IS LEPROSY TRANSMITTED BY INSECTS?

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Introduction

Although the leprosy bacillus was found by Armauer Hansen in 1874, and although nobody doubts that it is the cause of leprosy, the conclusive proof has never been obtained. As *Mycobacterium leprae* cannot be cultivated, pure cultures have not been available, and the few experiments which have been made to inoculate human subjects with lepromatous nodules have either been negative or of doubtful positivity, because the person in question might have acquired the infection from another source. So the paradoxical situation exists, that although the microorganism is generally accepted as the cause of leprosy, we still lack the proof of its causative relationship and even if we are convinced of that we are ignorant of its mode of introduction into the human body.

It is generally believed that leprosy is transferred from one human being to another through intimate contact, which if of longer duration is more effective. How the germ is transferred through contact has never been precisely explained. In spite of certain similarities to tuberculosis, there is no reason to think that leprosy is transmitted in a similar way. The lungs are not affected by leprosy and there is no reason to assume that contagion takes place through inhalation of infected material. Neither is infection likely through ingestion of food or drink, for although it is possible that victuals may be contaminated by *M. leprae*, intestinal lesions do not belong to the picture of leprosy and no such portal of entry has been claimed for human leprosy, although Marchoux and Sorel found that rat leprosy could be transmitted through the stomach.

The actual mode of transfer has never been precisely detected. Some have thought of the nasal mucosa as a portal of entry, but in this country lepromatous lesions in the nasal mucosa were most uncommon and not likely to be initial lesions. Others have thought the bacilli might be transmitted from lepromatous ulcers, without indicating how infection could be brought about. For it is by no means clear how the infection could be conveyed, even if a person got his hands contaminated with *M. leprae*, as the organisms do not penetrate the skin, and it is very doubtful if they can infect through ingestion. Infection through scratches or some skin wounds is of course possible, but such a mode of infection has never been proved, and experience from leprosy endemic countries has given no special indications of such a mode of transmission, as far as I know.

Leprosy in Iceland has been very prevalent during the last centuries, until a hospital was built specially for leprosy patients at

the turn of the century, when there were over 200 cases in a population of 70,000. Since then the number has decreased rapidly, so that now there are only six patients left in a population of 160,000.

At the time when leprosy was most prevalent, the hygienic conditions of the population were very poor. Almost the entire population lived in poor and dark huts in the country, where lice and fleas abounded. Scabies was a common disease and the belief was widespread that to be without lice was a sign of bad health.

If it were true that leprosy could be spread by these skin parasites, it would be only natural for the disease to develop into the scourge which it actually was during the last three centuries in this country.

Reasons for enquiry. Investigations into possible insect transmission of leprosy could profitably start from Iceland, where the insect fauna is more limited than in most, if not all, countries where leprosy has been prevalent. Here there are no anopheles, no culex, no ants, no cockroaches; bedbugs have been practically non-existent, and yet leprosy has been just as widespread as in many countries where mosquitoes and all kinds of insects abound. If transmission is brought about by insects, the vectors would have to be sought among the limited number of species which exist here.

For this purpose we wrote to 62 hospitals and leprosaria, partly also to medical authorities in various parts of the world, listing the parasites which we thought to be the only ones likely to transmit the disease in this country, and asking them to answer the enquiry list for their country. We received replies from 42 countries. The questionnaire is given in Table I in the Appendix to this paper.

The replies. From all 42 institutes, health ministries, etc., we received our questionnaires carefully completed. Several were accompanied by additional pieces of information and various kinds of comment. Some added that they did not believe insects had anything to do with transmission of leprosy, most of them displayed interest in the inquiry, and some were convinced that leprosy is transmitted by one or more kind of insects.

A summary of all the replies to our questions is given in Table II in the Appendix to this paper.

In Table III the frequencies of insects in the above mentioned territories are shown numerically, and given in the Appendix to this paper.

It will be seen from the summary in Table II that two parasites are reported in all countries, namely the *Pediculus capitis* and *Pediculus pubis*, whereas the body louse is reported as absent in 21% of the territories in question. Two other parasites, *Pulex irritans* and *Acarus scabiei*, are reported as more or less frequent in 93–95% of leprosy endemic territories. As our questions refer to present conditions, it is of course possible that those two parasites were

more frequent formerly, when leprosy was more widespread than now.

