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(Continued from p. 440.)

REPORT ON THE PREVALENCE OF MEDITERRANEAN FEVER AMONGST BRITISH TROOPS IN MALTA, 1905.

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(b) Latrine Air.—The condition of the latrines in the different barracks in Malta is, in many cases, extremely unsatisfactory, the cause generally being an inadequate water supply. The type of latrine in general use is the "Jennings' continuous pipe latrine," which is a good pattern, and, when properly used, quite free from offence. The dry-earth system is still in use in some barracks. At Lower St. Elmo new water-closets were fitted up in the early part of 1905, with improved siphonic flushing arrangements; although these arrangements are susceptible of further improvement the latrines, both upstairs and downstairs, have been kept in a sanitary condition without difficulty, and the water supply has been ample throughout the year.

At St. Andrew's Barracks, only recently completed, the latrines are new and of good pattern, and the water supply has been, so far, ample. At Fort Ricasoli, and at Valletta, Cottonera, Forrest, Ientarfa, Citta Vecchia and Gozo hospitals, the water supply has been sufficient, and the latrines kept in good order.

Throughout the rest of the barracks the latrines have not, speaking generally, been kept in a satisfactory condition. In the various barracks that make up the Cottonera Lines the supply of water for flushing has habitually been inadequate; indeed, it has often been altogether cut off, so that the latrine pans have been allowed to become partially dry, excreta remaining in the pans and fouling the sides, and in this way gradually drying up and becoming scattered about as dust; this occurred at Polverista, St. Paul's Bastion, Vittoriosa, and elsewhere. At Upper St. Elmo, St. James
Cavalier, Floriana Old Barracks, and Verdala, the water supply has been scanty, and the flushing not done often enough; consequently the latrines have habitually, or frequently, been over-full; in which case, when they are emptied, there is a likelihood of excreta remaining on the sides of the latrine to a greater or less extent, and eventually becoming dried and disseminated as dust. At Tigne a new latrine has quite recently been opened; at present it is in good order and quite clean. Tigne (until July, 1905), Manoel, Pembroke Fort, Intarfa, Gozo, and all the outlying forts and encampments (except Fort Rinella and Camp Mellieha) have had the dry-earth system of removal; the removal is effected once only in the twenty-four hours, very early in the morning, about 3 or 4 a.m. As the greatest use of the latrines takes place between 8 and 10 a.m., it follows that the excreta are retained in the lines for from sixteen to eighteen hours every day, instead of being removed at the earliest possible moment. If the application of the dry-earth were immediate and thorough, this retention of foul matter might perhaps be harmless, or even inoffensive. As a matter of fact, it is very seldom the case that the system is properly carried out, and the net result is that dry-earth latrines are generally in a filthy and insanitary condition for, at any rate, many hours of the day and night. All the latrines on this system in Malta (with very few exceptions) have been habitually in a foul state. Fort Rinella and Camp Mellieha have a water system of removal, with a good supply of water. Fort Ta Silch has had a dry-earth latrine for night use (which has also been habitually used during the day), and a temporary trench-system just outside the fort; this arrangement has been very unsatisfactory.

The only barracks that can be considered to have been free from the effluvia of faecal matter are those first mentioned, viz., Lower St. Elmo, Ricasoli, and St. Andrew’s; also Fort Rinella and Camp Mellieha; in all the others persons using the latrines have, during a great part of the day, been subject to whatever risks may be considered to arise from breathing air contaminated with faecal emanations, that is, effluvia from excreta in a more or less fresh condition. All the hospitals have been free from this risk. The case as regards Mediterranean fever in these barracks, is that the occupants of Lower St. Elmo have suffered more than those of any other barracks, and the occupants of St. Andrew’s to about an equal extent with those of most of the barracks (see Table I.); Ricasoli has suffered but slightly. The hospital population has suffered considerably, but this can hardly have been on account of the state of
the latrines, which have been maintained in a satisfactory condition throughout the island.

In the two barracks that have suffered least, although in Ricasoli the latrine air has been free from faecal emanations, in Verdala the reverse has been the case; while of two barracks lying alongside of each other, and similar in situation and general construction, St. Andrew's, with quite new latrines well flushed, has suffered more than St. George's, with scantily-flushed latrines, many of which have been in existence for a long time, and have therefore become proportionately foul.

There does not appear, therefore, to be any definite evidence connecting the incidence of Mediterranean fever with the presence of faecal emanations, as far as concerns the troops, during the period under review.

As regards married families, the principal Married Quarters—Camerata, Tigne, Old and New Floriana, New Verdala, St. Nicholas, Ricasoli and St. Andrew's—are provided with water-closets of excellent pattern, and are quite free from any kind of drain or latrine emanations. This cannot be said of the older quarters, such as St. Nicholas Back, and the old St. George's blocks, where latrines of old pattern are still in use; nor of the hired quarters in Strada Magazzini, Floriana, which have been already alluded to. Although a few cases have occurred in the latter quarters, most of the women and children attacked have lived in the newer quarters (such as New Floriana), which are provided with water-closet chambers and fittings of the best and most modern kind. Such cases cannot be regarded as due to infection through "faecal emanations."

