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THE PLAGUE OF ATHENS: 430–428 B.C. EPIDEMIC AND EPIZOÖTIC

In a recent re-assessment of the medical aspects of the Plague of Athens which is, to date, the most scholarly and comprehensive, Poole and Holladay[1] have emphasized the tendency of many infectious diseases markedly to decline in virulence over decades and centuries and, sometimes, significantly to change their clinical manifestations.[2] In the light of modern medicine they consider four possibilities: (i) The Plague was a disease (or combination of diseases) which still exists today. This they regard as improbable. (ii) It still exists in some remote place or places unknown to medical science. This is discussed and dismissed. (iii) It became extinct. (iv) It was caused by an agent which nowadays causes a significantly different clinical syndrome. They conclude as follows: 'The truth, we suggest, almost certainly lies in possibility (iii) or (iv). But we can see no way of choosing between them. On either view the question: "What was the Athenian Plague?" is in principle unanswerable if the questioner is wanting to attach to the Plague the name of some modern disease or diseases'.

The admirable analysis and detailed re-assessment of these authors is never in dispute and we accept their immuno-genetic conclusions without reservation. It would seem, however, that they have overlooked some epidemic and epizoötic diseases prevalent today which, because of their congruity, in two instances striking, with the Athenian Plague, may prove of sufficient interest to warrant reconsideration of (i).

The reason why most of the 'favourites' in the differential diagnosis of the Plague of Athens have had to be deemed non-runners is that, unlike them, the disease described so minutely by Thucydides was clearly epizoötic as well as epidemic. Human carrion resultant upon human death in the Plague is avoided by birds and dogs, which, when they do partake, are observed to suffer (2. 50). Also, in a not dissimilar epidemic in Rome in 212 B.C.[3] the presence of cattle in the city was observed to prolong the duration, and exacerbate the severity, of the disease. Poole and Holladay[4] suggest that this could be explained by assuming that the host specificity of, say, dog distemper may have evolved from a virus of wider target potentiality. This does not, however, accord with the view they properly emphasize, that infections tend, over the years, to diminish in virulence. Dog distemper nowadays behaves much more like a newcomer upon the scene: the virus is highly fatal for dogs. Infectious diseases with a significant veterinary dimension are: rabies, anthrax and, with special Mediterranean relevance, Malta Fever (*brucellosis melitensis*); leptospirosis and tularaemia also spring to mind. Earlier scholars have properly discounted anthrax and rabies. These, like infective polyneuritis,[5] are so dissimilar to the disease described by Thucydides

[1] J. C. F. Poole & A. J. Holladay, 'Thucydides and the Plague of Athens', *CQ* n.s. 29 (1979), 282–300.

[2] Several scholars, over the years, have ascribed to the Plague of Athens several causes encompassing all the familiar human epidemics: bubonic plague, typhus, typhoid, measles, smallpox and several others. It would be inappropriate here to list again the arguments for and against these pestilences, which have already, many times, been exhaustively described and, for one reason or another, discarded.

[3] Livy, 25. 26; Diodorus, 14. 71.

[4] J. C. F. Poole & A. J. Holladay, op. cit. n. 1.

[5] In a critique of the word '*στερισκόμενοι*', meaning either active or passive ablation of the limbs and genitalia in the Plague of Athens due to gangrene, L. Mercier, ('Essai d'interprétation

that they may at once be rejected. Malta Fever, enzoötic in goats, which is today the most severe form of human brucellosis, does not now resemble the Plague of Athens, especially in the form of the rash it occasionally exhibits, but it sometimes occurs in a fulminating form with an haemorrhagic exanthem, possibly the 'black spots' of some descriptions, and is of a deadly severity which superficially suggests the events of the 5th Century B.C. However, as with typhoid fever, not even in this form is the vesiculo-pustular rash so typical of the Plague of Athens encountered.[6]

