

YELLOW FEVER IN SOUTH WALES, 1865

by

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The only known occasion on which yellow fever was transmitted within the British Isles was during an epidemic in Swansea in September/October 1865. The only other similar epidemic in Northern Europe was in St Nazaire in 1861.¹ These appear to have been rare instances of mosquito-borne epidemics in which all the mosquitoes carrying the virus, and involved in transmission, were released from a single source over a short period (perhaps of hours). Although the Swansea outbreak is mentioned in a number of reviews,^{2,3,4} its details are to be found only in the Eighth Report of the Medical Officer to the Privy Council, 1866, with an excellent appendix by George Buchanan.⁵

THE EPIDEMIC

The barque *Hecla* set sail from Swansea⁶ on 1 May 1865 and arrived in Santiago de Cuba on 9 June without calling at any other port. The ship's boy, George Wilson, died of yellow fever in Cuba, and an able seaman, Hansel Pedersen, was left in hospital "sick of fever" when the ship sailed for home. Two new able seamen were signed on at

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¹ W. Coleman, 'Epidemiological method in the 1860s: yellow fever at Saint-Nazaire', *Bull. Hist. Med.*, 1984, 58: 145-163.

² G. Augustin, *History of yellow fever*, New Orleans, [the author], 1909, pp. 434-443.

³ H. R. Carter, *Yellow fever: an epidemiological and historical study of its place of origin*, Baltimore, Md., Williams & Wilkins, 1931, p. 43.

⁴ H. H. Scott, *A history of tropical medicine*, London, Edward Arnold, 1939, vol. 1, p. 290.

⁵ Sir George Buchanan (1831-93) was at this time physician to the London Fever Hospital and medical officer of health for the parish of St Giles in the Fields, one of the most insalubrious parishes in London and notorious for its "rookeries" or tenements. In 1861, he became an occasional inspector for the Medical Department of the Privy Council and it was in this capacity that he was sent to Swansea to investigate the outbreak of yellow fever. For background information see Royston Lambert, *Sir John Simon and English social administration*, London, McGibbon & Kee, 1962; Roy M. MacLeod, 'The frustration of state medicine 1880-1899', *Med. Hist.*, 1967, 11: 15-40.

⁶ At the time, Swansea was a Municipal Borough of some 43,000 people. "Swansea is the principal seat of the copper trade of Great Britain, importing copper ore from various parts of the United Kingdom, and very largely from Cuba and Chili. There are extensive smelting works to the north of the town and they employ large numbers of men. Ironworks, potteries, patent fuel works, and shipbuilding also give abundant occupation to the rapidly growing population. And the exporting of coal and other minerals and of manufactured produce is another important part of the trade of the port. There is no present lack of employment nor any exceptional destitution in the town. The local government of Swansea is in the hands of a mayor and corporation, who are the local board of health. Certain functions relating to the shipping of the port are vested in the harbour trustees, the customs officers, and the coast guard." G. Buchanan, *Report . . . on the outbreak of yellow fever at Swansea. Appendix no. 16 to the eighth report of the Medical Officer to the Privy Council with appendix. 1865*, London, HMSO, 1866, pp. 440-441.

Santiago as replacements, one of whom, John Thomson, had been discharged the previous day from hospital and subsequently died of “ague fever” on either 9 or 11 August after fourteen or sixteen days’ illness. The ship’s log⁷ gives the shorter time and Buchanan’s report the longer. The *Hecla* sailed for Swansea on 26 July “with a clean bill of health”.⁸ On board were four officers, ten mariners, and two passengers. As to what happened during the voyage, there are discrepancies between Buchanan’s report and the captain’s log, the latter showing signs of having been written up when time permitted and when the captain thought later that it might be advisable. Some entries are not in chronological order and a sequence of events which appears to have happened over a few days is given only one date. According to Buchanan, there were deaths on 11 and 24 August and on 1 September after sixteen, three and forty-two days’ illness respectively; according to the log, the first death was on 9 August. Several other members of the crew were sick during the voyage, the captain noting in the log (entry dated 26/27 July) that six men were ill (including the man who was first to die) and that they had been suffering from fever for fourteen days. By 9 August, four were able to return to work. Men were also noted as being sick in an entry dated 21 August but, while they presumably included the man who died on the 24th, there is no mention of the number of men unable to report for duty. The diagnoses of the illnesses during the voyage cannot be established as there was no doctor on board and no record of clinical details; but some were almost certainly yellow fever.

“On Friday, September 8, the *Hecla* barque, a wooden sailing vessel, William Clouston master, . . . was boarded at 5 pm. by George Morgan, a Swansea pilot 15 miles to N.E. of Lundy Island . . .”⁹ The master, having told the pilot that he was shorthanded through losing three crew on his voyage home, and with another “sick of the dropsy”,⁹ asked for assistance in coming in to harbour. A tug towed the *Hecla* into port early the following morning after five men had gone on board. No report was made to the authorities of infectious disease being on board nor was a quarantine flag displayed. The *Hecla* was moored alongside the Cobre wharf in the North Dock, the two passengers and the crew dispersed, and unloading began. Three men were landed sick, two of whom were recovering from “fever”; one the captain reported ill of “dropsy”.¹⁰ By midday, information had reached the mayor that men had died on the voyage home and that one had been landed “seriously ill”.¹⁰ The deaths were rumoured to have been from yellow fever; and two doctors, on examination of James Saunders, the sailor allegedly with dropsy, diagnosed him as dying from yellow fever. He died within minutes of being seen by a third doctor and by the mayor, who represented the local board of health. “The body of Saunders was put into a tarred sheet, and buried within four hours of his death; the house where he died was immediately emptied, and disinfected with limewash and chloride of lime; and for further safety all the houses in the court were similarly treated. The bedding and clothing of the dead man were destroyed, and the house was again cleansed and disinfected before it was allowed to be tenanted, a week after. The mayor also set the

⁷ In the library of the National Maritime Museum, Greenwich.

⁸ Buchanan, *op. cit.*, note 6 above, pp. 446–447.

⁹ *Ibid.*, p. 444.

¹⁰ *Ibid.*, p. 445.

police to find out the passengers and crew of the *Hecla*, and sent the sanitary inspector . . . to have their clothes and rooms and persons fumigated with chlorine.”¹⁰ The owners of the *Hecla* proved uncooperative when the suggestion was made that she should be moved; and the “authorities found themselves powerless to insist on her removal”,¹¹ so, before police action could be taken to batten down the hatches, some thirty tons of ore had been unloaded. The authorities spent the next three days in disinfecting the *Hecla* and her cargo.

As we now know, by this time the mosquito vectors would have left the *Hecla*, but it appeared to the local board of health that their measures had been ineffective and that despite the resistance of the owners, other measures had to be taken; especially as “the popular voice was expressed to the same effect in mutterings that the *Hecla* should be burnt if she lay another night in dock”.¹² On 29 September, she was moved a mile from the nearest houses and disinfected again. By this time, although the authorities could not know it, the epidemic was nearly over. The first victim on shore had developed yellow fever on 15 September, and by the time of the *Hecla*'s removal from the North Dock there had been twenty-three cases. There were only six more cases (or probable cases) to come and the last of these fell ill in Swansea on 4 October. There were seventeen deaths. Table 1 sets out the dates of onset, recovery or death, age, sex, and the probable circumstances of exposure to infection. One case is omitted: that of Dr Griffiths, who lived “far away from the docks” and had had no contact with them. He had attended one of the yellow fever cases, but his own illness was not typical of yellow fever and may have been obstructive jaundice. Although five other of the Swansea cases were classified by Buchanan¹³ as doubtful, these have been included here as “probable” cases as their clinical descriptions are not inconsistent with the diagnosis. There were three associated possible cases: the crew of the *Eleanor* which lay alongside the *Hecla* from 16 to 18 September, then sailed to Llanelly where they became sick on 23 and 26 September and on 2 October. Two of them died—one, examined only after death, was adjudged at inquest to have “died by the visitation of God”.¹⁴ The description of the other fatal case was characteristic of yellow fever.

