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NOTES ON TYPHUS FEVERS IN KENYA

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(With 11 Figures in the Text)

IN preliminary studies on typhus-like fevers occurring amongst Europeans in Kenya (Roberts, 1935), each case then investigated gave a history of having been in contact with dogs. Evidence was obtained to establish the fact that the disease was transmitted through the bite of a tick, *Rhipicephalus sanguineus* Latr., and that a large number of houses where cases had occurred harboured enormous numbers of this species.

In this paper, circumstantial and experimental evidence is produced to show that there is a probable association between the presence of rats and fleas and a non-lesion type of typhus, and that the presence of an initial lesion is a pathognomonic symptom of the *R. sanguineus*-borne type.

A TYPICAL *SANGUINEUS*-BORNE CASE OF TYPHUS

As no account has as yet been published describing a typical *sanguineus*-borne typhus case in Kenya, the following history is given:

23. ii. 36. Felt ill—nothing definite except a pain in the right side of chest.
25. ii. 36. Noticed a septic spot under right breast. Still felt ill, but continued work. Headache and night sweats began. Noticed red streaks up to axilla.
27. ii. 36. Seen by Dr Wilkinson for first time. Septic sore under right breast—black centre. Glands in right axilla very tender. Abdomen generally tender. Vomiting. Arneth count showed acute infection. 16 c.c. anti-streptococcal serum given.
1. iii. 36. Rash appeared for first time on palms, forearms and body.
7. iii. 36. Feels better. Headache gone.
12. iii. 36. Better.

Twenty-two days spent in hospital. Convalescence, one month.

Laboratory findings

28. ii. 36. Blood culture, *Staphylococcus albus* (probably a contamination).
5. iii. 36. Haemoglobin, 100%.
White blood cells, 11,200.
Red blood cells, 5,310,000.
Polymorphonuclears, 63%.
Lymphocytes, 26%.
Mononuclears, 10%.
Turk cells, 1%.

12. iii. 36. *B. typhosus*, nil.
B. typhosus para A, nil.
B. typhosus para B, 1–50.
OX 19, nil.
OX 2, nil.
OXK, 1–250.
B. melitensis, nil.

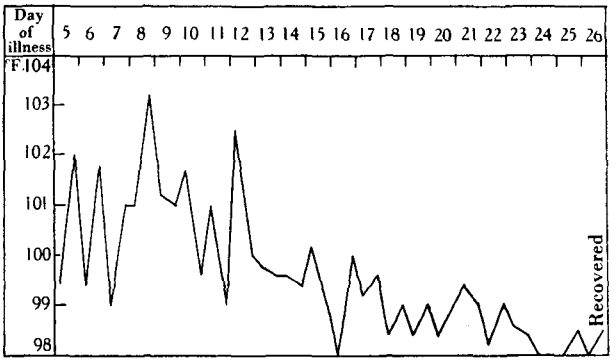

Fig. 1. Temperature chart for human case of *sanguineus*-borne typhus.

On the morning of 2 March, the lesion below the right breast was excised. It was very hard with a black centre, and resembled the "tache noir" of fièvre boutonneuse. The excised lesion was kept in saline until the following morning, then cut up into small pieces and pounded in 5 c.c. saline.

Two c.c. of this extract were inoculated intraperitoneally into two guinea-pigs.

Guinea-pig no. 1. Intraperitoneal inoculation 3 March with extract from human lesion. Very slight unilateral scrotal swelling on 7th day. Died morning 8th day.

Guinea-pig no. 1 A. Subinoculation from no. 1. Died evening of 6th day. Slight scrotal swelling prior to death.

Guinea-pig no. 1 B. Subinoculation from no. 1. Slight scrotal enlargement noted on 5th day. Very little scrotal change noted on 6th and 7th days, except hardening of testicles. 9th to 13th days the swelling was more pronounced, but less than that noted in other pigs. Steady loss in weight over period of 21 days, from 561 to 549 g.

Guinea-pig no. 1 Aa. Subinoculation from no. 1 A above. Scrotal reaction commenced on 4th day. Swelling very pronounced 5th, 6th and 7th days. Killed morning of 7th day. Rickettsiae present and numerous in smears from tunica vaginalis. Further subinoculations carried out with this material.