From the replies one would suspect the following ectoparasites particularly: *Ped. capitis*, *Ped. pubis*, *Pulex irritans*, and *Acarus scabiei*.

Some will object that these four parasites are just those that are ubiquitous, and that their prevalence in leprosy endemic territories does not prove anything. They might say that we could just as well attribute leprosy to sunshine, wind or air, or any other thing that is everywhere.

But looking closer at those things, we can see that:

1. Leprosy cannot be transmitted exclusively by any flying insect that bites. In Iceland there are no *Anopheles* and no *Culex*. The only flying insect that bites is *Simulium vittatum*. As this insect is reported as non-existent in 66% of leprosy endemic territories, it is inconceivable that leprosy could be transmitted exclusively by this species. Also it is so short-lived, living only a few days, that the chance of transmission would be very small.
2. The bedbug, *Cimex lectularius*, can be ruled out as a vector in Iceland. That of course does not prove its innocence in other countries.
3. The sheep louse, *Melophagus ovinus*, has probably nothing to do with leprosy, as it lives on sheep and only exceptionally attacks humans. Its reported absence in 50% of leprosy territories supports this view.
4. The body louse, which I had thought of as a possible vector, probably plays if anything a small role in transmitting the disease. Not only is it reported absent in 21% of leprosy territories, but in 14 territories, where naked tribes are living, leprosy is reported among nine of them; if the body louse was the only vector, leprosy would not be found among those who go naked, although the body louse may exist in the rudimentary garments which naked people wear.

Lice and fleas. The head louse and the pubic louse are found in all the territories and fleas in all but five. MCCOY and CLEGG[2] found acid-fast organisms in lice and several other investigators have found acid and alcohol resistant organisms in lice. On the other hand, nobody has been able to prove that these organisms were *M. leprae*, nor will that be possible so long as *M. leprae* can neither be cultivated *in vitro* nor in animals. Nevertheless, the investigations of MUÑOS RIVAS have brought the entire problem nearer its solution, as will be discussed later. Even apart from the experimental investigations, there are some cogent reasons which point directly to lice and fleas as transmitters.

It is well known that in hospitals of a high hygienic standard,

transmission of leprosy does not take place from the patients to healthy staff. On the other hand, it is seen in all leprosy countries how the patients infect their surroundings when they live among other people in their dirty and unhygienic living quarters at home.

It has long been believed that leprosy might be transmitted like a venereal disease through cohabitation, and in some leprosy districts it is considered particularly dangerous to stay over night in the dwelling of leprosy patients. If the pubic louse can transmit the disease, it would be in sexual contact.

The discrepancy between the lack of spread of leprosy to staff in the hygienic conditions of a hospital compared with the spread of leprosy in the home would be explained if verminous skin parasites, especially lice and fleas, transmit the disease. There is every reason to think that these bloodsuckers may ingest leprosy bacilli when they suck blood from the skin of leprosy patients, in whom *M. leprae* is contained in enormous amounts in the lepromas. Furthermore, as the louse will bite twice a day and the flea may bite every night for months on end, it would be remarkable if they did not harbour *M. leprae* in their intestinal canal. When such lice and fleas attack a healthy person one must expect the microorganisms in their intestinal canal to enter the skin of the bitten person, just as is known to happen in the transmission of typhus and plague.

Acarus scabiei. If the female acarus could ingest *M. leprae*, it might be able to transmit the disease by its burrowing into the skin, where *M. leprae* would be deposited with the excrements and might be able to grow from out of the burrows. Even though the burrows are mainly in the epidermis, the parasite reaches the Malpighian layer and a part of the burrow will therefore penetrate the corium, where *M. leprae* may be implanted by this means.

A degree of association between scabies and leprosy has long been known, since DANIELSEN and BOECK[3] described heavy forms of scabies in leprosy patients, which later was confirmed by several authors and goes by the name of "gale norvégienne" which in reality is nothing but impetigo imposed on a case of scabies. BASSEWITZ[4] described a similar case of leprosy plus scabies, the first reported from Brazil, in which he suspected transmission by the scabies mite.

G. MUÑOS RIVAS has found enormous numbers of acid-alcohol-fast bacilli in the intestines of *Acarus scabiei*, collected from dwellings of leprosy patients. His work deserves a special section.

