the committee lady to the treasurer, and nothing to the nurse herself—she receives a regular wage.

Under the auspices of the central association there have been established a number of lending groups for the interchange of nurses. The more this can be extended in the county, the better for the associations working in the county.

We have borrowed nurses from all over the country, and the travelling expenses become heavy where the borrowed nurse has to be brought from a distance.

There are five associations in the county affiliated to the Holt Oakley Association, and I am satisfied that the more we get established the sooner we shall cease to hear of the necessity of midwives, and of the everlasting difficulty with the "Lady of Improvidence."

THE TRANSMISSION OF TRYPANOSOMA LEWISI BY THE RAT-FLEA (*CERATOPHYLLUS FASCIATUS*).

BY
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In a recent number of this JOURNAL¹ Mr. Strickland has communicated the results of some experiments carried out by him on the question of the mechanism of transmission of *Trypanosoma lewisi* from rat to rat by the rat-flea. Mr. Strickland succeeded in infecting clean rats by contaminating their food with infected fleas, and arrives at the following conclusions, amongst others:

1. Infection of rats with *T. lewisi* is caused by the rat's act of eating infective fleas.
2. It is not caused by contamination of the rats during a short time, nor by their being bitten by the fleas.

We have been making experiments on the same subject for over a year, and hope soon to publish a full account of our results with regard to the transmission of the trypanosome by, and its development in, the rat-flea. Since, however, Mr. Strickland has forestalled us with regard to one of our results, and has drawn from it conclusions with which we cannot agree, we wish to state (1) that we have also found that rats can be infected by devouring infected fleas, (2) that we do not consider this to be the sole nor even the usual method by which the transmission of the trypanosome from rat to rat is effected by the flea.

I.

In the dissection of fleas performed by us with a view to following out the development of the trypanosome we have frequently found cysticeroids in the body-cavity of the flea, and this fact suggested at once that the rat infected itself with the tapeworm by eating infected fleas, a supposition which was confirmed experimentally by our colleague Dr. W. Nicoll.² From this it was evident that it must be a common habit of rats to eat their fleas, and it naturally occurred to us that they might infect themselves with the trypanosomes by the same method. We therefore carried out last year several feeding experiments, taking fleas from the infected breeding-cage, that is to say, from a breeding-cage for fleas in which a rat infected with *T. lewisi* is always kept in order to feed the fleas. The fleas were killed by crushing their heads with a forceps, and then they were mixed with sop of bread and milk and given to rats. Some of these experiments gave a positive result, some did not. Dr. Nicoll obtained similar results incidentally in the experiments he carried out on the infection of the rat by the cysticeroids of the flea. He made use of fleas from our infected breeding-cage in his experiments, for the reason that the cysticeroids had been found in fleas from that cage. It will suffice for the present to quote the data kindly supplied to us by Dr. Nicoll.

1.

Five rats born November, 1909.
Two fed with fleas from the infected breeding-cage daily from January 26th to February 14th.

On the latter date both had large infection of trypanosomes. Other three control rats showed no trypanosomes.

2.

Four rats 2 months old.
Two fed daily with fleas from the infected breeding-cage, from April 4th to 22nd. Both showed trypanosomes at the end of a fortnight.
The other two rats showed no trypanosomes.

Dr. Nicoll's experiments thus furnished decisive confirmation of our previous experiments, showing that rats could become infected with *T. lewisi* by eating infected fleas. Other experiments, however, which were carried on by us at the same time led us to the conclusion that in Nature infection of the rat by eating fleas is an exceptional and aberrant method of transmission of the trypanosome. It is known that rats can acquire infection with trypanosomes by eating other infected material, such as the blood or organs of other rats containing living trypanosomes, and Manteufel has shown that rats can even be infected with *T. lewisi* by allowing blood containing trypanosomes to dry on the unbroken skin. Rats in their fights often kill and eat each other, and doubtless may sometimes acquire an infection as a result of cannibalism of this kind, but no one has suggested that this is a normal method of transmitting trypanosomes. We should not, therefore, have thought it worth while to publish separately the experiments cited above, were it not for Mr. Strickland's second conclusion that we have quoted.

II.