(c) Urinal Air.—The recent researches as to the viability of \textit{M. melitensis} in dust, and the demonstration that Mediterranean fever can be communicated to goats (though not, so far, to monkeys), by feeding them on dust infected with the urine of Mediterranean fever patients, make it necessary to examine into the condition of barracks in regard to the presence or absence of urinary contamination of the air. Throughout the island the barrack urinals are constructed on the same general plan, viz., ranges of partitioned stalls made of slate, flushed with water from a sparge pipe, the flow being carried direct into the nearest drain. It has been for some years the custom to cover the slate surface with tar from time to time, a result of which has been that the surfaces have generally become rough and uneven, leading to collections of urinary sediment all over the lower part. The water
flushing has also been quite inadequate to keep the stalls clean; this has been partly due to an insufficient quantity of water being used, and partly to its being inefficiently applied, the holes of the sparge pipes being very generally blocked up, or the pipes themselves being fixed in a wrong position. The consequence has been that barrack urinals have generally been dirty and ill-smelling. During the past year a new arrangement has been brought into use, according to which the water flushing is omitted, and in its place the urinal surface is coated over with a mixture of kerosene oil and lampblack or tar. The best application for the purpose is a substance called “heavy oil,” but, as this has apparently not been procurable in Malta, various substitutes have been used in its stead; a mixture of colza oil and tar in equal parts, as used at Imtarfa, appeared to me to be the most effectual, and needed only to be applied once a week. No deposit takes place on the back of the stall, and there is not the least offensive smell. Elsewhere, results have not been so satisfactory. But when this, or some similar application, is used effectively, the urinals are undoubtedly cleaner than under the old arrangements. Although water must not be distributed over the surfaces to which the oil or tar has been applied, it is necessary to flush the drain with water, and to wash down the floor of the urinal frequently, otherwise the floor and the drain will become foul. This is what has occurred in practically every urinal in every barrack throughout the island; urine has been allowed to dry on the floor, and so become converted into dust and pollute the air.

With the knowledge that we now have that Mediterranean fever often occurs in an ambulant and unrecognised form, there is little doubt that infective urine has been widely distributed throughout barracks in this way. On the other hand, it has been shown that exposure to direct sunlight destroys the specific organism in a few hours (Horrocks). In some barracks, as in Upper and Lower St. Elmo, the old barracks and bastions in Cottonera Lines, Verdala, St. Francis, Marsamuscetto, Old Laboratory, the old part of Floriana, and in the detached Forts, the urinals are under cover and shielded from the direct rays of the sun. This is also the case in all the hospitals. Under such circumstances *M. melitensis* might live for several days, as Horrocks has found that it will survive for twenty-eight days in ordinary street dust, and in “building dust.” In the newer barracks, such as Tigne, New Floriana, St. George’s, St. Andrew’s and Imtarfa, also at Manoel, Ricasoli, Gozo, and, of course, in all the camps, the urinals are out
in the open, without covering of any kind. The duration of infectivity of the dried urine would appear in these places to be very short, indeed, almost negligible. It is certainly the case that the places which have suffered most, viz., Valletta and Cottonera Hospitals, Lower and Upper St. Elmo Barracks, have urinals that would retain infectivity longer than such barracks as Ricasoli, St. George's, and Imtarfa, that have suffered comparatively slightly. Also Floriana New Barracks have had fewer cases proportionately than the Old buildings. But in the case of the two hospitals named much more care has been taken than in barracks generally to keep the floors of urinals clean, and in these places I do not think any appreciable risk of infection can have been incurred in this way. St. George's and St. Andrew's are identical in this particular respect, but have suffered differently; and Verdala, which has fared better than any other barrack but Ricasoli, has urinals as dark, and almost as confined, as in any barrack. While there can be no doubt that every care ought to be taken to prevent fouling of the ground with urine, and to cleanse it frequently, when fouled it can hardly be said that the fouling which has occurred affords any satisfactory explanation of the distribution of the disease during the recent epidemic.

There is another way, however, in which urinary infection may have been spread. None of the barracks in Malta are provided with night urinals. In every case the urine tub is still in use. In the older barracks it is placed on the floor outside the barrack-room door in the verandah or passage. In the newer barracks a special stand is provided. At Tigne New Barracks, St. Andrew’s, and the new blocks at St. George’s, the tubs are placed in an alcove behind the barrack-room, and, on the upper floor, have to be brought through the room, in order to be taken downstairs to be emptied. It must often happen that urine gets splashed about on the floors. It is conceivable that infection might be spread in this way, and that the admission rate from these new, and in most respects sanitary, barracks has been raised from this cause.

Although *M. melitensis* can survive in dried dust for about a month, and it has been found possible to infect goats by feeding them on such infected dust, experimental infection by inhalation has not been fully demonstrated in regard to monkeys. In Part I. of these Reports Horrocks detailed two experiments which indicated that "*M. melitensis*, when present in dry dust, is

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1 It is probable that the same thing happens, though it is not necessary, on the lower floor, in order to save trouble.
capable of being absorbed by monkeys"; but in the account of further experiments in Part IV., the same observer stated that it had "not been found possible to infect monkeys with dust polluted with urine from Mediterranean fever patients and then thoroughly dried. Goats, however, can be infected in this manner." As the enormous doses of strongly infected dust employed in these experiments are only occasionally capable of transmitting the disease, the probability of there being any habitual pathogenic property in the dust of urinals or rooms contaminated in the manner just mentioned, appears to be very remote. The possibility, however, cannot be disregarded; and although the quantity of the contagium may have been minute at any one point of time, it is likely that it has been constantly present in such places as Lower St. Elmo.

