paired frequently.

There were thus obtained 124 eggs of which the date of laying was known to within a few hours, and the next proceeding was to attempt to rear some of them, but here unexpected—and at present unaccountable—difficulties were met with. There was certainly no reason to suppose any of the eggs unfertilised, yet most of them refused to hatch under what seemed to be quite favourable conditions.

The daily batch of eggs was at first removed with great care, egg by egg, to a separate tube, and subjected to different conditions of temperature. A few strands of the cloth were removed with each egg to avoid any danger of injuring it, yet none of the eggs so disturbed hatched out. It was not until the plan of leaving them *in situ* was adopted that any success was obtained. Of 24 eggs so left on the cloth as they were laid, and kept under the same conditions as the mother, eight hatched out after an incubation period of eight days. Several days transpiring without the appearance of any more larvae, it seemed likely that the remaining eggs were dead, and the tube was transferred to the waistcoat pocket and therefore subject to room-temperature at night, which was on some occasions considerably below freezing point. Nevertheless six others hatched out after an incubation period of upwards of a month. The behaviour of the eggs was therefore extremely erratic, and whatever the cause of the failure to hatch many of them, it is an important fact that several eggs laid previously to December 15, 1908 (for the mother died that night), hatched between January 13 and January 17, 1909, after having endured great variation of temperature and after having for three weeks received no attention as regards hygrometric conditions. It is clear that danger from nits of *P. vestimenti* does not cease till at all events five weeks from the date of laying.

The most troublesome part of the experiment, the rearing of the larvae to the adult condition, still remained to be carried out. Their small size renders them difficult to control, and they are much more prone to wander and less apt to adhere to the cloth than the mature forms, so that great care is necessary to guard against their escape. As might be anticipated, they have a tendency to scatter and establish themselves in new positions. For these reasons only a small number is at all manageable, and four of the larvae were selected for rearing. Of these two were brought to maturity, both proving to be males.

The larvae are able to feed immediately on emergence. One caught in the act of leaving the egg was transferred to the hand and fed at once. Moults occurred about every fourth day, and were apparently three in number, the insects attaining their mature form about the eleventh day, though, as was the case with the mother, four or five more days elapsed before sexual functions were entered upon. It may be incidentally mentioned as proving that colouration is a very unsafe guide in distinguishing this species from *P. cervicalis*, that one of the specimens reared was well chitinised and characteristically marked, while the other remained entirely pale-coloured until its death. They lived about three weeks after their final moult.

The life-cycle of the insect, as indicated by these experiments, would appear to be the following :—

Incubation period	eight days to five weeks.
From larva to imago	eleven days.
Non-functional mature condition	four days.
Adult life	male, three weeks. female, four weeks.

It is quite likely that under absolutely normal conditions the natural adult life would be longer, and it is possible that the incubation period may sometimes be shorter than the time here given, but, as far as this experiment goes, the "egg to egg" period under the most favourable conditions would be about 24 days. The louse certainly displays no undue haste in reproducing itself, and this deliberation is as astonishing in a creature of parasitic habits as its great sensitiveness to adverse conditions. When once thoroughly established, however, the large nnmber of eggs laid must render its increase extremely rapid.

Body-lice, unfed, appear to die quickly at any temperature. In the case of all verminous clothing sent, most of the insects were dead on arrival. On one occasion a louse was found alive after five days of starvation, but it was moribund and unable to feed. A few survived four days' fasting in a fairly active condition, but this seems to be about the limit period for danger of infection from the insects themselves, though their eggs, as we have seen, may retain their vitality for a month or more. Probably those lice which survived the longest were just about to moult when taken from their host. The survival period was not lengthened by keeping them at body-surface temperature; in fact, they seemed to succumb more quickly.

Larvæ newly hatched perish in 36 hours unless they succeed in obtaining food.

The following conclusions may be drawn from the observations described above:

Lice and (*à fortiori*) their eggs may pass through the flock-making machine without being crushed. The lice themselves are incapable of surviving more than three or four days without food, and it is extremely unlikely that any of them would be alive when the flock was converted into bedding. The eggs, however, may take a month or more to hatch, and it is quite possible that living eggs might be present in bedding.

CECIL WARBURTON.

197