THE MODE OF TRANSMISSION OF LEPROSY.

BY

T. LINDSAY SANDES, M.A., M.D.,

RESEARCH MEDICAL OFFICER, ROBBERN ISLAND LEPROSY ASYLUM,
SOUTH AFRICA.

THE mode of transmission of leprosy from the infected to the healthy is a question which has hitherto baffled research. Of the infectivity of the disease no one who has studied its history and has carefully investigated any considerable number of cases, their previous life and social relations, and who considers the evidence without prejudice, can, I think, have any doubt.

In the first place, a word as to heredity. It is exceedingly improbable that an ovum, still less a sperm cell, could contain so relatively large an intruder as a lepra bacillus and yet suffer so little derangement of its great but excessively delicate potentialities as to render successful fertilization and development possible. This view was first enunciated by Virchow in discussing the germ-inative transmission of tuberculosis, and it has never been adequately refuted. We are aware that the infections of pebrine disease of silkworms, and of syphilis, are capable of being deposited previous to fertilization in the parental elements, but in both these cases the progeny, mature or otherwise, show widespread infection and the diffuse ravages of the particular disease immediately, or more usually shortly after, birth. I have had the opportunity on two occasions of examining the tissues of the offspring of leper parents which were either stillborn or had died soon after birth; in neither of them was the lepra bacillus or anything suggestive of its presence discoverable. In well-marked cases of tubercular leprosy bacilli may be demonstrated in the ovaries, prostate, seminal fluid and elsewhere in the genital tracts, but careful and repeated search has failed to discover the organism in either the sperm or germ elements. This, of course, is negative evidence, nevertheless it is not entirely valueless. Placental transmission, unless as an accident, also seems highly improbable. The bacilli are at any time very difficult of demonstration in the blood. During acute exacerbations of the disease with the formation of fresh tubercles, fever, sickness, and other signs of general infection, they are not so difficult to find. But pregnant females, in my experience at any rate, are remarkably free from these superimposed attacks of acute leprosy, however much they may relapse afterwards. Microscopic examinations of placentae have shown no bacilli nor lesion attributable to their previous presence.

Children are undoubtedly more susceptible to infection than adults, and as a rule the disease makes rapid and destructive progress in their young tissues. Infection, however, takes place not only by reason of an increased susceptibility in their junior years, but also on account of the unlimited opportunities afforded for its transmission during the early period of dependence and intimate contact of parent and offspring.

Commensal feeding, and the fact that the bacillus flourishes in the products of tryptic digestion, suggest the possibility of a primary alimentary infection; the bacilli, perhaps, after ingestion reach the small intestine and find a suitable medium, whence they subsequently make their way into the general circulation and so establish the disease. But considering the delicacy of the lepra organism in its initial stages of artificial growth, the adverse conditions it is likely to meet in the gastric and intestinal tracts, the absence, so far as my inquiries have gone, of an early clinical history in consonance with such an infection, and the negative results of *post-mortem* examinations of early cases of the disease as regards involvement of the intestinal tract and mesenteric lymphatics, it seems to me that this mode of transmission of the infection, if it does occur, must be rare.

Inhalation of dried bacilli floating as dust may also be suggested as a probable path of infection. Ulceration, with dense bacillary infiltration of the nasal mucous membrane, is the rule in tubercular leprosy. But again, although an early lesion, it is not initial; in fact, it is not observed until the general infection is distinctly pronounced. Infiltration, nodule formation, and ulceration of the larynx and adjacent mucous membranes are very

frequent, but only as late, or subterminal, complications in tubercular leprosy.

Leprotic involvement of the lungs is very uncommon. Clinically I have never known it, and in my last 50 *post-mortem* examinations microscopic inspection has always failed to discover undoubted lepra bacilli or granulomatous reaction due to their presence, although the tubercle bacillus and the results of its presence were very frequently observed.

In brief, then, we have no reason to believe that the infection of leprosy is transmitted *ante-partum*, and both the mode and the site of primary infection have hitherto remained undiscovered.