(d) The habits of the bulk of the Maltese population, as in Southern Europe generally, bring about a fouling of the ground with fecal and urinary excreta. The offices of nature are performed not only in private, but in public, places, advantage being taken of every nook and corner that offers. Around the barracks that are situated in the old fortifications there are so many ditches and secluded spots that the whole neighbourhood is sometimes a latrine; even within barrack limits it is often impossible to prevent this fouling of the ground by the native population. Floriana Barracks (including Notre Dame, Bavelin and the intermediate ground) and Verdala, also all the Cottonera Lines, are instances in point. Outside Lower St. Elmo on the shore of the harbour, and in the Jews' Sallyport, the condition of the ground is particularly filthy: Wherever building operations are being carried on, as has been the case between Porta Reale and Floriana Barracks during the past year, the fouling of the ground is also extreme. On one morning I counted thirteen separate dejecta immediately outside the northern end of Floriana Barracks. It may be said that wherever troops are quartered in or near native towns or villages this fouling occurs in the immediate vicinity of their dwellings. Where they are removed from this undesirable propinquity it does not exist, as, for instance, at Manoel, Tigne, Ricasoli, Intarfa, Gozo. The civil authorities seem powerless to put a stop to this nuisance; and, of course, the military have no control over ground outside barracks. However, insanitary and disgusting as this con-

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1 There is, I believe, one exception to this. I was informed that the troops occupying Lower St. Elmo are charged with the duty of keeping clean the Jews' Sallyport, which is used as a latrine by the natives of the neighbourhood.
dition is, it is not easy to prove any bad effects resulting from it in regard to Malta fever, in view of the strong disinfectant action of sunlight that has been already mentioned. Only in such places (like the Jews' Sallyport), that are covered in, would the specific micro-organism retain its vitality for any considerable length of time. So also in the streets generally, though many corners are fouled, it may be assumed that the virulence of *M. melitensis* is soon destroyed by exposure to the sun. In the fields human excrement is frequently used as manure. Horrocks has found that *M. melitensis* may survive for twenty days in manured garden soil in the laboratory; but in the open fields, fully exposed to the sun, this would only be possible at some distance below the surface, from which situation it would not be likely to be dispersed about in the air, and inhaled or swallowed by any passer-by.

The air of the streets of Valletta and other Maltese towns is, however, polluted from another source, viz., from the underground cellars, or basements, often used as dwellings, and in which there are often water-closets of the most defective kind. These closets are very scantily flushed with water, which has to be fetched by hand for the purpose, and, supposing any inmate of the basement dwelling is suffering from Mediterranean fever, must undoubtedly be a source of danger to the other occupants, and not only to the occupants, but to the passers-by in the streets above. The effluvia that rise from these basements are often very offensive, and obviously excrementitious; as these places are dark, and never penetrated by the sun's rays, there is no reason to suppose that *M. melitensis* would lose its virulence in a hurry in such a situation. Alternations of temperature cause currents, upwards and downwards, from these basements; and it is within everyone's experience that the current upwards is sometimes (like the effluvium) of considerable strength, and quite able to carry up micro-organisms from the closet below to the street above. In this way the men occupying barracks such as Upper and Lower St. Elmo, which cannot be approached except by passing along streets having basement dwellings of this kind, are more liable to aerial infection than the occupants of barracks, such as those at Pembroke and Imtarfa, situated away from such streets and dwellings.

(e) In the late Captain Hughes' treatise on Malta Fever there is a strong body of evidence in regard to the association of fever outbreaks with "insanitation"; implying by this, contamination of the air of the barrack or dwelling with emanations from drains, cesspits, &c., or putrefying organic matter, or polluted soil. Fifteen
separate outbreaks, of greater or less extent, are carefully described, in which the connexion certainly appears to be one of cause and effect. I made particular enquiry of one hundred and eighty-seven patients suffering from the disease, as to whether they had been conscious of any insanitary condition, or "bad smell," in or near their quarters, which might seem to be connected with their illness. The information gained was disappointingly meagre. In only six cases was there any idea, from the patients' side, of any connexion between "bad smells" and their illness. In one case a w.c. in the officers' mess, where the man was employed, had been frequently stopped up and offensive. In two cases the regimental latrines sometimes became choked, and the men had to clear them, which was a disagreeable job. A man employed at the officers' mess in the Inquisitors' Palace slept on the ground floor, where there were often bad drain smells. One man (and one only) complained of the bad state of the latrines in Cottonera Lines. One sergeant complained of a bad smell in his "bunk," which was very imperfectly ventilated (Lower St. Elmo). This testimony is of very slight importance one way or the other; all one can say is that there does not appear to have been any notable or widespread offensiveness in any of the barracks sufficient to excite attention. This is, after all, what one would expect in barracks, where the dwelling rooms are quite disconnected from the latrines and drainage. Only in the old fortress barracks, and in hospitals, are these conditions reversed. But during the last ten years very great improvements have been made in the condition of these old barracks, and the insanitary conditions detailed by Hughes are not, to the best of my belief, now existing in any quarters occupied by troops in Malta. The evidence collected by him is, in my opinion, strongly in favour of a causal connexion between Mediterranean fever outbreaks, and the laying on of excrementally polluted air to dwelling rooms; but I have not been able to gather any similar evidence that would in any way explain the incidence of the disease during the past year amongst the troops.

§ 6.

Having reviewed the influence of water, food and air as channels of infection in Mediterranean fever, with on the whole a negative result, that is, without having succeeded in tracing any definite relationship between its mode of prevalence amongst the troops and

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1 This quarter (and the mess building) was evacuated shortly afterwards. When I examined it I could find no defect in the drainage arrangements.
the existence of conditions pointing to probable infectivity of these media, we are now led to the consideration of what appear to be the only other alternatives, viz., direct or semi-direct contagion, and the agency of some biting insect.

As to direct contagion, Hughes, writing in 1897, dismisses the question very shortly. "Patients suffering from other diseases, occupying beds next to cases of undulant fever, do not develop this fever, nor do the military sick attendants in fever wards suffer more from this fever than those working in other wards, or so much as soldiers in many of the barracks in Malta who have not entered the hospital previous to the onset of their attacks."