The work of G. Muños Rivas. In Bogotá, the capital of Colombia, since 1939 he has been working on the relationship between arthropods and leprosy. In a publication[7] from 1942 this author puts forward a series of arguments and experiments, which point to the flea as the main transmitter of leprosy. One of his arguments is that the leprosy patients come mainly, if not exclusively, from humid

parts of the country, where fleas abound in the primitive huts of the population. He refers to some of his colleagues who have maintained that fleas are an obligatory transmitter of leprosy. He has performed a great number of experiments to elucidate this problem, of which only the main gist can be cited here. In 200 fleas caught and examined in the antileprosy dispensary in Cundinamarca, he found acid-alcohol-resistant bacilli (a.a.r.b.) in 32, or 16%.

In a paper now about to be published he describes how he dissects the stomach out of the flea, rubs its contents on a slide and examines them for a.a.r.b. In this way he has examined 1,627 fleas which were fed experimentally on leprosy patients, and found a.a.r.b. in 187 or in 11.4% of the fleas.

On the other hand, the author examined 575 fleas from places free of leprosy. In these fleas there was not a single positive finding of acid fast bacilli.

From animals in a leprosy sanatorium he examined 174 fleas of various kinds, all of them negative.

The author was interested to examine fleas developed from larvae deriving from experimentally infected fleas. In 338 *Pulex irritans* of this origin he found a.a.r.b. in eight, or 2.36%. In 177 *Pulex irritans* from non-contaminated sources he found none positive.

That over 2% of pulex larvae, which never have bitten a leprosy patient, but are descendants of parents which have bitten a leprosy patient, contain a.a.r.b. is a significant finding, which may be of importance.

With a trituration of fleas nurtured on leprosy subjects, he inoculated four young monkeys and obtained in two of them lesions which resembled leprosy and contained scanty a.a.r.b. in the corresponding lymph glands.

In acarinae he found great amounts of a.a.r.b. in parasites collected from dwellings of leprosy patients. Similar bacilli were also found in mites outside foci of leprosy, but they were more abundant in the foci. The number of these bacilli in the intestines of mites in an environment of leprosy may, according to him, be fantastic. He also found the eggs of the mites infested with a.a.r.b.

Thirty mice were inoculated by fixing a mite to the skin of their tail with a special technique. Of the 30 mice, two developed typical murine leprosy.

The existence of a.a.r.b. in the intestines of most acarinae causes great difficulties in transmission experiments with leprosy. But the existence of other a.a.r.b. does not exclude their possibility of transmitting *M. leprae* also.

On the whole, the investigations of Muños Rivas are by far the most extensive that anybody has done to prove the transmission of leprosy by insects.

His opinion is that any arthropod is a potential vector of leprosy. Especially so *Pulex*, *Acarinae* and *Ornithodorus*.

Can winged insects transmit leprosy? With his report from Martinique, Dr. P. OLLE sent a paper by E. MONTESTRUC and R. BLACHE in which is described an apparent transmission of *M. leprae* by mosquitoes. A 31-year-old woman came to the Institut Pasteur in Martinique with a well nourished baby. The mother had leprosy of four years duration, with numerous fresh lepromata in the face. The child had several erythematous indurated patches in the forehead and cheeks. These lesions were caused by mosquito bites on the previous day. In all, nine bites were visible. From one of these lesions a little serous fluid was removed and examined microscopically. Great numbers of acid-fast bacilli were found and numerous globular cells, stuffed with acid-resistant bacilli. These were without doubt *M. leprae*. The child was isolated from its mother and put under a mosquito net. Five days later the lesions had disappeared and no bacilli were found in the serous fluid. Seven days later a fresh mosquito bite was found, also containing acid-fast bacilli. After another week this lesion had disappeared and the bacilli also. The house of the mother was found to be heavily infested with mosquitoes, among which were *Culex fatigans*, *Aedes aegypti* and several unidentifiable Culex. In the intestines of one culex numerous acid-fast bacilli were found. The child received sulphone treatment and no further information of development of leprosy is mentioned.

Although *M. leprae* may be transmitted by mosquitoes, it is not likely that such a transmission plays any considerable role in the propagation of the disease. If mosquitoes were of any considerable importance in this respect, the disease would be expected to spread in hospitals and leprosaria to the medical and nursing staff. Also the disease when imported to London and Paris, etc., would spread from the leprosy subjects to healthy people in the surroundings. But although hundreds of leprosy patients have been imported to these densely populated areas, no contagion has taken place.