There was no doubt of the diagnosis in the fully developed case:

Rachel Williams, aged 35, married, living on the island at the top of Cobre Row. Ailing in no definite way for a week before 27th September, when she was seized with diarrhoea and vomiting, but on 28th was well enough to go to church in the evening. On the morning of 29th had rigor and intense frontal headache, and when seen by Mr. Andrew Davies at 10 ½ a.m. had violent pain in loins and along spine, eyes suffused and face flushed, great general heat of skin; no jaundice; pulse 132. Ordered calomel and James's powder every four hours, with cold to head. Seen again at 10 p.m., when slight improvement was noted. —September 30th, 10 a.m. Less pain in head and back, pulse 118, temperature much less, no vomiting or epigastric pain; two stools; plenty of natural looking urine. —October 1. Vomited four times in night between three and five a.m., everything vomited was black; light brown stool last night. Seen by Mr. Davies and myself at two p.m. Face pale, lips bluish; peculiar frown; no wandering or coma. Says “she feels better”. Skin cool; sweating, feet cold; temperature in axilla 98.4°; trace of yellowness in conjunctivae; no oedema of

¹¹ *Ibid.*, p. 446.

¹² *Ibid.*, p. 454.

¹³ *Ibid.*, p. 449.

¹⁴ *Ibid.*, p. 467.

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feet; pulse 94, very small and soft; tongue dryish black; frequent efforts to vomit; vomita copious black, a black powder in a somewhat glairy-looking liquid; no tympanitis; epigastrium very tender; two stools to-day; one seen is semi-solid, mixed black and grey, mottled. No urine passed to-day, unless a teaspoonful of pale fluid with the stool be urine On the same day, October 1, at 5 p.m., delirium began, and when seen by Mr. Williams at six p.m. she was insensible, with trismus and general rigidity of the muscles. Skin cold, but not blue; frequent vomiting of same black fluid; pulseless at wrist; no urine. Died at 6.50 in same state. When her body was seen next day, was very yellow, with streaks of blue in the face, and hands and finger nails blue. I pressed hard for an autopsy, but her husband would not permit it

The patient was seen during life by several medical men, who stated that the fatal cases which they had themselves recently attended exhibited nearly identical characters. It is also well to mention, as having influenced public opinion at Swansea quite as much as the assurances of the doctors, that a Cuban gentleman, Don Pedro Ferrer Landa, saw the body of Mrs Williams after death, as well as another case which afterwards recovered, and that he recognized the precise appearances that to a practised non-medical eye are most striking in the progress of yellow fever, and after death from it. He had previously been as incredulous as the doctors themselves at first were as to the possibility of yellow fever extending itself in English latitudes.

The sudden accession, with intense headache and spinal pain; the high fever, giving way soon to collapse; the black vomit and yellow skin; the suppression of urine; the retention of the faculties;—these are symptoms which, with death on the third day of illness, appear to establish beyond question the diagnosis of yellow fever.¹⁵

TABLE 1. EPIDEMIOLOGICAL TABLE OF CASES OF YELLOW FEVER IN SWANSEA IN 1865

<i>No.</i>	<i>Sex</i>	<i>Age</i>	<i>Place of probable infection</i>	<i>Date of onset</i>	<i>Date of death</i>
1	M	32	<i>Hecla</i> (able seaman on board).	At sea	9 Sept.
2	M	25	Worked on North Dock.	15 Sept.	Recovered
3	M	33	Patrolled the east side of the North Dock.	17 Sept.	22 Sept.
4	F	20	Lived about 150 yards from <i>Hecla's</i> mooring.	18 Sept.	22 Sept.
5	M	24	Worked on island/on board <i>Hecla</i> 9 Sept.	18 Sept.	22 Sept.
6	F	21	Lived in house adjacent to where <i>Hecla</i> was unloaded. Servant to no. 15.	18 Sept.	Recovered
7	M	25	Worked in smithy on the island.	19 Sept.	24 Sept.
8	F	55	Lived on island.	20 Sept.	26 Sept.
9	F	46	Lived on island.	20 Sept.	27 Sept.
10	M	c.35	Lived 150 yards from <i>Hecla's</i> mooring.	20 Sept.	Recovered
11	F	15	Lived on island. Granddaughter of no.8.	21 Sept.	27 Sept.
12	F	52	Lived on island. Wife of no. 19.	22 Sept.	25 Sept.
13	F	11	Lived on island. Daughter of no. 9.	22 Sept.	Recovered
14	F	23	Lived 150 yards from <i>Hecla's</i> mooring. Wife of no. 10.	22 Sept.	26 Sept.
15	F	?	Lived in house adjacent to dock where <i>Hecla</i> was unloaded.	23 Sept.	Recovered
16	M	Adult	Worked on board <i>Eleanor</i> . Moored near <i>Hecla</i> 16–18 Sept.	23 Sept.	25 Sept.

¹⁵ *Ibid.*, pp. 450–451.

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17	M	18	Lived on island. Son of no. 9.	24 Sept.	27 Sept.
18	F	18	Lived on island. Daughter of nos. 12 and 19.	25 Sept.	Recovered
19	M	Adult	Lived on island, went on board <i>Hecla</i> . Husband of no. 12.	25 Sept	Recovered
20	M	Adult	Worked on island 14–15 Sept.	25 Sept.	Recovered
21	M	23	Worked in shipyard next to Cobre Wharf.	26 Sept.	29 Sept.
22	M	60	Mate of <i>Eleanor</i> , moored near <i>Hecla</i> 16–18 Sept.	26 Sept.	30 Sept.
23	F	35	Lived on island. Wife of no. 29.	29 Sept.	1 Oct.
24	F	10	Lived on island. Daughter of no. 9.	30 Sept.	Recovered
25	M	18	Worked on island in copper assay office.	1 Oct.	10 Oct.
26	M	“Ship’s boy”	Worked on <i>Eleanor</i> , moored near <i>Hecla</i> 16–18 Sept.	2 Oct.	Recovered
27	M	20	Worked in Richardson’s yard.	3 Oct.	Recovered
28	F	6	Lived on island. Daughter of no.9.	3 Oct.	Recovered
29	M	c.40	Worked in Richardson’s yard. Husband of no. 23.	4 Oct.	5 Oct.

Source: compiled from a table on p. 455 of Buchanan, op. cit., footnote 6.

The incubation period of yellow fever is 3–6 days and about half the cases had their onset within twelve days of the arrival of the *Hecla*. In the sixteen fatal cases, the duration of illness ranged from two to ten days but thirteen of them died 3–7 days after onset. In the individuals who recovered, the illness lasted from five to around twenty-nine days. The long duration attributed to some of the illnesses presumably included convalescence. The overall mortality of the epidemic was forty-three per cent, which compares with the overall death rates of 10–57 per cent found in introduced epidemics in the United States in 1873.¹⁶ There may have been mild cases which were not recognized. Of those who were infected in Swansea there was no significant difference in mortality between males (9/15) and females (7/13) and the similar number of cases in both sexes suggests that infection was generally acquired in or around the houses rather than on the wharf or ship. In this respect it is notable that the disease did not affect the Bristol and Swansea pilots who boarded the ship on arrival, the five seamen who brought it into port, the customs officers and men, or “almost all” the labourers who unloaded the cargo.¹⁷

¹⁶ J. M. Woodworth, ‘The yellow-fever epidemic of 1873; reports from medical officers, U.S. Marine-Hospital Service with note by the supervising surgeon’, in J. M. Toner and J. M. Woodworth, *Contributions to the study of yellow fever*, Washington, Marine Hospital Service, 1874, p. 51. (Reprinted from the *Annual report. Supervising Surgeon U.S. Marine-Hospital Service 1873.*)

¹⁷ Buchanan, op. cit., note 6 above, p. 452.