Guinea-pig no. 2. Intraperitoneal inoculation 3 March with extract from human lesion. Scrotal reaction commenced on 6th day. Scrotum very large on 7th, 8th and 9th days. Remained large during 10th, 11th and 12th days, but retracting. Died during night of 13th day. Further subinoculations carried out with this material.

Post-mortem report on *sanguineus*-borne typhus in guinea-pigs

Heart. Coronary vessels injected and the musculature congested, no other abnormalities seen.

Lungs. Oedematous and slightly congested. Small subpleural haemorrhages were present.

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Liver. Appeared slightly enlarged. Cloudy swellings present, organ was friable.

Spleen. Four times normal size. Surface was not smooth. Pulp oedematous and congested.

Intestines. Blood vessels congested but no haemorrhages found.

Kidneys. Cloudy swelling and some injection of superficial vessels. No lesion found in bladder.

Suprarenals. Very congested.

Testicles. Oedematous and enlarged. Very congested.

Tunica. Gelatinous fluid.

Peritoneal cavity. Contained free fluid.

Brain. Congested.

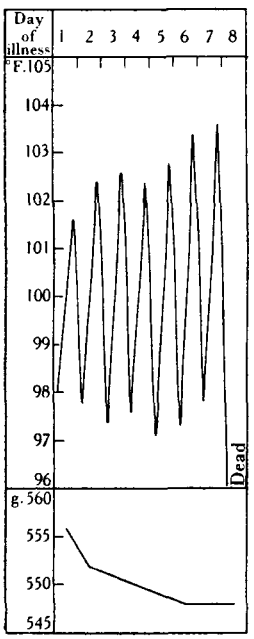

Fig. 2.

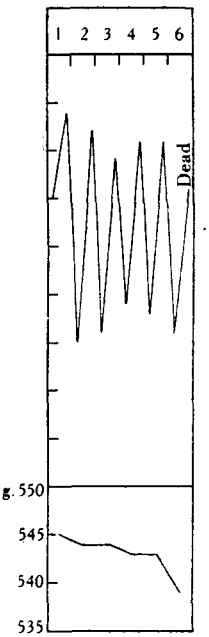

Fig. 3.

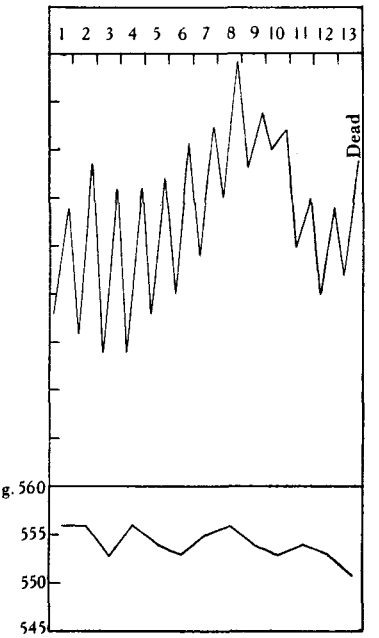

Fig. 4.

Fig. 2. Temperature and weight chart of guinea-pig no. 1.
Fig. 3. Temperature and weight chart of guinea-pig no. 1 A.
Fig. 4. Temperature and weight chart of guinea-pig no. 2.

No subcutaneous oedema was found, nor was there any appreciable enlargement of lymph glands.

The two cardinal post-mortem signs are enlargement of the spleen and the presence of ascites.

NON-LESION TYPE OF TYPHUS

A case of clinically diagnosed typhus occurred in which there was no initial lesion present on the body. He suffered a febrile period of 7 days and a rash appeared on his legs on the 7th day. Three days later, when admitted to hospital, the rash was general, including soles and palms. No signs of tick or

other bites were found on his body. Eyes not congested. No headache. Lungs unaffected.

