

Brucellosis and Maltese goats in the Mediterranean¹

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Abstract

British army doctors studied a fever which affected many servicemen in Malta: now known as the 'Corps Disease'. Although the organism was found, it was some time before the transmission by goats' milk was discovered. However, other means of transmission may have been important.

About 10% of the milk was infective and measures by the armed forces effectively controlled the disease. For the Maltese, controls were ineffective and cases rose. In 1936 pasteurised milk went on sale. In World War II most goats were eaten, but with peace the disease returned. Eventually strict control measures eliminated the disease – after one small epidemic.

Malta Fever, now known as brucellosis was endemic around the Mediterranean. Maltese goats, prized for their prolific milk yield were recognised as carriers of the disease and were sent packing. They had, however, passed on the bacteria to other breeds. Brucellosis is still a serious disease in the region.

Introduction

“They used to say it had something to do with the goats” (Maltese friends – 1985).

There are many infectious diseases which affect children, sometimes with high mortality, but leaving the survivors with protection. A high infant mortality may mask these diseases and it is only when adults from distant temperate countries come in large numbers that epidemics, with characteristic symptoms occur. The arrival of thousands of young, healthy soldiers has often led to epidemics and the disablement of the force. Such armies have been accompanied by doctors who have noted the incubation and other features. Army doctors have been prominent in tropical disease research: Lavarán in Algeria, Ross in India, Bruce in Africa and Walter Reed in Cuba. Their researches led to greater understanding of many diseases and, in many, to better health for their young

¹ *Acknowledgements:* The author is grateful to the *Wellcome Trust* for a grant towards expenses and to the Libraries mentioned in the footnotes for their kind assistance.

soldiers. Unfortunately, it has often been much more difficult to apply the new knowledge to the benefit of the local peoples. One such case is the story of Malta or Mediterranean Fever (now known as undulant fever or brucellosis) which was endemic throughout the Mediterranean, but whose etiology was recognised and investigated because it affected soldiers and sailors on the island of Malta.

Mediterranean Fever: Why Malta?

Malta received many injured and invalids from the Crimea in 1855 and 1856: while in Malta some of these men appeared to be infected with a new type of fever. It is possible that this fever was brought from the Crimea and only noticed in Malta, as will be discussed below. With the building of the dockyards and the fortifications of the island many soldiers and sailors came to the island and, among these newcomers, several hundred fell sick each year. Marston, an army doctor, distinguished three types of fever in a report on fevers in Malta. The first was typhoid or enteric. The second was a Simple Fever which was short, not dangerous and of 3-5 days duration. The third was Mediterranean Fever which he compared with relapsing fever and which was very common in Malta.² Soldiers with this fever had an average stay in hospital of nearly ninety days with a range of 15 days to two years, but the mortality was very low at about two percent.³ In general, Mediterranean or Malta fever had clinical features which distinguished it from others.

This was the time when the microscope could supplement the use of the stethoscope and the thermometer, but until the discoveries of Pasteur and Koch, only a vague diagnosis could be made. With the new science of bacteriology, one could discover an organism, make a sure diagnosis, perhaps discover the method of infection and remove the source.

Surgeon Captain David Bruce arrived in Malta in 1884 after qualifying in medicine in 1881. He worked in the Station Hospital, Valletta, originally the Holy Infirmary of the Knights of Malta and now the Mediterranean Centre. He confirmed Marston's differentiation of Malta and typhoid fevers and in 1886 determined to find the cause of Malta fever. Bruce's wife, Mary Elizabeth Steele, was a brilliant microscopist, an adept laboratory technician (having worked with Robert Koch in Berlin), a talented histology and pathology artist and an unfailing collaborator in his research.⁴ Bruce stained hundreds of sections of the spleen of a soldier who died on 26 December 1886 of Malta fever and found vast numbers of single micrococci. In July 1887 he made stab cultures in

² Marston, J.A., 'Report on fever (Malta)', *Medical Report for 1861*. Army Medical Department, London, 486-521.

³ Bruce, D., 'Observations on Malta fever', *British Medical Journal*, 1889, no.1, 1101-1104.

⁴ Cassar, P., [Historical Section]. 'Guide to the historical and clinical exhibition on Brucellosis'. *British Medical Association (Malta Branch), Twelfth Clinical Meeting 19th-12th April 1969*, 1-22.

nutrient agar and cultured the micrococci for four generations.⁵ He then found that a single monkey was susceptible to infection with the bacteria, but that two guinea pigs, eight rabbits and nine mice were not.⁶ This was before the invention of the agglutination test using samples of blood; because he based susceptibility on the presence of disease in the animals, he was unable to diagnose a carrier state, a concept unknown at that time.