Decisive proof that "the rat's act of eating infective fleas" is not the usual method by which it becomes infected is furnished, in our opinion, by experiments in which, after putting a single flea from the infected breeding-cage on a clean rat for a short time (usually about three days), we have recovered the flea and dissected it, and the rat has become infected in due course; and by other experiments in which we have succeeded in infecting several rats by means of one and the same flea.

For these experiments we used specially constructed rat-cages, each consisting of a tin cylinder, 6 in. in diameter, 10 in. in height; the bottom is closed in with tin, the top by a tightly fitting tin cover, which has an opening sufficiently wide to admit air for the rat, but barred doubly with both wire gauze and finely meshed cloth gauze, the former to prevent the rat forcing its way out, the latter to make it flea-proof. Into such cages were put, first, a small quantity of sawdust at the bottom; secondly, a rat carefully examined to make sure that it had neither trypanosomes in its blood nor fleas on its skin (if necessary chloroformed to rid it of fleas); thirdly, a single flea which had been taken from the infected breeding-cage two or three days previously, and kept isolated before being put on the rat, with the double object of avoiding any possibility of direct transmission of the trypanosomes, and of making the flea hungry. In these cages we never had the slightest difficulty in recovering the flea. Generally, as soon as the rat was lifted up, the flea was seen at once in the sawdust at the bottom; if not there, it was found on the rat, usually on the inner side of the thigh.

In these experiments by no means every flea taken from the infected breeding-cage produced an infection, even though the flea when dissected showed trypanosomes in its digestive tract. We have performed 63 such experiments, which may be divided into two periods: 37 from August 2nd to November 11th, of which 6 gave positive results; 26 from November 12th to December 14th, which were all negative. Of these 26 negative, however, in 6 the flea was left on the rat only for a few hours, and when dissected was not found to contain blood in its stomach and probably had not fed. It is curious, nevertheless, that the experiments in the early winter all had negative results, and this is probably more than a coincidence. In the warmer months the average of positive results is very nearly 1 in 6. In the whole 63 experiments we failed three times to recover the flea, and it may have been eaten by the rat in these cases, but as the result was negative in each case, it makes no difference one way or another. In two experiments the flea was dead when recovered: these also were negative in result.

It will suffice to quote here in tabular form the six experiments that gave positive results :

	Flea put on Rat.	Flea Recovered.	Trypanosomes first Seen in Blood of Rat.	Multiplication Period Ended.	Condition of Flea when Dissected.
1	Aug. 2, '10	Aug. 5, '10	Aug. 11, '10	Aug. 13, '10	Trypanosomes scanty in stomach.
2	Sept. 19, '10	Sept. 22, '10	Sept. 28, '10	Sept. 30, '10	Trypanosomes swarming in stomach.
3	Oct. 10, '10	Oct. 14, '10	Oct. 17, '10	Oct. 22, '10	Trypanosomes not found.
4	Oct. 20, '10	Oct. 25, '10	Oct. 28, '10	Oct. 31, '10	As last.
5	Nov. 1, '10	Nov. 4, '10	Nov. 14, '10	Nov. 16, '10	As last.
6	Nov. 11, '10	Nov. 15, '10	Nov. 23, '10	Nov. 25, '10	Trypanosomes swarming in rectum.

With regard to this table it should be remarked, first, that the multiplication of the trypanosome in the rat occupies the first eleven or twelve days after the actual infection has taken place; secondly, that the fleas which produced these infections showed, when dissected, various conditions, from an infection of the digestive tract so scanty that trypanosomes were not found by microscopic examination in the fresh state, to others in which the stomach or rectum were teeming with them.

Flea A.

No. of Rat.	Flea put on.	Result.	Trypanosomes First Seen in Blood.	Multiplication Ended.
265	Feb. 14 to 18, '11	+	Feb. 24, '11	Feb. 27, '11
249	Feb. 24 to March 1, '11	0	—	—
260	March 1 to 6, '11	+	March 15, '11	Rat died March 16, '11
291	March 6 to 13, '11	0	—	—
293	March 13 to 17, '11	0	—	—
295	March 17 to 22, '11	+	March 27, '11	March 31, '11
249	March 23 to 27, '11	0	—	—
291	March 27 to April 1, '11	+	April 5, '11	April 9, '11
293	April 1 to 5, '11	0	—	—
249	April 5 to 10, '11	0	—	—
262	April 10 to 15, '11	0	—	—
296	April 15 to 20, '11	+	April 22, '11	April 25, '11
263	April 20 to 25, '11	+	May 1, '11	May 5, '11
292	April 25 to 29, '11	+	May 1, '11	May 6, '11
293	April 29 to May 4, '11	0	—	—
*294	May 4 to 9, '11	?	—	—
249	May 9 to 15, '11	0	—	—

* Rat died May 9, 1911.

