

TYPHUS FEVER
WITH PARTICULAR REFERENCE
TO THE SERBIAN EPIDEMIC

BY

RICHARD P. STRONG, M.D., S.D.

DIRECTOR OF THE AMERICAN RED CROSS AND INTERNATIONAL SANITARY COMMISSIONS TO SERBIA
PROFESSOR OF TROPICAL MEDICINE, HARVARD UNIVERSITY MEDICAL SCHOOL

GEORGE C. SHATTUCK, A.M., M.D.

MEMBER OF THE AMERICAN RED CROSS SANITARY
COMMISSION TO SERBIA
GENERAL MEDICAL SECRETARY, LEAGUE OF
RED CROSS SOCIETIES

A. W. SELLARDS, A.M., M.D.

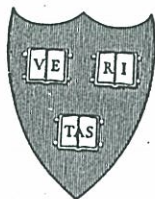
MEMBER OF THE AMERICAN RED CROSS SANITARY
COMMISSION TO SERBIA
ASSISTANT PROFESSOR OF TROPICAL MEDICINE
HARVARD UNIVERSITY MEDICAL SCHOOL

HANS ZINSSER, M.D.

BACTERIOLOGIST OF THE AMERICAN RED CROSS
SANITARY COMMISSION TO SERBIA
PROFESSOR OF BACTERIOLOGY, COLUMBIA UNIVERSITY

J. GARDNER HOPKINS, M.D.

BACTERIOLOGIST OF THE AMERICAN RED CROSS
SANITARY COMMISSION TO SERBIA



PUBLISHED BY THE AMERICAN RED CROSS

AT THE

HARVARD UNIVERSITY PRESS

CAMBRIDGE, MASS.

1920

disease in its breaking out and progress, nor any other condition of weather exert a perceptible influence in these respects. It is in this sense that almost all the authorities express themselves.

Osler has remarked that the gradual disappearance of the disease in Great Britain and on the continent has been one of the great triumphs of sanitation and this also proved to be the case in connection with the epidemic in Serbia. It will be recalled that this epidemic of typhus fever was the first extensive and serious one to occur since the demonstration of the method of the transmission of this disease by lice in 1909-10. It should be emphasized that the efforts of all of the physicians, sanitarians, nurses, and particularly of the people generally in Serbia being directed against the spread of the disease by pediculi, the suppression of the epidemic by intensive work was accomplished within a period of six months.

METHOD OF TRANSMISSION

In connection with the Serbian epidemic, it is also important to refer to the method of transmission of the disease.

As long ago as 1876, Murchison suggested, in addition to other measures in connection with the prevention of typhus, that in order to prevent an individual from acquiring such infection, it was necessary to protect him from lice. In 1903, at the International Sanitary Congress held in Paris,¹ Dr. Cortezo made a statement based upon his experiences in an epidemic at Madrid that typhus fever is transmitted by lice and fleas, but no data of specific experiments were supplied demonstrating these facts. It has been for a long time a well-recognized fact that epidemics of typhus fever and of relapsing fever occur side by side and under similar conditions, and the close association of these two diseases has indeed been noted since 1739. This fact and the work carried out upon relapsing fever by Sergent and Foley² and Mackie³ and Smith⁴ suggested

¹ Official abstracts of Proceedings of the Conference, p. 343.

² Sergent and Foley: Bull. Soc. de path. exot., 1908, i, 174.

³ Mackie: Brit. Med. Jour., 1907, ii, 1706.

⁴ Smith: Medical Thesis (London), 1909, John Bale Sons and Danielson, Ltd.