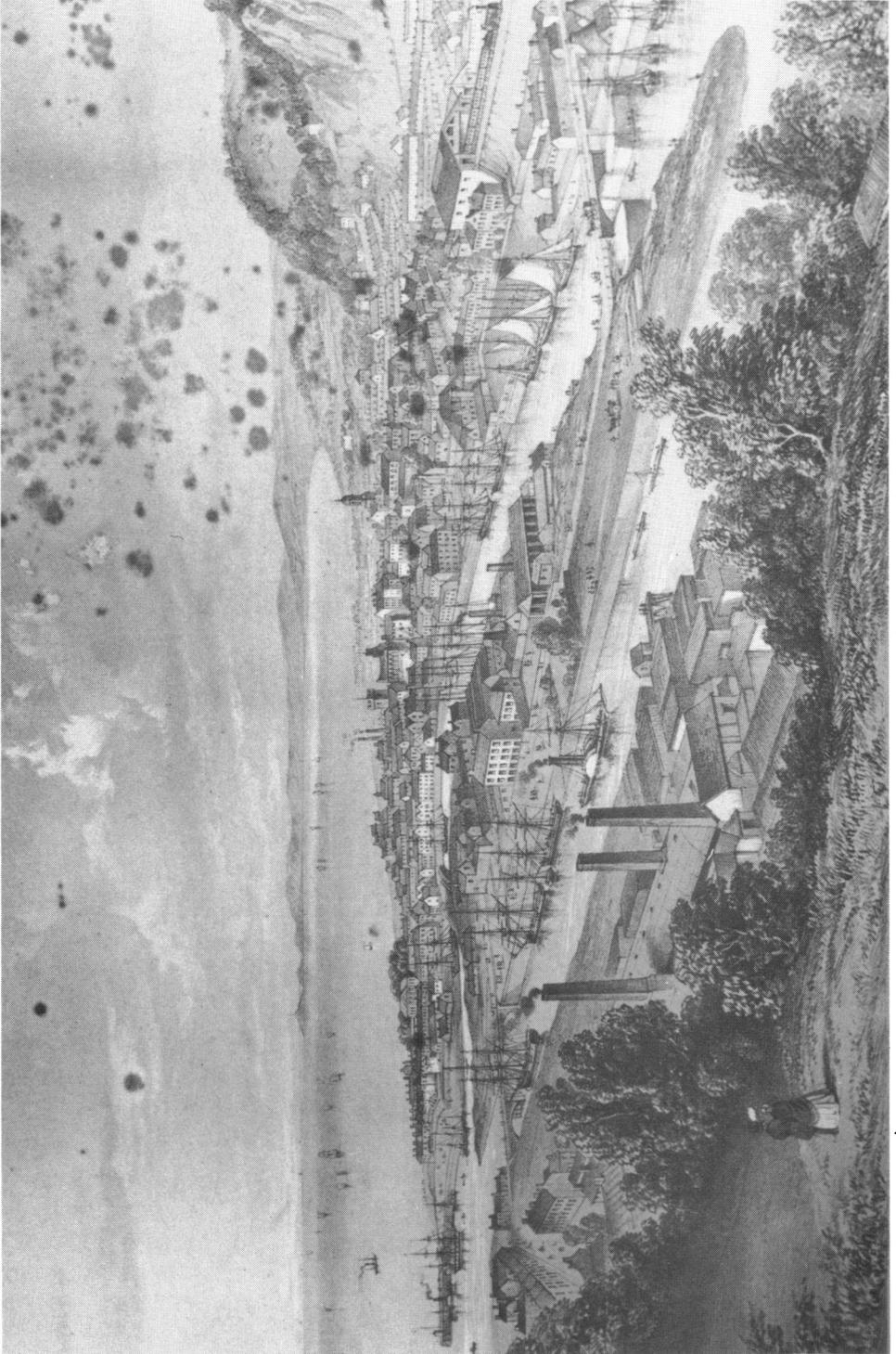


Plate 1 A photograph of a print by Newman & Co. of Swansea North Dock and the Island c.1858.
(Courtesy of Swansea Museum.)

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On the island alongside which the *Hecla* docked (fig.1 and plate 1) there were some eighteen cottages. Of the twenty-five cases in Swansea, fifteen were resident on the island and eight worked daily around the dock. The remaining two lived at the Pelican Inn some 150-200 yards from the *Hecla*. Of the fifteen cases on the island, eleven were within three families living in houses close around the Cobre wharf where the *Hecla* was unloaded.



Figure 1 Map of the North Dock and Island, Swansea, in 1865 with * marking the location of cases of yellow fever.

CONTEMPORARY COMMENT

In a memoir of her father, Buchanan's second daughter, Alice, says that there was "excitement and panic and the fever threatened to spread over the country".¹⁸ As she was not born until 1866, this can be only hearsay. The local and national newspapers

¹⁸ [A. Smith], *Memoir of the Buchanan family*, Aberdeen, [privately printed], 1941, p. 18

gave a more restrained account although simmering local rivalries seem to have surfaced.¹⁹ The first mention of the *Hecla's* imminent arrival was in the *Shipping and Mercantile Gazette* of 1 September 1865,²⁰ and her docking on 9 September was noted in the issue of Monday 11th.²¹ No mention was made of her carrying yellow fever until 6 October,²² by which time the epidemic was over. The Swansea weekly paper, the *Cambrian*, reported the epidemic most fully. Published on Fridays, its issue of 15 September reported that the *Hecla's* flag was flying at half-mast on arrival, indicating that at least one of her crew had died on the voyage. It went on to say that "the pilot soon brought the news ashore that five of the crew had succumbed [*sic*] to the malignant yellow fever so prevalent in Cuba at this season of the year. The other portion of the crew were so ill that fresh hands had to be despatched to bring the vessel into port, which was done on Saturday morning. The scene on the vessel being berthed, and as the relatives knew the fate of their husbands or brothers, was most distressing."²³ This account agrees neither with the crew list nor with Buchanan's report (see above).

With the following week bringing cases of yellow fever among the local population, the *Cambrian* called for a fever hospital to provide adequately for such occurrences, and returned to the attack with: "we know however that someone was guilty of serious negligence. Perhaps more than one are not wholly blameless and it would have been wrong in those whose duty is to see the law duly administered to have permitted so grave a dereliction to pass by unnoticed."²⁴ In its next issue, the *Cambrian* emphasized that although there had been cases of fever traceable to the *Hecla*, "Our object in alluding to the subject is to allay, as far as we possibly can, any unnecessary alarm on the part of the public, and to guard them against the very exaggerated reports which are current. The most eminent medical men are unanimous in their opinion that the peculiar kind of fever which now exists in the vicinity of the North Dock of the port is not necessarily contagious—that it cannot spread to any extent in this climate, and that its fatality is due in a great measure to the extraordinary temperature which has prevailed during the last few weeks."²⁵ It went on to report the arrival of Buchanan and added that the Board of Health was to consider the appointment of a medical officer of health. The nature of the "highly exaggerated reports" can be deduced from a letter signed "A Constant Reader" in the *Cambrian Daily Leader* alleging that the *Hecla* was owned by friends of the mayor and that her cargo was destined for his brother's firm, which was why she was given free pratique to enter harbour.²⁶ The *Cambrian Daily*

¹⁹ The mayor's family, like many of the major shipowners and ore-smelters, had moved to Swansea from the north-east of England. They were not only among the town's leading shipowners but were also shipbuilders specializing in ships for the copper ore trade although the *Hecla* was built in Hartlepool and owned by Ord & Co. of Sunderland. R. Craig, 'The copper ore trade', in D. Alexander and R. Ommer (editors), *Volumes not values: Canadian sailing ships and world trades*, St Johns, Memorial University of Newfoundland Maritime History Group, 1979, p. 284.

²⁰ *Shipping and Mercantile Gazette*, 1 September 1865, p. 2.

²¹ *Ibid.*, 11 September 1865, p. 3.

²² *Ibid.*, 6 October 1865, p. 6.

²³ *Cambrian*, 15 September 1865, p. 5.