Leptospirosis has escaped the attention of modern scholars in their search for an acceptable cause of the Plague of Athens. This is somewhat surprising since the disease, albeit named after Weil,[7] was much earlier described on the Russian Front in the Napoleonic War by Buonaparte's personal physician Larrey[8] under excruciating war-time conditions differing fundamentally from those prevailing in Athens only in that, climatically, extreme cold, rather than extreme heat, prevailed. Overcrowding, squalid living conditions and dietary uncertainty were common to both. Jaundice is, however, conspicuous in the severe and fatal forms of Weil's disease know to us today[9] and it is difficult to believe that, had this very striking symptom been in evidence, Thucydides would have failed to mention it. Renal failure, rather than hepatic, as jaundice would at first suggest, is now known to be the cause of death in the vast majority of clinical cases of leptospirosis in man and animals,[10] so the absence of jaundice in the Athenian Plague may not quite so decisively exclude this infection. Ophthalmia with sequential blindness has, moreover, been described in this disease.[11] It is, however, in the animal dimension that leptospirosis seems so attractive an explanation for the Plague of Athens. There is a vast spectrum of animal susceptibility to this infection: dogs, bandicoots, monkeys, mules, voles, jackals, pigs and a wide variety of cattle. Spontaneous leptospiral disease in birds has not been recorded, but hens and their eggs are readily infected experimentally. The range and severity of leptospirosis among animals is wide. Only rodents and especially the brown rat (*R. norvegicus*) are asymptomatic carriers, but the smaller species of *Muridae*, especially voles, do succumb to the infection. In addition to *L. icterohaemorrhagiae* fewer than ten of the sixty or more known serological types of leptospire cause significant disease in man; they include *L. canicola*, a virulent pathogen in dogs.[12]

de σπερισκόμενοι et de la 'peste' d'Athènes', *Bull. Assoc. Guillaume Budé* (1974), 223–6) advances this wholly fanciful diagnosis of the Plague of Athens. Not only is this a trivial disease, rarely more than a transient nuisance – the Guillan-Barré syndrome, recently afflicting Mr Anthony Wedgwood Benn – but neither its neuro- nor vascular pathology allows of the development of gangrene, nor is it certain, even, that it is an infectious disease; it may well be numbered amongst the auto-immune disorders and it is never epidemic. Mercier, with scarcely more justification, suggests the name 'Athens 'flu', cf. the Spanish 'flu of 1918–19. This, too, neither epidemiologically nor nosologically bears the slightest resemblance to the Plague of Athens.

[6] Acute fulminating Dengue or Dengue Shock should, for the sake of completeness, be mentioned, especially as the disease is particularly associated with modern Greece. But here the similarity with the Plague of Athens ends.

[7] A. Weil, 'Über eine eigentümliche, mit Milztumour, Icterus und Nephritis einhergehende akute Infectionskrankheit', *Deutsch. Arch. Klin. Med.* 49 (1881), 208.

[8] D. J. Larrey, 'Fièvre jaune, considérée comme complication des plaises d'armées à feu', *Mémoire de Chirurgie, Militaire et Campagnes* 2 (1812), 18.

[9] G. Buchanan, *Spirochaetal Jaundice*. Spec. Rep. Ser. Med. Res. Coun. No. 213 (London, H.M.S.O., 1927), 56.

[10] J. A. H. Wylie, 'Relative importance of the renal and hepatic lesions in experimental leptospirosis ictero-haemorrhagica', *J. Path. Bact.* 58 (1946), 351–65.

[11] J. M. Alston & J. C. Broom, *Leptospirosis in Man and Animals* (Edinburgh, 1958), pp. 107–11.

[12] R. V. Williams, 'An unusual case of canicola fever complicated by homonymous hemianopia', *Med. Press.* 236 (1956) 162–8.

Tularaemia has not hitherto been mentioned as a possible contender for the aetiology of the Plague of Athens but, as will be seen, epidemiologically, epizoötically and clinically, it concurs better with Thucydides' account than any other infectious disease prevalent today. The symptoms according to Thucydides were these (2. 49): (i) Heat in the head; (ii) inflammation of the eyes; (iii) suffusion with blood of tongue and throat; (iv) foetid breath; (v) hoarseness with violent coughing; (vi) vomiting of bile; (vii) retching and convulsions; (viii) pustular and ulcerating skin eruption; (ix) total body hyperaesthesia and restlessness; (x) irresistible desire for water to assuage thirst and immersion therein to alleviate body heat; (xi) terminal exhaustion apparently produced by diarrhoea; (xii) loss of toes, fingers and private parts; (xiii) destruction of eyes and, (xiv) if recovery supervenes, amnesia.

