Editorial.

MALTA FEVER.

Historical.—This paper is written for the purpose of bringing up to date our knowledge of this fever. Its history, in relation to the Royal Army Medical Corps, may be briefly summed up as follows: The first paper of any importance was written in 1861 by Assistant Surg. J. A. Marston.[1] In it he described the fever from the clinical side very completely and clearly; and it will repay any one interested in the disease to read this paper. The next is by Surg.-Major Veale[2] in 1879, in which he describes cases of the fever invalided to Netley from Gibraltar, Malta and Cyprus. The next event of any importance was the discovery of the specific organism of the disease on July 9, 1887, and which was named *Micrococcus melitensis*.[3] Ten years afterwards, in 1897, Professor A. E. Wright and Surg.-Major Semple[4] applied the method of serum diagnosis to this fever, and this has greatly helped the working out and differentiation of it from enteric, malarial and other acute specific fevers. In this year also the late Surg.-Capt. M. Louis Hughes[5] published his book, of 219 pages, on Mediterranean, Malta or Undulant Fever, which contains everything known on the subject up to that date, and also a full bibliography.

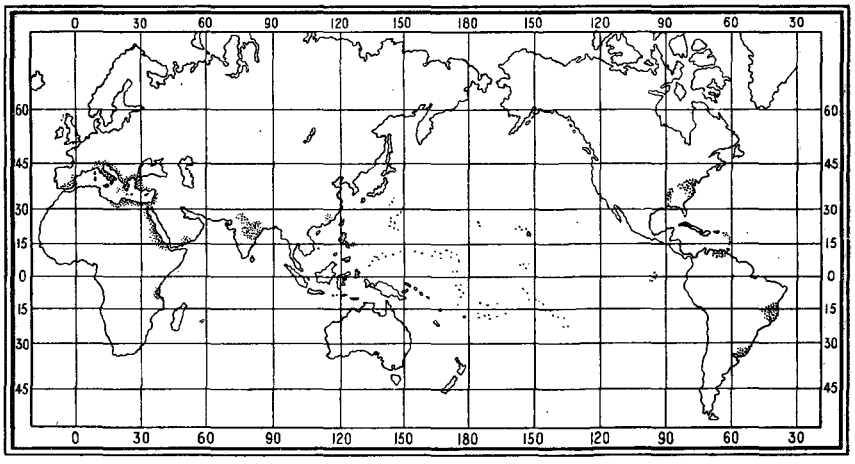
Geographical Distribution.—The following map shows roughly the distribution of this fever, as known up to the present time.

Doubtless further knowledge will greatly extend this distribution. For example: when we were in Kimberley, in South Africa, in 1901, we were shown a case of fever which from the temperature chart and history looked remarkably like Malta fever. As the case was convalescent, we could do no more, but we would be greatly obliged if one of our officers at Kimberley would take the matter up. It was owing to the kindness of Dr. Watkins, Kimberley, that we saw the case. The disease is known in Kimberley as camp fever.

During life the agglutination test is useful, if it is not possible to obtain a splenic puncture. If a death occurs, the planting out of the splenic pulp on agar-agar would probably

show whether the *Micrococcus melitensis* is present or not, and this, of course, would be the most satisfactory kind of diagnosis.

This fever has been reported from *Spain* — Gibraltar; *Islands of the Mediterranean*—Balearic Islands, Corsica, Sardinia Sicily, Malta, Gozo, Cyprus, Crete; *Italy*—Rome, Naples, Caserta, Benevento, Campobosso, Aricca, Terano, Fermo, Padua, Cittanova, &c.; *Greece*—Athens, Cephalonia; *Turkey*—Constantinople, Smyrna; *Palestine*—Jerusalem; *Africa*—Tunis, Algiers, Alexandra, Suakin, Massowah, Zanzibar, Kimberley (?); Aden; *India* — Calcutta, Mian-Mir, Nowshera, Secunderabad, Simla, Delhi, Agra, Allahabad, Choabattia, Subatha, Assam, Swat Valley; *China*—Hong Kong; Phillipine Islands; Fiji Islands; *North America*—Mississippi Valley; *West Indies*—Cuba, Puerto Rico; *South America*—Venezuela, Brazil, Montevideo.



Map showing the Geographical Distribution of Malta Fever.