typhus & relapsing fever

with the absence of differentiation between the body

that lice were also probably the transmitters of typhus fever. However, in 1909, Nicolle¹ working in Algiers showed by actual experiments that the chimpanzee could be infected with the typhus virus by the injection of a small amount of blood from a human active case of the disease. He then showed that lower monkeys could be similarly infected by the inoculation of the chimpanzee's blood, and that then the infection could be transmitted from monkey to monkey by means of the bites of infected body lice (*Pediculus humanus* var. *corporis*). This work was shortly afterwards confirmed in the United States by Ricketts and Wilder² and by Anderson and Goldberger,³ who also showed that the lower monkeys might be infected directly with human typhus blood or by the bites of lice that had fed upon human cases of the disease. Later it was shown by different investigators, Wilder,⁴ Goldberger,⁵ Prowazek,⁶ Sergent,⁷ and Nicolle,⁸ that the disease may be transmitted to monkeys by inoculating them with the contents of crushed lice or with faeces of infected lice, the lice or their faeces becoming capable of conveying infection from two to eleven days after feeding upon typhus infected blood, and the blood in typhus fever cases being found infective from the third to the tenth day of the attack. A few experiments which have been undertaken with bedbugs and fleas seem to show that these insects do not transmit typhus fever. From other experimental work performed, first by Anderson and Goldberger⁹ and more recently by Toepfer¹⁰ Nicolle¹¹ and others, and from observations made

body lice
★ specific

✓ ¹ Nicolle: Compt. rend. Acad. d. sc., Paris, 1909, cxlix, 157; Ann. de l'Inst. Pasteur, 1910, xxiv, 243.

² Ricketts and Wilder: Jour. Am. Med. Assn., 1910, liv, 463; Wilder: Jour. Infect. Dis., 1911, ix, 9.

³ Anderson and Goldberger: Pub. Health Rep., Wash., 1910, xxv, 177; also Bull. Hyg. Lab., U. S. P. H. S., Wash., 1912, Bull. No. 86, p. 13.

⁴ Wilder: loc. cit., 1911.

⁵ Goldberger: Pub. Health Rep., Wash., 1912, xxvii, 297; and Bull. Hyg. Lab., U. S. P. H. S., 1912, No. 86, p. 37.

⁶ Prowazek: Berl. klin. Wehnschr., 1913, l, 2037.

⁷ Sergent, Foley, and Vialatte: Compt. rend. Acad. d. sc., Paris, 1914, clviii, 964.

⁸ Nicolle, Blanc, and Conseil: ibid., clix, 661.

⁹ Anderson and Goldberger: loc. cit., 1912.

¹⁰ Toepfer: Deutsch. med. Wehnschr., 1916, xlii, 1251.

¹¹ Nicolle: Bull. de l'Inst. Pasteur, 1920, xviii, 49.

by Foster in the Philippines ¹ it seems not unlikely that *Pediculus capitis*, the head louse, may also sometimes transmit the disease. Further experimental work on this question, however, would appear desirable. Nuttall ² apparently inclines to the belief that Goldberger's experiments are not entirely convincing but Nicolle ³ states that *P. capitis* may convey the disease. It has also been suggested that infection may occur in man by the ova of infected lice being rubbed or scratched into abrasions of the skin, but it has not yet been definitely demonstrated if hereditary transmission of the typhus virus occurs in lice, the evidence on this question being contradictory.

There have been no scientific and properly controlled actual experiments performed upon human beings which demonstrate that typhus is transmitted by lice, though Moczutowski in 1900 and Yersin and Vassal ⁴ and Ostero ⁵ demonstrated by human experiment that the disease could be transmitted by direct injection of typhus blood. However, in a few instances in which accidental infection or experiments in man were carried out in connection with transmission by lice, the evidence has been in favor of the view that the transmission of typhus is through this agency. These human experiments, however, had not been adequately controlled as is evidenced from the following summary of them. ⁶

Sergent, Foley, and Vialatte, ⁷ trying to prove the transmission of recurrent fever by the louse, made lice who had fed on a patient of recurrent fever bite a man. Another man was inoculated with similar lice, and still another with eggs from such lice. All of them developed typhus. Sergent, Foley, and Vialatte explained this by assuming that the patient was suffering from typhus at the same time or was already infected with typhus. This seems not unlikely, as it is well known that both of these

¹ Foster: Arch. Int. Med., 1915, xvi, 363.

² Nuttall: Parasitology, 1917, x, 52.

³ Nicolle: loc. cit.

⁴ Yersin and Vassal: cited by Thoinot, Paris Med., 1915, Nos. 49-50, p. 473.

⁵ Ostero: cited by Vincent and Muratet, "Exanthematic Typhus," Univ. of London Press, 1917, p. 207.

⁶ Banus: Intern. Jour. Pub. Health, Geneva, 1920, i, 69.