When the flea was searched for on May 15th it could not be found.

Flea B.

No. of Rat.	Flea put on.	Result.	Trypanosomes First Seen in Blood.	Multiplication Ended.
272	Feb. 14 to 18, '11	+	Feb. 24, '11	Feb. 28, '11
259	Feb. 24 to March 1, '11	0	—	—
253	March 1 to 6, '11	0	—	—
292	March 6 to 13, '11	0	—	—
294	March 13 to 17, '11	0	—	—
296	March 17 to 22, '11	0	—	—
259	March 23 to 27, '11	+	March 30, '11	April 4, '11
253	March 27 to April 1, '11	+	April 5, '11	April 7, '11
292	April 1 to 5, '11	0	—	—
294	April 5 to 10, '11	0	—	—

When the flea was searched for on April 10th it could not be found.

Still more striking are the results obtained by feeding a single flea on a number of rats successively. In this experiment we took, on February 14th, 10 fleas from the infected breeding-cage, and put each flea on a separate rat in a flea-proof cage of the kind already described. On February 18th each of the 10 fleas was recovered and put by itself in a test-tube containing a little damp sand, while the rats on which they had been put were examined daily. On February 24th 2 of the 10 rats were found to be infected; the other 8 never showed infection. The 8 fleas which had produced no infection were returned to the infected breeding-cage, but the 2 that had infected their respective rats, henceforth to be known as Flea A and Flea B, were put on a succession of clean rats, with the results shown in the accompanying table.

The experiments show, in the first place, that Flea A infected seven rats and Flea B three rats, consequently that these infections could not have been brought about by the rats eating the flea. Secondly, they show that an infected flea does not infect at every feed, and consequently they throw light on the small percentage of fleas taken from the infected breeding-cage which produce an infection when placed on a rat *only for a short time*. Thirdly, they show incidentally that a flea lives a considerable time. Flea A, a female of uncertain age on February 18th, was to all appearance healthy and vigorous on May 9th, when last seen. Possibly both A and B were eaten finally by the last rats on which they were put; we cannot say.

In conclusion, we venture to assert that the experimental results cited by us support our belief that the infection of rats with *T. lewisi* is not brought about normally through the rat eating the flea; and from other evidence, which we hope to publish in full detail at a future time, we believe that the normal method of transmission is that the ripe, infective form of the trypanosome—the final form of the developmental cycle which it passes through in the flea—is regurgitated from the stomach of the flea into the wound made by the proboscis of the flea during the act of feeding. Considering the problem of the transmission of trypanosomes as a whole, the conclusion that infection is effected by the bite of the invertebrate host receives abundant support from other known cases of trypanosome transmission. No one can suppose that human beings acquire trypanosomiasis by eating tsetse-flies in Africa or bugs in Brazil; and Miss Robertson's recent researches on fish trypanosomes² show conclusively that fishes are infected by the bites of leeches. We consider, therefore, that the infection produced by the vertebrate host devouring the invertebrate is an exceptional occurrence without any bearing on the general problem of the transmission of trypanosomes.

REFERENCES.

¹BRITISH MEDICAL JOURNAL, May 6th, 1911, p. 1049. ²Ibid., March 18th, p. 621. ³Phil. Trans., B., vol. 202, p. 29.

COMPARATIVE NUTRITIVE VALUE OF WHITE, STANDARD, AND WHOLE- MEAL BREAD.

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(Second Note.)

DR. CHALMERS WATSON,¹ criticizing our first note,² said that we ought to have fed our rats on bread and milk, not on bread and water. Just after reading his letter we passed through a slum in Bethnal Green. The children were out from afternoon school, and had been home for tea. Many were out in the street munching slices of bread. Some of the slices were brown and some white, but all had nothing on them; plain bread and a drink of tea or water was their meal.

The bread question is one that affects particularly the very poor. It matters little to those who can afford milk, meat, bacon, cheese, etc. The point we have to settle is how