The fever has even been reported as occurring in England. A man, aged 26, had not been abroad since the age of 8 years. From March, 1897, till the end of September of the same year, he was resident physician in a hospital in Plymouth. On October 1, he assumed the duties of junior house physician in the out-patient department at St. Bartholomew's Hospital, London, where he was employed during the whole of that month. He first began to feel ill in the beginning of November, and from the symptoms of the case it was at the time concluded

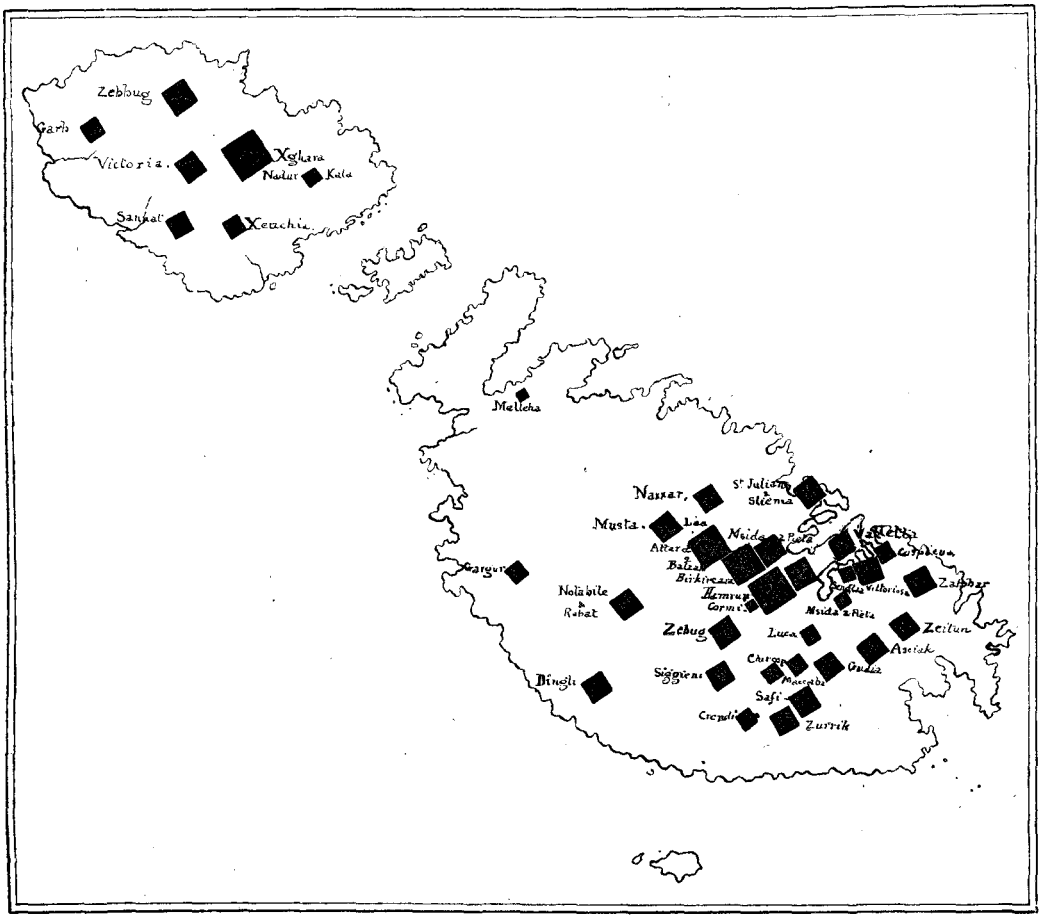
that this was a case of Malta fever, contracted either at Plymouth or London, although no definite source of infection could be traced.

Hughes, in the *British Medical Journal*, September, 1899, says that the limitation of the endemic prevalence of Malta fever appears to be primarily a question of temperature, and that in Europe to the north of the annual isotherm, 55° F., only imported cases are seen, which do not become endemic foci.

Distribution in Malta.—It will be useful now to enquire more strictly into the distribution of Malta fever as it occurs in Malta. For this purpose a map has been compiled from a paper read by Dr. T. Zammit before the Malta Archæological and Scientific Society, on May 23, 1902. In this paper he gives the following table, giving the average population, and average annual number of cases of Malta fever in the various towns and villages per thousand of the population for ten years, 1892-1901.