From Manila, Dr. J. N. RODRIGUEZ reports that in the course of his epidemiological study of leprosy he has been struck by the strange dissemination of leprosy: "There are, for example, two villages of about the same size, say about 250 inhabitants each, only 10 km., or even less, distant from each other, inhabited by the same race of people with the same health habits, nutrition, etc. The incidence of leprosy in one village is high, of the order of say three cases per thousand inhabitants, while in the other village the rate is only 0.2 per thousand. In spite of much visiting back and forth among the inhabitants of the two villages, including the leprosy patients, during half a century the disease has not spread from one village to the other which is so close.

As the author remarks, if there is an insect vector, it cannot fly or travel far. The observations of Dr. Rodriguez fit in better with the transmitting role of fleas, acari and lice, than with mosquitoes or any winged insects.

Concluding remarks. As the exact transmission of leprosy from a sick person to a healthy individual has never been explained, the vague term of transmission by "longstanding, close contact" cannot be accepted without further definition of what it implies.

As leprosy has always been known to spread where squalor and vermin abound, but to stop spreading when cleanliness of body and housing are adopted, even when contact is frequent, the chances of infection by simple, direct contact, seem to be negligible.

The transmission by insects, although not yet satisfactorily proved, is the most likely mode of transmission. In 42 leprosy endemic territories the head louse and the pubic louse were present in all, and *Pulex irritans* and *Acarus scabiei* in almost or probably all. As G. MUÑOS RIVAS has shown, the human flea, *Pulex irritans*, is probably the vector of greatest importance, but all arthropods are possible transmitters of the disease.

While so little is known about transmission of leprosy it might be worthwhile to start an experiment somewhere, working on the hypothesis that fleas, lice and *Acarus scabiei* are the main transmitters of the disease.

An isolated community, preferably an island where leprosy is heavily prevalent, should be selected for this purpose. No harm would be done, should the result be negative, and the costs should not be prohibitive. The eradication of human skin parasites is not a particularly difficult problem to solve, not as difficult as eradication of malaria-transmitting mosquitoes which has been successfully carried out in many parts of the world.

The havoc to health and life still wrought by leprosy among many nations would justify such an experiment, which, if successful, would open up new possibilities for fighting this old scourge of humanity.

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APPENDIX

TABLE I: FORM OF ENQUIRY. The enquiries were sent out on a single sheet containing questions as follows:—

Occurrence and frequency of insects in.....(your country):

	Frequent	Infrequent	Non-existent
Pediculus capitis			
Pediculus vestimenti			
Pediculus pubis			
Pulex irritans			
Xenopsylla cheopis			
Melophagus ovinus			
Acarus scabiei			
Simulium vittatum			
Other *Simulia*, which?			
Cimex lectularius			
Other insects which you suspect?			

Special Questions: Have you any tribes that go naked? If so, is leprosy known among them? Is the body louse unknown among them?

TABLE II: RESULTS OF THE QUESTIONNAIRE OUTLINED IN TABLE I:—

Brazil: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent are *Melophagus ovinus* and *Simulium vittatum.* There are no other insects. Naked tribes occur, with no leprosy and no body lice among them.

Taiwan: Frequent are *Ped. cap.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*,and *Cim. lect.* Infrequent are *Ped. pub.* There are other insects, and no naked tribes. Non-existent are *Ped. vest.*

Costa Rica: Frequent are *Pul. irr.* and certain *Simulia.* Infrequent are *Ped. cap.*, *Ped. pub.*, *Xen. ch.*, *Melo. ovin.*, *Ac. sc.*, and *Cimex lect.* Non-existent are *Ped. vest.* There are other insects and no naked tribes.

Cuba: Frequent are *Pul. irr.*, *Ac. sc.*, and *Cim. lect.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Xen. ch.*, *Melo. ovin.*, and *Simul. vitt.* There are no other insects, and no naked tribes.

Malaya: Frequent are *Ped. cap.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent are *Ped. pub.*, *Pul. irr.*, and certain *Simulia.* Non-existent are *Ped. vest.*, *Mel. ovin.*, and *Simul. vitt.* There are other insects and no naked tribes.