The following table is extracted from a paper by Captain J. C. Kennedy, and shows the prevalence of Malta fever amongst patients and orderlies at Valletta Hospital, as compared with the garrison in Valletta, for the years 1897—1904. The figures are ratios per 1,000:

<table>
<thead>
<tr>
<th>Year</th>
<th>Valletta Garrison</th>
<th>Valletta Hospital patients</th>
<th>Valletta Hospital orderlies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1897</td>
<td>42.11</td>
<td>11.05</td>
<td>80</td>
</tr>
<tr>
<td>1898</td>
<td>22.78</td>
<td>29.99</td>
<td>163.63</td>
</tr>
<tr>
<td>1899</td>
<td>22.54</td>
<td>32</td>
<td>34.48</td>
</tr>
<tr>
<td>1900</td>
<td>26.68</td>
<td>6.44</td>
<td>54.05</td>
</tr>
<tr>
<td>1901</td>
<td>43.11</td>
<td>45.75</td>
<td>121.21</td>
</tr>
<tr>
<td>1902</td>
<td>16.90</td>
<td>34.18</td>
<td>48.78</td>
</tr>
<tr>
<td>1903</td>
<td>67.31</td>
<td>24.53</td>
<td>50</td>
</tr>
<tr>
<td>1904</td>
<td>45.42</td>
<td>14.43</td>
<td>169.23</td>
</tr>
<tr>
<td>Average</td>
<td>36.23</td>
<td>24.79</td>
<td>92.4</td>
</tr>
</tbody>
</table>

Captain Kennedy points out that venereal patients, and patients suffering from injuries, were much more liable to contract the disease than others, the ratio being 3.31 per 1,000 venereal admissions; 2.42 per 1,000 admissions for injury, and only 0.76 per 1,000 admissions for all other diseases. He explains this by the facts that these patients spend a longer time in hospital, on the average, than any others (except Malta fever), and that they are all treated in one ward, 20B, which is in communication with, indeed, is part of the same room as, other wards containing Malta fever patients. In 1905, 11 cases have apparently been contracted in Valletta Hospital,

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1 *Journal of the Royal Army Medical Corps, May, 1905.*
2 Cases that have been diagnosed as Malta fever within twenty days after admission, and cases that have been changed from simple continued fever to Malta fever after admission, have been excluded. Also cases that have been admitted from outside, but which may have contracted the disease inside, hospital are not included.
of which 8 were staying in 20B Ward and 2 in 20A Ward; the ward in which the remaining case stayed is doubtful. At Cottonera 10 cases apparently contracted the infection, of which 3 were inmates of wards in which the fever cases were treated. As regards orderlies, Kennedy states that of the 11 who contracted the disease at Valletta in 1904, 8 were doing duty in 20A, 20c, and 37 wards, containing Malta fever patients. In 1905, of the 19 at Valletta who were attacked, 11 were employed in the fever wards. At Cottonera 5 out of 7 cases amongst orderlies were similarly employed, as were the two cases of R.A.M.C. at Citta Vecchia.

Now, leaving on one side for a moment the case of the orderlies, who are exposed to various possible sources of infection, what is the most probable explanation of the occurrence of these cases of infection in patients who are confined to the hospital precincts, and in some instances to their beds? At both Valletta and Cottonera Hospitals the drinking water is above suspicion, the milk has been "pasteurised" since the middle of 1904, and the wards are absolutely free from any kind of contamination from sewer air, or latrine air, or urinal air. Whatever the sanitary shortcomings of the "Long Ward" in Valletta Hospital may be, it is certainly not exposed to any danger of this kind; neither are the other wards in this hospital, nor any of those at Cottonera. Of course, patients who are able to get up make use of the latrines and urinals of the hospital; but in neither of these hospitals has there been any failure in the water supply to latrines, leading to insufficient flushing, nor has there been any reason, even the slightest, to suspect that drain effluvia gain access to the latrine or closet chamber. The latrine for 20B Ward is certainly old and defective, and a considerable waste of water results on account of the defective fittings; also the latrine and urinal for No. 37 has a rough floor, which requires concreting. But though these conditions are insanitary and undesirable, they cannot be reasonably held to be causative of Mediterranean fever.

The condition that appears to be the most probably effective in the causation of these hospital cases is the presence in the wards of a large quantity of disease-producing material in the bodies of the patients themselves. It is known that the specific organism is present in the blood, and is excreted in the urine; it is possibly excreted in feces, but up to the present has not been demonstrated in the breath, saliva, or perspiration. Transmission by direct contagion is therefore not theoretically probable; by indirect or semi-direct contagion through clothing soiled with excretal discharges
it is not improbable in the nature of the case, although hitherto there has been no proof of this mode of spread. The position, however, is not unlike that of enteric fever, which is now considered (in fact, may be said to have been proved) to be spread by means of "contact," i.e., close association. Presumably this happens by infective urine or faecal matter fouling the skin or clothing of the patient, and then becoming disseminated through the air, and inhaled; or finding its way into articles of food or drink and being swallowed. We have the authority of Koch for the opinion that transmission of enteric in this way is its most important mode of propagation. A few years ago this would have been considered most unlikely, but proofs have been accumulating. I do not see that there is any essential difference between the position as regards enteric fever transmission and Mediterranean fever transmission. Where there is a large quantity of the infective material accumulated in one place, i.e., in a hospital, there the likelihood of its spread is the greater. That this spread occurs but very seldom is because the obvious precautions usually taken are sufficient; but when the number of cases (i.e., quantity of specific poison present) is largely increased, it may probably happen that the precautions are not increased pari passu, because the labour involved increases out of all proportion to the working power present. A patient severely ill may pass involuntary evacuations twice or three times in the night. There may be (and have been) two or more such cases in the same ward; obviously the risk of dissemination of infective particles becomes much increased when this occurs. Even with the best methods of disinfection in every detail, of the person, of the clothes, of the evacuations, there must be a chance under such conditions of infective material being spread about. This seems to be a mode of propagation that cannot be excluded; it is applicable to the other occupants of the wards, and especially applicable to the actual attendants on the fever cases.