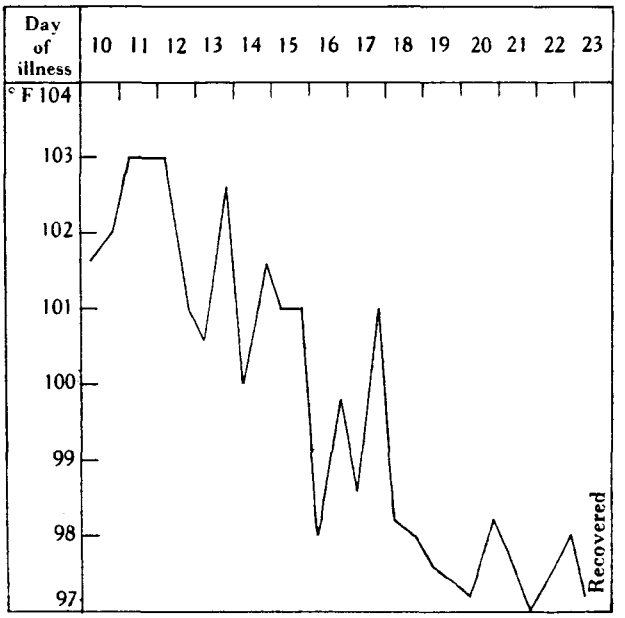

Fig. 5. Temperature chart for human case of non-lesion tpyhus. ?Flea borne.

Laboratory findings (13. x. 35)

General examination of urine.

Reaction. Acid.
Spec. gravity. 1·016.
Albumen. Present. Small amount.
Sugar. None detected.
Deposit. Few epithelial cells and uric acid crystals.

Examination of faeces for ova and cysts.

No ova.
Flagellate cysts.

Examination of blood.

Polymorphonuclears 85%. Slide indicated a leucocytosis. The polymorphonuclears seen were of a granular and immature type.
Lymphocytes 12%.
Mononuclears 3%. One myelocyte seen.

Total period of illness: 23 days.
Total period in hospital: 14 days.

Two other persons employed in the same occupation and buildings also contracted a similar disease, both of whom spent about 3 weeks in hospital. Both remained in a very weakened condition after discharge and suffered pains in the head, limbs and back for some time.

The three cases were employed at a brewery, where large quantities of malt were in storage. One type of malt, from Czechoslovakia, is received in wooden boxes, tin lined and rat proof. The other type, from England, is received in sacks. The malt store had an earthen floor and the malt was raised on small wooden platforms. An appreciable quantity of the malt had fallen from both boxes and sacks during transfer to hoppers. Rat faeces were present in large quantities on the floor, sacks, boxes and other articles. Persons employed at the brewery stated that rats swarmed in the malt storage room, also upstairs, where the malt is fermented and run through hoppers.

Four people were employed there, three of whom had contracted typhus. One man who usually takes the malt out of store reported that he frequently arrived home and picked off five or six fleas from his person, but that he never felt their bites. The other three stated that they were very susceptible to flea bites. This person, has not, so far, contracted typhus, whereas those susceptible to flea bites did contract the disease.

All four persons emphatically denied being bitten by ticks and stated that they had no recollection of being bitten by any insect other than fleas. No dogs were kept on the brewery premises.

Some of the native staff had also been ill and were generally absent from their employment for about a month, but as they retired to their reserves it was not possible to obtain any history of these cases.

RAT AND FLEA SURVEY OF BREWERY PREMISES

28 ♂♂ 41 ♀♀ *Rattus rattus* were trapped.

Fleas obtained

339 ♂♂ 354 ♀♀ *Xenopsylla cheopis*. Average—10·0 per rat trapped. 184 ♂♂ 189 ♀♀ *X. brasiliensis*. Average—5·4 per rat trapped.

Also, large numbers of *Leptosylla segnis*.

Rat mortality

Five *Rattus* were found dead in traps and forty-one died subsequently in captivity between 17 March 1936 and 6 April 1936.

It is not believed that these rats died of poison. Post-mortem appearances did not suggest such to be the case and also the time factor excluded poison, many of the rats having been in captivity over 21 days.

From the material collected at the above centre, inoculations were made into guinea-pigs, and some typical results are shown in Tables 6 to 11.