²⁴ *Ibid.*, 22 September 1865, p. 5.

²⁵ *Ibid.*, 29 September 1865, p. 5.

²⁶ *Cambrian Daily Leader*, 29 September 1865, p. 3.

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Leader, despite its greater frequency of publication, did not report the epidemic as fully as the *Cambrian*, but it does appear to have been opposed to the mayor, accusing him, in its first report of the *Hecla's* arrival, of exacerbating the alarm because he "deemed it needful to take steps to prevent the diseases spreading in the town".²⁷ The allegations of "A Constant Reader" were indignantly denied by the mayor in the issue of Monday 2 October²⁸ and repudiated by the paper in an article published the previous Saturday, which also said that it had broken its silence on the subject because reports on the epidemic had appeared in the London evening papers on 27 September and the morning papers of the 28th.²⁹ The earliest report that has been traced in the London papers is in the *Morning Post* of 2 October 1865,³⁰ which quoted the article in the *Cambrian Daily Leader* of 30 September. On the following day, both the *Morning Post*³¹ and *The Times*³² had leaders on the epidemic but emphasized that yellow fever "has never established itself in the British Isles, though in numerous instances ships with cases aboard have come into our ports. It ought to be reassuring to the public to know that real 'yellow Jack' is incapable of propagation in our temperate climate."³¹ On succeeding days, other London papers contented themselves with printing brief paragraphs or reprinting articles which had already appeared in the local press, most of them linking the outbreak to the torrid heat.

Buchanan's report was not made public until it was incorporated into the Medical Officer's Report to the Privy Council for 1865, which was published the following year. However, its gist was given in the *Cambrian*,³³ which called for steps to be taken to improve the general state of public health in Swansea. The local papers welcomed the appointment of a medical officer of health and the *Cambrian* and *Cambrian Daily Leader* called for the building of a fever hospital.^{33,34} By the end of the third week in October, the mayor had written to all the local papers to say that there had been no new cases of yellow fever during the last thirteen days. On 31 October, the *Hecla* left Swansea for Valparaiso with a new master, Captain Harris.³⁵

AETIOLOGICAL CIRCUMSTANCES AND MECHANISMS

The mosquito, *Aedes aegypti*, has been responsible for the transmission of all epidemics of yellow fever in the New World and is the main vector of epidemics in West Africa. Other species of the same genus (*Stegomyia*) have been implicated in epidemics in Southern Sudan, Ethiopia, and in riverine gallery forest areas of the Sahel. The infection is perennially maintained between epidemics by primates and *Stegomyia* species in the large forests of West Africa; and by primates and *Haemagogus* species in the tropical forests of the New World. However, we need concern ourselves only with

²⁷ *Ibid.*, 11 September 1865, p. 2.

²⁸ *Ibid.*, 2 October 1865, p. 3.

²⁹ *Ibid.*, 30 September 1865, p. 5.

³⁰ *Morning Post*, 2 October 1865, p. 8.

³¹ *Ibid.*, 3 October 1865, p. 4.

³² *The Times*, 3 October 1865, p. 8.

³³ *Cambrian*, 6 October 1865, p. 5.

³⁴ *Cambrian Daily Leader*, 30 September 1865, p. 4.

³⁵ *Cambrian*, 3 November 1865, p. 5.

A. aegypti in Havana or Swansea. Indeed, on most, if not all, the Caribbean islands, except Trinidad, *A. aegypti* was the only vector species.

The global distribution of *A. aegypti* is defined by the temperature below which it is unable to breed. Thus perennial breeding (and transmission) is broadly limited in the northern hemisphere by the January isotherm for 16°C (60.8°F) and in the south by the corresponding July isotherm. The limits for seasonal breeding and transmission are the corresponding isotherms for July in the north and January in the south (see fig. 2.). Finlay had remarked that in Havana the mosquitoes were most active from May to October.³⁶ The *Hecla's* master noted the longitude and latitude in the log only when he buried a member of the crew, but it is clear that she sailed a little to the east of Bermuda (the first man being buried latitude 27° 31 north and longitude 70° 35 west), and then continued in a north-easterly sweep across the Atlantic to the Bristol Channel. She would thus have been south of the July 70°F isotherm for about one-third of her voyage, and probably south of 60°F isotherm for the entire voyage.

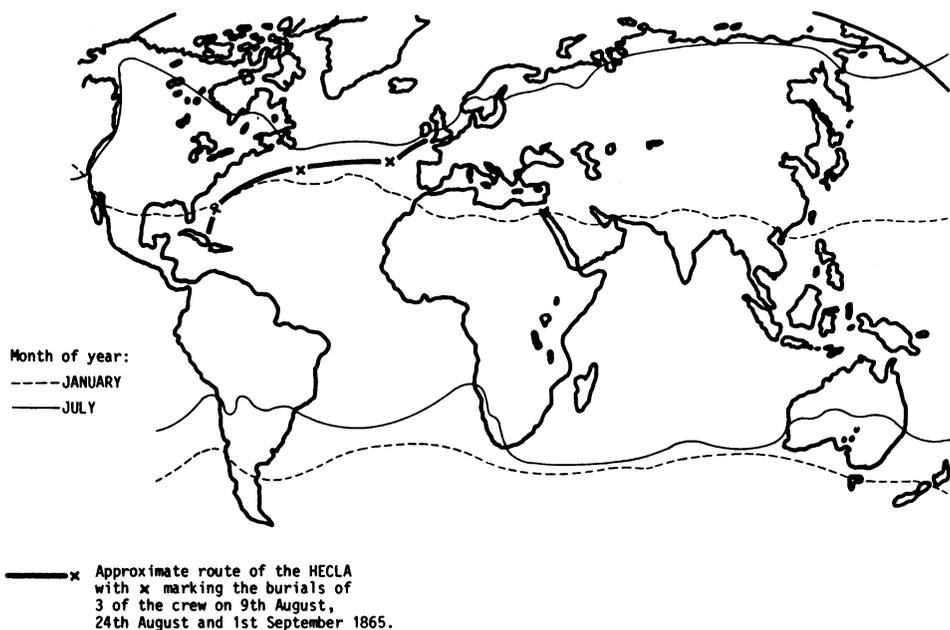


Figure 2 Map showing the 60° isotherms in January and July in the northern and southern hemispheres and the probable course of the *Hecla*.

Epidemics can occur only where a high proportion of a population is susceptible to infection (i.e. not previously infected or vaccinated). Gorgas pointed out that "Havana is unique in being the only City on the Western Continent where yellow fever has really

³⁶ C. Finlay, 'Yellow fever: its transmission by means of the *Culex* mosquito', *Amer. J. med. Sci.*, 1886, 42: 395-409.

been endemic during historic times".³⁷ This was because of the large annual influx (4,000–40,000) of fully susceptible Spaniards. Over the period 1856 to 1900, the annual number of deaths in the City from yellow fever ranged from fifty-one to 2058—in fifteen of these forty-five years there were more than 1000 deaths. In 1865, 138 deaths from yellow fever were recorded. The monthly distribution of deaths was not recorded until 1871 but the pattern that must have prevailed in 1865 is clear: the peak number of deaths was in July or August in twenty-two of the twenty-nine years from 1871 to 1900.³⁷

A. aegypti breeds mainly in water containers, particularly drinking-water containers, and was widespread and numerous in the Caribbean seaports of the mid-nineteenth century—and indeed today. In the absence of piped water supplies, prevalent domestic water storage containers (and nowadays discarded tins and motor tyres) provide for prolific breeding where the temperatures are favourable. There was widespread breeding in the water storage containers on sailing ships: mosquitoes came aboard in warm climates and persisted so long as the temperature was high enough for breeding and survival. "In ships, especially those long in tropical waters, larvae used frequently to be found in the containers for wash basins in cabins and in various places in the hold and elsewhere. Breeding is particularly common in stored water in barrels or tanks, on country boats, dhows, etc."³⁸ From a survey of small boats in the Gambia in 1902, Dutton estimated that each boat would produce about 2000 mosquitoes per week.³⁹ Bana found *A. aegypti* breeding on more than half of sailing vessels and smaller craft entering Bombay harbour—drinking-barrels and -boxes were "often teeming with larvae".⁴⁰ There is some evidence that breeding can occur in brackish water, but breeding in the bilges was probably not important.^{41,42} With the coming of steamships with piped water supplies, the risk of *A. aegypti* breeding on board ship was greatly reduced.