With regard to the behaviour of the epidemic among the troops in barracks, from the preceding part of this section it appears that neither water, nor food, nor air contaminated with drain emanations, will explain the incidence of the disease; the one fact that stands out most clearly is that the fever has occurred in a number of small outbreaks, almost strictly localised in some place, or limited to some small body of men. Examples of this have been instanced in the case of G and H Companies, Essex Regiment, at Lower St. Elmo; A Company, Royal Dublin Fusiliers, at St. George's; the men of the Royal West Kent Regiment, who
occupied the Old Barracks, Floriana. In each of these instances, where several cases of fever occurred in the same room, or same set of rooms, there was an appreciably larger quantity of infective material in those rooms than in the barracks generally; the more there was of it present, the more likelihood would there be of the infection spreading.

There is one condition, common to Lower St. Elmo and Floriana Old Barracks, that would presumably be of importance in aiding this spread of infection. The rooms are casemates, most inadequately ventilated. If it be granted that the infective material is disengaged from the bodies of persons suffering from the disease, no better place could be found for its accumulation from day to day and night after night than a casemate such as those in question. It is extremely improbable that a thorough change of air ever takes place in these cavernous chambers. It is quite impossible that any thorough change should be effected frequently. The construction of the rooms and their size prevent it. I do not think it too much to say that the Long Ward in Valletta Hospital is in similar case as regards change of air. Though very large and lofty, the thorough change of the contained air is very difficult to effect; and as the upper windows have not (to the best of my belief) been fully utilised as outlets, I consider that there has been an accumulation of infective material in the air of this ward from day to day and night after night.

In regard to the barrack-rooms at St. George’s that were so much affected (A Company, Royal Dublin Fusiliers), nothing can be said against their ventilation. But the bedcots are crowded together, so that only about 12 inches separate each pair of beds, and there has therefore been concentration of the persons, and, consequently of the infective material. It may be asked in this, as in the other cases where many barrack-rooms are similarly circumstanced, why some should be affected and not others. The reply would be that it is necessary that the poison should be introduced, and probably introduced in some notable quantity; having once been introduced, the conditions mentioned would naturally favour its spread.

There are two main difficulties to be met in adopting this theory, or explanation, of the prevalence. One arises from the fact that M. melitensis, though often sought for, has not been found either in the air of the Valletta Ward or in the dust collected from it, and from the Cottonera Wards. The other is that it has not been found possible, so far, to infect monkeys with urine-infected
dust. It must be admitted that these are substantial difficulties in the way of this explanation.

§ 7.

In regard to the question of transmission by fomites, the experiments of Horrocks, who found that *M. melitensis* could be recovered from khaki cotton, khaki serge, and blankets up to the 80th day; and of Shaw, who recovered it from blue serge up to the 78th day, show that this form of dissemination has practical importance. The necessity for disinfection of clothing, &c., is fairly obvious. The procedure that has been carried out has varied in the different corps stationed in Malta, as appears from the following statements obtained from the regimental authorities:—

Royal Garrison Artillery (Upper St. Elmo), 65th Company.—In the earlier part of the year the kit and bedding of men admitted to hospital were placed in the company store until instructions were received from the medical authorities that they should be sent to hospital for disinfection. Since the middle of August, in the case of all men admitted with "fever," the kit and bedding have been put on one side in the "Old Magazine," awaiting instructions as to their disposal.

96th Company.—It has always been the custom to put on one side the kit and bedding of all men admitted to hospital. When the case was declared to be "fever," the whole kit and bedding has been sent to Cottonera Hospital for disinfection.

Tigne, 99th Company.—The kit and bedding of all men admitted to hospital have been placed in company store; on receipt of instructions from the medical officer in charge of the district, either "kit," or "kit and bedding," have been sent to the lazaretto for disinfection.

1st Company.—Same as 99th Company. In about half the cases "bedding" only has been specified, and the "kit" has not been disinfected.

102nd Company.—The kit and bedding of all men admitted to hospital are placed in company store. In infectious cases a paper of questions is sent by the medical officer to the commanding officer; one of these has reference to the kit and bedding; if they have not been disinfected they are to be sent to the lazaretto for disinfection. It may be ten days after a man has been admitted to hospital that instructions arrive as to disposal of kit.

Ricasoli, 5th Company.—When a man goes to hospital, his kit
and bedding are taken into the company store; if instructions come from the hospital authorities his "kit" is sent to Cottonera for disinfection, but not the "bedding."

63rd Company. Same as in 5th Company, except that the "bedding" is sent to be disinfected, but not the "kit."

100th Company. Same as in 5th Company; the bedding is not disinfected.

Hampshire Regiment (Verdala).—When a man reports sick, his kit and bedding are brought out of the barrack room and placed in the company store. If he is not admitted to hospital, he takes his kit and bedding back to the barrack room. If he is admitted, his kit and bedding are stored in the company store, the blankets being all stacked together in order, the sheets all together, and the mattresses all together. There is no certainty that a man receives the same blanket on discharge from hospital as he handed in when admitted. Sheets and pillow slips are washed. No difference is made between "fever" cases and others. Any dirty clothing in the kit bag remains in situ. In infectious cases, instructions come from the hospital authorities to the commanding officer that "kit and bedding" are to be sent to hospital for disinfection on some named date. Some days, a week or more, may elapse (after the man's admission) before these instructions are received.

