

## CHAPTER 13

### Yellow Fever

**aka. Yellow Jack.**

**aka. Vomito Negro.**

Yellow fever is a notorious companion of malaria and like malaria is transmitted by a mosquito. Yellow fever, however, is caused by a virus, known as an arbor virus because it is arthropod-borne. Arthropod is an awkward term made necessary by the need to include the mites and ticks in the definition as both transmit viruses but are acarids and not strictly insects (members of the Insecta).

The yellow fever virus belongs to the group of viruses known as the flavoviruses; it is about 20–60 nanometers wide, (1 nanometer = 1/1,000,000,000 of a metre or 10 Angstrom units) so can only be seen by the electron microscope. It causes disease by invading the human liver. The disease commences some 3–6 days after the bite of an infective mosquito with mild influenza-like symptoms; chills, some fever and headache for a few days, at which stage it may resolve spontaneously having caused no more discomfort than a backache, loss of appetite and some prostration. It may progress to a fulminating fever of 103° F (39.5°C) or more. The fever is always accompanied by severe long-bone ache and intense headache. Albuminuria (albumin in the urine) follows with continuing fever. Jaundice sets in, to give the disease its name and there is some bleeding under the skin. The pulse rate increases, but may be followed by a period of calm when the pulse rate drops. The patient starts to vomit and the vomit may be tinged with blood progressively until old blood gives the vomit the characteristic black colour. This is due to bleeding into the intestine particularly the stomach. Spontaneous bleeding may occur anywhere both internally and externally. At this stage the patient is near death. If the patient recovers he is immune to a second attack for life.

The epidemiology of yellow fever is complicated. It is a zoonosis, the virus being transmitted from animals to man by mosquitoes but after that the disease may become epidemic when it is transmitted by mosquitoes directly from man to man. The true home of the virus is in the monkeys of the forests of South and Central America, the Caribbean and Africa south of the Sahara. From this enzootic base it has broken out to man in these areas and then occasionally becoming epidemic and spreading to ports and river systems within the limits

of the latitudes of 40 N and 35 S in North America and Europe as well as causing epidemics in its areas of origin.

It has never spread to Asia, which is something of a puzzle, as suitable mosquitoes and susceptible monkeys are present in Asia for the spread of the disease. One explanation has it that other arbor viruses akin to the yellow fever virus are present and common in Asia and these cross-react immunologically with the yellow fever virus and prevent it taking hold.

In order to found an epidemic the virus is first set up as an enzootic among the forest monkeys in the forest canopy where the mosquitoes which transmit the virus live and bite. These mosquitoes are species of the genus *Haemogogus* in South America and *Aedes simpsoni* among others in Africa. From time to time this enzootic among the monkeys becomes epizootic for poorly understood reasons and may in that form enter a village and man either because the monkeys encroach on the village and the infection is picked up by the mosquitoes which bite man or because man encroaches on the monkey habitat and is bitten accidentally by an infected mosquito carrying this newly virulent virus.

Once the epizootic virus enters the village there are present in the village the ubiquitous *Aedes*, which is a notorious vector of yellow fever and a constant companion of man in South American and African 'bush' villages. This mosquito is able to breed in very small expanses of water such as discarded bowls or tin cans. Carter and Strode show that unlike *Anopheles*, the vectors of malaria, which bite at night, *Aedes*, vectors of yellow fever, bite during the day the most common of these *Aedes* vectors is *Aedes aegypti*, the yellow fever vector *par excellence*.

Like all zoonoses the epidemiology of yellow fever is endlessly interesting with its permutations and combinations of animal and human behaviour necessary to bring the virus and host together in such a manner that disease results. It is not possible here to discuss these problems in the depth they deserve, but it can be said that the virus may be relatively harmless to its monkey hosts but on other occasions it may kill monkeys on a large scale, particularly in South America.

In man in Africa it is obviously possible for the virus to give man a mild disease as antibodies to yellow fever can be found among villagers with no memory of a yellow fever-like disease. Usually, however, it is highly pathogenic during epidemics. Man with yellow fever is infective to mosquitoes in the first few days of the disease and the mosquito incubates the virus for about ten days before becoming infective.