The flight and biting activities of the mosquito, the rate which the yellow fever virus multiplies, and the longevity of the mosquito are all markedly influenced by environmental temperature. At temperatures below about 16°C, both flight and biting activities are greatly reduced. Finlay observed that mosquitoes were most active between 16°C (60.8°F) and 35.5°C (96°F).³⁶ Within this temperature range, the flying distance of *A. aegypti* is dependent on how far it has to go to find a blood-meal (in the Caribbean it is almost entirely a man-biter) or a place in which to oviposit. The normal flight range is less than 100 m "although a flight of 300 m is not rare".⁴² In East Africa,

³⁷ W. C. Gorgas, 'Results obtained in Havana from the destruction of the *Stegomyia fasciata* infected by yellow fever', *Sanitary Department Havana Series 4*, 1902, p. 7.

³⁸ Sir S. R. Christophers, *Aedes aegypti (L.): the yellow fever mosquito*, Cambridge University Press, 1960, p. 57.

³⁹ E. Dutton, 'Report of the malaria expedition to the Gambia, 1902', *Liverpool School of Tropical Medicine, Memoir X*, 1903, p. 18.

⁴⁰ F. D. Bana, 'A practical way of dealing with *Aedes aegypti (Stegomyia fasciata)* mosquito breeding in country craft', *Indian med. Gaz.*, 1936, 71: 79–81.

⁴¹ J. W. Fielding, 'Notes on the bionomics of *Stegomyia fasciata*. Fabr.', *Ann. trop. Med. Parasitol.*, 1919, 13: 259–296.

⁴² J. Bonne-Wepster and S. L. Brug, 'The subgenus *Stegomyia* in Netherlands India', *Geneeskundig Tijdschrift voor Nederlandsch-Indie*, 1832, 72: Bijblad 2, 13–38.

McClelland *et al.* found that at a mean air temperature of 24°C *A. aegypti* bit every four days on the average (range 3-5 days); the lower the temperature, the longer between feeds.⁴³

The body temperature of a mosquito is only slightly above that of its environment and as (within limits) the rate of multiplication of viruses is proportional to temperature, the length of the extrinsic incubation period is similarly controlled.⁴⁴ Davis showed that the minimum extrinsic incubation period of yellow fever in *A. aegypti* at constant temperatures varied from four days at 37°C to eighteen days at 21°C and to more than thirty days at 18°C.⁴⁵ However, in nature, temperature varies diurnally and Bates and Roca-Garcia investigated the effects of fluctuating temperatures. They found that while the minimum extrinsic incubation period was ten days at a constant temperature of 30°C and twenty-eight days at 25°C, mosquitoes held daily for twenty hours at 20°C and four hours at 30°C had a minimum extrinsic incubation period of twenty-three days, and those held for twenty hours at 25°C and for four hours at 35°C a period of twelve days.⁴⁶ These figures are, however, all minima, and Bates and Roca-Garcia went on to demonstrate that the proportions of mosquitoes becoming infective increase with time. Thus in a particular example they found that the percentage of mosquitoes infective increased from an average of 13.5 per cent after up to twenty days after infection, to 56.5 per cent after 21-30 days, and to 87.5 per cent after 31-60 days. For similar reasons, the dose of virus administered by a mosquito increases with the time since infection. However, longevity in *A. aegypti* is also dependent on temperature and relative humidity (RH).⁴⁷ In saturated air its mean survival was 16.7 days at 10°C, 7 days at 23°C, and 6.4 days at 30°C (corresponding to daily average survivals of 94, 87, and 85 per cent respectively). At 23°C the survival of blood-fed *A. aegypti* was influenced by RH as follows:

RH%	0	30	60	80	100
Mean Survival (days)	2.7	3.8	6.5	7.9	100
Daily average survival %	69	77	86	88	90
Expectation of life (days)	3.3	5.4	9.5	12.0	13.8

⁴³ G. A. H. McClelland and G. R. Conway, 'Frequency of blood feeding in the mosquito *Aedes aegypti*', *Nature*, 1971, **232**: 485-486.

⁴⁴ A case of yellow fever circulates the virus in the bloodstream from perhaps twenty-four hours before onset of the illness until the second or third day after onset. If the case is bitten by *A. aegypti* during that time, the virus in the blood will (if the concentration is high enough) invade the mosquito tissues, multiply, and in due course infect its salivary glands and saliva. The period from infection to infectivity (i.e. virus in the saliva) in the mosquito is known as the *extrinsic incubation period*. When the mosquito bites again after the extrinsic incubation period it will inoculate virus and if the person bitten is susceptible (i.e. not vaccinated or previously infected) infection will become established and may cause disease varying from mild to fatal, partially depending on the dose of virus inoculated. The period between infection and the onset of disease is known as the *incubation period*.

⁴⁵ N. C. Davis, 'The effect of various temperatures in modifying the extrinsic incubation period of yellow fever virus in *Aedes aegypti*', *Amer. J. Hyg.*, 1932, **16**: 163-176.

⁴⁶ M. Bates and M. Roca-Garcia, 'The development of the virus of yellow fever in haemagogus mosquitoes', *Amer. J. trop. Med.*, 1946, **26**: 585-603.

⁴⁷ D. J. Lewis, 'Observations on *Aedes aegypti*, L. (Dipt. Culic.) under controlled atmospheric conditions', *Bull. entomol. Res.*, 1933, **24**: 363-372.

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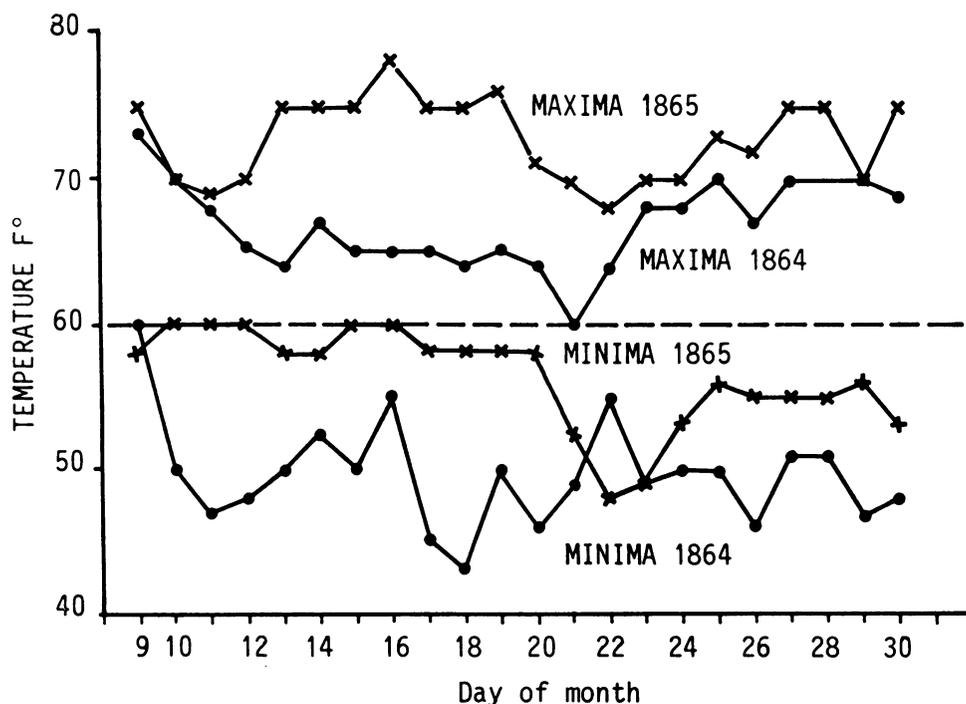


Figure 3 Comparison between the temperatures in Swansea in 1864 and 1865 drawn from information provided in tables on pp. 456–457 of Buchanan, op. cit., footnote 6.