⁷ Sergent, Foley, and Vialatte: Compt. rend. Acad. d. sc., 1914, clviii, 964.

head lice as
transmitting ✓

head lice
he mean
may ✓



ress of the cases resembled typhus in other respects and that the patients were known to have been exposed to this infection. Having seen no such case I am skeptical of the diagnosis of "typhus without eruption."

If there were cases of typhoid among my patients I failed to recognize them although this disease was always borne in mind. There should be no difficulty in distinguishing typhoid from typhus when the eruption is well marked and typical, but, after a transient or scanty eruption has disappeared, doubt may arise.

Typhus with eruption on the face, as in the case seen by Dr. Sellards, might bring measles into question. The subsequent course of the fever and the characteristic changes in the rash, however, would soon settle the diagnosis.

The Widal reaction has lost much of its value for diagnosis since antityphoid inoculation has become such a common practice. Moreover, McClure¹ says that a positive Widal reaction in low dilutions is common in typhus. Clumping occurred in a few of our typhus cases at a dilution of 1 in 25. Agglutination tests for paratyphoid A and B were always performed with the Widal test. They were uniformly negative.

The bites of fleas and of other vermin, when numerous, may resemble an eruption, or may confuse the picture when an eruption also exists. Similarly, scabies may mask a rash or even lead to an erroneous diagnosis of typhus fever. (Series No. 33.)

The case of Series No. 88 presents a particularly complex combination of skin lesions. Drug eruptions, a profuse crop of rose spots in typhoid, haemorrhagic eruptions in the acute exanthemata and skin lesions in secondary syphilis, plague or influenza may require to be differentiated from typhus. The spots of purpura, cerebrospinal meningitis or acute endocarditis are not likely to cause difficulty.

The association of scurvy with typhus, which has been observed in some epidemics, and the possibility of combined infection of typhus with typhoid, dysentery, diphtheria, relapsing fever, or the exanthemata should be borne in mind.

¹ McClure: Handbook of Fevers, N. Y., 1914, p. 321.

1st
mention I
think.

here we go
again! →

of our patients. Not only were their skins originally dark in most cases, but a multitude of bites and scratchings had added to the pigmentation.

When there was more or less acne intermingled with an eruption and a multitude of bites the picture was confusing.

Purpuric Spots were found singly in a few cases beneath the finger nails or on the pads of the fingers during convalescence. One of the latter developed into a small pustule.

Sudamina were frequently observed about the neck and shoulders.

Yellowness of the *palms* of the hands was noted in two cases late in the disease.

Herpes was observed repeatedly, most often on the ears, several times about the nose or lips, and occasionally on other parts of the face.

III. *Circulatory Signs and Symptoms*

Heart Rate and Pulse Rate. The pulse rate corresponded with that of the heart except when the pulse was extremely weak. In the case of Autopsy No. 23 on the last day of life such a discrepancy occurred.

In the first half of the febrile period the pulse rate was low, as a rule, in proportion to the temperature. It ranged most often between the upper eighties and one hundred or slightly higher with temperatures of 103° to 104°. Sometimes the pulse rate remained low throughout the illness (Series No. 48). In other cases, particularly in the sicker patients, the rate increased gradually to 120 (Series No. 59) or higher. Most of the patients whose pulse rate went above 130 died. Rates between 140 and 148 were counted, however, in a few patients who recovered (Series Nos. 9 and 93). The pulse often followed the temperature closely (Series Nos. 9, 61, and 93). In fatal cases with a terminal rise of temperature the pulse usually followed the temperature (Autopsy Nos. 18 and 25). Two patients dying with *moderate fever* had pulse rates that were *relatively high* (Autopsy Nos. 23 and 24) on the last days.

