

NOTES AND QUERIES

Smallpox: A Difference of Opinion

Editor's note: The review which follows is reprinted from the Economic History Review by kind permission of the author and the editors. L.P.S. has not reprinted a review article before nor invited a response from the person whose work is being reviewed, but in this case, the prospect of starting a useful debate in which any of our readers interested in smallpox could participate, seemed to justify a departure from normal practice.

L. Bradley (Ed.). Smallpox Inoculation. An Eighteenth Century Mathematical Controversy. Translation and Critical Commentary (Nottingham: University of Nottingham Adult Education Department. 1971. Pp. 72. 75p.)

This pamphlet essentially consists of translated copies of the memoirs written by Bernoulli and d'Alembert in 1760 as part of their controversy over the advisability of being inoculated against smallpox. Bernoulli's memoir is the more important of the two, if only because he, unlike d'Alembert, displayed a correct understanding of probability theory. Bernoulli also attempted to present some evidence on questions such as smallpox mortality rates, and even though his evidence is mostly impressionistic, it has some value to the medical and demographic historians, whereas d'Alembert has virtually nothing to say on this topic. Both protagonists agreed on the overall benefit to be derived from inoculation in diminishing smallpox mortality; their disagreement lay over whether mathematical rational considerations should weigh more heavily with individuals contemplating inoculation than the psychological fears of the immediate risk involved in such a preventative measure (the parallel with the current debate about the use of the contraceptive pill is too striking to ignore). Bradley in his introduction suggests that Bernoulli's memoir should be of use "to the demographer because it gives an impression of the degree of smallpox mortality in the mid eighteenth century". Unfortunately, it is impossible to know how valid some of Bernoulli's impressions are. We do know that two of his key assumptions in his mathematical calculations are factually incorrect: it is not true that "provided one has not already had smallpox, one always runs the same risk of catching it" (this may have been true of large eighteenth-century towns but it was not true of people living in the countryside), and nor is it true

"that the risk of dying of smallpox, when one is attacked by it ... (is) the same for all ages" (it is known to vary markedly with age). He probably reached these erroneous conclusions because his experience was confined to large towns and the only statistical evidence available to him was for places like London, Vienna, Berlin and Breslau. It was on the basis of such evidence that he reached his conclusions about the degree of smallpox mortality. Such mortality is known to vary between urban and extreme rural areas - for example, extremely isolated areas such as the Orkney Islands and Iceland had massive smallpox mortalities due to the absence of a pool of antibodies built up through previous epidemics. Also the statistics that Bernoulli refers to are of completely unknown quality; work that I have just completed on the reliability of parish registers as a source of demographic data (to be published in Population Studies) suggests that statistics for places such as London could be completely worthless on account of the gross unreliability of basic information. Similarly, Bradley in his otherwise excellent introduction states that "inspection of parish registers reveals many parishes, including some of the smaller towns, where serious epidemics of any kind were few, or even non-existent, over the whole of the eighteenth century." Given what we know about the nature of smallpox as a disease, it is impossible for any area of the country to escape its attention without exposing itself to the risk of the kind of massive mortality touched on above. The lack of evidence of epidemics in some parishes would lead me to suspect the reliability of the source of demographic information - and there are at least two contemporary descriptions of the existence of private smallpox burial-grounds which were used in the eighteenth century to deposit corpses without the usual Anglican burial rites and registration processes. There are other reasons why parish register data could be very unreliable which cannot be discussed here, but there is one general lesson to be drawn from Bernoulli's memoir in this respect: demographers of the eighteenth century tended to be dependent on the evidence available to them, and this invariably was for large towns in which only about a fifth of the population lived. Historians should beware of the mistakes made by Bernoulli and should not commit the historical fallacy of assuming that surviving statistical evidence is necessarily representative of the actual situation. However, in spite of these flaws in Bernoulli's argument, I can recommend Bradley's presentation of them in an excellently produced pamphlet at an attractive price.

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Leslie Bradley comments

It may seem ungracious to raise objections to Dr. Razzell's kind review of my work, but I am sure that he himself, in the interests of historical debate, would not wish me to pass over views which he expresses in it and which I believe to be erroneous.

In my introduction to the Bernoulli and d'Alembert Memoirs, after setting them in their historical context, I develop two themes. The first is that in his memoir, Bernoulli makes what is, so far as I have been able to find, the first attempt at a mathematical theory of the propagation of an infectious disease, the fore-runner of the highly sophisticated modern models of N.T.J. Bailey and others. Now any mathematical theory must start from basic postulates, assumptions which, though not corresponding precisely to conditions in a complex natural situation, are simple enough to treat mathematically and yet sufficiently accurate to form the basis of a useful theory. This is what Bernoulli did and it is what Bailey and the other modern mathematical statisticians do. Bernoulli never pretended that the assumptions to which Razzell objects were precisely accurate. What he did maintain was that they accord reasonably well with the known facts (and I quote the opinion of Dr. K. Dietz, a medical statistician, that this is indeed so); and, having developed his mathematical theory, he showed that it led to a conclusion about the overall degree of smallpox mortality which agreed with the then generally accepted observations, namely that "smallpox carries off a thirteenth or a fourteenth part of every generation". Moreover, he was well aware that the mortality figures which he quoted were derived from the larger towns and that his theory applied to what we now call an endemic situation, that is one in which smallpox was continually present to a substantial extent, as opposed to the epidemic, or severe isolated outbreak.