The control of yellow fever in South America was one of the great achievements of the Rockefeller Foundation who used the elimination of *Aedes aegypti* as the main means of control and the viscerotomy service as the main epidemiological tool for the discovery of outbreaks. This service was based on an instrument which took a sample of liver from all dead people at post-mortem compulsorily by law, in a manner which did not give offence to the bereaved relatives. It was possible to diagnose yellow fever from the piece of liver taken. Finally the instrument for the world-wide control of yellow fever has been

vaccination, after the workers at the Rockefeller Institute modified the Asibi strain of yellow fever virus to produce the 17D strain which was sufficiently innocuous, while still infecting man, to be used as a live vaccine.

There is a theory that the yellow fever virus came originally from Africa. Carter gives us a scholarly account of the disease which struck the Mayas, a few years before the arrival of Cortez. In the Maya records there are two descriptions of diseases (other than dysentery), one called *mayacimil* (= maya death) and the other called *xekik* (= blood vomit). He points out that the black vomit of yellow fever cannot usually be recognised as being caused by blood. Corlett, rather puzzlingly, ascribes black vomit to plague and *vomito negro* to yellow fever. Carter notes that Finlay believed that a later Mayan epidemic was yellow fever and that the Mayas did know yellow fever. We are always talking about the lowland Mayas. Carter is doubtful though he does accept that *mayacimil* might have been yellow fever but finds no evidence for knowledge by the Mayas of yellow fever before the outbreak of *mayacimil* (see also under smallpox).

The epidemic which occurred in the Yucatan just after the Conquest is not accepted as yellow fever by Carter, though he does accept the 1648 outbreak in Maya country as described by Lopez de Cogolludo as yellow fever. He worries about the great gap in time between the *mayacimil* and this outbreak. Major believes that this 1648 outbreak was yellow fever and it destroyed the Yucatan Mayas. He dates yellow fever from much earlier among the Mayas than does Carter.

From 1648 onwards yellow fever became a well-known disease and one greatly feared by the mariners of the Caribbean, the merchants of southern and eastern North American sea-board and the Spaniards of the Americas. Yellow fever is suspected as the disease which brought Drake's crew low after their little chase of the Spaniards over the island of St Jago in 1585, though the timing and the persistence is a little suspect unless infected *Aedes* were shipped as well. By the late eighteenth-century the dread of disease had shifted from plague to yellow fever as epidemic after epidemic swept through the young United States of America and its fingers brushed Europe's western ports. Yellow fever was malaria's right hand in Africa and did almost as much as malaria to block European advance into that continent. We have, however, no records which lead us to believe that yellow fever, or indeed malaria, debilitated the efforts of the African peoples to develop as nations as did epidemic sleeping sickness within the medical memory of the Europeans.

There is no record of the disappearance of whole peoples or kingdoms due to the twin mosquito-borne diseases as there is for the damage done by sleeping sickness to the Kissi people in West Africa by the decimation of their population, or to the tribes of the northern and north-east shores of Lake Victoria-Nyanza, moving, as it did, whole peoples away to seek safer dwellings inland. The two mosquito-borne diseases were more insidious in Africa but if both were in full operation they must have played their part in retarding the aspirations of any emerging or emergent nation in Africa, perhaps yellow fever even more so as it

is epidemic and does affect adults.

In the Americas Moll tells us that yellow fever was the possible cause of the failure of the first three towns to be built in Jamaica, and early attempts to colonise Puerto Rico by Ponce de Leon were frustrated by the disease. That the cause was yellow fever is doubtful as it did not seem to be properly established as an epidemic disease until the seventeenth-century. Moll does ascribe two disease outbreaks in the West Indies to yellow fever in 1635 and 1640 and gives this disease a contributory role in the drying up of Spanish immigration to the Americas in the seventeenth-century. Napoleon's dreams of a Caribbean Empire broke on the scourge of yellow fever when seven eighths of the 25,000 French soldiers sent to reconquer Haiti died, largely from a yellow fever epidemic.

This disease was to act as a great deterrent to would-be invaders of the Spanish Main and it repelled attacks by the British against Cartagena in 1741 (see *Roderick Random* by Tobias Smollett) and against Havana in 1762. It was even called the patriotic disease in South America as it attacked invaders rather than locals. It remained a major scourge in the West Indies killing up to 85% of the infected population at times. Between 1853 and 1900 it killed 36,000 in Havana alone, nearly half of them in the outbreak which lasted from 1870 to 1879. Even when the US troops ousted the Spanish in 1898, yellow fever showed its mettle and attacked the US troops severely, stinging the USA into doing the research, brilliantly carried out by Walter Reed and his team, which led to the discovery of the role of the mosquito in the epidemiology of the disease and eventually to the vaccine. Yellow fever took its toll of both sides in Bolivar's struggle to rid South America of its Spanish overlords. Yellow fever's most famous victory and its greatest defeat took place in Panama, to which we will return later.