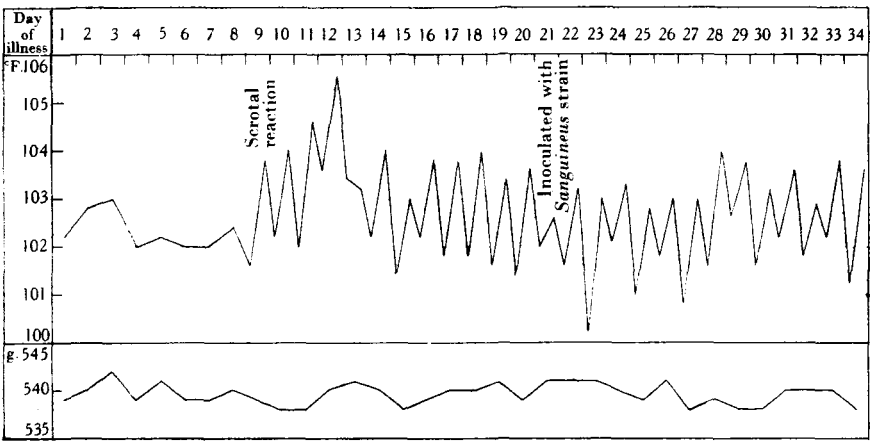

Fig. 6. 13 ♂♂ 28 ♀♀ *Xenopsylla cheopis* taken from *Rattus*, ground up in 3 c.c. *N* saline. 1 c.c. of filtrated emulsion inoculated intraperitoneally into guinea-pig. Scrotal reaction commenced on 9th day. This animal was tested for cross immunity between *cheopis* and *sanguineus* strains of virus.

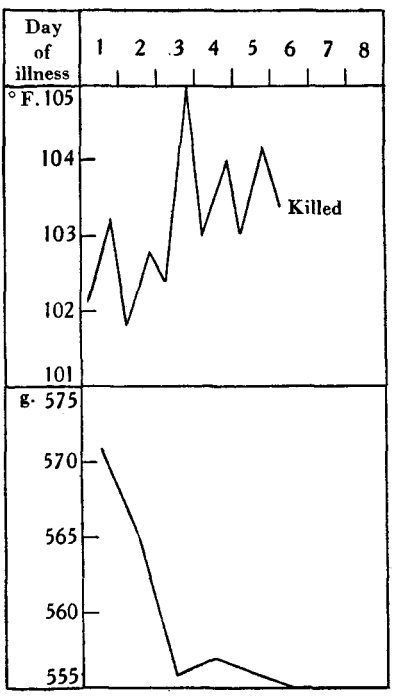

Fig. 7.

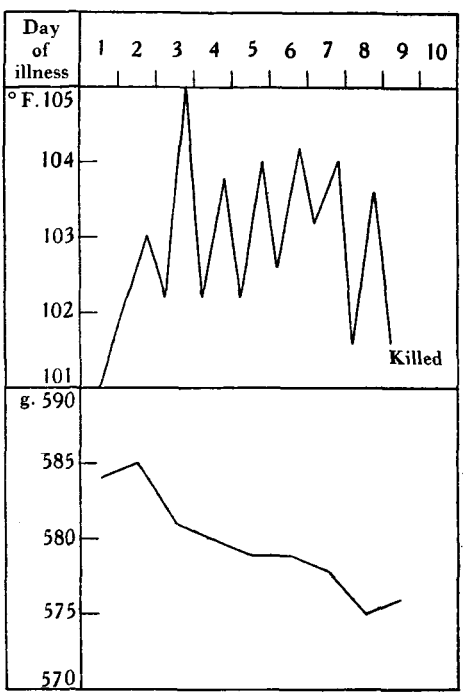

Fig. 8.

Fig. 7. 9 ♂♂ 16 ♀♀ *X. cheopis* taken from *Rattus*, ground up in 3 c.c. *N* saline. 1 c.c. of filtrated emulsion inoculated intraperitoneally into guinea-pig. Animal lethargic with slight reaction in scrotum on second day. Killed morning of 6th day. Weil-Felix reaction of blood, 1–50 OXK. Rickettsiae demonstrable in tunica smears.

Fig. 8. The brain and testes from the above guinea-pig emulsified in 5 c.c. *N* saline. 1 c.c. injected intraperitoneally into guinea-pig. Killed morning of 9th day. Rickettsiae demonstrable in tunica smears.