My second theme is the relation of the estimates of smallpox mortality which Bernoulli quotes, and which were generally accepted by his contemporaries, to the present discussion on the steep rise in the population of England in the second half of the eighteenth century. On the one hand, it has been argued that the predominant factor in this rise was a marked decline in mortality due, it is suggested, to improvements in hygiene and medicine; on the other, that the predominant factor was a rise in fertility. Razzell supports the former view, but goes much further. In an article in the Economic History Review (1) he claims that the diminution in smallpox

mortality alone due to the increased use of inoculation was the major factor, and he goes so far as to say "Inoculation against smallpox could theoretically explain the whole of the increase in population, and until other explanations are convincingly documented, it is an explanation which must stand as the best one available". It is this extreme view of the degree of smallpox mortality which he is defending in the above review, and to do this he has to make two points. First he has to show that Bernoulli's estimates of endemic smallpox mortality were seriously inaccurate. So far as one can gather from the review, the attack on the estimates quoted by Bernoulli depends on Razzell's high estimate of the degree of unreliability of the parish registers. But the article in Population Studies which he mentions ⁽²⁾, and in which he sets out to demonstrate this, has serious flaws, not the least of which is his initial assumption that "baptism has always been performed by the Anglican church in the parish of residence". Anyone who has attempted a family reconstitution knows that this is just not so; where the mother came from another parish, it was frequently the custom to take the first child, and sometimes later children, to the mother's old parish for baptism. We shall need much better evidence than this. But even if we double Bernoulli's estimate that endemic smallpox killed one in thirteen of every generation, it is still not enough. Razzell states: "In order for inoculation against smallpox to account for the whole of the population increase, smallpox mortality before inoculation must have been about 310 deaths per 1,000 born" ⁽³⁾; that is, about one in three. And again: "For the time being it will be sufficient to note that recorded smallpox deaths accounted for between 11.6 and 50 per cent of all those born and dying and that actual smallpox mortality was possibly twice as large as that actually recorded" ⁽⁴⁾. In order to justify these very high over-all mortality figures, Razzell now has to show that in the villages and small towns in which four fifths of the population lived, and in which, if it occurred, smallpox would be epidemic ⁽⁵⁾, mortality from smallpox was very high indeed, averaged over the whole country and for a considerable period of time. He is able to quote recorded instances of such high mortalities, and he assumes that they are typical. But, as I point out in my introduction, inspection of parish registers reveals many parishes, including some of the small towns, where serious epidemics of any sort, smallpox or otherwise, were few or even non-existent over the whole of the eighteenth century ⁽⁶⁾. Razzell's reply is that "the lack of evidence of epidemics in some parishes would lead me to suspect the reliability of the sources and there are at least two contemporary descriptions of the existence

of private burial grounds which were used in the eighteenth century to deposit corpses without the usual Anglican rites and registration processes". But two out of some 15,000 parishes is hardly convincing, and I know of no evidence to suggest that such burial grounds were common. Indeed, I suggest that the evidence is that, in general, villages and small towns managed to preserve normal registration and even churchyard burial under quite serious epidemic conditions. I happen to be working at the moment on the famous outbreak of plague at Eyam, Derbyshire, in 1666. In spite of a very high mortality and the closing of the churchyard for burials, the evidence suggests that burial registration continued to be carefully carried out and reasonably accurate. For the majority of villages and small towns it is, I maintain, highly unlikely that the degree of under-registration would conceal epidemics of such severity and frequency as Razzell's theory demands.

Were Razzell's high mortality or my low mortality parishes the more typical? At present this is an open question. Can Dr. Razzell, or L.P.S. readers who have been studying eighteenth century parish registers, produce more conclusive evidence? We need lists of parishes:

- (a) in which high smallpox mortality is recorded or can reasonably be inferred.
- (b) in which no serious epidemics can be seen to have occurred.
- (c) in which burial registration appears to have broken down on account of high epidemic mortality.

For good measure, it would be useful to have lists of recorded inoculation. Was it really as widespread as Razzell suggests or was it, like so many of the factors which demographers have to consider, subject to wide regional differences?

Until we have this evidence, I am inclined to believe that Bernoulli's estimates are nearer to the mark than the high figures which Razzell suggests. Bernoulli lived in a period of intense scientific activity with a growing emphasis on careful observation. His sources of information, as he himself points out, were faulty, but can we really pretend that our information about his period is any better?

L. Bradley

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- (1) Economic History Review, Second Series, XVIII, No. 2. August 1965.
- (2) Population Studies XXVI, No. 1. March 1972.
- (3) Economic History Review XVIII, No. 2, p.329.
- (4) Economic History Review XVIII, No. 2, p.325.
- (5) An attack of smallpox, from which the patient recovers, confers virtual immunity against the disease, through the formation of antibodies. If smallpox were introduced into a community in which it had never before occurred, none of the population would be immune, the disease might well attack the whole, or almost the whole, of the community and mortality could be severe. Those who recovered would be immune, and a further introduction of the disease within a limited time would affect a smaller proportion of the inhabitants. If the community were isolated and no outbreak occurred until the previously affected generation had died out, the "pool of antibodies" would be gone and the community would again be very vulnerable. In point of fact there were, in England, a number of large towns in which smallpox was endemic and few villages would be so isolated that the pool of antibodies would disappear. I consider Razzell's reference to the Orkneys and Iceland misleading.
- (6) Further evidence that heavy epidemics were not as widespread as Razzell suggest will be found in the article "Crisis Mortality" by Dr. R.S. Schofield in Local Population Studies No. 9.