An old man who died suddenly and unexpectedly with a

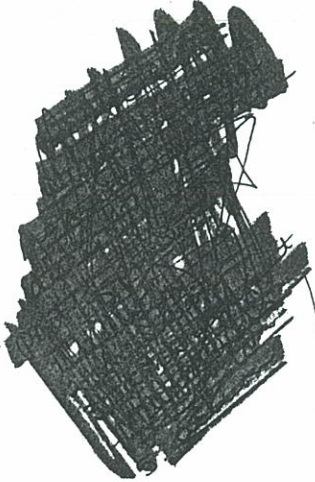
mit against their will to delousing measures. The first problem is to change their mental attitude so that they will be willing to coöperate and spread the doctrine of the campaign. For this reason it has been recommended that there should be instituted as an important part of the new campaign a comprehensive plan of education regarding the prevention of typhus designed to reach practically the entire population. Particular effort will be made to arouse and stimulate the activities of the people generally through religious organizations, schools, the press, through cinema exhibitions, relief organizations, magistrates, and other officials of towns and villages, and prominent business men. In this connection a play has been written by Major Richard Taylor of the staff of the League of Red Cross Societies, which is now being performed in Poland. This play, which is in the form of a drama, depicts the terror of this widespread disease, particularly among the poorer classes of the population in Poland, and at the same time it shows how it may be fought successfully by proper measures. One of the most interesting scenes depicts the arrival of a relief commission for health work in a village which is ravaged by typhus.

Dr. Buchanan of the Ministry of Health of Great Britain, and a member of the Interallied Medical Commission of the League of Red Cross Societies to Poland, since his return from Poland has not relaxed his efforts in Great Britain in connection with the medical relief of that country. Very recently at the British Ministry of Health an International Health Conference was held at the instigation of the Council of the League of Nations, at the sessions of which relating to Poland Dr. Buchanan presided. Representatives of the Polish government and of the League of Red Cross Societies furnished this Conference with information concerning Poland's needs in combating the typhus scourge; and the Conference agreed that action by the League of Nations was necessary. The measures necessary to combat this epidemic on a large scale were set forth, namely, the establishment of sanitary cordons, hospitals, delousing stations, the provision of food and fuel; and expert direction of the work; and it was recommended that, whenever

*back to
the future!*

*where would a
copy of this
be?*

ment will seriously impel and support the campaign there would seem to be every reason to feel that under the efficient direction of Colonel Godlewski, who has been placed in entire charge of this work, assisted by Colonel Shaw in charge of the inspection service, Colonel Gilchrist in charge of bathing and delousing work, and Colonel Chesley in charge of distribution of American supplies, we may look forward with confidence to the administration of the campaign. The present plan of campaign includes a comprehensive scheme for cleaning up central Poland inasmuch as all reports indicate that the disease has obtained a firm foothold throughout the entire territory of Poland and is no doubt spreading more or less extensively from these foci. It is the intention, however, that there should be no relaxation but an additional prosecution of the work of excluding the disease along the eastern and southern frontiers.



Poland, however, has so many serious problems confronting her that neither many of the governmental officials nor the people at large have as yet become thoroughly and sufficiently aroused to the importance and necessity of ridding the country of the disease. The epidemic has not been sufficiently prevalent or the mortality sufficiently high as to convince the people of the necessity for an intensive efficient anti-typhus campaign and of the inevitable inconveniences which must accompany it. Indeed the general attitude of many of the people in Poland is hostile to anti-typhus work, perhaps because often during the German occupation the people were compelled to submit to the necessary delousing measures which were applied by the Germans with military severity. As has been emphasized in this article in discussing the Serbian epidemic, one of the most important features in the suppression of this epidemic was the coöperation of the people in all efforts to eradicate the disease. In Serbia, however, the disease was general, and the very great majority of the families in the entire country has suffered from it. In Serbia also the mortality was in the neighborhood of 50 per cent, whereas in the Polish epidemic it has scarcely been above 9 per cent. As Colonel Shaw writes, it is manifestly impossible to compel a whole population to sub-

might suggest early
 symptom before diagnosis
 thus ?? tests at this time

TYPHUS FEVER

Year	Investigator	Rickettsia bodies or organisms resembling them found in
1917	Lopez	Blood of typhus fever, found same intraleucocytal bodies, in 77 out of 90 cases. <u>Blood must be taken from well-marked cases and at the height of the fever, to contain these bodies.</u>
1917	Schmidt	Organisms found in 3 cases only, out of many cases of five-day fever examined.
1917	Jungmann and Kuczynski	Blood of typhus patients during first days of the rash, and also in trench fever. Had never found organism in other diseases.
1917	Werner and Benzler	In the stomach of lice fed upon cases of <i>febris quintana</i> .
1918	Brumpt	53 out of 72 body lice taken from healthy prisoners of war, pure culture found in the alimentary canal and in some cells. 16 lice from healthy prisoners of war were all infected, etc.
1918	Arkwright, Bacot, and Duncan	Lice fed on trench fever patients. Normal lice fed on persons not exposed to trench fever infection remained free from Rickettsia.
1918	Kuczynski	In the petechiae of typhus cases, in sections of liver in the endothelial cells of the capillaries, and in free phagocytic cells.

