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JOHN GRAUNT AND HIS *NATURAL AND POLITICAL  
OBSERVATIONS*\*

By D. V. GLASS

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I. SOME NOTES ON THE LIFE OF JOHN GRAUNT

IN commemorating the work of Graunt, the founder of demography, it was clearly desirable that a search be made for further information on his life. Perhaps the most striking result of that search has been to show how heavily we must still depend for our knowledge of Graunt as a person on Aubrey's notes (1)—both in their original form and in their more elegant elaboration by Anthony Wood (2)—and on the brief but warm comment by another of Graunt's contemporaries, the famous book-collector, Richard Smyth. 'An understanding man', Smyth called him, 'of a quick witt and a pretty schollar, my old acquaintance' (3). Hull added a few facts (4), and there are some interesting snatches of correspondence from Petty to, or about, Graunt in Lord Lansdowne's volume (5). These remain basic sources. But additional material has been found elsewhere—in the City of London Records and in the records of the Drapers' Company, as well as in the full Petty correspondence from which Lord Lansdowne cited a few sentences. The contribution of these and other sources will be seen as the story is pieced together (6).

John Graunt was born on 24 April 1620, the son of Henry and Mary Graunt. According to Aubrey, Henry Graunt was a Hampshire man by birth. But he had been apprenticed in London in 1604 (when he was 12 years old) and was admitted to the Freedom of the Drapers' Company in 1614. He was described as a collar maker, first in Abchurch Lane and later in Birchin Lane, in the parish of St Michael Cornhill (7), where his children were born. The register of St Michael suggests a large family—seven children at least, including a set of twins—with John Graunt appearing to be the eldest, or at least the first of his family to be baptized in that parish (8).

He was 'educated while a Boy in English Learning', Anthony Wood says of John Graunt. It was presumably not too brief an education, for he did not enter apprenticeship until he was over sixteen. At that age he was bound

\* This paper introduced a Discussion on Demography held at the Royal Society on 15 and 16 November 1962 to celebrate the tercentenary of the publication in 1662 of John Graunt's book *Natural and political observations made upon the bills of mortality*. The full Discussion is published in *Proc. Roy. Soc. B*, 159, 1-255 (Part No. B. 974).

apprentice to his father—described as a haberdasher of small wares—and after five years was admitted to the Freedom of the Drapers' Company by patrimony. He apparently worked with his father. The records show only five apprentices during the period 1641–68, which does not perhaps suggest a very large business. But Graunt's position must have been substantial, for he held a number of important offices in the Drapers' Company—he was Warden in 1671, and a member of the Court of Assistants 1671–73 (9). He also served many Ward offices (as his father had done) in Cornhill Ward; was on the Grand Jury List, 1658–61; foreman of the Wardmote Inquest 1669–70; and a Common Councilman around 1669–71 (10). After the Great Fire he became a member of the New River Company, in trust for one of the shares belonging to Sir William Backhouse, and probably continued in the Company until 1670 (11). For several years, according to Aubrey, he was Captain in the 'Trayned Band' and a Major for two or three. He lived in a fair-sized house (12) and Pepys described his collection of prints as the best of 'anything almost I ever saw' (13).

Relatively little is known about John Graunt's immediate family. The bare facts of his marriage are fairly clear. He married in February 1641, just before receiving his freedom from the Drapers' Company. His bride—aged 17—was Mary Scott, described as of the Parish of St Botolph Bishopsgate, though other information suggests that she may have come from an Essex family (14). But so far, the baptismal records of his children have not been found. Aubrey believed that there were two children—a son who died in Persia and a daughter who became a nun in Ghent. The son has not been discovered, but a girl who appears to be the daughter has been traced as entering the convent of the Holy Sepulchre at Liège and 'taking ye Habitt of Religion' in 1667, at the age of 18 years (15). The deaths of two other children—both daughters—are recorded in the registers of St Michael Cornhill, but not their baptisms (16). In his *Observations*, Graunt referred to the number of 'Heterodox Believers'—'so peevish were they, as not to have the Births of their Children *Registred*, although thereby the time of their coming of Age might be known, in respect of such Inheritances, as might belong unto them . . .' (17). But even if Graunt's own practice had followed his demographic precepts, the parishes in which his children were registered have not yet been ascertained.