	Average population 1892-1901	Yearly number of cases of Mediterranean fever °/₀₀ of population average of the ten years 1892-1901		Average population 1892-1901	Yearly number of cases of Mediterranean fever °/₀₀ of population average of the ten years 1892-1901
MALTA.			MALTA—*continued.*		
Valletta	23,283	3·08	Tarxien and Paola ..	4,054	1·43
Floriana	6,131	4·88	Zurrik	3,521	3·20
Msida and Pietà ..	3,467	5·33	Safi	333	3·60
Sliema and St. Julian's	9,691	5·26	Crendi	1,287	2·40
Hamrun	8,257	8·21	Mcabba	1,156	1·90
Cospicua	12,106	2·39	Chircop	606	2·31
Vittoriosa	6,497	3·50	Zeitun	7,080	3·03
Senglea	7,331	1·42	Zabbar	5,347	4·78
Notabile and Rabat ..	7,455	4·11	Asciak	1,469	3·67
Dingli	709	3·66	Gudia	1,149	3·13
Zebbug	5,379	4·38			
Siggieui	3,118	3·30	GOZO.		
Birkircara	7,867	6·68	Victoria	5,088	3·87
Lia, Attard and Balzan	4,418	7·98	Gharb	1,360	2·57
Naxxar	3,457	2·63	Zebbug	862	4·98
Musta	4,443	4·32	Sannat	1,070	2·15
Gargur	1,332	1·80	Xghara	2,456	8·63
Melleha	2,106	0·71	Xeuchia	1,675	2·39
Cormi	7,801	0·47	Nadur and Kala ..	3,991	1·42
Luca	2,941	2·14	Ghainsielem	1,070	0·93

The following map represents this distribution by means of squares, whose size is proportional to the number of cases per thousand occurring in each town and village.



Map of Malta and Gozo, showing the Distribution of Malta Fever in the various Towns and Villages of the two Islands.

This is an interesting map and shows that our old ideas regarding the comparative absence of Malta fever from the inland parts of the Island and of Gozo were false. The disease is seen to be as prevalent in the country villages as in the big cities. We used to think that the neighbourhood of the Grand Harbour was the hot-bed of the disease, but the map

shows that the disease is more prevalent in such inland towns as Birkircara and Hamrun in Malta, and Xghara in Gozo, than even in Valetta or the three cities.

But perhaps it would be useful to describe at this point the physical characters of Malta, the towns and villages, the populations, the water supply, and methods of sewage disposal. This description is taken from a paper written in 1888, but which is probably as true at the present day as it was then.

"Malta, the principal island of a small group called the Maltese Islands, which comprises Malta, Gozo and Comino, is situated 50 miles south of Sicily, which can easily be seen on a clear day, and 200 miles east of the African mainland." Malta is a small island, being only 17 miles long and 9 miles broad. It is separated from the neighbouring island of Gozo by a narrow strait, 4 miles wide, in which lies the islet of Comino.

The island is built up altogether of sedimentary rocks, which have been divided by various geologists into upper and lower limestones and various intermediate beds of sandstone. These beds of sandstone are mostly formed of a very porous stone, and are traversed by innumerable fissures. Between the sandstones and the upper limestone there is a bed of marl which plays an important function in regard to the water supply of Malta. The eastern half of the island, and by far the most populous part, has been denuded of the upper limestone and marl, so that almost all the cities and villages of Malta are built on a porous sandstone. A microscopical examination of the rocks shows that the upper and lower limestones are composed of corallines, calcareous algæ and large foraminifera; whereas the so-called sandstones are made up of pelagic foraminifera, resembling in many respects, and to a very large extent, deep sea deposits.

Malta is one of the most densely populated places in the world. According to Dr. Cousins, the able author of the last census, which was taken some twenty years ago, the proportion of the population, exclusive of His Majesty's troops, is 144,312 to the square mile. Nearly one-half of this population (67,000) is concentrated, as might be expected, in the vicinity of the magnificent harbour, called the Grand Harbour, the shipping of which affords employment to thousands of the poorer inhabitants of the neighbouring cities and villages.

Valetta, the capital of Malta, is situated upon a tongue of land which forms the western boundary of the Grand Harbour and separates it from the Marsamuscetto or Quarantine Harbour. In its vicinity, near the base of the tongue, is its suburb, Floriana. On the other side of the Grand Harbour are the dense centres of population known as the three cities. Two of these, namely, Senglia and Vittoriosa, are also situated upon tongues of land which run into the Grand Harbour at right angles to the peninsula, upon which Valetta and Floriana are built. At the base of these two cities, but separated by a small intervening space, is situated the third of the fortified cities, namely Cospicua. Valetta is a handsomely built city, and to a stranger passing through appears to be very clean, but the houses are badly constructed, being lofty and built round narrow, well-like courts, down which little sunlight and pure air can struggle. The area of Valetta is only one-third of a square mile, and into this narrow space are crowded some 25,000 persons, the proportion of its population being therefore more than 78,000 to the square mile. If the area covered by the numerous sparsely populated buildings, such as the palace, the club, and the very numerous churches, was deducted, this proportion would be found to be much greater.

The most densely populated part of Valetta is called the Manderaggio. This quarter, inhabited by a very poor class of people, principally boatmen, is situated close to the Marsamuscetto Harbour, and only some few (fourteen) feet above the level of the sea. It covers two and a half acres, upon which dwell 2,544 persons, giving a proportion of 636,000 to the square mile. Another densely populated and low-lying quarter is that of Strada Fontana, which lies in a deep hollow behind the fortifications. It is also inhabited by the very poorest class.