As a result of observations on a large number of cases of leprosy, I was led to direct increasing attention to the skin as the probable site of primary inoculation. Over a year ago, therefore, I decided to conduct my researches in this matter with a view to establishing or eliminating any part the commoner and more widely distributed domestic insects might play. I considered the common house-fly (*Musca domestica*). The *Stomoxys* genus and the *Haematobia irritans* or horse-fly are vicious biters, and on *a priori* grounds, more probable carriers of infection, though the latter rarely bites man; but they are uncommon on this island, and I determined to work, in the first place, with the more abundant material at hand. Further, I examined the common flea (*Pulex irritans*), also the local varieties of mosquito (*Culex* and *Anopheles*), and finally the bed-bug (*Acanthia lectularia*). My methods were simple. The insects were confined for a period of from twenty-four hours to twenty days in a test tube with a little cotton-wool. The test tube was kept in the laboratory incubator. The hungry insects were then placed in a large watch-glass with some cotton-wool, and fixed by adhesive plaster and bandages to the selected site. In the case of flies and mosquitos a light wire frame with netting was found preferable. An infiltrated area on the posterior surface of the forearm was found to be suitable and convenient. The following table summarizes the results of the examination of smears of insects so fed made within half an hour of feeding:

70 Flies ...	...	Enclosed over ulcerated leprotic surfaces. Two acid-fast bacilli found in the stomach of one fly and one in the stomach of another.
80 Mosquitos...	...	One contained three acid-fast bacilli.
60 Fleas...	...	Two contained acid-fast bacilli—two bacilli in one flea, one in the other.
75 Bugs...	...	Twenty contained acid-fast bacilli.

The bugs frequently contained acid-fast bacilli in the alimentary canal. The mosquitos, fleas, and flies very rarely contained bacilli, or they rapidly disappeared or were no longer recognizable; indeed, in the cases of the mosquitos and fleas I hesitated some time in consideration of the isolated red rods as to whether they were actually bacilli or stained fragments of tissue; I therefore venture no further statements about them. After these preliminary experiments, attention was concentrated on bugs. Lepra bacilli are undoubtedly imbibed by the bug, and are demonstrable without much difficulty in smears made from the debris of the intestinal canal. I say lepra bacilli advisedly; they retain their acid-fast staining, and show the morphologic characteristics associated with this organism. No acid-fast bacilli were found in unfed bugs. They are usually isolated, but I have counted as many as twelve in one field. They do not readily disappear, but can be found up to sixteen days after the insects are fed. Acid-fast bacilli answering all characteristics of the lepra bacillus were also found in smears made from the tissue juices and circulating medium of bugs fed on lepers, in smears of the macerated head and of the proboscis (five days after feeding), and, finally, I found a bacillus once in the excreta deposited on the inner surface of the test tube.

On May 2nd last some bugs were fed on a patient with well-marked tubercular leprosy, who at the time showed a fresh crop of nodules, was feverish, and, in fine, exhibited all the signs of an acute exacerbation of the disease. When the insects had been affixed to the patient for eight hours they were removed and found distended with blood. Again, on the fifteenth day of the same month the same insects were reapplied to the same patient for a few hours. Next morning, May 16th, one insect was

found dead. I made a smear of the stomach contents, and also of the body tissues well apart from the intestine. The former contained a few bacilli; in the latter, stained at the same time and by exactly the same method, field after field displayed squadrons and platoons of acid-fast bacilli. Their individual appearance differed considerably, however, from the classic lepra organism. They were shorter, some of them almost coccoid; they were more homogeneous in staining, displayed no granularity, had occasionally a median constriction, occasionally a terminal clubbing. The great majority were arranged in groups, the individuals of the groups showing a tendency to adhere in parallel formations, like the cohesion of floating logs. They appeared to me to be young lepra bacilli in full prolific activity—not having yet assumed the senile or degenerative forms usually observed in the impacted bacillary masses of human tissues.

Owing to the recent work of Drs. Clegg and Duval, who have shown that the presence of the amino-acids is essential for the artificial cultivation of the bacillus, I was able to compare these bacilli with others artificially cultivated. They were very similar. In some, though slight differences were recognizable, such differences were less than those observed in comparing different bacilli of the same slide. Careful comparison left little doubt in my mind that the organisms from the bug and those from the cultures were identical. It seems to me probable that the bug actually died of acute leprosy.

I have recently endeavoured to demonstrate the transmission of the bacillus by fed bugs to healthy tissues. Bacilliferous insects were applied to shaven areas on guinea-pigs, rabbits, and monkeys, and to the clean, unaffected arms of "arrested" maculo-anaesthetic lepers. Small portions of tissue surrounding the bite were excised immediately the insect left its mark and at varying times afterwards, and sections cut and stained. The results have, in the case of the lower animals, been uniformly negative. On one anaesthetic leper a small papule appeared at the site of the bite. This papule was excised but no bacilli were found in it. A definite bacillus was, however, found a considerable number of sections away from the edge of the papule, but whether it had been injected by the insect or had been deposited there previously or independently it was impossible to decide.

On consideration it will be apparent that it would be sanguine to expect any marked result from the application of these leper-fed bugs. Guinea-pigs and rabbits are uninoculable with leprosy, and leprosy bacilli, so far as my investigations have gone, rapidly disappear if injected into their tissues. As regards maculo-anaesthetic lepers, it seems to me that during most of the time they suffer from the disease they are partially immune, and only their peripheral nervous system affords a suitable soil for the growth of the bacillus. If the disease be indeed "arrested" even this partial susceptibility disappears.

