

Reaction of the Human Body Louse: (*Pediculus humanus corporis*) to the Ingestion of Guinea Pig Blood.

VICTOR CABASSO.* (Introduced by Herald R. Cox.)

From the Section of Viral and Rickettsial Research, Lederle Laboratories Division, American Cyanamid Company, Pearl River, N. Y.

There seems to be no doubt that man apparently is the only natural host of the body louse. Human body lice have occasionally been found on domestic animals but, as Nuttall noted¹ “. . . this fact has the same importance as finding a louse on the hearth-rug.”

Charles Nicolle² on the other hand, in experimental typhus fever studies, had no difficulty in feeding lice repeatedly on monkeys (*Macacus rhesus*) and found that a certain proportion of lice when fed on monkeys will remain alive for as long as 20 days. However, Bacot and Segal³ found only rare survivors among lice fed on monkeys for 4 successive days.

While some successful attempts have been reported of feeding body lice on rabbits, guinea pigs, mice, fowl, pigeons, etc., many more failures are recorded. It has often been claimed that blood of certain animals (particularly of rodents) is toxic to the genus *Pediculus* but, as Buxton noted,⁴ no one yet has conducted experiments comparing the longevity of lice given a single blood meal on guinea pigs or rats, or on man, to that of unfed lice.

Thus, the possibility exists that the blood of animals, other than of man, is not toxic to the body louse, but that the body louse is able to digest human blood because its digestive enzymes are specific only for human red blood cells.

The following experiments, conducted at

the Pasteur Institute of Tunis, seem to confirm this hypothesis. Only one species of rodent, the guinea pig was used.

Experiment I: One hundred female lice from the stock laboratory colony were divided into 2 lots of 50 lice each (A and B). The lice were placed in an incubator at 30-32°C, and kept unfed for 30 hours in order to clear their intestines of the last human blood-meal. Lice of Lot A then were fed on the arm of a human volunteer while lice of Lot B were fed on the shaven and cleansed flank of a guinea pig. After feeding for one hour, the lice of both lots were seen to be fully engorged with blood, as indicated by the large red spot in their mid-gut visible through the integument. The lice of both lots were then returned to the incubator (30-32°C). At hourly intervals thereafter a few of the lice were withdrawn from the incubator, dissected in a drop of saline and examined microscopically with the following results:

Lot A. After one hour the lice showed a great number of intact red blood cells although it was observed that some red cells already had been destroyed as evidenced by the presence of a chocolate-brown amorphous mass. After 2 hours the number of intact red blood cells was decreased still further and by the end of 4 hours all the red cells had been destroyed. The spot in the mid-gut at this period appeared dark chocolate-brown, or almost black in color.

Lot B. The red blood cells remained intact in appearance until the death of the lice which generally took place about 48 hours after the ingestion of guinea pig blood. The intestines were still full of unchanged blood. A large number of lice died showing signs of ruptured intestines or radically altered permeability of the intestines. The red color,

* Associate member of Pasteur Institute of Tunis.

¹ Nuttall, G. H. F., *Parasitology*, 1917, **10**, 80.

² Nicolle, C., *Ann. Inst. Pasteur*, 1910, **24**, 243.

³ Bacot, A. W., and Segal, J., *Brit. J. Path.*, 1922, **3**, 125.

⁴ Buxton, P. A., *The Louse*, 1939, 2nd edition, Edward Arnolds, London.

limited at first to the intestines, diffused progressively into the abdominal cavity, into the legs and even into the extremities of the antennae until the entire louse was red in color with a darker spot present in the region of the mid-gut. This phenomenon occurs to a certain extent in normal louse colonies⁴ but appears rather more frequently among lice fed on guinea pig blood.

The above observations indicate that it is apparently impossible for the body louse to digest guinea pig red blood cells. It is believed that the intestines are ruptured by their exertions to destroy or eliminate the guinea pig red blood cells.

Experiment II. Three lots of 30 lice each (15 males and 15 females) 12-15 days of age, were isolated in separate boxes marked A, B and C. The boxes were placed in an incubator at 30-32°C, and the lice were held unfed for an average period of 36 hours. At the end of that time the lice were devoid of blood as could be seen through the integument. The following experiments were then performed:

Box A. The lice were fed on man for one hour. They were then returned to the incubator and held without further feeding until death occurred, as follows:

- 24 hrs.—29 lice alive; all fully engorged (1 male died prior to feeding)
- 48 " —29 lice alive; digestion of the blood meal completed
- 72 " —2 males and 2 females dead; 25 lice alive, intestines completely empty
- 96 " —no changes observed
- 120 " —all lice dead

Box B. These lice were fed on the shaven, cleansed flank of a guinea pig for one hour, and then stored unfed in the incubator (30-32°C) until death occurred as follows:

- 24 hrs.—30 lice alive; all fully engorged; no visible digestion of blood apparent
- 48 " —2 males and 4 females dead, the remaining lice move with difficulty; a large number show signs of ruptured intestines
- 72 " —all lice dead; the intestines are

still filled with blood of normal appearance

Box C. These lice which had already been starved for an average period of 36 hours, were held unfed in the incubator (30-32°C) until death occurred, as follows:

- 24 hrs.—30 lice alive; intestines completely empty
- 48 " —1 female and 4 males dead
- 72 " —all lice dead

An analysis of the above data indicates that: (1) Lice starved for an average of 36 hours, then fed only once on man, remain alive for approximately 4 additional days. This is the normal survival time of unfed lice under optimal conditions. (2) Lice starved for 36 hours following a human blood meal, and then allowed to feed once on a guinea pig, all die by the third day after ingestion of the guinea pig blood. Hence the time elapsed from the last human blood meal to the death of the experimental lice is approximately 4 to 4½ days. Thus, the total survival time of the lice (dating from the time of the last human blood meal) which fed on guinea pig blood (Box B) is approximately the same as that of lice which were starved for the same length of time but then fed a single time on human blood (Box A), or not fed at all (Box C).

Experiment III. Fifty 13-day-old lice were isolated in a box and held unfed in an incubator (30-32°C) for 33 hours. One died during this period. The remaining 49 lice were fed on a guinea pig for one hour and when fully engorged were placed in an incubator at 37°C for 2 hours. The purpose of this was to induce rapid dehydration and reduction of the guinea pig blood meal, permitting immediate feeding of the lice upon their withdrawal from the incubator. They were then fed on man for one-half hour. Subsequent half-hour human blood feedings were continued twice daily, morning and evening. All lice in this experiment remained alive until natural death occurred on the 35th to 40th day.

The above observations seem to confirm the hypothesis that guinea pig blood *per se* is not toxic to the body louse, since lice that have fed once on a guinea pig live their nor-

mal life span when they are allowed to continue their daily feedings on human blood.

Summary and Conclusions. Contrary to general belief, the experiments reported above indicate that guinea pig blood *per se* is not toxic to the human body louse.

In the first experiment it was demonstrated that the red blood cells of guinea pigs remain undigested in the gut of the louse.

In the second experiment it was shown that lice starved for an average period of 36 hours and then fed once on a guinea pig,

die within 72 hours, apparently of starvation. Control lice fed only on human blood, likewise were found to die 4 to 4½ days following their last human blood meal.

In the third experiment it was shown that lice fed once on guinea pig blood live their normal life span when their daily feedings are continued subsequently on human blood.

It would appear that human body lice secrete a digestive enzyme specific only for human red blood cells which makes it impossible for them to digest guinea pig blood.

15821

Mass Infection of Body Lice with *Rickettsia prowazeki*.

VICTOR CABASSO.* (Introduced by Herald R. Cox.)

From the Section of Viral and Rickettsial Research, Lederle Laboratories Division, American Cyanamid Company, Pearl River, N. Y.

In a preceding article¹ it was reported that body lice (*Pediculus humanus corporis*) which have engorged on guinea pig blood are unaffected and remain alive for their normal life span if subsequent feedings are continued almost immediately (within 2 hours) on human blood. As a result of this observation, infection of human body lice with *Rickettsia prowazeki* was achieved on a large scale, following a single meal on an infected guinea pig.

The inconveniences and disadvantages of infecting lice by the rectal route, the method employed by Weigl² for the preparation of typhus vaccine, are well known. Infection of body lice by feeding them on human typhus cases, while feasible, is nonetheless rather impractical. Guinea pigs, on the other hand, may be easily infected and maintained in the laboratory. The advantages of feeding lice on infected guinea pigs, followed by feeding the lice subsequently on *typhus immune*

humans, for the ultimate preparation of typhus vaccine are obvious.

Method of infection. Fifty female lice 12-13 days of age were starved for 30 hours. These lice, as could be seen through the integument, were devoid of blood. They were then allowed to feed on a guinea pig infected 10 days previously with the Tunis strain of classical louse-borne typhus.

The flank of the guinea pig had been shaved and rubbed with alcohol, as lice often refuse to feed if the guinea pig is not prepared in this manner. In 30 minutes the lice were fully engorged, as indicated by the large red spot visible in the mid-gut.

The lice were then placed for 2 hours in an incubator at 37°C, in order to induce rapid dehydration and reduction in volume of the engorged guinea pig blood. They were then allowed to feed on a typhus-immune man for one-half hour. Subsequent human blood feedings on a typhus-immune individual were continued twice daily. By the end of the 8th day, 37 of the 50 lice were still alive, while 13 had succumbed.

A number of the surviving lice were dissected and preparations of their intestines were stained with a mixture of May-Grün-

* Associate member of Pasteur Institute of Tunis.

¹ Cabasso, V., PROC. SOC. EXP. BIOL. AND MED., 1947, **64**, 437.

² Weigl, R., Arch. Inst. Pasteur Tunis, 1933, **22**, 315.