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FILE

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Dear Deborah,

I've read through the latest batch of material you sent me - and appreciate the effort you made to collect and Xerox it. As a result, I think I can offer a bit more perspective on the head louse-typhus relationships as presented in the scientific literature. I'll venture to recapitulate and interpret some of the items on which I have commented previously.

In Nicolle's paper of 1910 (Ann. Inst. Pasteur 3, 24, pp. 243-275) describing the experiments in Tunis which demonstrated the rôle of the human body louse in transmission of classical typhus, he did not implicate or even mention headlice as a possible alternative vector.

From 1910 to 1912, Anderson and Goldberger who had worked chiefly in Mexico published in USPHS Pub. Health Reports a series of papers summarizing their results; these were re-published as a monograph (Collected Studies, Bull. of the Hygienic Lab. # 86). Paper 5 states

"Although all the important features of the epidemiology of typhus are satisfactorily explained on the basis of its transmission by means of the body louse (*P. vestimenti*), nevertheless on account of the close relationship between this insect and the head louse (*P. capitis*) it seemed desirable to test the possibility of the transmission of the disease by this latter species...."

In one of 3 experiments a monkey bitten by headlice collected from typhus patient proved resistant on later challenge with virulent typhus blood. Also, a monkey inoculated with ground-up headlice which had fed on typhus patients showed an extended fever and was subsequently refractory to inoculation with virulent typhus blood.

They stated, "In this paper we present the first evidence incriminating any insect other than the body louse as an intermediary in the transmission of typhus fever ...." They concluded, "The head louse (*P. capitis*) may become infected with typhus. The virus is contained in the body of the louse and may be transmitted by subcutaneous circulation of crushed insect and, we believe, also by its bite."

In 1915 Foster reported the study of an outbreak of clinically mild typhus (resembling Brill's disease) among adults in their 20's seen in a military hospital on Mindanao. The patients were seen during the rainy season, in a temperate (rather than tropical) region, when blankets were required at night; patients lived or visited in a filthy, overcrowded, verminous environment and the heads of many individuals in the families were infected with headlice. Since the body louse had not been previously recognized by government entomologists to be found in the Philippines (? Tugon) Foster was convinced that the headlouse was the means of transmission. Transfusion of patients' blood produced a febrile reaction in 2 or 3 local monkeys, without eruption. (There were no lab. methods available to test the specificity of the results.) No attempt was made to experimentally transmit infection, <sup>from patients</sup> via lice to monkeys.

In Töppel's 1916 study of the typhus agent in the louse (*Deutsch.-Med. Wochschr.* 1916, 42, 1251-54), he reported chiefly on microscopic examination of Giemsa-stained smears of teased preparations (or sections) from the gut of the arthropods (over 5,000 in total, including controls). He described developmental forms of a morphologically and functionally distinctive microbe which he regarded as a bacterium (bacillus) rather than as a new variety/categor<sup>g</sup>y *la Rocha Lima*. His organisms were found profusely in cells or lumen of the gut, also in the dejecta. (Unfortunately he had no way to identify or tag the organisms serologically or otherwise, as Murray and Torrey could do many years later.) He had previously worked with body lice; here his focus was on headlice.

Töpfer was successful in demonstrating "his" organism in headlice from female typhus patients or convalescents who had ostensibly been deloused but whose hair had not been shorn. To eliminate the objection that the insects might be bodylice which had taken up residence on the head, he personally supervised collection of lice from patients in whom no body lice could be found. He was also able to distinguish head from body lice by differences in the morphology of abdominal segments. The lice showing organisms were "red ones" as in body lice, i.e. which had sucked up appreciable quantities of blood. He found infected adult headlice on 12 patients, which he considered to plead against admixture of the varieties; immature forms of lice were uniformly negative and there was no evidence that the agent was transmitted hereditarily. He was successful in artificially infecting headlice maintained on strips of felt. He concluded that headlice were more susceptible and observed that they die off more rapidly; therefore they may play a lesser role than body lice but sanitary anti-typhus measures should be directed against both varieties. He considered "his" organisms from headlice, as well as from body lice, to be etiologically responsible for typhus. They multiplied abundantly in the louse gut and could enter the human host via bites but also by rubbing the feces on the skin, squeezing the insect, or occasionally by other means (e.g. the conjunctiva). Experimental data were limited, though he did circulate a few guinea pigs with louse gut organisms and found that fever was provoked. (He conjectured that there may have been difficulties in publishing in a clinical journal, during wartime).

In Nicolle's review article on the status of experimental work on typhus, published in two parts early in 1920 in Bull. Inst. Pasteur, he specifically avoided citations of the prior work of others and presented the facts as he saw them. Part I dealt with evaluation of the susceptibility of various laboratory animal species and the methods for working with them; there is no mention of lice. It is in part II that he stressed the important role of body lice as the vector in typhus — but acknowledged the ability of the headlouse to likewise transmit infection, in a single sentence on p.55. (cf. my letter of

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In the monograph published later that year, Strong and his co-authors (including Dr. Z.) cited the foregoing report as furnishing some support for the thesis that headlice may sometimes transmit typhus - but they indicated that further experimental work on this matter would be desirable.

In "As I Remember Him", Dr. Z. recounts his 1928 visit to Tunis to work in Nicolle's lab on the transmission of typhus to monkeys via lice. Subsequently the two men travelled together in France and maintained regular correspondence (-would that letter still be located!). He also tells the amusing anecdote about collecting headlice in Boston for typhus studies. Thus he (and Nicolle) must have had no doubts about the vector potential of headlice and he expressed this in "Rats, Lice and History".

The work of Murray and Torrey in 1915, employing methods which enabled them to demonstrate that headlice can acquire infection by feeding on a mammalian host previously circulate with rickettsiae, also that the organisms proliferate in the gut to an extent which results in the insect's death, led them to a similar conclusion. (They may have been inhibited from attempting to transmit the disease via headlice to primates by the cost and logistics of maintaining such animals.)

In summary, even without the availability of the Nicolle-Zeissner correspondence the published evidence points to the undesirability of headlice as an associate in man's immediate environment, particularly if conditions were to favor proliferation and dissemination of the insect among populations including individuals who might be rickettsemic.

Hoping the foregoing will be helpful to you, I am

Sincerely

Morris F. Shaffer