The general weather situation in the south-west of England in September 1865 was described as “warm summer weather, with cloudless skies, from beginning to end, and a temperature exceeding 70°F on most days; and on the 18th, of 78°F. A little drizzle, scarcely amounting to rain, fell on two days, measuring only .05 of an inch. Barometer steady, at above 30 in”.⁴⁸ The daily temperature maxima and minima recorded in Swansea during the period of the epidemic are compared with those of the previous summer in fig. 3, showing that the summer of 1865 was particularly warm and above the temperature for *A. aegypti* activity for a high proportion of the time.⁴⁹ The likely diurnal pattern of temperature and humidity can be estimated from the twenty-year (1961–80) pattern of temperature and RH in July at Cardiff Airport (fig. 4), which shows that for a temperature range of 12.5–18.3°C, the temperature was lowest between 4 and 5 am and highest between 2 and 4 pm; it exceeded 15.4°C (the mean) for twelve hours (9 am to 8 pm). The RH was over eighty per cent for thirteen hours (8 pm to 8 am) and did not fall below seventy per cent for the remainder. The mean maximum and minimum temperatures at Swansea during the epidemic were 22.7°C and 13.9°C

⁴⁸ R. F. Sturge, *Thirty years' weather at Bristol, from 1860 to 1889*, Bristol, [privately printed], 1890, p. 11.

⁴⁹ Buchanan, op. cit., note 6 above, p. 456–457.

respectively; and the mean temperature about 3.5°C higher than the above.⁵⁰ The RH pattern was probably similar.⁵¹

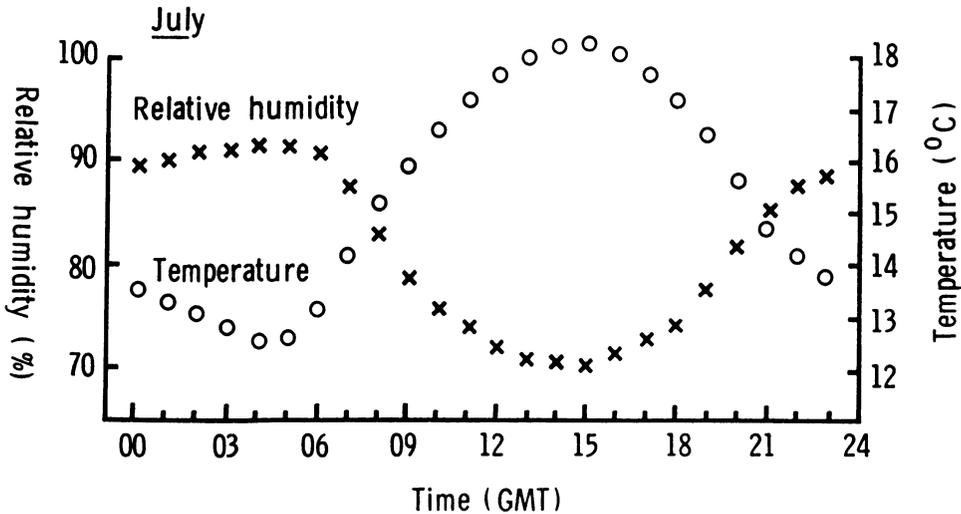


Figure 4 Graph of relative humidity at Cardiff airport. By courtesy of the Meteorological Office.

We conclude that during the epidemic, at a mean temperature of around 18°C, the minimum extrinsic incubation period would have been of the order of thirty days;⁴⁵ and that with an associated mean RH of around eighty per cent the approximate mean survival of *A. aegypti* would have been around seven days (equivalent to an average daily survival of eighty-seven per cent).⁴⁷

The probable interpretation of the *Hecla*/Swansea epidemic is therefore as follows. The *Hecla* left Cuba on 26 July with an unknown number of *A. aegypti* on board. These would have bred in water containers on board, taking blood meals as necessary from the crew and passengers, and subsequently (every 4–7 days or so) laying eggs which would hatch to produce more mosquitoes. There were deaths on 11 and 24 August and on 1 September; several other members of the crew were sick during the voyage, and three were landed sick, one to die within hours of arrival. This last case was diagnosed as yellow fever and it is probable that there were other cases during the voyage, both mild and severe. These would each have infected an unknown number of mosquitoes, varying proportions of which would have survived to become infective. Between blood feeds, mosquitoes rest in cool humid shady places such as the hold; and when the

⁵⁰ Very similar weather prevailed at Bodmin. J. Liddell, 'An abstract of a meteorological journal kept in Bodmin for 1865', *Annual report of the Royal Cornwall Polytechnic Society*, 1865, pp. 47–48.

⁵¹ F. Singleton, Meteorological Office, personal communication. Relative humidity in 1865 was either very poorly measured or not measured at all. In fact, Napier Shaw was charged, in 1878, with the task of studying and making recommendations regarding the measurement of relative humidity.

hatches were removed and the cargo disturbed, they would have flown out. If, as is likely from the weather reports, this was in bright sunlight they would probably not have bitten immediately but have sought a shady resting place, fairly close to the ship, at least until evening. *A. aegypti* bites mainly around dawn and dusk. Most of these mosquitoes would have sought a blood meal within three days or so and would subsequently have bitten every 4–7 days. As is shown in fig. 1 all cases were infected within 200 yards (i.e. within the flight range of *A. aegypti*) from the *Hecla*. The dates of onset of the cases are listed in table 1 and each of them would have been infected by mosquito bite 3–6 days earlier (the incubation period of yellow fever). The periods during which cases were infected are shown as bars (fig. 5) relating to the 4–7 day biting pattern of a population of mosquitoes released from the *Hecla*. The relationship between the dates of the infection of the cases and the mosquitoes' biting cycle shows that either four or five individuals were infected during the last relevant cycle. There must therefore have been a minimum of four or five infected mosquitoes (taken as 4·5 for the calculation) surviving since release from the *Hecla*. Using the estimate that eighty-seven per cent of this population of mosquitoes would have survived each day during this period, there would need to have been at least fifty-seven infected mosquitoes released from the *Hecla*. This estimate, although crude, shows that the number of mosquitoes required to account for the epidemic is well within the size of the likely population of mosquitoes present on the *Hecla* when she arrived. It is, of course, possible that some breeding of *A. aegypti* took place on land, but the time they would have needed to develop from egg to adult⁴¹ to become infected, then infective,⁵² (some five weeks in all) means that this could not have made any contribution to transmission. The epidemic came to an end because of the dying out of the original batch of infected mosquitoes released, and the colder weather that started in early October (the mean maxima and minima in the first week of October were 10·9°C and 3·0°C respectively) would have prevented further transmission.

CONTAGION OR MOSQUITO TRANSMISSION?

Contemporary interpretation of the epidemic and its control is of interest as the mosquito transmission of yellow fever was unknown at the time and the thinking was based on contagion. Considerable doubts were, however, expressed. The Medical Officer to the Privy Council, John Simon, after studying reports of the comparable epidemic of yellow fever in St Nazaire in 1861 (described further below) said: "I may state, as the conclusion to which a careful study of the official papers led me, that, in my opinion, it was only in a very qualified sense, it at all, that communication of yellow fever by means of personal intercourse could be said to be proven by the cases."⁵³ Later he pointed out that in the previous thirteen years, "persons, more or less ill with yellow fever, have on numerous occasions been landed at Southampton from West Indian steamers; but in no case, so far as my information extends, has it even been suspected that their disease has spread to other persons".⁵⁴ Likewise, Buchanan, having

⁵² Three weeks or more. Davis, *op. cit.*, note 45 above.