In the USA and Canada yellow fever struck Halifax, Boston, New York, Baltimore, Philadelphia, Norfolk, Savannah (which lost one third of its population in 1817–20), Charleston and above all New Orleans, causing dismay a havoc wherever it struck. Powell describe the outbreak of 1793 in Philadelphia, a town which contained at the time Washington, Jefferson, John Adams and Alexander Hamilton. The disease caused a constitutional crisis over where the capital of the thirteen states should be sited. It was this outbreak which made the reputation of one of the greatest of the USA's physicians – Benjamin Rush. Winslow reckons that yellow fever visited the eastern and southern sea-boards of the USA thirty five times between 1702 and 1800 and then attacked every year except for two years.

Philadelphia, for instance, suffered epidemics in 1699, 1741, 1747 and 1762, then came the 1793 epidemic which removed one-tenth of the population. Duffy (1966), however, plays down the effect of these outbreaks upon the colonists as yellow fever was the exception rather than the rule in the everyday diseases. He believes that malaria and dysentery did more harm than yellow fever and smallpox. Note, however, that he refers only to the colonists and not the red Indian. Duffy records the 1853 epidemic in New Orleans where 40% of the city

was sick and 10% died. In New Orleans in 1878 on July 24 four people died of yellow fever and on July 28 the up-river towns commenced a quarantine of river boats from New Orleans. Despite these precautions an epidemic of yellow fever swept up the Mississippi and by the time the epidemic was over 100,000 had been sick and 20,000 died. As with plague those who could, fled the river. The epidemic reached Ohio before it petered out.

The *John D. Parker* was towing barges and went up river from New Orleans in mid-July. By the time it reached Ohio it had lost 23 men dead and spread yellow fever up half of the Mississippi and nearly the whole length of the Ohio rivers. According to Duffy (1971) there was an epidemic of yellow fever in New Orleans as late as 1902. All these epidemics were, in fact, pandemics arising from South or Central America or the Caribbean. Yellow fever was attacking a young, emergent and vigorous nation in the United States and it did no permanent damage to that nation's emergence. A useful chronology of the USA's epidemics can be found in Marks and Beatty, while Moll has a complete account of all epidemics and pandemics in the New World.

Ships sailing from the New World or Africa to Europe carried fresh water in barrels, a situation made for the breeding of *Aedes aegypti*, so the long sea voyages did not see the demise of the virus and the disease was kept going by the ship's own tame *Aedes*. So yellow fever reached the shores of Europe, particularly Spain and Portugal. Cloudesley-Thompson believes that many Europeans must have died of yellow fever during the slaving journeys from West Africa to the Americas though many of the Africans would have survived as they could be immune. He places yellow fever at San Domingo in 1502 when many Spanish immigrants died including their leader Ovanda. He puts further yellow fever epidemics in San Domingo in 1554, 1560, 1567, 1583 and 1588, much of which was due to the slave trade. Ackerknecht (1965) tends to agree with Carter but puts the first recognisable outbreak as late as 1620 in Cuba despite the presence of the slave trade being there for some years. Cloudesley-Thompson has a chronology of yellow fever in the Caribbean.

Inevitably yellow fever arrived into the European ports, the only question was whether it could take a hold. It attacked Spain, Portugal and Italy, arriving at Cadiz in 1701 and 1731, Lisbon in 1723 where it took off 6,000 dead and Malaga in 1741. In 1810, a critical time for Spain as Wellington's Peninsula war was raging against Napoleon's marshals, Prinzing discusses yellow fever which played havoc in Cadiz, Cartagena and Gibraltar. The last outbreak was at Madrid in 1878. Coleman tells us that in the meantime it had got as far as the Atlantic ports of France, such as St Nazaire in 1861, and according to Smith and Gibson even to Swansea in 1865, though at such places there were no indigenous *Aedes aegypti* to keep the yellow fever going for any length of time in comparison with Spain where it is obvious that some indigenously propagated yellow fever did occur. It should be stressed that the *Buide Connail* or yellow plague of sixth-century Ireland was not yellow fever but probably relapsing fever.