Lancashire Fusiliers (Lower St. Elmo).—The kit and bedding of men admitted to hospital are stored in the company store (the prison cells being used for this purpose). The hospital authorities notify (after an interval of some days) when the kit and bedding are to be sent for disinfection. There are no means of keeping separate the kit and bedding of "suspected," i.e., fever cases; but if any man is admitted with "fever," his kit and bedding are sent for disinfection on the first Tuesday or Friday that follows.

Essex Regiment (Imtarfa).—The bedding and blankets of men admitted to hospital are sent for disinfection when so ordered by the hospital authorities, but the kit remains in the man's kit bag, unless obviously dirty, in which case it is sent to the wash. Kits and bedding are stored in parts of barrack rooms appropriated for the purpose, there being no space for their disposal in the rooms labelled "company store," which are little better than cupboards.

Royal West Kent Regiment (Floriana).—Formerly, the bedding of men admitted to hospital used to be left in the barrack room. Early in the summer of 1905, the practice commenced of sending the bedding of all cases admitted to hospital to be disinfected, so as to be on the safe side. The kit has been kept in company store.
in the two kit bags, and has not been sent for disinfection, nor have the dirty articles of clothing been washed, until the man's discharge from hospital.

Royal Dublin Fusiliers (St. George's).—Until the latter part of August only the bedding of cases of Mediterranean fever was sent to hospital for disinfection; cloth articles of clothing were exposed to the sun and brushed; khaki, underclothing, &c., was left in the kit bag in situ in company store. Since the beginning of September everything has been sent to be disinfected.

Rifle Brigade (St. Andrew's).—Same as Dublin Fusiliers.

From the above account it is obvious that the disinfection of the clothing and bedding of Mediterranean fever patients has been, during the greater part of 1905, far from complete. The want of uniformity in procedure is remarkable. Assuming that infective material may be present in soiled sheets, blankets, shirts, trousers, &c., there must have been opportunity for dissemination amongst the men of the same company, or unit, in many cases. In those instances where bedding (including blankets) has not been disinfected, it has been possible for the blankets or other articles that have been given into store by one man to have been taken into use by another man, as it is not the general practice to label the blankets, &c., individually; the company storeman would return to a man on discharge from hospital the same blankets that he had deposited in the store on admission, if he knew which they were, but this would not always be the case. In the instances when bedding has been sent to be disinfected on instructions being issued to this effect, there was generally an interval of a week or ten days before the instructions arrived, and during this time infection might be transferred to other blankets or bedding in contact with the infected articles. In those cases where the kit was not sent for disinfection, when the kit-bag was subsequently opened out, and any dirty shirts, &c., sent to the wash, there would be a chance of disseminating infective material. It is to be noted that, when a man goes to hospital, he generally puts on a clean shirt, &c., the dirty shirt, &c., going into his kit-bag. There is, therefore, some presumption that infective material might be present. When the washing day came round, sheets and pillow-slips would be sent to the wash; the dirty shirt, &c., might be sent to the wash, but it would more likely remain in the kit-bag until the owner came out of hospital.

As there were 487 cases of Mediterranean fever during the period under review, and therefore 487 bundles of bedding and kit to be handled, one would expect that if these articles were
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infective, the "company storemen" who handle them would show some increased liability to contract the disease. But in only one case could I ascertain that a storeman had been attacked. This was Private Burch, Essex Regiment, who was admitted to hospital on June 3, 1905. He stated that it was his duty to handle the clothing and bedding of Mediterranean fever patients, and that sometimes this had been offensive, especially after having been fastened up in a bundle for some time.

It would seem to be probable that infection might be conveyed through infective fomites; and if this be the case, the measures of disinfection that were taken—up to September—could not be supposed to prevent this dissemination, looking at the whole question broadly. If a comparison, however, be made between the severity of incidence in the different corps and the method of treatment of presumably infected kit and bedding, it is seen that there is no general relation between the completeness of the disinfection and the severity of the attack ratio.

<table>
<thead>
<tr>
<th>Kit and bedding disinfected—</th>
<th>Attack ratio per 1,000.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royal Garrison Artillery, 65th Company, Upper St. Elmo</td>
<td>83</td>
</tr>
<tr>
<td>&quot; &quot; 96th &quot; &quot; Tigne</td>
<td>69</td>
</tr>
<tr>
<td>&quot; &quot; 102nd &quot; &quot;</td>
<td>32</td>
</tr>
<tr>
<td>Lancashire Fusiliers, Lower St. Elmo</td>
<td>63</td>
</tr>
<tr>
<td>Hampshire, Verdala</td>
<td>27</td>
</tr>
<tr>
<td>Kit disinfected, not bedding—</td>
<td></td>
</tr>
<tr>
<td>Royal Garrison Artillery, 5th Company, Ricasoli</td>
<td>34</td>
</tr>
<tr>
<td>Bedding disinfected, not kit—</td>
<td></td>
</tr>
<tr>
<td>Royal Garrison Artillery, 63rd Company, Ricasoli</td>
<td>18</td>
</tr>
<tr>
<td>&quot; &quot; 100th &quot; &quot;</td>
<td>42</td>
</tr>
<tr>
<td>Essex, Imtarfa</td>
<td>88</td>
</tr>
<tr>
<td>Royal West Kent, Floriana</td>
<td>45</td>
</tr>
<tr>
<td>Bedding disinfected, kit sunned and brushed—</td>
<td></td>
</tr>
<tr>
<td>Dublin Fusiliers, St. George's</td>
<td>46</td>
</tr>
<tr>
<td>Rifle Brigade, St. Andrew's</td>
<td>54</td>
</tr>
<tr>
<td>Sometimes kit, sometimes bedding, sometimes both, disinfected—</td>
<td></td>
</tr>
<tr>
<td>Royal Garrison Artillery, 1st Company, Tigne</td>
<td>68</td>
</tr>
<tr>
<td>&quot; &quot; 99th &quot; &quot;</td>
<td>54</td>
</tr>
</tbody>
</table>

Systematic and complete disinfection has been carried out in all cases, I believe, since the middle of September, 1905.