Floriana, the suburb of Valetta, is a small, regularly built town. It has a population of 7,000, and is even more crowded than Valetta, the average number of persons to each inhabited dwelling being 10·44, whereas the average number in Valetta is 6·60; but it must be borne in mind that Floriana is situated in an isolated and healthy position.

The three fortified cities may be described together, and in a few words. The buildings are similar in structure to those of

Valetta, but are inhabited by a poorer class of people. Senglia and Vittoriosa are both built upon high ridges with steep sides. Cospicua, of the three, is the most huddled together, overcrowded, and has the poorest class of population.

Let us now direct our attention for a few minutes to the country villages or casals of Malta. These may be divided into two sets, viz., those lying towards the eastern end of the island, and those lying between Valetta and Notabile, the ancient capital. The villages lying to the east are inhabited by the least civilised of the Maltese, and in truth these people may be described as semi-barbarians. Let me attempt a description of their dwellings. Just outside the fortifications which surround the three cities lies the village of Zabbar, and a short distance further on the village of Zeitun. These may be taken as typical villages of the eastern set. In these two casals the construction of the houses is very different from that which obtains in Valetta and the three cities. Let us begin with the unit or building inhabited by one family. The plan is very simple, and was probably devised for motives of safety, when the island was apt to be overrun by any piratical crew. There is first built a square enclosure of the surrounding sandstone. The size of this enclosure, we shall say, is twenty feet square and twelve or fourteen feet high. In one of the sides a doorway is built for the purpose of gaining access to the interior. Against the inner walls are built various sized cabins with flat roofs. These cabins have no windows, but depend altogether for light and ventilation on a doorway. When these cabins are ranged against the walls the original building area of, say fifty square yards, is reduced to some ten or twelve. This remains roofless, and is the courtyard. These enclosures are closely packed together in double rows, and the lane running between them is, in many I have examined, not more than six or seven feet wide; so that these villages resemble nothing so much as aggregations of small-farm buildings and farmyards, each enclosed within its separate wall.

In the small courtyard of one of these village houses all the operations of life are carried on, such as cooking, eating, washing, &c. In one corner may be seen an uncovered and exceedingly primitive privy. In another the opening of the tank for drinking water. Near the door of the living room there is

often scooped out a hole or cellar into which is thrown all the refuse resulting from cooking operations. One of the cabin-like structures is used as a manure-room, wherein is stored as much filth and rubbish as possible, to be sold at intervals to the neighbouring farmers to spread over the fields. In others are found rabbits, poultry, and possibly a goat or pig. In a pent-up enclosure of this kind, reeking with all sorts of smells and swarming with flies and vermin, there usually lives a man, his wife and family of several children. These miniature court-yards are often very picturesque, with flowering plants scattered about, or a bright green vine trailing its branches irregularly over a corner of the enclosure, or partly roofing it by being trained along rude trellis-work. These plants, as might be expected, grow luxuriantly in the rich atmosphere of the courtyards, where they are protected from every breath of air.

The other, or central set of villages, lying between Valetta and Notabile, of which Hamrun, Zebbug and Birkircara are examples, are much more civilised than the eastern set, and as there has been a great increase of population in this part of the island of late years, very many of the houses are of modern construction. They are also more open, often have gardens, and may be said generally to take an intermediate position as regards their sanitary condition among the cities and villages of Malta.

Having thus dwelt briefly on the form of dwelling and population of the cities and villages of Malta, let us return to an important point, namely, their water-supply.

Valetta and the three cities are supplied principally by water collected from springs in the upper limestone hills some eight miles to the south-west. In the paragraph on the geological formation of Malta it will be remembered that, lying under the upper limestone, there is a bed of marl. Headings are driven for great distances at the junction of the limestone and marl, and the water, percolating through the very porous limestone, is caught on the marl, and finds its way in small streams along these headings, to be collected and conveyed to Valetta and the three cities by iron pipes under pressure. This water is principally conveyed in iron pipes, so that Floriana and Valetta have a constant supply under pressure of pure drinking water. This water can be obtained from numerous public taps,

and has also been introduced into many of the houses. Notably all the barracks have been supplied. It must be noted, however, that in many of the houses it is still stored in tanks under the houses.

This is a great improvement on what obtained in Valetta a few years back. At that time the water was conveyed in stone channels, by means of which the tanks under the houses were filled from time to time. These stone channels and underground tanks exposed the water to serious contamination.