In 1893 he named the bacterium *Micrococcus melitensis*. Bruce never acknowledged the help of his collaborator, but their discovery⁷ is commemorated by a plaque in Maltese and English on the outside of the Sacra Infirma, commonly known as the Knights' Hall (the Mediterranean Centre):

*In this building the British Army surgeon David Bruce together with
Dr. Joseph Caruana Scicluna confirmed the existence of the
microbe of undulant fever in the human spleen in 1887*

Themistocles Zammit, an outstanding Maltese doctor and archaeologist had modified a simple test for the presence of antibodies against the bacteria of the disease and begun experiments on the bacteria in culture.⁸ In 1902 he presented the first account of the epidemiology of the disease among the Maltese people, the first account for any civilian population.⁹ If more notice had been taken of his findings, much time and effort could have been saved.

Bruce became editor of the *Journal of the Royal Army Medical Corps (JRAMC)* from Volume 2 in January 1904. In that volume, Bruce had three editorials on Malta Fever.¹⁰ He repeated Zammit's analysis of incidence for villages and towns in Malta¹¹ and included a map (on pages 487-488) which he later reproduced in a pamphlet¹² although without crediting Zammit in either work. He wrote that 'Theobald thinks the mosquito *Acartomyia Zammitri* (Theobald) is the carrier although Zammit says he has not been able to induce the disease in monkeys by feeding them on micrococci.'¹³ He also

⁵ Bruce, D., 'Note on the discovery of a micro-organism in Malta Fever', *The Practitioner*, 1887, no.39, 161-170; Wyatt, H.V., 'Dr G. Caruana, the first Maltese Microbiologist.', *Journal of Medical Biography*, 2000, no.8, 191-193.

⁶ Bruce, D., 'The Micrococcus of Malta Fever', *The Practitioner*, 1888, no. 40, 241-249.

⁷ Bruce, D., 'Sur une nouvelle forme de fièvre rencontrée sur les bords de la Méditerranée', *Bulletin de l'Institut Pasteur*, 1883, no.7, 289-304.

⁸ 'Appendix P', *Public Health Department Report for 1897*. Malta, 1898; Wyatt, H.V., 'Sir Themistocles Zammit: his honours and an annotated bibliography of his medical work', *Maltese Medical Journal*, 2000, no.12, 27-30.

⁹ Zammit, T., 'Mediterranean fever from a sanitary point of view', *Malta Archeological & Scientific Society*, 23 May 1902 [16 pages plus 6 pages of discussion. Also published with the same title in the *Journal of State Medicine*, 1902, no.10, 399-412, but with very minor changes and no discussion.

¹⁰ Bruce, D., [editorials], *Journal of the Royal Army Medical Corps*, 1904, no.2, 485-502, 603-605, 731-736.

¹¹ *Ibid.*,

¹² Bruce, D., *The Extinction of Malta Fever (A lesson in the use of animal experiment)*, London, 1908.

¹³ Bruce, D., 1904, 501.

reported that Zammit had grown a culture from a culture itself seven months old. He concluded 'One thing appears perfectly clear, at least to our mind, and that is that no stone should be left unturned, no amount of labour thought too much, to enable us to gain knowledge of the natural history of Malta Fever'.¹⁴ During his time as editor, there were many articles about Malta Fever in the *JRAMC*.

The Mediterranean Fever Commission

Every year hundreds of soldiers and sailors were ill with the fever, the hospitals were crowded and many servicemen were invalided to Britain with the complication of rheumatism. The Admiralty began investigations in the Royal Navy hospital at Bighi, and Bruce was pressing for further work. Responding to a letter of 25 January 1904 from the Secretary of State, the Royal Society agreed to appoint an advisory board to supervise the investigations of a Commission in Malta.¹⁵ Colonel David Bruce RAMC was appointed chairman and Major W.H. Horrocks RAMC, Staff Surgeon E.A. Shaw RN and Dr. T. Zammit of the Board of Health (Malta) were appointed to the Commission. Bruce visited Malta from 13 June to 14 July 1904. The first monkeys arrived on 10 July 1904: Zammit made his first experiment with mosquito transmission the next day.¹⁶

At the end of September 1904 the scientists had made little progress and the two senior scientists left Malta, Zammit was ill and too busy and the other two members of the Commission did very little through the winter.¹⁷ Bruce wrote to the printers of the *Reports* concerning the major work of that first year¹⁸:

'Dear Harrison,

Enclosed is Johnstones 1st part - Please get it printed - There is nothing new in it, & nothing that helps us, but I hope his Part II will be more fruitful.'¹⁹

When work began again in May 1905, it seemed that there would be little progress. However, both Shaw and Zammit had infected goats and had even tested samples of milk: they were both convinced that goats played some part in the transmission of Malta fever, but it is clear that they thought that only a very few goats in the island might perhaps be infected. Bruce came for a month and was not impressed by the work with the goats. Two days after Bruce left, Zammit bought six goats of which five gave a

¹⁴ *Ibid.*, 605.