Iraq: Frequent are *Ped. cap.*, *Pul. irr.*, and *Xen. ch.* Infrequent are *Ped. pub.*, *Melo. ovin.*, *Ac. sc.*, and certain *Simulia.* Non-existent are *Ped. vest.*, *Simul. vitt.*, and *Cim. lect.* There are no other insects, and no naked tribes.

E. Nigeria: Frequent are *Ped. cap.*, *Ped. pub.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent are *Ped. vest.*, *Pul. irr.*, and *Melo. ovin.* Non-existent is *Simul. vitt.* There are no other insects, and there are naked tribes who have leprosy, and the body louse.

Paraguay: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, and *Ac. sc.* Non-existent are *Melo. ovin.*, *Simul. vitt.*, and other *Simulia*, and *Cim. lect.* There are no other insects. There are naked tribes, no leprosy among them, but the body louse among them.

Antigua: Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Cim. lect.*, and *Ac. sc.*, Non-existent is *Xen. ch.* There are no other insects, and no naked tribes.

Nairobi: Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Ac. sc.*, *Sim. vitt.*, and frequent is *Cim. lect.*

Colombia: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Melo. ovin.*, *Ac. sc.*, *Simul. vitt.*, and *Cim. lect.* There are other insects. There are naked tribes, with no leprosy and no body louse.

Netherlands New Guinea: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Xen. ch.*, *Ac. sc.*, other *Simulia*, and *Cim. lect.* Infrequent is *Pul. irr.* There are no other insects. Naked tribes exist, with leprosy among them.

Seychelles: Frequent are *Ped. cap.*, *Ped. pub.*, *Pul. irr.*, *Ac. sc.*, and *Cim. lect.*

Non-existent are *Ped. vest.*, *Xen. ch.*, *Melo. ovin.*, *Simul. vitt.*, and other *Simulia.* No other insects, and no naked tribes.

Israel: Frequent are *Ped. cap.*, *Ac. sc.*, and *Cim. lect.* Infrequent are *Ped. vest.*, *Ped. pub.*, and *Pul. irr.* Non-existent are *Xen. ch.*, *Melo. ovin.*, and *Simul. vitt.* There are other insects, and no naked tribes.

Portugal: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Melo. ovin.*, *Ac. sc.*, and *Cim. lect.* There are no other insects. Naked tribes exist, and leprosy among them, but no body lice.

Australia: Frequent are *Pul. irr.*, *Xen. ch.*, *Melo. ovin.*, and other *Simulia.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Ac. sc.*, and *Cim. lect.* Non-existent is *Simul. vitt.* There are no other insects, and no naked tribes.

Basutoland: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, and *Ac. sc.* Infrequent is *Xen. ch.* Non-existent are *Melo. ovin.*, *Simul. vitt.*, other *Simulia*, and *Cim. lect.* There are no other insects.

Martinique: Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, *Simul. vitt.*, and *Cim. lect.* There are other insects, and no naked tribes.

Malta: Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Melo. ovin.*, and *Cim. lect.* Non-existent is *Ac. sc.* There are other insects, and no naked tribes.

Philippines: Frequent are *Ped. cap.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent are *Ped. pub.* and other *Simulia.* Non-existent is *Ped. vest.* There are no other insects.

French Polynesia: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent are other *Simulia* and non-existent is *Simul. vitt.* There are no other insects and no naked tribes.

Niger Republic: Frequent are *Sim. vitt.* and other *Simulia.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Melo. ovin.*, and *Ac. sc.* Non-existent is *Cim. lect.* There are no other insects. There are naked tribes, with leprosy among them.

Barbados: Frequent are *Ac. sc.*, *Simul. vitt.*, and other *Simulia*, and *Cim. lect.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, and *Pul. irr.* Non-existent is *Melo. ovin.* There are other insects, and no naked tribes.

Ruanda Urundi: Frequent are *Ped. cap.*, *Ped. vest* , *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, other *Simulia*, and *Cim. lect.* Infrequent is *Melo. ovin.* There are other insects, and no naked tribes.

New Caledonia: Frequent is *Xen. ch.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Ac. sc.*, and *Cim. lect.* Non-existent are *Melo. ovin.* and *Simul. vitt.* There are other insects and no naked tribes.