Now some of these – fever, halitosis and restlessness – are common to so many febrile illnesses that they cannot by themselves be advanced in favour of any specific diagnosis, but when they are considered together with the vesiculo-pustular rash, the ophthalmia, the respiratory tract symptoms, the vomiting, diarrhoea and abdominal pain, a more closely definable syndrome becomes apparent. Woodward[13] specifically mentions the following symptoms of tularaemia: fever, prostration and headache; pneumonia with pleurisy; vesiculo-pustular rash and diarrhoea and vomiting, with collapse and syncope. Woodward[14] and Cluff[15] sub-divide the clinical types of tularaemia encountered in man as follows: (a) *The ulcero-glandular form*, characterized by a vesicular, pustular and ulcerating exanthem. Regional lympho-glandular swellings occur which are quite painless and do not ulcerate. This would account for Thucydides overlooking them and not using the word βουβών = swelling in the groin, a well-known word in Greek medicine which was associated then, as now, with bubonic plague. The absence of this word from Thucydides' account is in accordance with the rejection of this diagnosis for the plague of Athens. (b) *The enteric or typhoidal.* This is usually contracted by ingestion of infected material, including water. Swelling and ulceration of mouth and throat occurs; this is followed by diarrhoea with melaena. (c) *Pulmonary*. This form is dominated by an harassing (*sic*) cough with pneumonitis. (d) *Oculoglandular* tularaemia is associated with severe pain in the eye, intense congestional lachrymation, muco-purulent discharge and panophthalmitis. Corneal perforation and optic atrophy occur.

All these manifestations are in astonishing accord with Thucydides' detailed description, save only for the gangrene of the extremities and genitalia. However, as has already been emphasized above, there is a general tendency for infectious diseases to become less severe with the passage of time; also, before the advent of effective treatment, gangrene of the extremities was commonly observed in a wide variety of septicaemic diseases. Tularaemia is one of these, but it was not separately identified as an epidemic infection until barrier nursing and specific therapy of infectious diseases had been well established. Another result of the efficacy of antibiotic and chemotherapy is the disappearance from current medical text-books of descriptions of the symptoms and signs once often encountered in serious or fatal maladies of this type. However, a study of the medical texts of the pre-antibiotic era will serve vividly to recall Thucydides: Bartholomew Parr, an Exeter physician of 1809, wrote:

Gangrene/Mortification – Sphacelus.
The flesh is black, or livid, and the external skin generally full of blackish pustules. Later fevers

[13] Theodore E. Woodward, 'Tularaemia', Paul B. Beeson and Walsh McDermott, (eds.) *Textbook of Medicine* (Philadelphia, London & Toronto, 1975), pp. 378–81.

[14] loc. cit. (above n. 13.)

[15] Leighton E. Cluff, 'Tularaemia', in Hanson's *Principles of Internal Medicine*, eds. George W. Thorn et al. (New York, 1900), pp. 858–60.

attended with mortification are the virulent inflammatory ones with local inflammation or the jail (*sic*) and hospital ones.[16]

Gangrene of the genitalia is mentioned in considerable detail by Brannon[17] as occurring in typhoid and similar fevers. Dietary deficiency, especially scurvy, is frequently, and not surprisingly, mentioned as exacerbating this process. It will be recalled that the Plague broke out in the Piraeus 'at the end of the winter', a time when, even in the Mediterranean, a deficiency of fresh fruit, the main source of Vitamin C, sometimes prevails. The privations of the siege would, of course, have accentuated any shortage of this vitamin.