¹⁵ The body was called 'the Commission appointed by the Admiralty, the War Office and the Civil Government of Malta, for the investigation of Mediterranean Fever under the supervision of an advisory committee of the Royal Society' shortened here to Mediterranean Fever Commission [MFC]. The reports of the Commission were published by Harrison & Sons, London, in seven parts: 1905-1907.

¹⁶ Horrocks, W.H., 'Experiments on the mode of conveyance of the *Micrococcus melitensis* to healthy animals', *Reports of the MFC I*, 1905, 46-72.

¹⁷ Bruce, D., 'Introduction', *Reports of the MF IC*, 1905, 3-4.

¹⁸ Johnstone, R.W., *Report upon the general sanitary circumstances of the Maltese islands, with special reference to the prevalence of Mediterranean Fever therein. Reports of the MFC, Pt.II*, 1905, 3-62.

¹⁹ *Royal Society of London Archives*, MC 04130, 1 Nov. 1904.

positive agglutination test.²⁰ Later, one of these goats was found to be secreting the bacteria in her milk.²¹ Within the next few weeks, the MFC members had discovered that half the goats on the Island were positive and that one in ten was giving a positive milk sample.²² Although it took some time to convince even all the doctors on the Commission, a role for goats' milk in the transmission of the disease had been shown.²³

Although experiments showed that bacteria could also be transmitted venereally,²⁴ by insect bite, from inhaling dust and through abrasions especially by contaminated urine, these were probably rare among servicemen in Malta. Infection through drinking goats' milk was not only possible, but because about 10% of goats in Malta were secreting the bacteria in their milk, seemed to be the most probable source of the infections. Once this had been discovered, various remedies could be put into operation and past epidemics examined to test the new explanation.

²⁰ Zammit, T., *A preliminary note of the susceptibility of goats to Malta Fever. Proceedings of the Royal Society*, 1905, 76 B, 377-378. Also published in a shortened version as *VI. A preliminary note on the examination of the blood of goats suffering from Mediterranean Fever. Reports of the MFC III*, 1905, 83.

²¹ There is not a little confusion in the use of 'positive' because there are several tests.

1. The blood could be tested for agglutination (clumping) of the specific bacteria: this showed that agglutinating antibodies were present in the blood indicating either past or present infection.
2. Bacteria could be grown in culture from the blood indicating a present infection. However, if the sample of blood was too large, the bacteria might be inhibited by the antibodies present: too small a sample might contain no bacteria.
3. Milk could be tested for agglutination of the specific bacteria: this showed that agglutinating antibodies were present in the milk indicating either past or present infection. [Zammit's Test].
4. Bacteria could be grown in culture from the milk indicating a present infection which could cause infection in a person who drank raw milk or products.
5. Colonies of bacteria could be cultured from a sample of urine (or from a vaginal swab).

In an infection, bacteria might be present in sites where they were protected from the body's defences and from which they might later appear in the blood, milk or urine. Zammit was convinced that a goat once infected, was potentially a source of infection for life. The agglutination test for milk was the easiest to apply as the milk could be easily obtained unless the goat was dry. It is not always clear which test or tests were used. Many goats would give a positive blood agglutination although only a few would yield colonies from the milk ie only a few positive goats might be infectious at any one time.

Wyatt H.V., 'Sir Themistocles Zammit: his honours and an annotated bibliography of his medical work', *Maltese Medical Journal*, 2000, no. 12, 27-30.

²² See *Report of the MFC 1905-1906*, Pts. III – IV.

²³ See for instance Bruce, D., 'Editorial: Malta Fever', *Journal of the Royal Army Medical Corps*, 1906, no.6, 330-352.

²⁴ See reports of the MFC 1905-1907; Wyatt, H.V., 'Brucella melitensis can be transmitted sexually', *Lancet*, 1906, 348, 615.

Nevertheless, many questions remained unanswered. Much later, Sheldon Dudley, a naval surgeon, concluded that the fever was brought to Malta by ships carrying troops and injured from the Crimea in 1856.²⁵ Epidemics lasting two years in the absence of milk occurred on some ships of the British Mediterranean Fleet in the 19th century. From the living conditions on these ships, Dudley concluded that pneumonic spread was possible where many cases were in very close contact. Indeed, the extreme ease with which laboratory infections occurred might have suggested that in different circumstances, other means of spread might be important.

The British services

Staff-Surgeon E.A. Shaw RN of the MFC had inoculated goats with the micrococcus and showed that the goats were chronically infected. However, because his goat had a staphylococcal infection, he was unable to grow colonies from the milk.²⁶ He fed a monkey with milk from an infected goat, but the monkey died. When he learned in June 1905 that Zammit had found that five out of six purchased goats were infected, he returned to the Royal Naval (RN) Hospital at Bighi and tested the herd which supplied the milk. He found that 30 of 91 of the goats gave a positive agglutination and nine yielded colonies of the bacteria from their milk. He excluded these nine goats from supplying the hospital.²⁷ Nine months later he re-examined the herd, now only 74 goats, and found eight yielding colonies.²⁸ There had probably been no fall in the number of cases of Malta fever in the hospital.²⁹ Shaw's experience showed how difficult it was to prevent infected milk being supplied to the hospital, to have all milk boiled and to prevent staff and cooks from drinking raw milk.