The three cities are supplied by water conveyed from the south side of the island by the Fawara aqueduct, but until a recent date this water was stored in the underground tanks; in fact, it was only in June, 1887, that a constant supply under pressure was introduced.

The central set of villages lying between Valetta and Notabile, viz., Hamrun, Birkircara, Siggieui and Zebbug receive a plentiful supply of good water, but this is stored principally in underground tanks. Rabat and Notabile are provided with a good water supply, but a large quantity of the water consumed is from roofs and wells beneath houses. Other villages, such as Attard, Balzan, Lia and Musta receive in winter an abundant supply of aqueduct water; but this, again, is stored in underground tanks and largely used for agriculture.

The villages to the eastern end of the island, Zabbar, Zeitun, &c., have the worst water supply. The only source in 1887 was the water collected from the roofs, courtyards and lanes of the villages. In fact, in many of these enclosed dwellings which I have examined the rain is led by pipes from the roofs of the cabins to the courtyard, across which it streams and gains access to the well through an opening in the neck on a slightly lower level than the courtyard. From the description given above of the general filthy condition of these courtyards, swarming with children, dogs and poultry, some idea of the contaminated condition of the water in these tanks may be formed. As a rule it is so foul that the wonder is there is a single living being left in these villages. We have examined many samples of these tank-waters and found them all foul. In some instances the water, on being freshly drawn, was of the colour of pale sherry.

Let us now turn our attention to the removal of sewage in

Malta. As in treating of the water supply, we shall begin with Valetta, Floriana and the three cities. For the removal of sewage from these cities a complete and costly system of drainage by water carriage has been carried out for some years. Before that the drainage was effected by means of narrow channels cut in the porous sandstone, which conveyed, or failed to convey, the sewage into the harbours. The new main drain conveys the sewage by a circuitous route, several miles in length, and pours it into the sea at some distance from the mouth of the Grand Harbour. In the report of the last Cholera Commission by the sub-committee on the drainage, it appears that the street-sewers were found on inspection to be practically clean, that the gradients were sufficient to give a rapid flow, and the flushing apparatus worked efficiently; but the condition of the house-drains was less satisfactory. In almost every instance there was strong evidence of stagnation within the house-drains. The sub-committee satisfied themselves of this in several instances by pouring water down the drains and observing the putrid sewage that came out with the first flow. The sewage-flow seen in the street-sewers was black and putrid even close to the heads, giving further evidence of stagnation in the house-drains.

This defective action of the house-drainage is attributed to defective construction, principally as regards workmanship, and improper usage on the part of the occupiers. From this it would appear that although a great advance has been made in the drainage of the fortified cities, there still remains much to be done.

In the villages there are two methods of getting rid of the sewage. One is by pouring it into cesspools in the vicinity of the houses; the other, by throwing it into one of the rooms of the dwelling, which receives the name of manure-room. In the central set of villages the sewage is as a rule got rid of by the cesspool system. By law these houses should be drained into separate water-tight cesspools in the street, but this would entail the trouble of frequent emptying, so the builder, taking advantage of the numerous fissures in the porous sandstone, takes care that the cesspool will communicate with one of them. Mr. Osbert Chadwick, C.E., in a memorandum on drainage, states that these cesspools may be cemented to the satisfaction

of the sanitary inspector, but as soon as he is gone a few blows of the pick-axe suffice to make a leak. Many of these cesspools have never been emptied since they were made, the contents slowly leaking into the porous rock. As may well be imagined, this is a fruitful source of contamination to neighbouring wells; but the manure-room is the most transcendent abomination. This obtains, as was pointed out in a previous part of this paper, in most of the poorer villages, such as Zabbar, Zeitun, and those lying towards the eastern end of the island, where manure is valuable for use in the neighbouring fields. In this room, close to the living rooms and pent up by the enclosing walls, all the filth and refuse of the family and animals are stored. This hoard is increased by the daily addition of dung scraped up from the streets or roads by the younger members of the family.

From what has already been noted, it is evident that the sanitary condition of Malta, as regards drinking water and drainage, is mostly in a very barbarous condition, but as regards the most densely populated part of the island, viz., Valetta and the three cities, a very great deal has been done within the last few years. These cities, from being among the worst drained and worst watered of Mediterranean cities, are now amongst the best; but in regard to overcrowding in the fortified cities, the condition is becoming daily worse. In the report of the Cholera Commission it is stated "that the fortified cities, and even some parts of the villages of Malta, are overcrowded to an extent that is dangerous to public health. Many blocks of houses exist so closely packed together that it is impossible to secure the proper amount of light and air. The general arrangements of the existing villages, as we have seen, is highly insanitary. From the narrow and tortuous streets, lanes branch off which are even narrower and more irregular. These are the only means of access to the densely built-over quarters, and they often terminate in blind ends. There is therefore an inadequate supply of both light and air.