Conclusions.

Reviewing the foregoing data, I venture to submit the following conclusions:

1. That considering the enormous numbers of lepra bacilli in the infiltrated or ulcerated skin and nasal mucosa of an active "tubercular" leper and the ingestion of bacilli by certain insects, direct contact and transmission by flies, fleas, mosquitos, or other insects, are possible modes of spread of the disease; but such infection, if it ever does take place, is accidental and exceptional.

2. That having found acid-fast bacilli answering as far as our imperfect tests permit to the characteristics of lepra bacilli in a considerable proportion (about 30 per cent.) of specimens of *Acanthia lectularia* up to sixteen days after feeding on lepers, there is reason to believe that this species of insect constitutes a very important agent in the spreading of leprosy. Unfortunately this view can be proven with finality only by the application of bugs previously fed on lepers to the persons of healthy individuals with the resultant development of the disease, unless, indeed, it be found, as there is some reason to hope, that certain monkeys and anthropoid apes are susceptible of inoculation with leprosy.

In connexion with the foregoing conclusions, I quote in brief a few details, obtained without leading question or suggestion, of the early history of a patient—an European of intelligence and with a clear memory of the onset of the disease:

H. M., No. 1,039, aged at the time 11 years (whose father had been removed as a leper to this asylum some time previously, and whom the son used frequently to visit), observed for the first time in the year 1901 a small red papule under his chin. It enlarged slowly, becoming in area, to use his own simile, about the size of a sixpenny piece. It was indurated, and resistant to treatment. It remained thus, slightly raised, hard, and of a reddish hue for two complete years before any further symptoms appeared. In the year 1903 he noticed for the first time a bluish puffiness of his cheeks; later slight thickening of his eyebrows, and a diffuse but moderate swelling of the entire countenance. Towards the end of the year tubercles began to appear on his face. Thereafter, tubercles continued to appear at irregular intervals on his face. The glands of his neck became involved. From this time onwards the tubercles and other typical signs were of universal distribution, and showed a diffuse systemic infection.

The initial pimple, and later tubercle, on the chin would appear to have been the primary lesion, probably caused by the bite of a leprosy-infected bug.

In the communities where it is endemic leprosy is notoriously a disease of the dirtier classes. It is not, however, necessarily associated with poverty, except in so far as this is a concomitant of squalor. In South Africa, although leprosy is more prevalent among the lower strata of the population it is by no means confined to them. Of the cases in Europeans a considerable percentage is derived from families in which poverty and privation are unknown, but where the practice of the elements of domestic hygiene and cleanliness is in abeyance. Cases do occasionally occur in persons whose habits are, in general, cleanly, but on inquiry one sometimes finds that lapses from such habits have occurred, affording opportunity for the transmission of the infection by the means suggested. There is in this asylum, for example, a patient who once held a position of responsibility in a crack English regiment. He had always been of scrupulously cleanly habits when circumstances permitted. He states, however, that under the exigencies of campaigning in India, and later in South Africa, he frequently slept between, and retained for temporary use when no others were available, blankets belonging to and previously used by natives.

A NOTE ON THE TRANSMISSION OF LEPROSY.

By E. C. LONG, M.R.C.S., L.R.C.P.,
PRINCIPAL MEDICAL OFFICER, BASUTOLAND.

THE means by which the leprosy bacillus is introduced into the human body have not yet been definitely established.

Commensal feeding, direct inoculation or contagion have been generally accepted as being the most likely methods of introduction; but no proof of any of these methods has yet been adduced, and I believe the leprosy bacillus has hitherto not been found outside the human body.

The fact that leprosy is most common among people of unclean personal habits and living in unhygienic surroundings points to some co-existing source of contagion.

The possibility of the bacillus being carried by vermin occurred to the writer. With a view to testing this hypothesis, bed-bugs obtained from huts which had never been inhabited by lepers were caused to bite lepers in the neighbourhood of leprosy nodules on the face. The bugs were then killed and the alimentary tract and its contents examined. In every bug that bit freely a bacillus was found which in shape, size, and staining reactions is similar to the *Bacillus leprae*.

Control bugs from the same hut gave in every instance a negative result.

The experiments are still in progress, and it is intended, as soon as circumstances permit, to solve the following questions:

1. How long the bacilli remain in the bug's body.
2. If bugs which over a period of weeks have fed on the blood from leprosy nodules present any evidence of growth of bacilli in their tissues.
3. What organs of the bug contain bacilli
4. Whether any other vermin—for example, fleas and lice—contain bacilli.