West Australia: Frequent are *Ped. cap.* and *Ac. sc.* Infrequent are *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Melo. ovin.*, and *Cim. lect.* There are no other insects. There are naked tribes, with leprosy among them, and body lice.

Zanzibar: Frequent are *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.* Non-existent are *Simul. vitt.* and other *Simulia.* There are no other insects, and no naked tribes.

Spanish Guinea: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Ac. sc.*, and other *Simulia.* Infrequent is *Cim. lect.* and non-existent is *Melo. ovin.* There are other insects. There are naked tribes, with leprosy among them, and body lice.

Netherlands: Frequent is *Pul. irr.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Non-existent are *Simul. vitt.* and other *Simulia.* There are no other insects and no naked tribes.

Argentina: Infrequent are all the listed insects. There are no other insects, and no naked tribes.

Hong Kong: Frequent are *Ped. vest.*, *Xen. ch.*, and *Ac. sc.* Infrequent are *Ped. cap.* and *Ped. pub.* Non-existent are *Pul. irr.*, *Melo. ovin.*, *Simul. vitt.*, and other *Simulia*, and *Cim. lect.* There are other insects, and no naked tribes.

Southern Rhodesia: Frequent are *Ped. cap.*, *Ped. pub.*, *Ac. sc.*, other *Simulia*, and *Cim. lect.* Infrequent is *Xen. ch.* Non-existent is *Ped. vest.*, *Pul. irr.*, *Melo. ovin.*, and *Simul. vitt.* There are no other insects, and no naked tribes.

North Borneo: Frequent are *Ped. cap.*, *Ac. sc.*, and *Cim. lect.* Infrequent is *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Melo. ovin.*, *Simul. vitt.*, and other *Simulia.* There are no other insects.

Hawaii: Frequent are *Ped. cap.* and *Xen. ch.* Infrequent are *Ped. pub.*, *Pul. irr.*, and *Cim. lect.* Non-existent are *Ped. vest.*, *Melo. ovin.*, *Ac. sc.*, *Simul. vitt.*, and other *Simulia.* There are no other insects, and no naked tribes.

Mauritius: Frequent are *Ped. cap.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent are *Ped. vest.* and *Ped. pub.* Non-existent are *Melo. ovin.*, *Simul. vitt.*, and other *Simulia.* There are no other insects, and no naked tribes.

Sarawak: Frequent are *Ped. cap.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent is *Ped. vest.* There are no other insects; there are naked tribes, with leprosy among them, and body lice.

Dutch Antilles: Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, and *Ac. sc.*

French Guiana: Frequent are other *Simulia* and *Cim. lect.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, and *Ac. sc.* Non-existent are *Pul. irr.*, *Xen. ch.*, *Melo. ovin.*, and *Simul. vitt.* There are no other insects. There are naked tribes, with no leprosy, but body lice.

Bombay State: Frequent are *Ped. cap.*, *Ped. pub.*, *Xen. ch.*, *Ac. sc.*, and *Cim. lect.* Infrequent is *Pul. irr.* Non-existent are *Ped. vest.*, *Melo. ovin.*, *Simul. vitt.*, and other *Simulia.* There are other insects. There are naked tribes, with leprosy among them, but no body lice.

Jamaica: Frequent is *Cim. lect.* Infrequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Xen. ch.*, *Ac. sc.*, and other *Simulia.*

Iceland: Frequent are *Ped. cap.*, *Ped. vest.*, *Ped. pub.*, *Pul. irr.*, *Melo. ovin.*, *Ac. sc.*, and *Simul. vitt.* Infrequent is *Xen. ch.* Non-existent are other *Simulia* and *Cim. lect.* There are no naked tribes.

TABLE III

	Frequent	Infrequent	Non-existent	Total F + I	Non-existent %
Pediculus capitis	25	17	—	42	0
Pediculus vestimenti	12	21	9	33	21
Pediculus pubis	16	26	—	42	0
Pulex irritans	21	18	3	39	7
Xenopsylla cheopis	21	14	4	35	10
Melophagus ovinus	4	11	15	15	50
Acarus scabiei	27	13	2	40	5
Simulium vittatum	4	6	19	10	66
Other *Simulia*	10	9	10	19	34
Cimex lectularius	23	11	7	34	17