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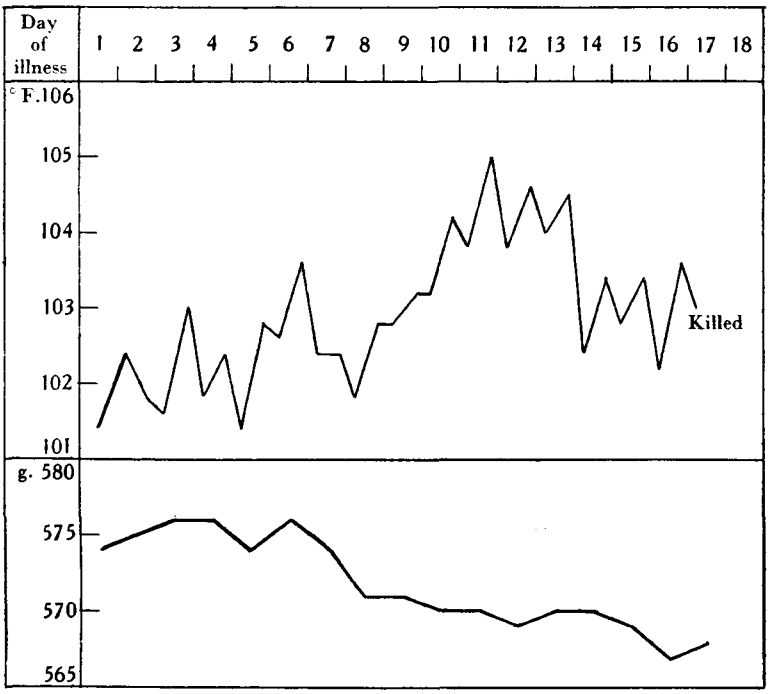

Fig. 9. 1·5 c.c. citrated blood from guinea-pig depicted in Fig. 7, inoculated intraperitoneally into guinea-pig. Animal killed on 17th day and subinoculations from brain and testes emulsion passaged ten times.

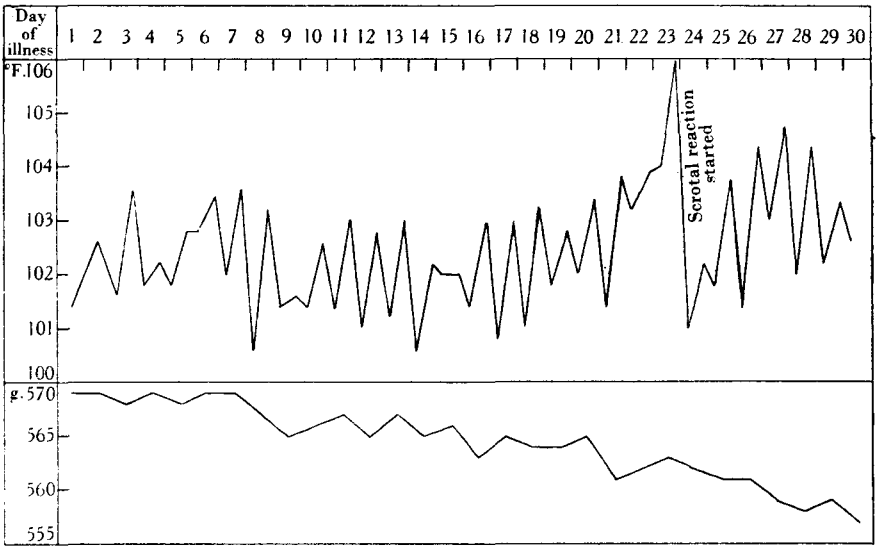

Fig. 10. From *Rattus* dying in captivity after 21 days, brain and testes emulsion inoculated intraperitoneally into guinea-pig. The dead *Rattus* at post-mortem showed an acute septicaemic condition, with testicles and heart congested, and spleen very slightly enlarged. The bacteriological examination of these rats was negative. Subinoculations from material taken from this guinea-pig was passaged several times.