In theory it should have been fairly easy to prevent infected milk from reaching soldiers and sailors. The men were confined to ships or barracks where milk and milk products would have to pass the guard on the gate. The cooks could be given instructions, were supervised and could be punished. Nevertheless, successive measures met with limited success. About one third of the patients at the RN Hospital caught Malta fever there and the staff, especially the cooks, had a very high attack rate. Goats' milk had been given as a specific remedy. From about 1900 milk was supposed to be boiled to prevent typhoid fever, but the methods used were faulty. After Shaw's further investigations, more stringent measures were taken in April 1906 for the boiling: in July, preserved milk was substituted for goats' milk. An average of 104 cases a year 1902-

²⁵ Dudley, S.F., 'Some lessons of the distribution of infectious diseases in the Royal Navy. Lecture III. The history of undulant fever in the Royal Navy', *Lancet*, 1931, I, 683-691.

²⁶ Wyatt, H.V. 'Royal Navy surgeons and the transmission of Brucellosis by goats' milk', *Journal of the Royal Naval Medical Services*, 1999, 85, 112-117.

²⁷ Shaw, E.A., 'III. Mediterranean fever in goats, cows, and other animals.' *Reports of the MFC 1906*, Pt.IV, 16-26 [reprinted in the *Journal of the Royal Army Medical Corps*, 1907, no.2, 1-12].

²⁸ Shaw, E.A. 'III. Further Observations on goats, cats, rats, and ambulatory cases in connection with Mediterranean fever.' *Reports of the MFC, 1906*, Pt.V, 37-41.

²⁹ Kennedy, J.C., 'Malta Fever', Unpublished MD thesis, University of Edinburgh, 1908.

1905, and 50 cases in the first quarter of 1906 became a single case from April 1906 to the end of 1907.³⁰

In the ships of the Fleet from May 1906 the milk was to be boiled and tested with addition of ortol to samples: in the presence of large numbers of bacteria, the coloured dye ortol would lose its colour (the oxygen would be used by the bacteria and the dye reduced to its colourless form). From 270 cases a year before 1906, there were only six cases a year from 1907 to 1914.³¹ Similar measures were taken by the Army, with similar results.

The Commission had not considered other sources of infection from goats' milk. *Grog*, a mixture of rum and milk was popular in the bars. Of two kinds of ice-cream, one was made from boiled milk and therefore harmless. However, the cheaper variety was simply frozen milk with flavouring.³² Butter was not made from goats' milk, but the cheeses were and the bacteria were retained in the cheese, not the whey.³³ The popular cheese cakes -*pastizzi* -if cooked properly are harmless. These sources may explain the few remaining cases each year.

From 1906 the British services used only condensed or evaporated milk. The use of condensed milk by the wealthier Maltese was partly fostered by the advertisements in *The Daily Malta Chronicle* for example: 'Cows Head brand full cream'; "Bear Brand" Milk is a real swiss milk of the highest standard'; 'Milkmaid brand condensed milk'; a half page advertisement for Sterilized Milk Life Belt Brand said 'as supplied to HMY "Victoria and Albert" during the voyage in the Mediterranean of HM the Queen...'. In some of the local bars in Maltese villages, one is still offered a choice of fresh pasteurised cows' milk or a tin of evaporated milk.

The Maltese and the goats

Characteristic of Malta, especially in Valletta, are the low gates of brass or iron which protect the front doors against the entry of goats.³⁴ Between 4000 and 5000 goats were driven into Valletta every morning and afternoon, to be milked in the street. As there was no refrigeration, milk was bought twice or more a day. People did not use the pint measure and so bought two pence worth of milk. Boiling goats' milk destroyed the flavour.

³⁰ Ibid.

³¹ Stephens, J.W.W., 'Undulant fever in the naval, military and civilian populations of Malta', *Annals of Tropical and Medical Parasitology*, 1922, no.16, 11-20.

³² Kennedy, 1908.

³³ Ibid.

³⁴ Luke, Sir H., *Malta, an account and appreciation*, London, 1960 (2nd edn.).