The causative organism of tularaemia, *Franciscella* (formerly *Pasteurella*) *tularensis*, is closely related to the Plague bacillus, *Yersinia* (formerly *Pasteurella*) *pestis*. Tularaemia is enzoötic in a wide variety of animals amongst which it erupts epizoötically: the list includes rabbits, squirrels, woodchucks, musk-rats, skunks, coyotes, foxes, dogs, mice, quail, chickens, pheasant, snakes and domestic cattle. Butchers and poulterers are amongst the most frequent occupational victims of this disease. Transmission to man is effected by flies and ticks, the latter possibly acting as a reservoir as well as a vector, as they do for many other pathogens because the arthropod provides an intra-nuclear habitat for the micro-organism and, therefore, a transgametal capability. Animals dying of tularaemia not infrequently do contaminate water supplies and infect carcass-meat, which, if insufficiently cooked, may cause infection in man.[18] It is noteworthy in this context that the group of organisms of which the *F. tularensis* is an example have an unenviable reputation as a cause of laboratory infections amongst technicians and micro-biologists, and these cases are often of alarming severity and, on occasion, therapeutic intransigence.[19] Now, in such laboratories the cause of infection is known in anticipation and the appropriate antibiotics are exhibited at the first sign of illness. The fact that the disease can still be severe, even in the face of this unique advantage, confirms that, untreated, tularaemia would almost certainly be attended by an appropriately high mortality, comparable with that experienced in the Plague of Athens. Immunity following infection is high. Thucydides points out (2.51.1) that those who recovered from the infection were emboldened to tend the acutely sick. Recurrences were reported but apparently without fatal issue.

The causative organism of tularaemia was isolated from animals in 1912, but the first human case was described in 1914. The absence of awareness of the disease amongst the medical profession led to very few cases in man being recognized before 1946. Since then the medical profession, especially in the United States, has become increasingly conscious of the likelihood of this infection. A particular feature of the epidemiology of tularaemia is its prevalence amongst purveyors of butchers' meat, poultry and game, as well as in wild-life curators, game-keepers and poachers. It is therefore clear that the vast majority of cases of human tularaemia have been diagnosed and successfully treated since broad-spectrum antibiotics have been

[16] Bartholomew Parr, *The London Medical Dictionary*, Vol. II (London, 1809), pp. 219–20.

[17] John Winters Brannon, *Twentieth Century Practice of Medicine*, ed. Thomas C. Stedman, Vol. XVI (London, 1899), p. 682.

[18] The capacity of water to spread infectious disease has been recognized from time immemorial. At the height of the Plague, the Athenians blamed the Spartan enemy for poisoning the cisterns, and in the Middle Ages the proliferation of the Black Death was widely attributed to Jews deliberately poisoning the wells. If tularaemia (or leptospirosis) was responsible for the Athenian Plague, the citation of such scapegoats is unnecessary. Human and animal carrion in the reservoirs would have sufficed to maintain the epidemic.

[19] L. H. Collier, personal communication.

available; such treatment and good nursing have inevitably distorted the mortality statistics, making comparison with infection and death rates of the disease in Athens in 430 and 428 B.C. virtually impossible. Our knowledge of tularaemia, its incidence and epidemiology, was enhanced in 1968 when a serious epidemic occurred in the State of Vermont, U.S.A.[20] among musk-rat hunters and skinners; many of the quarry were found to be victims of the epizoötic. Forty-six human cases were confirmed serologically, of which eight were asymptomatic; of these eight, four were under 20 years of age. Infection depended upon the exposure to infected animals; males therefore predominated, since they were most at risk. Of the remaining 38 cases which exhibited clinical disease, no fewer than fourteen were gravely ill with the ulcero-glandular type of the disease and one patient with gastro-intestinal symptoms and prostration required intravenous life support. So, it is probably safe to assume that had efficacious antibiotic treatment *not* been available, most, if not all, of these would have died. This would yield a mortality rate of between a third and a half of those with symptoms; a figure roughly in accord with the Athenian experience.

The rarity of tularaemic case-to-case infection in man may well, at first, seem to militate against this disease being equated with the Plague of Athens. However, as has been mentioned in some detail above, the circumstances prevailing in Athens were profoundly different from those of modern times during which tularaemia has erupted. Bacteraemic diseases are, in fact, rarely communicated from man to man unless the micro-organism concerned is present abundantly in the excreta or other *materies morbi*: sputum, urine, faeces etc., and, as a result, spread as dust or droplets, which may be carried in the air or contaminate fomites which, in turn, act as a vehicle for man-to-man transmission. Where there is a skin eruption, as is the case in tularaemia, dissemination would be facilitated by crowding, so evident in Athens during the siege. In modern times, however, eruptive cases would, from the very first suspicion of the disease, have been placed in clinical isolation, a procedure rendered mandatory by the known infectivity of tularaemia amongst laboratory workers. Moreover, as both ticks and deer-flies have been inculpated as vectors in the human disease, it is clear that ecto-parasites, which today tend to be discounted as disseminators of infectious disease in hygienic communities could, and probably did, play a major rôle in the spread of the disease in the Plague of Athens. Most important of all is the recognition of the fact, emphasized by Poole and Holladay,[21] that the virulence of the parasite *vis-à-vis* the host is widely variable and that, if the cause of the Plague of Athens were a pathogen known today, it is likely to have been far more virulent then than now.