⁵³ *Eighth Report of the Medical Officer to the Privy Council with appendix 1865*, London, HMSO, 1866, p. 32.

⁵⁴ *Ibid.*, p. 34.

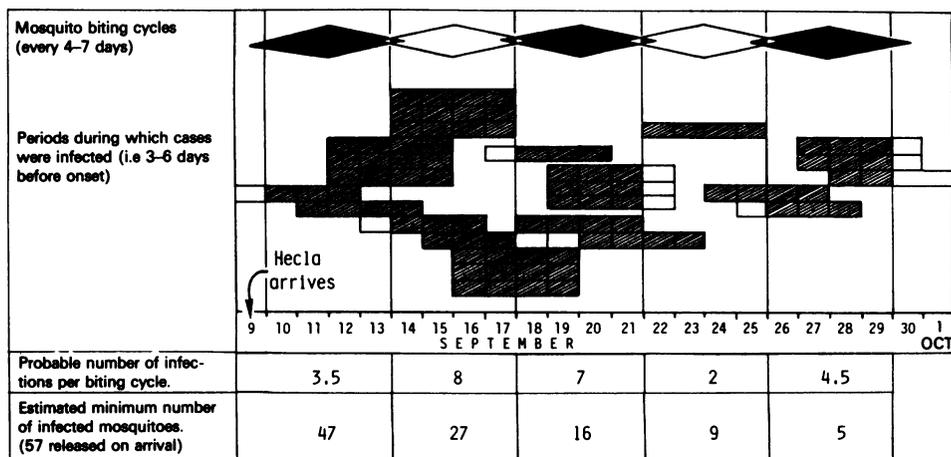


Figure 5 A diagrammatic model demonstrating how the release of infected mosquitoes from the *Hecla* could account for the epidemic.

The minimum number of *infected* mosquitoes required are calculated from: (a) in the last cycle five infected mosquitoes are taken to be the minimum to infect 4.5 cases; (b) the probability of the mosquitoes surviving each twenty-four hours (p) under the prevailing conditions (see text) is estimated at 0.87; (c) with the survival rate p^{19} would be the proportion surviving to the nineteenth day, i.e. 7% (d) calculating back with p^n , where n is the number of days from release from the ship, the figures are shown for the midpoint of each biting cycle.

considered the evidence of the Swansea epidemic, concluded as follows: "There were twelve centres from whence the disease, if it had been communicable from person to person, had the opportunity of spreading, and many of these localities were perfectly adapted for the spread of contagious diseases; yet in no single instance out of all these did any person (whose business did not lead them to the infected neighbourhood of the docks) get yellow fever or any disease at all simulating it. The conclusion then appears indisputable, that if the fever was communicable at all by personal contagion it was only so in an extremely feeble degree."⁵⁵

It was not until the 1950s that Macdonald⁵⁶ realized how to integrate the events (in terms of malaria) in the vertebrate and invertebrate hosts of such infections so as to use them to interpret the epidemiology of vector-borne diseases. Smith⁵⁷ extended these concepts to arthropod-borne viral infections.

In 1881, Carlos Finlay first published his idea that yellow fever is transmitted by *A. aegypti* (called by him "the *Culex* mosquito"); and presented preliminary experimental evidence to support it.⁵⁸ Although it has been suggested that earlier authors had conceived the idea, Finlay's biographer, J. Guiteras, dismissed this as follows:

⁵⁵ Buchanan, op. cit., note 6 above, p. 453.

⁵⁶ G. Macdonald, *The epidemiology and control of malaria*, London, Oxford University Press, 1957, pp. i-xvii.

⁵⁷ C. E. G. Smith, 'Factors in the transmission of virus infections from animals to man', in *The scientific Basis of Medicine. Annual Reviews*, 1964, 125-150.

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There is no difference whatever between the credence of the negroes of Africa or the peasants of Italy who believed that fevers were produced by the bites of mosquitoes, and the writings of Nott, Beaupierthuy and King. He who follows these authors chronologically, may imagine from the outward show of scientific apparel, that he is progressing in a process of evolution of a great doctrine, but he soon finds that he is moving in a vicious circle that brings him back to the negroes of Africa and to nothing practical. No one of them touches the keystone of the problem—the transmission of a parasite from the sick to the well. It may appear for a moment that Dr. Beaupierthuy strikes out of this circle, and that he brings forward, out of the gossamer of his wild fancies a fact, when he speaks of the mosquito *à pattes rayées de blanc*, the *zancudo bobo*. But a careful study of this work will show that his mosquito was not the *Stegomyia*, and that he does not anywhere state that it is the agent in the production of yellow fever. On the contrary, he excludes this mosquito because of its domestic habits, precisely the motive that induced Dr. Finlay to select it as the intermediary host of the yellow fever parasite. The Frenchman was imagining something that might bring the infection from decomposing matter in swamps, the Cuban saw the transmission from man to man: the former was chimera, the latter was the truth.⁵⁹

The validity of Finlay's work was still being disputed in 1901,⁶⁰ and it is true that his experiments were based on the transfer of mosquitoes from infected to experimental subjects after only 2–5 days (less than the extrinsic incubation period) lest he should "run the risk of developing a severe or a fatal attack, such as I was particularly anxious to avoid".⁶¹ In 1901, Reed *et al.* published their definitive experiments showing that yellow fever was transmitted by *A. aegypti*.⁶² Meanwhile, however, the point was being made by the success of controlling yellow fever in Havana by destruction of *A. aegypti*.⁶³ In February 1901, mosquito control was rigorously introduced by: (1) mosquito-proofing of water receptacles and oiling of other water bodies; (2) mosquito screening of yellow fever cases within two hours of reporting; and (3) pyrethrum powdering of all premises with cases and of adjacent premises. The effect was that while there were 310 deaths from yellow fever in Havana during 1900, there were only eighteen in 1901, twelve of them in January and February before the control measures had been effectively introduced.

COMPARISON WITH THE ST NAZAIRE EPIDEMIC

The 1865 epidemic in Swansea had been preceded by a similar episode at St Nazaire in 1861.⁶⁴ On 13 June 1861 the *Anne Marie* left Havana where yellow fever was epidemic; during the voyage, between 2 and 12 July, there were twelve cases, apparently of yellow fever, on board. The *Anne Marie* arrived at St Nazaire on 25 July, twenty days after the last death during the voyage and thirteen days after the last sickness. The cargo was discharged between 25 July and 3 August. The ship's mate,

⁵⁸ C. J. Finlay, 'The mosquito hypothetically considered as the agent of transmission [*sic*] of yellow fever', in *Selected papers of Dr Carlos J. Finlay*, Havana, [privately printed], 1912, pp. 27–43. A translation by Finlay of a paper which he published in *Anales de la Academia de Ciencias medicas, fisicas y naturales de la Habana*, 1880/81, 18: 147–169.

⁵⁹ J. Guiteras, 'Dr Carlos J. Finlay: biographical notes', in *op. cit.*, note 58 above. p. XXXIII.

⁶⁰ W. Reed, 'The propagation of yellow fever; observations based on recent researches', *Medical Record*, *New York*, 1901, 60: 201–209.

⁶¹ C. J. Finlay, 'Finlay's mosquito theory before and after its official investigation', *ibid.*, pp. 343–344.

⁶² W. Reed, J. Carroll, and A. Agramonte, 'Experimental yellow fever,' *Amer. Med.*, 1901, 2: 15–23.

⁶³ Gorgas, *op. cit.*, note 37 above, p. 14.