Following the work of the Commission, pamphlets in English, Italian and Maltese on the danger of using raw goats' milk were distributed throughout the island in 1906.³⁵ Two examples from Malta were used to illustrate the link between milk and fever. In the previous four years 216 cases had been reported from 2 small villages and 31 goats of 203 were found to be infected. However, the 900 inmates of two Institutes with their own goats had been free of the disease for many years, as were their goats which had no contact with village goats. However, 'the bulk of the Maltese population, who thought they knew better, have not heeded the caution repeatedly given out by the Sanitary Officers to the danger of using unboiled milk'.³⁶ Some doctors also questioned the role of goats' milk in a campaign which only ceased in 1916.³⁷

In 1906 the goatherds went on strike to prevent the authorities sampling the milk for presence of the infective bacterium. The goatherds now drank the milk which they had previously only sold and many became ill so that numbers of cases of Mediterranean fever actually increased in 1906.³⁸ Due to hard times the number of goats decreased from 17, 110 in 1907 to only 7, 619 in 1910: in this time 461 infected goats were destroyed. The incidence of the disease among Maltese fell until 1911, but then steadily increased almost seven fold by 1934 when 1909 cases were reported.

In 1908 the Government had appointed a local Commission which included Zammit, and its Report in 1909 led to new Regulations.³⁹ Dairies had to have a window and a proper floor and all goats and sheep were to be marked and registered. All such animals were to be examined at least twice a year. All milk had to be boiled before selling. Animals which were positive for both the milk and blood agglutination tests were to be destroyed.⁴⁰ By 1912, more than 30, 000 goats and 5,500 sheep had been tested and 788 had been destroyed: it is not clear how many goats there were on the island. Three percent of goats gave a positive reaction in 1910, but this rose with dips and peaks to 15% in 1931 and 1934, a proportion worse than that revealed by the *MFC Reports* in 1905-1906.

There were never enough inspectors and for some time the animals for destruction at the abattoir were resold to their owners at the back, the compensation being shared. When this ruse was discovered, all animals were destroyed at the Lazzaretto on Manoel Island. Owners sold their goats in the smaller sister island of Gozo where inspections were less frequent.⁴¹ Herds supplying the wealthier towns like Sliema had 18% positive

³⁵ Caruana Scicluna, G., *The Milch-goat as a factor in the propagation of Mediterranean Fever* (no publisher), Three similar publications in English, Italian and Maltese 8 pages.

³⁶ Zammit, T., 'Undulant Fever in the goat in Malta', *Annals of Tropical and Medical Parasitology*, 1922, no.16, 1-10.

³⁷ Cassar, P., *Sir Themistocles Zammit and the controversy on the goat's role in the transmission of Brucellosis (Mediterranean fever) 1909-1916*, Malta, 1981.

³⁸ Eyre, J.W.H., 'The incidence of Mediterranean Fever in Malta and its relationship to the size of the goat population', *Lancet*, 1912, I, 88-89.

³⁹ 'Regulations for the prevention of the spread of Mediterranean Fever', *The Malta Government Gazette*, no.5173, 21 June 1909.

⁴⁰ *Public Health Department, Report for 1909-1910*, Section J – 1910.

⁴¹ *Annual Report on the working of the Public Health Department for the financial year 1930*, Malta, 1931.

animals, but because the milk was boiled there were few cases.⁴² In the poorer villages 19% of goats were positive and the number of cases increased.⁴³ By 1936 the consumption of unboiled milk in shops had been prevented (in theory, see below), but many people were too poor or had no facilities to boil their milk.⁴⁴

In 1931 a Special Committee was set up to consider the pasteurisation of milk. The Committee reported in 1933 and recommended pasteurisation of all goats' milk. On the 11th May 1938 the Milk Centre was opened. In the country areas depots with large covered yards where goats could be milked under supervision were made. The milk was weighed, cooled, put into cans and taken to the Milk Centre for pasteurisation.⁴⁵ Milk was sold in quarter pint waxed cardboard cartons and in two, one and half pint bottles sealed with aluminium caps. Milk was delivered by electric vans using ice from the Centre to keep the cartons cool.

Raw goats' milk was prohibited in Valletta and goats disappeared from the streets. However, of 92 samples of milk from coffee shops, 32 were unboiled and one sample was half water.⁴⁶ Raw milk was smuggled into the city. Raw cows' milk could still be sold, but was usually bought by families who boiled it. In 1939 goats and raw milk were prohibited in the towns of Sliema, Saint Julian's, Gzira and Msida, a fairly compact area with better housing.⁴⁷ Pasteurised milk was now available all over Malta, but brucellosis was still common on Gozo. A research station was established and a fulltime research officer appointed: after four months he contracted the disease and was ill for seven months.⁴⁸ In the second report of the station, it was suggested that male goats be castrated, only selected males be used as studs, all females brought to the station for servicing and each be given a live vaccine each time. It was estimated that there were between 40 000 and 100 000 goats on the islands.⁴⁹

The war for Malta began in June 1940 and there followed a siege with very heavy bombing and very severe food shortages until early 1943. Many goats were killed for food and the number of cases dropped to only 173 in 1944, 51 of which came from Gozo.