Still less is known of how or when Graunt came to meet Petty. The general possibilities of such a meeting are visible enough. Graunt had considerable status in the City, and not solely because of his wealth or official position. He was obviously well-read. Though his formal education had ceased when

he entered apprenticeship, he continued to study by himself. He 'rose early in the morning to his study before shop-time', Aubrey said, and 'he understood Latin and French'. He was proficient at writing shorthand, and read widely on Socinianism—an anti-Trinitarian doctrine very similar to Unitarianism. He was a 'great peacemaker' and was often used as an arbitrator. At the same time, he was 'very facetious and fluent in his conversation.' He knew the kind of people whom Petty would be likely to see in London—including Pepys; Samuel Cooper, the miniaturist; John Hayls, the portrait painter; and Benjamin Rudyerd, the poet (18). In so small a cultural world, a meeting between Graunt and Petty was almost inevitable. Friendship between them must have developed fairly rapidly, for by about 1650 Graunt was using his influence to have Petty appointed to a Gresham Professorship of music. In 1659, Graunt and Petty were involved, together with John Martyn, printer to the Royal Society, in the purchase of land in Lothbury (in the City of London) (19). And in 1660 Petty gave Graunt his power of attorney (20). It was perhaps in that connexion, in 1662, acting as Petty's agent, that Graunt was engaged in property transactions in Romsey, Petty's home town (21).

No documents so far available indicate when Graunt began to interest himself in a study of the Bills of Mortality. In the Preface to his *Observations*, he explained that, having been born and bred in the City of London, he had always noticed that most of those who regularly bought the Bills, merely looked at the total number of burials, or saw if anything unusual had occurred among the causes of death and then talked about it at the next social occasion. Or in times of plague, there might be a much more immediate and practical concern. It was because he believed that better use could be made of the information that he embarked upon the study and collected the necessary data from the Company of Parish Clerks (22). Graunt's friend, Richard Smyth, was also interested in mortality, but in a strictly personal way, and drew up a dated 'catalogue of such persons deceased whome I knew in their life time . . .' (23). Graunt's interest was quantitative, but that interest may well have been stimulated because, as Aubrey said, he had 'a hint from his intimate and familiar friend', Petty (24). Nothing more definite is known until the *Observations* were published in 1662 (25). Events then moved fairly rapidly. The book itself was obviously a considerable success—Pepys was buying a copy at Westminster Hall in March, and a second edition was issued before the end of the year (26). Graunt (in February) presented 50 copies to the Royal Society, and he was proposed as a candidate and, after the examination of his book by a weighty committee, was elected into the Society on 26 February 1662 (27). His name thus appeared in the list attached

to the Second Charter of the Society. It was Graunt whom Sprat cited as evidence that the Royal Society 'diligently search out and join to them, all extraordinary men, though but of ordinary Trades' and that the Society would continue to do so. For it was 'the Recommendation which the King himself was pleased to make, of the judicious Author of *The Observations on the Bills of Mortality*: In whose Election, it was so far from being a Prejudice, that he was a Shop-keeper of London; that his Majesty gave this particular Charge to his Society, that if they found any more such Tradesmen, they should be sure to admit them all, without any more ado' (28).

In the affairs of the Society, Graunt played some part until the Great Fire. He did not contribute seriously to the scientific or philosophic discussions—some remarks on the increase in the numbers and size of carp in a pond at Deptford and of salmon in the Severn; a brief comment on Dr Goddard's discourse on coffee, written at the King's command at a time when Charles II was perhaps already contemplating the banning of coffee-houses because of the excessive freedom of speech of their *habitués*; and he presented a box of 'Maccasar poison', which was 'ordered to be tried at the next meeting; by dipping a needle in the poison, and pricking some dog, or cat, or pullet with it'. He also added to his *Observations*, producing a third edition which, 'upon a report of Sir William Petty of his having perused the additions of Mr Graunt to his *Observations upon the Bills of Mortality*, the president be desired to license the reprinting of that book, together with such additions: which was done accordingly' (29). The third edition appeared in July 1665; Brouncker immediately sent a copy to Pepys, and Oldenburg was soon (in September) writing to Boyle about it (30).