The Micrococcus melitensis.—It is by the entrance of this minute organism into the blood and organs of man that this disease is set up. It is therefore most necessary to study and understand it as fully as possible. This coccus or coccobacillus is about 0·33 μ in diameter, and usually occurs singly or

in pairs, but when grown in broth it appears in short chains. "In broth cultivations after about ten days' incubation it is not uncommon to find chains of ten to fourteen members; these are very readily broken up, so that attempts to make permanent specimens are not invariably successful. A bacillary form also occurs in cultures which have been grown at ordinary temperatures (18° C. to 20° C.). Agar cultures, which have been started for a few days at body temperature, and then kept for a few weeks (*e.g.*, four) at room temperature, often consist almost entirely of bacilli; the same is true of the cultures grown on gelatine. The length of these bacilli is about two to four times the breadth; some of them are somewhat curved" (Durham).[6] It is non-motile. It stains easily with all the basic aniline dyes, but loses its colour very rapidly when treated with alcohol or other decolourising agent, and becomes unstained by Gram's method. The absence of a fixation agent makes the bacteriological examination of tissue sections at present an impossibility. It readily emulsifies. That is to say, the individual cocci are very loosely bound together, and readily separate on being stirred up in a drop of water, unlike, for example, the plague bacillus in this. This property makes it very satisfactory in agglutination experiments.

Artificial Cultivation.—The growth of this micrococcus is extremely slow. It is important that media which are only faintly alkaline should be used. If markedly alkaline no growth takes place. "It grows very scantily at a temperature of 18·5° C., growing best at about 37° C. or 38° C. At temperatures between 40° C. and 42° C. growth is suspended. Above 42° C. artificial growths die. If kept moist at 15·5° C. for long they die. Cultivations sent to England during the winter died on the way" (Hughes).

Growth in Broth.—After two or three days the broth becomes turbid. If allowed to stand for some time there is a deposit of flocculi, but the fluid remains turbid, and there is no pellicle formation. Indol reaction negative. No odour produced. "If serum from a case of Malta fever be added to the broth the fluid remains clear, and a compact, felt-like growth takes place at the bottom of the tube in the course of weeks" (Birt and Lamb).

Plate Cultivation.—"In well-diluted plate cultivations (*e.g.*,

ten or so colonies to the plate) the colonies attain a diameter of 1·0 to 1·5 m.m. in four days; 2·0 to 2·5 m.m. in ten days; after a few weeks they may attain a size of several millimetres, if the medium is kept moist. Though this discrepancy in the rate of growth may be due to an habituation to artificial media, it is more probably to be ascribed to the mode of preparation and condition of the agar, since cultures made from the tissues of infected rabbits and guinea-pigs are quite visible after three days' incubation, even though only one or two colonies develop. There is, however, here the possibility that the growth arises from a mass of several agglutinated cocci. The whiteness of the almost hemispherical colonies by reflected light, and the clean-bright brown translucency by transmitted light, are extremely characteristic; this appearance is retained to some extent in old colonies, several m.m. in diameter, but the bacterial mass then has a slightly brownish hue, and from its thickness becomes opaque. Such colonies are sometimes somewhat umbilicated. Under the microscope, seventy-two-hour-old plates show that the superficial colonies are circular, with an even border; they are bright and translucent, the periphery being pale grey, whilst the centres have a brownish tinge; the whole colony shows no definite structure beyond being very finely granular. With age they become less translucent, and brown up to the margin. The deep colonies (seventy-two hours) are very bright, with a slightly yellowish tinge; later they become a deep sepia brown. When large quantities are sown a confluent growth results. *Milk* is not clotted. *Neutral litmus whey* (Petruschky) becomes only slightly turbid; in twenty-four hours alkalinity is apparent; this increases slightly in the following days, but only reaches 3 per cent. of decinormal H_2SO_4 after three weeks' incubation, In 1 per cent. peptone solution, with either *lactose* or *glucose*, the coccus grows more freely; in both cases alkali is produced. No gas bubbles are formed. On *potato* it grown fairly freely. The growth is not visible, for there is no alteration of the surface; the condensation water becomes turbid. The cocci are rather larger than those grown on other media. On *coagulated blood serum* a white moist growth takes place. *Alkali-albumin jelly* (Lorrain Smith) is not a favourable medium for this coccus; this is in accordance with the observation that highly alkaline media are not well tolerated" (Durham).