Our studies regarding the occurrence of Rickettsia bodies in lice which have fed upon healthy persons have confirmed those of a number of observers already referred to. Lice collected from healthy men in different parts of France, where neither typhus fever nor trench fever were present, were often found to contain Rickettsia in their dejecta: from 20 to 40 per cent of such lice examined, collected in different groups, revealing these bodies. In some of these normal lice, microscopical examination of the excreta or material from the alimentary tract showed them to be severely infected with Rickettsia bodies. Others were only moderately or very slightly infected, while in the remaining no definite Rickettsia were observed. Obviously from a microscopical examination, it is sometimes extremely difficult to say whether these bodies are not present in small numbers in the lice. Plate XXI, Figures 1 and 2, demonstrate the Rickettsia bodies in the excrement of normal lice.¹ There

¹ These photomicrographs were kindly made at the Pasteur Institute by Dr. P. Jeantet, who is in charge of the photomicrographic work of this Institute. I wish to express my thanks to both Dr. Roux, the Director of the Pasteur Institute, and to Dr. Jeantet, for this courtesy.

Year	Investigator	Rickettsia bodies or organisms resembling them found in
1916	Toepfer	Blood of Volhynia fever. Also in lice from typhus fever patients. Lice from typical Volhynia fever contained bodies in alimentary tract similar to typhus fever organism. Bodies both free and inside the cells.
1916	Toepfer	Examined smears and sections of 500 lice. Confirmed his former observations regarding organism in infected lice. <u>Same parasite found in lice from heads of patients and in artificially infected normal lice of this species by placing them upon the sick. Smears from lice fed on typhus blood contained organism.</u> Described intracellular diplobacilli in tissues of typhus patients.
1916	Hanser	Confirms Toepfer's discovery of forms in intestinal cells of lice fed on typhus patients.
1917	Munk and Rocha-Lima	Found diplobacillus in blood of Volhynia fever cases, but also found same in blood from patients with other diseases or even from healthy ones. Munk made 70 experiments on patients diagnosed as Volhynia fever cases, — 51 positive for <i>R. pediculi</i> , 11 negative, 6 doubtful. Among negatives were some typical cases. Among 33 control tests, 26 were negative and 6 infected same as lice from Volhynia fever cases. These 6 cases upon which the lice were fed which proved positive for Rickettsia were 3 malaria, 1 bladder disease, 1 bronchitis, 1 inguinal hernia. <u>One normal gave rise to strongly infected lice.</u> Rocha-Lima and Korbsch attempted propagation of Volhynia fever with lice, but not successful although lice were strongly infected.
1917	Toepfer and Schuesler	In 400 lice which had fed on 35 patients, bacteria-like organisms were found in the infected lice. Organisms found constantly in intestinal canal of lice removed from typhus patients and often in cells of alimentary tract. Control lice fed on other individuals than those suffering with typhus fever remained free. <u>Organism found only in lice fed on blood of typhus patients during febrile (not post-febrile) period.</u>
1917	Toepfer	In article on war nephritis describes similar organisms to those seen in lice fed on cases of typhus or Volhynia fever. <u>Found similar organisms in 3 diseases, i. e., spotted fever, Volhynia fever, and nephritis.</u>
1917	Otto and Dietrich	In lice placed on patients. Infection not hereditary. They infected lice with Rickettsia by feeding them on a case of typhus fever without the exanthem.

1-11



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as small short rods. Polar staining rods and diplobacilli forms were present. He believes these organisms to be bacilli and not protozoa, and considers that they are the cause of the disease.

Toepfer¹ in a more recent work examined smears and sections of 500 lice. He believes he has confirmed his former observations regarding the presence of an organism in infected lice. He criticizes the name of *Rickettsia prowazeki* as giving a wrong impression of the nature of these organisms.²

He found the same parasite in lice (*Pediculus capitis*) taken from the heads of patients, and he was also able to artificially infect normal lice of this species by placing them upon the sick. Smears made from lice which had previously fed on the blood of patients infected with typhus fever were found to contain nearly pure cultures of the organisms.