§ 8.

The discovery by Horrocks and Kennedy of *M. melitensis* in considerable numbers in the stomach contents of two species of mosquito (*Culex pipiens* and *Stegomyia fasciata*), indicates that transmission through the medium of biting flies is a possible mode of propagation. The arguments in favour of direct contagion or aerial transmission would apparently hold good equally in regard to mosquitoes, as carriers of infection, in places such as Malta,
where they abound. Granted the presence of infective material in a ward or barrack room, in the shape of hospital patients or ambulatory cases of the disease, transference to the healthy in this way becomes easily intelligible; the numerous localised outbreaks are explicable on this hypothesis as reasonably as by direct or semi-direct contagion. The only contribution that I am able to offer to this part of the subject is to mention that, of ninety-seven patients from whom a definite statement was obtainable as to their experience of mosquitoes, thirty-one asserted positively that they have never, or practically never, been bitten at all; eighteen stated that they had been bitten very slightly; while forty-eight admitted that they had been bitten a good deal. Without attaching much value to these statements (which, however, I believe to be accurate as far as they go), bearing in mind the rarity with which *M. melitensis* has been found to be present in the mosquito (four times in 896 individual mosquitoes), the chances seem to be very much against the entrance of the germ into the body having taken place in this way in the case of the forty-nine men who were either bitten but very slightly or not at all. But the number of men dealt with is insignificant.

### SECTION IV.—CONCLUSION AND RECOMMENDATION.

The chief facts ascertained in this inquiry into the prevalence of Mediterranean fever amongst the troops in Malta have been summarised in Section III., § 1; the various modes of propagation of the disease that have been suggested by different observers have been considered in order, and, on the evidence of the facts ascertained, a negative conclusion as to their ability to explain the behaviour of this epidemic has been arrived at in regard to transmission (1) by water, (2) by milk or other articles of food, (3) by air contaminated with excremental (fecal or urinary) effluvia; transmission (4) by direct or semi-direct contagion, or (5) through the agency of mosquitoes, appears from the evidence, to be more probable than in any other way; it is difficult to separate these two modes of dissemination the one from the other under the circumstances existing in Malta, and provisionally I think they may be considered together. Fully admitting that no proof has been afforded in support of this opinion, I still consider that there is a high degree of probability attaching to it, and one quite sufficient to warrant the adoption of certain measures of prevention or precaution.

Whatever view be taken of the mode of propagation, the fact is undoubted that certain barracks have suffered much more than
others; among these are Lower St. Elmo, Upper St. Elmo, and the old barracks at Floriana.

If considerations of economy and the maintenance of the health of the troops were the only things to be considered, probably the cheapest and most healthful course to pursue would be to evacuate these barracks altogether. If military considerations render this impracticable, I consider that an efficient alternative would be afforded if the following procedure were carried out:—

(1) Let it be recognised that these casemate barracks are entirely exceptional in their construction and need to be specially dealt with; the occupancy should be reduced from the present numbers (calculated on a cubic space of 600 cubic feet or less per head) to one which would allow 750 cubic feet at the very least per head, as is now admitted to be necessary in the case of all new barracks in the command. No height above 12 feet should be reckoned as available for ventilation in the calculation of this space.

(2) During the summer months tentage for 25 per cent. of the occupants of Lower St. Elmo should be drawn (as is the case in all the other barracks in Malta, except Intarfa and Pembroke), so that the condition of the barrack rooms at night may be alleviated as much as possible in regard to heat, stuffiness and organic contamination of the air.

(3) As even under the best possible conditions, change of the air in these casemate barracks is very difficult, and accumulation of impurities on the walls and ceilings therefore much greater than in barracks of ordinary construction, all walls and ceilings of rooms and passages should be limewashed at frequent intervals, say, once a month; this would ensure the removal of dirt, the extermination (for the time) of mosquitoes, and for practical purposes would be a disinfectant measure. As the work could be done by the troops, the expense would be insignificant.

(4) There is sufficient evidence to warrant a presumption, at any rate, of localised infection, or semi-direct contagion. In the event of two cases of Mediterranean fever occurring in the same room within a fortnight, the barrack room should be evacuated and limewashed, the men being accommodated in tents for the time: after this has been done, the room might be re-occupied; but if another case occurs within a fortnight of re-occupation, it should again be evacuated, and the body of men isolated as far as possible.

(5) If in any company, or small detachment, several cases occur in quick succession (e.g., two in one week, or three in a fortnight) this body of men should be regarded as infected. They should be placed under canvas, or transferred elsewhere; the measures suitable for
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each individual outbreak of this kind can be decided on according to the special circumstances of each case. The remarkable freedom from fever experienced by the Gozo detachments of the Essex Regiment (which regiment suffered so severely at Lower St. Elmo) indicates that, if any small infected body of troops were removed from their surroundings to a detached spot (e.g. Gozo, or Mellieha, &c., &c.), and scrupulous attention paid to their sanitation in every detail, the infection may be expected to die out. Once it is evident that a body of men is infected, the sooner the move is made the better; probably a very short distance would suffice; but there must be no overcrowding, and every detail of sanitation must be carefully attended to. The rooms evacuated should be fully disinfected with formalin or other disinfectant.