Growth on Gelatine.—When stab cultivations are made into 10 per cent. nutrient gelatine, and kept at 22° C., little growth takes place. At the end of a month the needle track has become slightly developed, and on the surface can be seen a minute smooth white growth, not larger than a pin-head. No liquefaction of the gelatine takes place.

Growth on Agar-agar. — Cultures made directly from the organs after death on this medium show no growth for about four days if kept at 37° C., and seven days if kept at 25° C. After the organisms have been artificially cultivated for some time outside the body they acquire a tolerance of their new environment and grow more quickly, so that the growth may appear in as little as two days. The colonies when they do appear are small, transparent and dew-like, and may be only seen at the lower end of the slope. In a stab cultivation the growth appears as minute pearly white spots scattered round the point of puncture, and minute round white colonies are also seen along the course of the needle track. After some weeks the colonies on the surface grow larger and join to form a rosette-shaped growth, while the needle track becomes strongly marked, solid-looking, and yellowish-brown in colour, with serrated edges. After the lapse of some months the growth remains restricted in area and its colour deepens to buff. "If the medium is tinted with litmus a distinct alkaline reaction is seen by the third day" (Durham, Gordon).

This micrococcus can be distinguished from all other microbes by its slow growth, its appearance on agar, its microscopical characters, and its behaviour to specific serum.

"The micrococcus does not grow on sea-water solidified with agar, not even when the sea-water was taken from a sewage outfall and was of a distinct brown colour. The micrococcus grows on an agared solution of normal human fæces" (Zammit).[7]

Vitality of the Micrococcus.—"If kept at a suitable temperature colonies retain their vitality for three months" (Hughes). "The micrococcus of Bruce can be grown successfully from a culture seven months old" (Zammit). "Colonies on agar allowed to dry completely were found to be dead when tested three years later" (Hughes).

I am not aware that any experiments have been made in

regard to the vitality of this micro-organism in the dust, in soils, on food, or in water, but it certainly would be useful information, and it is to be hoped that all these points will soon be cleared up.

Habitat of the Micrococcus outside the Human Body.—No one has up to the present found this parasite in external Nature. We wrote in 1887 that on account of the high temperature required for its growth the length of time which elapses before the colonies appear, and the absence of any well-marked morphological or cultural characteristics, the search for it outside the body will be very difficult, if not impossible. Shaw made many experiments to try to isolate the microbe from the air of wards in the Naval Hospital, Malta, but with no success. Horrocks also examined the air of rooms in which cases had occurred, but always drew blank.

Kennedy writes from Malta "that there has been an extraordinary amount of Mediterranean fever amongst the men of the regiments this summer (1903), and we have put it down to the turning up of the soil in building new barracks and quarters near by." He goes on to say "that he feels more and more convinced that the disease is air-borne, and that a possible point of entrance is the tonsils." He does not, however, describe any experiments carried out to prove the truth of this theory, either in the way of examination of the soil or of the air.

In this quest after the micrococcus outside the body the first thing to do will be to find a suitable medium for its detection. We are glad to hear that Horrocks is persevering in this direction, and hope he will be successful. We do not know how the injection of suspicious material under the skin of monkeys would answer, but it might be tried. Suppose that the air of a particular room was to be examined. By a suitable apparatus any quantity of air could be drawn through water and that water injected. Again, this small body we see in the spleen and blood and which we call the *M. melitensis* may be under quite another form in some stage of its existence outside the body. This is not likely, but should be borne in mind.

How does the Micrococcus Leave the Body?—Kennedy writes that the examination of the breath of patients suffering from the disease has not yet given any result. No experiments have

been made in regard to perspiration. "Up to the present I have been unable to find the micrococcus in any of the samples of urine I have tried" (Kennedy).

"Various attempts have been made by us to isolate the organism from urine during the course of the fever in man. These have in all cases been unsuccessful" (Birt and Lamb). Horrocks also investigated the urine with the same result. Durham, on the other hand, states that as the result of his experiments on rabbits and guinea-pigs, the cocci were found in the blood, brain, spleen, liver, kidney, urine and femoral marrow, and he points out that in these animals, which died or were killed long periods after the inoculation, the presence of the cocci in the urine is especially to be noticed. He believes there is a localisation of the micrococcus in the kidney in cases which run a chronic course, and he gives a case of a guinea-pig which was killed seven months after inoculation, from whose urine a pure culture was obtained, whereas the organs were mostly sterile. This agrees with an observation made by me in 1887, in the case of Pte. G. W., who died of Malta fever fifty-three days after his admission to hospital. The micrococcus was only recovered from the kidney; the liver and spleen were sterile.