The breeding of goats was resumed in 1945 and the number of cases jumped to a 1 000, and reached 2 410 in the next year.⁵⁰ The Chief Government Medical Officer wished that all the goats had been killed in the war. The number of cases gradually fell in Malta as a new pasteurisation plant increased the amount of safe milk; more areas were closed to raw milk and cows' milk was increasingly used.⁵¹ Gradually goats' milk was

⁴² *Annual Report – Public Health Department, 1927*. Malta, 1928.

⁴³ *Annual Report – Public Health Department, 1931*, Malta, 1932.

⁴⁴ *Annual Report – Public Health Department, 1936*, Malta, 1937.

⁴⁵ Barnes, S., *Why Malta*, Malta, 1987.

⁴⁶ *Annual Report – Public Health Department 1938*, Malta, 1939.

⁴⁷ *Annual Report – Public Health Department 1939*, Malta, 1940.

⁴⁸ [Anon], 'First progress report of the Undulant Fever Committee', *Malta Government Gazette Supplement XLII*, 18 May 1937, 541-565.

⁴⁹ [Anon], *Second progress report. Brucella melitensis Research Station*, Malta, 1939.

⁵⁰ *Annual Report – Public Health Department 1945 and 1946*, Malta, 1946, 1947.

⁵¹ *Annual Reports – Public Health Department, 1950-1954*.

replaced by cows' milk which was now pasteurised and although some families still drank raw milk from their own goats, the number of cases of brucellosis fell. An eradication programme was launched in 1956, but was never properly implemented. In April 1958 the first Milk Marketing Board plant opened in Gozo.

Eventually, in 1988, a determined effort began to eradicate brucellosis and tuberculosis from cows, goats and sheep on both Gozo and Malta. At last the regulations included all animals, domestic as well as those whose products were for sale. In the first six months, nearly a thousand cows and 250 goats and sheep failed the tests and were killed.⁵²

From 1992 to 1994 only twenty one cases were notified, but in 1995 a small outbreak affected more than 130 people, including two visitors from Britain, who ate cheeselets made from goat cheese. There was one death.⁵³

Mediterranean Fever in the Mediterranean

'Mediterranean fever is a malady which, on account of its manifestations and chronicity, will become one of the most common and stubborn diseases.... Mediterranean fever is the disease of the future.'

Charles Nicolle⁵⁴

The seven *Reports of the MFC* published by the Royal Society, may have had a limited circulation. However, the important findings on the role of goats' milk in the transmission of the fever received wide publicity. Many papers from the *Reports* were republished in the *JRAMC* although some were shortened. Some were summarised in the *Journal of Tropical Medicine* and there were leaders in that journal, the *British Medical Journal* and *The Times*. The role of goats' milk became well known and Maltese goats in particular were targeted. In 1909, a police serjeant who drank fresh unboiled goats' milk every day was reported from German South-West Africa to have Malta fever.⁵⁵

An editorial in 1905 had argued that the name Malta fever was inappropriate as the disease was found in almost all the islands of the Mediterranean, many parts of Italy, Greece, Turkey, Palestine, from several parts of Africa from Algiers to Zanizibar as well as other parts of the world. However, Shaw wrote that many of these reports were wrong

⁵² [Anon.], Disease-free cows rise from 50 to 75%, *Times of Malta*, 28 September 1988, 17.

⁵³ [Anon.], 'Brucellosis associated with unpasteurised milk products abroad, *CDR weekly* 1995, no.5, (32), 1; 'Brucellosis epidemic diminishing', *Times of Malta*, 18 August 1995 and 28 July 1995.

⁵⁴ Quoted by Abela-Hyzler P., 'Undulant fever in Malta. An analysis of a public health problem.' Unpublished DPH thesis, London School of Hygiene and Tropical Medicine, London, 1964.

⁵⁵ Werner, H. *Uber Maltafieber in Deutsch-Sudwestafrika. Archiv fur Schiffs und Tropen Hygiene* 1909; 13 Heft II. [comments in *Journal of the Royal Medical Corps*, 1909, no.13, 610-611].

as he had made tests on the French and Italian littoral with negative results:⁵⁶ his technique must have been at fault.

Gibraltar

Major Horrocks RAMC was stationed in Gibraltar when he was appointed to the MFC in 1904. He served twice in Malta and made long contributions to the *Reports of the MFC*. He returned to Gibraltar and made a retrospective study of the fever, correlating numbers of cases with the number of goats on the Rock.⁵⁷ A wave of fevers began in 1874 and reached a peak in 1882, but fevers which were probably Malta fever, known locally as Rock fever, could only be differentiated after 1884. Over 400 cases of Malta fever occurred in 1884 and fell rapidly to none in 1904. Horrocks found that there had been about 1800 Maltese goats on the Rock in 1883: the goats grazed on the upper slopes for which passes were issued. As the fortifications increased, the pastures were reduced. Many goats were sold and in 1890 only about 600 passes were issued. In 1893, goats were excluded from another area and the stock of goats fell to 300. In 1905, Horrocks found only 254 goats on the Rock.