(6) The above recommendations refer especially to the three old barracks that have suffered severely from Mediterranean fever; there are other old barracks of similar defective construction to which the same recommendations are applicable, though Mediterranean fever has not been especially prevalent in them during the past year. Such are St. James Cavalier, Salvatore Counter Guard, St. Francis' Barracks, Marsamuscetto, Old Laboratory, all the barracks in the Cottonera Lines, and Fort Chambray, Gozo. In all of these the recommendations as to 750 cubic feet of space per head, 12 feet of height only being reckoned for the calculation of space, frequent limewashing, and evacuation and disinfection on the occurrence of Mediterranean fever, equally apply. Although they have not suffered in 1905, their defects are such that a prevalence of the disease is to be feared, if the infection be introduced in sufficient amount. Tentage is already authorised to be drawn for these barracks in the hot weather.

(7) In the modern barracks in Malta, which are so satisfactory in their construction and general sanitary conditions, the above recommendations do not appear to be necessary; but the principle of a stitch in time equally holds good; any succession of cases in a barrack room would indicate the advisableness of evacuation, disinfection, and isolation.

(8) The defects in the supply of water for sanitary purposes throughout the Cottonera district (including Verdala), at St. James Cavalier and at St. George's require immediate attention. The provision of an ample supply of sea water, or No. 2 water, in order to flush the latrines and drains properly, is such an obvious necessity, that it is strange that a recommendation to this effect should require to be made. Increased pumping power appears to be what is wanted, but this is a matter for the Royal Engineer depart-
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ment to determine. The necessity is urgent. Latrines should be flushed at least three times a day, and four times a day if water is available.

(9) The management of urinals has not been properly carried out: systematic application of "heavy oil," or some efficient substitute (such as colza oil and tar, as used at Imtarfa); the omission of water flushing for the stalls (which, strangely enough, has very generally been used along with the oil treatment); but the careful washing of the floors of urinals, and flushing of the urinal drains with water; these are the measures indicated.

(10) Where the dry-earth system of excreta removal is still in use, a removal of three times instead of once in the twenty-four hours is recommended; this will necessitate the provision of suitable receptacles for the pail contents. The present system is too barbarous and offensive to be tolerated. There is no reason why what is strictly forbidden in India should be universally permitted in Malta: I refer to the retention in the latrines of pails, full of filth, for the greater part of the twenty-four hours. The nearest approach possible to the immediate removal system (according to the Indian fashion) should be made. It is to be hoped that the dry-earth system will, before long, be completely abolished in Malta, except for temporary camps.

(11) If the above recommendations (8) to (10) are carried out, it is to be expected that the contamination of the air of barracks generally by excremental emanations, also the risks due to disease conveyance by flies, will cease; until this is the case no barrack can be considered to be in a good sanitary condition, whether in reference to Mediterranean fever or any other infectious disease. There is one special preventive measure directed against Mediterranean fever infection that has been carried out during the past year, viz., the boiling or "pasteurising" of milk for the troops. This requires to be continued in the strictest possible manner. As regards the married families, for whom this is more important than for the troops, it might be feasible to provide Aymard sterilisers to treat the milk supply of the large married quarters centrally, and therefore more effectually. If this is impracticable, special instruction and warning should be continually given, not only to new arrivals, but to all the married people, as to the necessity for sterilising goats' milk, or else substituting condensed milk for it.

(12) As success in dealing with this disease, as in other infectious fevers, will probably largely depend on stopping the beginnings of an outbreak, i.e., carrying out the principle of Obsta
principiis; perhaps the most important thing of all is to find out as early as possible when and where anything like an epidemic prevalence is commencing. The existing arrangements for arriving at a diagnosis are satisfactory; if, however, this could be expedited, it would be very desirable that it should be done. But what is required, in my opinion, is some method of tracking out the cases as soon as they occur; not waiting for a final diagnosis, which cannot be arrived at for perhaps ten to fourteen days, but examining the patient, his surroundings, habits, movements, &c., &c., whenever there is even a probability of the case being one of Mediterranean fever. Information can be easily obtained at the time, which afterwards can only be got at with difficulty and labour, or not at all. The existing establishment of medical officers is not, in my opinion, adequate for this work, they being all fully employed as it is, especially during the summer months, when the sickness is greatest.

I consider, and recommend, that two extra medical officers be employed to give their whole time to this epidemiological investigation work, over and above the work that has been hitherto and is now being done in the laboratories and in the various hospitals. The tracking out of the early cases by a skilled observer ought to lead to important results in the way of ascertaining modes of infection, and, consequently, the carrying out of effectual measures of prevention. I do not think that one medical officer would be sufficient, the ground to cover is too extensive, and the investigations must be undertaken without delay in each case; in the summer months, at least two officers would be busily occupied every day. They should be employed for this purpose only.

(13) Immediate and effectual disinfection of clothing and bedding of men admitted to hospital with Mediterranean fever, and of patients in hospital suffering from this disease, should be carried out as a matter of course. To be effectual, the disinfection must be complete, not as was formerly the case.

(14) Isolation of Mediterranean fever patients when in hospital is indicated. The difficulty is to carry it out at Valletta Hospital.

(15) The management of the Long Ward at Valletta Hospital, so as to ensure proper change of air, is a very difficult problem to solve. I am convinced that much more ventilation, a much more frequent and thorough change of air than has hitherto been the case, is required. More advantage might be taken than was the case last summer of the existing windows in the upper storey. A new hospital is urgently required, as has been insisted on for about thirty years past.