Another, now very rare, bacterial disease which has been suggested as a possible explanation of the Athenian Plague is glanders,[22] a pulmonary infection in man which also exists as a mild contagious dermatitis known as farcy. The causative organism, *Pseudomonas* (formerly: *Pfeifferella*) *mallei*, causes, primarily, a disease of *Equidae*. Cattle and pigs are absolutely resistant and other domestic animals are very infrequently infected in nature. These data alone militate against glanders being the culprit and, moreover, as Poole and Holladay[23] have pointed out, not only is glanders in man of virtually 100% mortality, which would have wiped out many more than

[20] L. S. Young, D. S. Bicknell, B. G. Archer, J. M. Clinton, L. J. Leavens, J. C. Feeley & P. S. Brachman, 'Tularaemia Epidemic: Vermont, 1968', *New Eng. J. Med.* 280 (1969), 1253–60.

[21] J. C. F. Poole & A. J. Holladay, op. cit. n. 1.

[22] C. H. Eby & H. D. Evjen, 'The Plague of Athens: A New Oar in Muddied Waters', *Journal of the History of Medicine and Allied Sciences* 17 (1962), 258–63.

[23] J. C. F. Poole & A. J. Holladay, 'Thucydides and the Plague: A footnote', *CQ* n.s. 32 (1982), 235–6.

the Plague of Athens actually did, but also the infection in man was very rare indeed, even when the horse and man enjoyed a numerous and very close environmental propinquity, as during the industrial revolution before the horse was significantly superseded by steam locomotion and the internal combustion engine. As we have seen, in both leptospirosis and tularaemia, where man is relatively remote from the animal reservoirs concerned (even in sewers, rat urine is massively diluted and hunters are not spatially very intimate with their quarry), explosive epidemics are recorded in modern times when conditions are far less favourable to cross-infection than was the case when horses teemed in the squalid mews and slums of the mid-19th Century.

The demography and sociology of the Plague of Athens are of interest. The most precise information given by Thucydides (2.58.3) is as follows: out of 4,000 hoplites (foot soldiers) in the expeditionary force led by Hagnon to Potidaea, over a quarter perished.[24] Foot soldiers and cavalry are not only in the prime of life but they tend to get for themselves, by fair means or foul, the best available lodgings and rations. Longrigg[25] states: 'In any epidemic higher losses are almost invariably sustained amongst the very young, the very old, the poor and sick, than among the richer and able-bodied'.

This statement must be treated with the utmost caution. If, as seems probable, the Plague of Athens were an unfamiliar immunological challenge – a 'new' disease in common parlance, then it would have afflicted, as it did, those in the prime of life, especially males. The very young, very old, and otherwise frail succumb less to 'new' diseases than to those endemically well established.[26]

Today epizoötic tularaemia is a less grievous malady in animals than it would be in man, were the latter left untreated. This indicates that the disease in man may be of relatively recent date. But two and a half millennia ago in Athens, the Plague, if it was tularaemia, would have been notably less well established in man or beast and correspondingly more severe in both, thus explaining nicely how the latter were seen to die more frequently than is the case now. If the Plague of Athens be extant today and of similar nosology, then tularaemia would seem to fit the picture reasonably well.[27]

Dept. of Theology, Exeter University J. A. H. WYLIE
Dept. of Classics, Exeter University H. W. STUBBS

[24] J. C. F. Poole & A. J. Holladay, op. cit. n. 1, p. 287.

[25] James Longrigg, 'The Great Plague of Athens', *History of Science* 18 (1980), 209–25.

[26] J. A. H. Wylie & L. H. Collier, 'The English Sweating Sickness – A re-appraisal', *J. Hist. Med.* 36 (1981), 425–45.

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