Some imported Spanish goats bred with the Maltese goats. Horrocks found that the serum of some of the Spanish goats gave a positive agglutination and other evidence of infection. At least some of the Rock goats were sold in Spain and bred with Spanish goats. Horrocks was told that Spanish goats from Malaga were sold to Oran, Algiers, Tangier and other towns on the African coast, probably taking the infection with them.

North Africa

Dr. Sergent and colleagues examined people and animals in Oran and in the nearby village of Kleber where there had been an outbreak of fever in 1906-1907. They found that the cases originally thought to be typhoid, were in fact Malta fever and that some animals and goats were positive.⁵⁸ As two of the cases had no contact with goats or goats' milk, they concluded that infection might also occur through contact with harness contaminated with urine of an infected mule. Sergent concluded from experiments and frequent laboratory infections that infection could easily result from simple contact.⁵⁹ In Algiers, the majority of milch goats were Maltese with some of Spanish and mixed breeds, tended by Maltese. Only four per cent of milks tested gave a positive reaction

⁵⁶ [Anon.], 'Is Malta fever peculiar to Malta?', *Journal of Tropical Medicine*, 1905, no.8, 364-365.

⁵⁷ Horrocks, W.H., 'V. Mediterranean fever in Gibraltar.' *Reports of the MFC* 1906, Pt.V, 54-56. [reprinted in *Journal of the Royal Medical Corps*, 1907, no.8, 374-384.]

⁵⁸ Sergent E., Bories [Studies in Mediterranean fever in the village of Kleber (Oran) in 1907], *Annales de L'Institut Pasteur*, March 1908, [Comments in *Journal of the Royal Army Medical Corps*, 1908, no.11, 215-216].

⁵⁹ Sergent, E., [Studies in Mediterranean fever], *Annales de 'Institut Pasteur*, March 1908 [Comments in *Journal of the Royal Army Medical Corps*, 1908, no.11, 216].

and the authors noted that there were far fewer goats per person in Algiers compared with Malta.⁶⁰ Later Sergent reported that a Committee of three doctors had investigated the occurrence of Malta fever in Algeria and had recommended that the importing of Maltese goats be confined to Algiers and Tunis and that only goats free of the infection should be admitted.⁶¹

Brucellosis is recognised as one of the easiest diseases to be acquired by laboratory workers and veterinarians: several of the workers in Malta contracted the disease. Nicolle recorded a young worker at the Institut Pasteur in Tunis who contracted the fever⁶² and from 1903 to 1926 no less than ten workers there had contracted the disease.⁶³ In 1909 Nicolle and Conseil reported a major study of goats in Tunis with a map of all the stables and places where milk was sold.⁶⁴ Some of their conclusions were embodied in a Government Decree which forbade the importation or transit of goats or their meat and offal from Malta.⁶⁵ In 1914 Hayat reported the success of the Decree in reducing the incidence of the fever in Tunis and Algiers.⁶⁶ However, there was no reduction in Oran where Spanish goats brought the disease with them from Western Algeria and Morocco (see above). The work at the Institut Pasteur in Tunis continued and included a vaccine to immunise young goats.⁶⁷

In 1910 Malta fever was confirmed in Tripoli where there had been 6 cases in May 1907.⁶⁸ One case was a Maltese baker, born in Malta, but living in Tripoli since he was five. He had not returned to Malta, but had had fever when five and eleven: he habitually drank goats' milk.

Abela-Hyzler wrote that 'the successful stamping out of Undulant fever in Port Said in Egypt at the time [1920] by the destruction of all the infected goats' was a good example of Zammit's views.⁶⁹

⁶⁰ Sergent, E., Gillot, V., Lemaire, G., [Studies on Mediterranean fever in goats in Algiers in 1907], *Annales de L'Institut Pasteur*, March 1908, no.11, 216].

⁶¹ Sergent, E., [Malta fever in Algeria], *Bulletin de la Societe de Pathologie Exotique* 1908. [Comments in *Journal of the Royal Army Medical Corps*, 1908, no.10, 454].

⁶² Nicolle, C., 'Une observation de fièvre mediterr. par contamination de laboratoire', *Archives de L'Institut Pasteur de Tunis*, 1906, 155-158.

⁶³ [Anon.], 'Oeuvre scientifique: fièvre mediterr.', *Archives de L'Institut Pasteur de Tunis*, 1926, no.15, 18-23.

⁶⁴ Nicolle, C., Conseil E., 'Recherches sur la fièvre mediterr..' *Archives de L'Institut Pasteur de Tunis*, 1909, 157-173.