In another paper on the aetiology of typhus, Toepfer³ describes the organism found in tissues of typhus patients and in infected lice as intracellular diplobacilli.

Hanser⁴ reports that he has confirmed Toepfer's discovery of bacteria-like forms in the intestinal cells of lice fed on typhus fever patients.

Toepfer⁵ in another article upon war nephritis describes similar organisms to those which he had observed in lice fed upon cases of typhus fever or of Volhynia fever. He regards this form of nephritis as a specific disease, probably transmitted by lice. He also considers it plausible that the virus circulates in the blood. Guinea pigs inoculated with blood from the nephritic cases grew lean and had bloody urine, but no rise in temperature. In the lice from the nephritic cases, especially those which had fed during the early stages of the disease, definite bacteria were found almost without exception. He also infected lice by feeding them on the nephritic cases, and in order to control these results he put lice of the same breed upon healthy people and these remained uninfected. These or-

¹ Toepfer: Deutsch. med. Wchnschr., 1916, xlii, 1251.

² Rocha-Lima (ibid., 1353) in a subsequent paper controverts the statement of Toepfer regarding the nature of *Rickettsia prowazeki* found in the intestinal cells of infected lice.

³ Toepfer: ibid., 1383.

⁴ Hanser: ibid., 1254.

⁵ Toepfer: Med. Klin., 1917, xiii, 678.

head lice
infected!



Control lice fed on other individuals than those suffering with typhus fever remained free from these organisms. From microscopic examination, the organisms seemed to be in pure culture in the infected lice. This organism was found only in lice which had been fed for some days on the blood of patients during the febrile period. Lice fed during the postfebrile period did not apparently become infective. The eggs and offspring of the infected lice were not found capable of producing infection. The parasites continued to develop in the intestine of the lice and apparently remained infective indefinitely. They were not able to cultivate the organism. The injection of the contents of the alimentary tract of an infected louse into a healthy guinea pig produced a febrile condition similar to that produced by the injection of the blood of a typhus fever patient.

In connection with Volhynia fever Toepfer¹ called attention to the presence of characteristic bodies in the blood in Volhynia fever. In three cases of this disease he observed spirochaetes. In one instance, in a fresh specimen, the organism was motile. In lice taken from typhus fever patients he found bodies similar to those described by Rocha-Lima. He is unwilling to commit himself whether a connection exists between the bodies and the spirochaetes.

In another paper relating to Volhynia fever, Toepfer² expresses the opinion that the organisms described by His and Werner as the cause of this fever were accidental artefacts. He found in the blood small parasitic-like bodies, but did not consider that these were diagnostic. He, however, convinced himself that the virus was circulating in the blood in this disease as he performed experiments by injecting five cubic centimeters of blood intraperitoneally into guinea pigs and obtained similar temperature curves to those which were injected with blood from typhus patients. He found that lice taken from typical cases of Volhynia fever contained in their alimentary tract bodies similar to the typhus fever organism. These bodies were found both free and inside the cells of the louse, and appeared

¹ Toepfer: Berl. klin. Wchnschr., 1916, liii, 323.

² Ibid.: München med. Wchnschr., 1916, lxiii, 1495.

Spirochaetes
found in
lice
(? spirochaetes
lymph. in same)
Typh

lieved that *Bacillus proteus X 19* possesses specific properties in connection with the disease, and Werner and Leoneanu¹ and Hilgermann and Arnoldi² have even made human inoculations for protection against typhus with this organism. On the other hand, Nicolle, Hort³ and others believe that typhus is due to a filterable virus. On account of the attention that has been recently called to the *Rickettsia* in relation to the disease and the opportunities for the investigation of the aetiology of typhus which will undoubtedly occur in connection with the epidemics of this disease in Central and Eastern Europe, it seems advisable to present here a detailed account of the investigations which have been already made in relation to the *Rickettsia*.