⁶⁴ Described by John Simon in *Eighth Report*, *op. cit.*, note 53 above, pp. 31–33; and by François M. Mélier, 'Relation de la fièvre jaune survenue à Saint-Nazaire en 1861', *Mém. Acad. imp. Méd.*, 1863/64, 26, 2^eme partie: 1–224.

who had remained on board, developed yellow fever on 2 August and, on the following two days, a cooper working on board and a mason working on the quay also succumbed. On 5 and 6 August, “many of the labourers” working on and around the ship were affected. A succession of ships tied up alongside the *Anne Marie* and their crews were affected: the *Chastan*, all five crew; the *Dardanelles*, the sole person on board; the *Cormoran*, two cases; two cases on a steamer which had been near the *Anne Marie* for two days; seven possible cases on lighters which had been two days near the *Anne Marie*; several cases on the *Arequipa* during its voyage from St Nazaire to Cayenne, perhaps because she already had breeding *A. aegypti* on board as she had arrived from Sierra Leone. The “total mischief”⁶⁵ was described as forty-four cases and twenty-six deaths. “The weather is said to have been extremely hot—more like that of a tropical than of an European climate.”⁶⁶

The main differences between the two epidemics were: first, that while few, if any, of those who worked on the *Hecla* after arrival were affected, those who worked on the *Anne Marie* were severely affected; and secondly, the cases in Swansea were closely grouped around the ship, while in St Nazaire they were much more widely distributed. The *Anne Marie* carried sugar, a hygroscopic substance which probably created a higher RH in the hold (even after the removal of the hatches) than would have prevailed in the *Hecla*, with copper ore. This may have enabled the mosquitoes to linger rather than to take refuge in nearby shady humid places. The houses at Swansea were very close to the dock and their inhabitants would have provided readily available blood meals for the mosquitoes; in St Nazaire there was little or no nearby residential accommodation and the mosquitoes would have to have flown further to feed.

WHY WERE THESE EPIDEMICS UNIQUE?

In the mid-nineteenth century, the occurrence of yellow fever on ships from the Caribbean was by no means uncommon, and some arrived in European ports with cases still sick on board. At Swansea, Buchanan ascertained from the keeper of the light and meteorological registrar that on 26 July 1843 a pilot had boarded the brig *Alderman Pirie* arriving from Cuba, several of whose crew had died of yellow fever during the voyage. He left the ship on 27 July and died “with symptoms of yellow fever” on 28 July. The period of two days from exposure to death is, however, inconsistent with this having been yellow fever. A similar episode of two persons becoming ill (one dying) within a few days of exposure occurred in August 1851 on the ship *Henrietta* from Cuba, and in July 1864 the shipkeeper on the *Mangosteen*, which arrived from Cuba with a history of fever during the voyage, was suddenly taken ill and died on the third day. He was “confirmed a case of yellow fever” but no details are given.⁶⁷

Buchanan examined “a book kept to show the receipt of wages and effects of deceased seamen” for probable deaths from yellow fever and found the following:

⁶⁵ *Eighth Report*, op. cit., note 53 above, p. 32.

⁶⁶ *Ibid.*, p. 33.

⁶⁷ Buchanan, op. cit., note 6 above, pp. 443–44.

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- 1862: the *San Jose*, two seamen at Cuba; the *Florence*, one seaman at Cuba; the *Cornwall*, five at Cuba and five at sea; the *Ellen* seven at Cuba and one at sea; the *Hampshire*, one at Cuba; the *Mangosteen*, one (from “fever”) at Cuba; the *Countess of Bective*, five at Cuba; the *Dorsetshire* and the *Cobrero*, each four at Cuba.
- 1863: the *Florence*, the *Stains Castle* and the *San Jose* each one seaman at Cuba; the *Cornwall*, one at Cuba and two on the homeward passage.
- 1864: the *Dorsetshire*, two seamen at Cuba; the *Mangosteen*, one at sea from “fever”; the *Pedro Ferrer*, one at Cuba.
- 1865: of 24 ships arriving from Cuba and discharging their crews at Swansea, the *Augusta Schneider* lost one at Cuba, the *Victoria*, two on the voyage home; and the events on the *Hecla* are described above.⁶⁸

By the early 1850s, transatlantic shipping was rapidly changing from sail to steam. The steamships were new and had piped water supplies; *A. aegypti* therefore was much less likely to establish breeding colonies on board.⁶⁹ At the same time, they crossed the Atlantic much more rapidly—around two weeks as compared with five, six, or more weeks for sailing vessels. Ship-borne yellow fever was thus much less likely to lead to the release of infected mosquitoes on arrival in Europe, but steamships were more likely to arrive with yellow fever cases still active. The different picture can be illustrated by the voyage of the *La Plata* in November 1852 from St Thomas (Virgin Islands) to Southampton.⁷⁰ The *La Plata*, “the newest and finest vessel” of the line,^{71,72} spent only four days at St Thomas, having made the “fastest ever” outward voyage direct from Britain in twelve days, eight hours.⁷¹ She was tied up alongside the wharf, and 1400 tons of coal were loaded by 400 women with baskets. The temperature was 98°F in the shade and the crew slept on deck. Steamships were reported to be more liable to epidemics at St Thomas than sailing ships which lay off shore in the harbour and did not spend days at the quay loading coal. Several colliers at the wharf while *La Plata* was there lost “nearly all hands” due to the epidemic. Yellow fever was also prevalent in the town.^{71,73}

The *La Plata* sailed for home on 14 November with a crew of 150, and 68 passengers among whom were ten invalids taken on board at St Thomas. One of these invalids died of yellow fever on the day after boarding. On 5 November, the ship’s engineer fell

⁶⁸ *Ibid.*, p.444.

⁶⁹ Carter, *op. cit.*, note 3 above, p. 25.

⁷⁰ J. Wiblin and A. Harvey, ‘An account of the yellow fever as it occurred on board the R. M. S. ship “La Plata” in the month of November, 1852’, *Lancet*, 1853, i: 148–151.

⁷¹ T. B. Phillips, ‘Yellow fever as it occurred on board the R. M. steamer “La Plata”, on her homeward voyage from St. Thomas, West Indies, in the month of November last’, *ibid.*, pp. 293–296.

⁷² Although overcrowded and poorly ventilated. G. Milroy, ‘The yellow fever on board the R. M. steamer “La Plata”’, *ibid.*, pp. 460–461.

⁷³ Milroy reported that at Kingston, Jamaica, almost the entire crew of two colliers were affected by yellow fever with a high proportion of deaths, and that there had been similar incidents a few years earlier at Havana, Cuba and at other West Indian ports. G. Milroy, ‘The yellow fever on board the “La Plata”’, *ibid.*, p. 350. Sullivan, who claimed “a residence of some years in Havana”, said that “Yellow fever is endemic in the large Antilles, Cuba, Havana, New Orleans, the Coast of Florida, and Mexico, and prevails occasionally as an epidemic in the smaller Antilles, Jamaica, St. Thomas, Martinico, &c”. J. Sullivan, *The endemic diseases of tropical climates with their treatment*, London, Churchill, 1877, p. 155.

ill with yellow fever, and on 8 November the captain and three others. On each of the next five days there was a further new case. In all, there were fourteen cases during the voyage and one more occurred eight days after the vessel had been released from two days' quarantine on arrival at Southampton on 18 November. Most, if not all of them were due to yellow fever. There was only one case among the sixty-eight passengers, fourteen in the crew of 150. Of the fourteen crew who were affected, seven were engineers or coal-trimmers.⁷¹ There was clearly higher incidence and mortality in the stokehold and engine room where the warm humid conditions would have made any *A. aegypti* that came aboard at St Thomas avid for a blood meal. There was no transmission at Southampton but the temperature prevailing at that time of year would have prevented any surviving *A. aegypti* from biting.

CONCLUSION

Although the events of 1865 are unlikely to recur, because of changes in transportation methods, they provide a warning that if infected mosquitoes are imported to Britain during a favourable period of weather, they may transmit any infection they harbour. In 1983, there were two cases of malaria within a few miles of Gatwick Airport which can be accounted for only by the inadvertent importation of infected mosquitoes on aircraft possibly from West Africa or Ethiopia.⁷⁴

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⁷⁴ D. Whitfield, C. F. Curtis, G. B. White, G. A. T. Targett, D. C. Warhurst, and D. J. Bradley, 'Two cases of falciparum malaria acquired in Britain', *Br. med. J.*, 1984, **289**: 1607-1609.