It is therefore evident that although the micrococcus has never been isolated from the urine of cases of Malta fever in man, still the probability is that the cocci do leave the body in the urine, and no efforts should be spared to settle this point by experiment. [From the above it would appear that the older chronic cases would give more chance of success than the earlier and more acute. Few observations have been made as to the micrococci leaving the body by way of the bowel. Horrocks writes he has investigated the fæces of cases, but so far has failed to isolate the micrococcus. Lastly, there remains one other way of the coccus leaving the body, and that is by blood-sucking insects. It has been shown by Gilmour[8] and Shaw[9] that the coccus does exist in the blood; in fourteen cases examined by them the micrococcus was obtained in pure culture from the blood of seven. This theory of the micrococcus leaving the body through the instrumentality of biting flies is a favourite one at the present day. Zammit thinks a mosquito may do it, and Theobald goes as far as to point to the species

Acartomyia Zammitri (Theo.) as the carrier. If this is so, surely it would be easy enough to experiment on these lines, by keeping the mosquitoes in cages and feeding them alternately on affected and healthy monkeys.

How does the Micrococcus Enter the Body?—On this most important subject little or nothing is known. In 1887 we wrote that since this fever is caused by a definite vegetable organism it is difficult to picture such a particle rising into the air from fluid or solid substances in which it may be supposed to find a suitable soil for growth. On this account we thought it probable that Malta fever might be chiefly carried by means of drinking water or other fluid or solid foods to which the contagium had gained access. Against this is the fact that the great improvement which took place in the water supply of Valetta and the three cities did not diminish the fever to any marked extent.

The micrococci have never been found in water or food-stuffs. Zammit says he has not been able to induce the disease in monkeys by feeding them on micrococci. Wright also attempted to give the disease to these animals by feeding them on a suspension of the micrococcus in milk and also failed. Experiment is therefore against the micrococci gaining access to the body by water or food.

It is quite different as regards the skin. The smallest quantity of a culture applied to a scratch or injected under the skin will give rise to the disease in man and monkeys. In fact, this disease is one of the most dangerous to work with in the laboratory. Wright accounts for this by the fact that the blood has little or no bactericidal power on this microbe, so that the smallest quantity introduced into the blood may hold its own, grow and multiply.

We do not know whether this micrococcus will pass through the healthy skin or mucous membranes, but one case is reported in which infection was supposed to follow an accidental inoculation on the conjunctiva. As is known, touching the nostril of a guinea-pig with blood containing plague bacilli will give rise to the disease; experiments should be made to test this on monkeys with the micrococcus.

Kennedy thinks that a possible point of entrance is the

tonsils, but he does not seem to have made any experiments to strengthen this.

As this paper is already too long, we will take an opportunity of continuing the subject in a future number of the Journal.

BIBLIOGRAPHY.

[1] "Report on Fever (Malta)," by J. A. Marston, Assistant Surg., R.A. Army Medical Report, published in 1863, vol. iii., p. 486.

[2] "Remarks on the Cases of Fever from Cyprus, Malta and Gibraltar, treated at Netley," by Surg.-Major H. Veale. Army Medical Report, vol. xxi., p. 260, published in 1881.

[3] "Note on the Discovery of a Micro-organism in Malta Fever," by Surg.-Capt. D. Bruce. *Practitioner* for September, vol. xxxix., 1887; and "The Micrococcus of Malta Fever." *Practitioner* for April, vol. xl., 1888; and "On the Etiology of Malta Fever." Army Medical Report, published in 1892, vol. xxxii., p. 365.

[4] "Note on the Technique of Serum Diagnosis of Acute Specific Fevers," by Prof. A. E. Wrightand Surg.-Major Semple. *Brit. Med. Journ.*, January 16, 1897, vol. i., p. 139; also January 30, 1897, vol. i., p. 258; and "On the Employment of Dead Bacteria in the Serum Diagnosis of Typhoid and Malta Fevers." *Ibid.*, May 15, 1897, vol. i., p. 1214.

[5] "Mediterranean, Malta, or Undulant Fever," by M. Louis Hughes, Surg.-Capt. Published by Macmillan and Co., 1897.

[6] "Some Observations on the *Micrococcus melitensis* (of Bruce)," by H. E. Durham, M.A., M.B. *The Journal of Pathology and Bacteriology*, December, 1898.

[7] "Mediterranean Fever from a Sanitary Point of View," by Them. Zammit, M.D. Malta Archæological and Scientific Society, May 23, 1902.

[8] "A Few Notes on the Bacteriology and Pathology of Mediterranean Fever," by Surg. R. T. Gilmour, R.N. Statistical Report of the Health of the Navy for the Year 1902.

[9] "Mediterranean Fever," by Staff-Surg. E. A. Shaw, R.N. Statistical Report of the Health of the Navy for the Year 1902.