THE SIGNIFICANCE OF RICKETTSIA IN RELATION TO DISEASE

In 1916 Rocha-Lima called attention to the presence of very minute bodies which were found in lice which had fed upon patients suffering from typhus fever. These bodies were present not only in the contents of the alimentary canal, but especially in the epithelial cells of the alimentary tract of these insects. He regarded them as very minute microorganisms. They were elliptical, oval, often found in pairs and bipolar in appearance. The smallest forms measured from about .3 to .4 μ and the larger ones, sometimes biscuit-shaped, from .4 to .9 μ . They were best demonstrated by staining in Giemsa's solution. These organisms were not at first found in lice which had not fed upon cases of typhus fever. The lice were said to become parasitized only after ingesting infected blood. Rocha-Lima pointed out that while these bodies slightly resembled bacteria in their morphology, they were in other respects more like the Chlamydozoa-Strongyloplasmata. He therefore proposed for them the name of *Rickettsia prowazeki* (n.g. n.sp.) evidently choosing this name in memory of Ricketts and Prowazek, both of whom succumbed to typhus fever which they contracted

¹ Werner and Leoneanu: München. med. Wehnschr., 1918, lxxv, 587.

² Hilgermann and Arnoldi: Deutsch. med. Wehnschr., 1917, xliii, 1582.

³ Hort: Brit. Med. Jour., 1917, p. 265.

mind that this does not exclude exceptional instances of infection by other means.

Typhus fever claims more victims in the medical profession than any other epidemic disease. The mortality among physicians in epidemics is generally high. Osler states in a period of 25 years in Ireland, among 1230 physicians attached to institutions, 550 died of typhus. Minkine reports that out of 13 physicians working at the typhus hospitals, 12 contracted the disease, and 6 of them died. Butler in connection with his typhus hospital unit states that of 6 physicians, 4 contracted it and 2 died. The mortality among the Serbian physicians, 126 out of 350, or 36 per cent, has already been referred to. Moreover, some of these physicians were immune from previous attacks contracted before this epidemic. Friedberger,¹ in reporting an epidemic at Schutzen in 1915, states that 24 of the doctors were attacked and 14 died, a mortality of 58 per cent; that of 332 nurses, 71 fell ill of whom 15 died, a mortality of 21 per cent; at the same time the disease among the Russian prisoners showed only a mortality of 7.8 per cent. Why is infection with typhus so common and the mortality so high among physicians? Is there an opportunity of direct infection by some means in which the virulence of the infection (as in pneumonic plague) is uniformly greater than when it is transmitted through the intermediate host, in the case of typhus, the louse; and in bubonic plague, the flea?

AETIOLOGY

Bacteriological investigations in regard to the aetiology of typhus were carried out during the Serbian epidemic in connection with several of the larger hospitals.

In spite of the very large amount of experimental work that has been performed in relation to the causative organism of typhus, there is no general unanimity of opinion upon the nature of the virus. A number of different investigators working in different epidemics in various parts of the world have described species of cultivable bacteria as the cause; others

¹ Friedberger: Ztschr. f. Hyg. u. Infectiouskrankh., 1918, lxxxvii, 475.

*Defecal?
They never
speak of STD*

*Virulence
re: intermed
host*

tuck¹ in Serbia of a nurse who protected herself very carefully, wearing a louse-proof suit. She had to sponge and swab the throat of a very severe case with serious lung and mouth complications. The patient was free from lice but coughing frequently. The nurse developed typhus after two weeks. Of the same opinion are Flueggi, Gaertner, Bujwid, Kisskalt, Uhlenhuth, and Stroklosinski,² Larrieu and Delarde and d'Halluin. Delarde and d'Halluin³ believe that in some cases of typhus during the epidemic they studied in Germany, droplets of saliva expelled in coughing were infectious, and when inoculated to the mucosa produced the disease. They also report the case of a physician who was found to be free from lice and yet contracted typhus. (One should not dismiss such evidence with the mere statement that the small larval stages of lice may well escape notice.) It does not seem entirely improbable that some of the doctors and nurses, who came repeatedly into very close contact with typhus cases and who have lost their lives from this disease during the war, contracted the infection perhaps because they regarded the only possible means of transmission to be by body lice, and only took precautions against this means of infection. That typhus may be sometimes transmitted by some other means than by the louse is a view held by a considerable number of physicians who have had during the war an unusual experience during epidemics, though little credence is given to this idea by some investigators who have no such experience and who have formed their judgment that the louse is the sole transmitter from the louse transmission experiments recorded in the literature.