In Africa yellow fever has been an important disease among other important diseases. It has already been pointed out that it was the companion of malaria in slowing the penetration of Africa by the European powers. It is fashionable today especially in Africa itself to decry the effects of this penetration but the fact remains that it was this very penetration which put and pushed Africa on the road of progress towards a better life for its inhabitants. Life in Africa remains still incredibly poor and its institutions fragile and weak. There is no doubt that progress towards better health, education and industrialisation would have been poorer and slower without the European powers and one does not have to be illiberal to say so. Yellow fever remains a force to be reckoned with in Africa even today as recent epidemics in The Gambia, Mali and Burkino Fasso have shown (1).

The Ethiopian epidemic of the early 1960s was particularly vicious, though luckily confined to a sparsely populated area. It killed 5,000 just the same. Gore noted yellow fever as endemic in the Senegal and The Gambia in the 1870s with epidemics every seven years or so. It is not much better today. There were epidemics in the Senegal in 1740 and Sierra Leone in 1764 and another epidemic at St Louis in the Senegal in 1780. Pym found yellow fever in the Cape Verde islands, Sierra Leone, the rest of the west coast and Spain in mid-nineteenth-century and noted that the disease was destroyed by the cold. Singer and Underwood say that the legend of both the 'Flying Dutchman' and Coleridge's *Rime of the Ancient Mariner* were about ships struck by yellow fever.

The rise and fall of yellow fever is epitomised in the building of the Panama Canal. De Lesseps, flushed with his victory over the Sinai desert and the construction of the Suez Canal, arrived in Panama with 86,000 French workers to cut the isthmus and build the Panama Canal. Not long after he had started 52,000 were sick and 22,000 had died of yellow fever and malaria. Panama was said to have two seasons, the wet, when you died in two to three days of yellow fever and the dry when you died in one to two days from malaria. A gloomy view which owes more to desperation than clinical accuracy. A penny-pinching administration refused to continue to pay de Lesseps and he retreated to France. In Havana a sanitarian called Gorgas had shown great energy and skill in cleaning up the city and preventing the breeding of *Aedes aegypti* and *Anopheles* and thus controlling both yellow fever and malaria.

Walter Reed's group had just demonstrated the *Aedes* transmission of yellow fever and Ross' discovery of the mosquito transmission of malaria had been known for some years. Gorgas, with enormous tact and energy, destroyed the breeding places of the mosquitoes and by the time he had finished there were few mosquitoes to be found in Havana. In 1904 there was a disastrous epidemic of yellow fever in the Panama Canal Zone and the authorities decided to call in Gorgas. He launched an immense programme of attack against the domestic breeding places of *Aedes aegypti* combined with the killing of any adult mosquitoes seen near the breeding places. New breeding places were prepared as traps for the adults. It was all too expensive for the Scrooges at the headquarters

of the canal organisation and they called a halt.

They had mistaken their man and Gorgas fought. Eventually an independent report from the American Medical Association was sought. It was touch and go but Gorgas was vindicated. He went on and even the redoubtable *Aedes aegypti* had to give him best defeated by its very aspect of danger, the ability to breed domestically. Yellow fever had been brought under control with quite surprising ease and speed (7 months). Malaria was a tougher opponent but it too eventually yielded. Gorgas was not universally thanked, as Coleman shows, the Far East thought that the ease with which shipping now passed into the Pacific Ocean would bring yellow fever to a previously free Asia. The USA and Britain did honour him and he was created Knight Commander of the Order of St Michael and St George and was given a state funeral in both Washington and London.

Yellow fever is said to have ruled the Spanish Main for two and a half centuries, defeating the attempts of the European powers to become dominant in the region as Spain's grasp weakened (2). Yellow fever is said to have inhibited much needed emigration from Portugal and Spain to South America and the Caribbean. Yellow fever sent the victorious de Lesseps of Suez packing from Panama. Yellow fever scared the living daylights out of the citizens of the south and east coasts of the USA, until cholera came along to give them something else about which to worry. The Atlantic sea-board of Europe was no less worried. Yellow fever arm-in-arm with malaria held back African development both indigenous and imported. Though yellow fever was said to have diverted trade from New Orleans to other ports in the USA, it seems to have caused not even a stutter in the progress of all parts of the USA and finally as a whole to world power status, indeed some believe that the failure of France to acquire and hold Haiti led directly to the Louisiana Purchase.