⁶⁵ Pacha-Bey, M., Documents officiels. Fièvre Mediterr.. Decret du 22 Septembre 1909 (7 Ramdane 1327). *Journal Officiel Tunisien*, 25 Septembre 1909. [reprinted in *Archives de L'Institut Pasteur de Tunis*, 1909, 156].

⁶⁶ Hayat, I., 'Regression de la fièvre mediterraneenn Tunisie', *Archives de L'Institut Pasteur de Tunis*, 1909, 157-173.

⁶⁷ [Anon.], 'Oeuvre scientifique: fièvre mediterraneenne', *Archive de L'Institut Passeur de Tunis*, 1926. No.15, 18-23.

⁶⁸ Ibrahim, T., 'Sur l'existence en Tripolitaine du Kala Azar et de la Fièvre Mediterraneenne', *Archives de L'Institut Pasteur de Tunis*, 1910, no.1, 158-159.

⁶⁹ See Abela-Hyzler,

Discussion

Why was the Maltese goat so infected and why was it found so far afield? Zammit quoted 'the Maltese goat is the hardiest, the tamest, the best milking goat in existence' and a yield of five and a half litres of milk per day was not uncommon.⁷⁰ The udders often trailed on the ground and so could easily become scratched and liable to infection from the urine soaked ground. Kennedy said that the goat-herd wet his hands with milk from one goat to lubricate the next and that transmission was probable as bites and injuries to the udders were very common.⁷¹

Once several goats were infected, progression through a herd would be rapid as the goats were kept together in filthy stalls and infection from the urine was certain. Transmission between herds may have been helped in Malta because of the peculiar geographical features: several thousand goats were driven twice a day into the main city of Valletta which is built on a narrow peninsula - all the goats having to pass through the same narrow entrance gates. The streets and alleys were soaked with urine, faeces and rubbish.

Malta was a poor island with virtually no natural resources - even water was scarce. The infant mortality was very high: in one village in 1933, the infant mortality was 630 per thousand and three out of four children had died by the age of five years.⁷² In the war a Royal Air Force (RAF) pilot wrote:

'In 1941, the village of Mosta represented perhaps the most blatant example of poverty and wealth in juxtaposition I had ever beheld. The massive Roman Catholic church, its hugely magnificent dome decorated internally with the most breathtaking display of marble and gold, was the focal point of a village that was primitive and deprived almost beyond description. The streets between the unkempt ruins of houses were mere rutted paths streaming with urine and excrement through which dark, bare-footed children shouted and played and goats dragged their bloated, milk-heavy udders as they scavenged among the filth and rubbish, the whole area buzzing with clouds of green-bodied flies all seemingly mesmerised by the summer heat.'⁷³

The discovery that apparently healthy goats could suffer long infections and be carriers of the disease, was 'one of the greatest advances ever made in the study of epidemiology'.⁷⁴ The dramatic reduction in the number of cases in the British army and navy was proof that, in most cases, infection from the goats' milk was responsible. In 1909 the now empty Great Ward of the Military Hospital was thrown open for a ball.⁷⁵ Yet cases in the civilian population increased and even 90 years later eradication in a

⁷⁰ See Zammit, T.

⁷¹ Kennedy, J.C., 45.

⁷² *Annual Report - Public Health Department, 1933*, Malta, 1934.

⁷³ Neil, T.F., *Onward to Malta*, 1992 [Airlife Publishing], 80.

⁷⁴ Tulloch, W.J., 'Sir David Bruce. An appreciation', *Journal of the Royal Army Medical Corps*, 1955, no.101, 81-90.

⁷⁵ [Anon], 'Royal Army Medical Corps ball at the Valletta Hospital', *The Daily Malta Chronicle*, 13 March 1909, 8-9; see also Cassar.

very small island was uncertain. Knowledge is not enough, there has to be education, money for compensation, staff and buildings, sensible regulations and much else must follow. Unless comprehensive measures are taken, the few remaining people or animals will infect others and the never ending circle continues. It is a lesson which has eluded malaria control and polio immunisation in the Indian sub-continent and Nigeria.

In 1993, the World Health Organisation (WHO/OMS) prepared guidelines for a regional brucellosis control program in the Middle East where the disease is endemic and may be on the increase: 'Brucellosis is regarded as the world's most widespread zoonosis and apart from its toll on people, has an enormous impact on the animal industry in many countries'.⁷⁶ Only constant vigilance will prevent its reappearing in areas of the Mediterranean where it has been eradicated or reduced. Civil war, unrest, natural disasters and famine produce conditions where old diseases resurface.

The MFC was successful in its researches, but few have studied its work this last century. Brucellosis is a disease which can spread in many different ways. People forget.



⁷⁶ [Anon], 'Renewed attack on brucellosis', *International Society for Infectious Diseases (ISID) News*, 1993, no 2 (3), 6.



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