Granting that the spread of the disease in epidemics is due to louse transmission, and that our methods in combating successfully this disease in epidemics need only be directed against such a means of transmission, nevertheless, it must be borne in

¹ Shattuck, G. C.: Harvard Graduate Magazine.

² Flueggi, Gaertner, Bujwid, Kisskalt, Uhlenhuth, and Stroklosinski: Med. Klin., 1915, p. 586.

³ Larrieu and Delarde and d'Halluin: Bull. et mém. Soc. méd. d. hôp. de Paris, 1916, xxxii, 320.

*backlash of
literature as
gospel*

the disease are due to this method of transmission alone, nevertheless, several careful observers have the impression that exceptionally and rarely typhus may be transmitted to those who come into close intimacy and contact with patients by some other means. In cases of typhus in which there are abrasions of the mucous membranes of the mouth, nose, and throat, the possibility of infection through coughing should be borne in mind. A number of observers are in favor of this idea. Thus Kraus believes that there is some other means of transmission than by the body louse, and states that this was the belief of all the Galician doctors who based their views on the observation that if the rooms containing typhus patients were kept well ventilated, no infection occurred among the personnel. Allan¹ is of the same opinion that, if a person not protected by a previous attack remains some time in a close, stuffy room near the patient, he runs the risk of contracting the disease although no lice may be present. Walter² suggests the danger of overlooking such a possibility and describes an epidemic which he could not entirely explain on the assumption of transmission by the louse. Friedberger,³ in his account of the epidemic in Pomerania, expresses doubts as to whether the louse is the real carrier, because he found cases that he could not ascribe to louse bites, among which were those of four doctors who developed typhus without even having felt a louse bite, and that of a lady who only once for a short time had entered a room occupied by patients in order to give them some apples.

The idea of droplet infection is also supported by Rondke,⁴ who bases it on the evidence of the case of one nurse who developed typhus when no new patients had been admitted for ten days, while all the sick people were free from lice. She had taken very carefully all the precautions advised, but did not wear a mask. A similar case is reported by Sellards⁵ and Shat-

¹ Allan: Brit. Med. Jour., 1915, ii, 841.

✓ ² Walter: Berl. klin. Wchnschr., 1915, lii, 851.

³ Friedberger: Ztschr. f. Hyg. u. Infektionskrankh., 1918, lxxxvii, 475.

⁴ Rondke: Med. Klin., 1915, p. 1152.

⁵ Sellards: Part III in this Report.

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phus fever. As yet there has been no experimental proof that the sputum or saliva in typhus fever contains the virus, but on the other hand there have been no careful experiments performed upon man in which the saliva or sputum have been employed for infection. Also, even if typhus may sometimes be transmitted to man by droplet infection, the experimental proof of this fact might be very difficult. In this connection we have only to recall the negative experiments performed upon man by Rosenau and his associates¹ in connection with the transmission of influenza by the sputum and by droplet infection. It must be borne in mind that the virus of typhus fever has repeatedly been shown to be present in the blood; that Moczutowski inoculated himself in this manner and suffered an attack of typhus fever after an incubation period of 18 days. Yersin and Vassal also inoculated two men with typhus blood who developed typhus after 14 and 21 days respectively. While the experimental transmission of typhus infection to monkeys and other animals is certainly sometimes very unsatisfactory,² and the proof that the infection has been actually transmitted not always definite and convincing without the most minute study, nevertheless, practically all such transmission experiments in animals are also in favor of the view that the virus of typhus is present in the circulating blood and that the blood is usually infected during the active period of the fever. As the virus is present in the blood it would not be surprising if some of the secretions also contained it. The experiments recently performed on man in demonstrating the method of transmission of trench fever are interesting in this connection.³ A series of inoculations in man with urine or urinary sediments and with saliva or sputum from typhus cases might give further information on this question. While it seems evident that the only common and important method of transmission of typhus is through the louse, and that epidemics of

¹ Rosenau: Jour. Am. Med. Assn., 1919, lxxiii, 311.

² See in this connection, Friedberger, Ztschr. f. Immunitätsforsch. u. exper. Therap., 1920, lxxix, 125, who states it is not possible to infect guinea pigs with typhus blood.

³ Trench Fever, Report of Commission Medical Research Committee, American Red Cross, Oxford University Press, 1918, p. 37.