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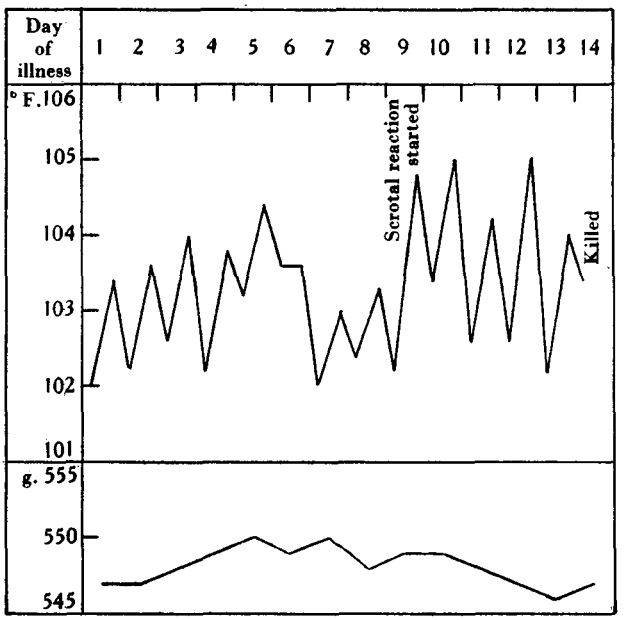

Fig. 11. Subinoculations from testes and brain material obtained from guinea-pig shown in Fig. 10. Virulence of material was enhanced.

Discussion

Kenya typhus is an acute disease that is characterized by onset of fever and severe headache, by a rash that appears between the 5th and 7th days, and by termination by lysis about the end of the second week.

Insomuch that the incidence of the main types of Kenya typhus are exclusively among those who keep dogs and among workers handling rat attracting foodstuffs, it appears that ectoparasites from dogs and rats should form the vectors of the disease. That only a few ectoparasites are capable of transmitting the disease is also apparent. Collections of ticks and fleas from general sources do not produce the typhus syndrome in guinea-pigs, but when taken from foci where cases have occurred they have produced the characteristic symptoms in experimental animals.

The suggestion that some vector, other than *Rhipicephalus sanguineus*, may be held responsible for the transmission of typhus in Kenya has already been made (Roberts, 1935). As a vector of the disease the rat flea (*Xenopsylla cheopis*) meets the requirements of the epidemiological evidence. Inoculation into guinea-pigs of emulsions of fleas removed from rats which had been trapped at a typhus focus resulted in the establishment of a strain of virus producing a typhus-like reaction in the animals. Similar results being obtained with the organs of rats.

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The course of the febrile reaction, the scrotal involvement, the post-mortem appearances, the demonstration of Rickettsiae in guinea-pigs have been similar to the findings of other workers.

Further, it has been possible to carry on the strains obtained, through passage in guinea-pigs, for several generations.

The available evidence indicates that *X. cheopis* is a probable insect vector of one form of typhus in Kenya.

The two forms of typhus occurring in Kenya, though much alike in their clinical features, are distinct diseases, distinguished from one another by their epidemiology and the presence or absence of an initial lesion.

SUMMARY

1. The history of a typical *sanguineus*-borne human case of typhus is given, together with the results of intraperitoneal inoculation of material from the initial lesion into guinea-pigs.

2. This material in the earlier inoculations caused a high mortality rate among guinea-pigs, and is characterized from the other material obtained from rats and fleas by the swing of temperatures between morning and evening.

3. Three cases of non-lesion typhus occurred in a brewery heavily infested with rats and fleas, the patients affirming they had been bitten only by fleas.

A high rat infestation was noted and a *Xenopsylla* index of 15·0 per rat.

4. Inoculation into guinea-pigs of emulsified brain and testicle material from *Rattus rattus* trapped at this typhus focus, and of emulsified fleas from the rats, resulted in the establishment of a strain of virus which produced a typhus-like syndrome in guinea-pigs.

5. Infection of guinea-pigs with strains of virus from rats, ticks and fleas, has been secured without any difficulty in Kenya, and it has not been found necessary to keep guinea-pigs on vitamin-deficient diets.

6. Typical scrotal reaction has been observed in the majority of guinea-pigs inoculated. The onset is generally sudden and coincides with the rise in temperature. Subsidence of the swelling and inflammation is gradual over about 3 days.

7. Loss in weight is not a marked feature of the forms of virus encountered in Kenya.

8. Post-mortem appearances in the rat- and flea-forms differ from those of the tick-type mainly in less ascites and slight enlargement of the spleen.

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