Graunt was active in other ways in the Society. It was through him that Petty channelled his proposals for constructing a double-bottomed ship. He was a member of Council from 1664 to 1666, of a committee concerned with the history of trades, of another to examine the Treasurer's accounts and of a delegation to ask for repairs to be made to Gresham College (31). His name continued to appear on the lists of the Society, though from the time of the Great Fire until his death, he held no office (32).

That he should have become less active is probably accounted for by his greatly worsened circumstances. His London property was destroyed in the Great Fire—and unlike Petty, he may have had little or no property outside London. Petty offered him money to rebuild, writing (4 February 1667) that 'I would rather forbear laying out that whole sum upon my own grounds than that you should want a house of your own wherein to manage your trade . . . for I study your concernment as my own . . .' (33). The houses were rebuilt

and, in addition, Graunt undertook, jointly with Petty, to rebuild a number of houses on Petty's land in Lothbury (34). But Graunt's affairs did not prosper. His two houses in Birchin Lane were sold to Petty in November 1671, though Graunt continued to live in one of them for a time (35). Yet the sale did not appear to produce any improvement. The information on Graunt's financial position is one-sided in that it is based almost entirely on copies of letters written by Petty to Graunt; no replies from Graunt have been found. But Petty's letters—which show an increasing irritation with Graunt's financial shortcomings combined with a persistent affirmation of friendliness to Graunt and his wife—indicate that Graunt was withholding rents which, as Petty's London agent, he should have allocated in accordance with Petty's demands. Already in November 1672 Petty complained: 'I perceive you are angry that I pay my debts in the manner I think fit, and take the liberty to dispose of my rents other ways, whereof you might have advertised me before I made the appointment. I have been many years tender to your credit, but you too hastily abandon mine' (36). In early December Petty again complained to Graunt that he had not provided the accounts which had long been promised (37), and at the same time wrote to Brookes, giving him a power of attorney and asking him to take over the rents (38). The unpaid rents were referred to in letters in late December, in January and in a last letter in February 1673 (39).

There seemed to be no way out of Graunt's financial crisis. Petty discussed the possibility of employment in Ireland. But his own estates were in Kerry, in 'an obscure corner of the world', not apparently attractive to or feasible for Graunt (40). An appointment in Dublin with Sir Henry Ford (Secretary of State for Ireland) was considered, but no explicit offer was forthcoming (41). The collapse had been very rapid. In 1671 Graunt was living in Birchin Lane and holding substantial offices in the Drapers' Company, in his Ward and in the City. By 1673 he was in acute difficulties. Aubrey says that he went bankrupt. There are no documents to confirm this. But Graunt left the Birchin Lane house and moved to a small shop in Bolt Court, St Dunstan's in the West, his final home (42).

The reasons for this marked change in Graunt's fortunes are far from clear. The initial turn may have been the consequence of the Great Fire and the destruction of his London properties. Unwise estate speculation may also have been involved and perhaps Graunt paid too little attention to his haberdasher's shop. Whatever the primary causes, it is likely that the difficulties were accentuated by Graunt's change of religion, and that at a time when English Catholics were under heavy attack. According to Aubrey, Graunt—who had

been brought up as a Puritan and later adopted an anti-Trinitarian doctrine—turned Roman Catholic, became a zealot, and ‘layd down trade and all other publique employment for his religion . . .’. This may in part explain the location of his last home in St Dunstan’s, one of the areas in which Catholics from the provinces tended to congregate (43). When Graunt became a Catholic is not known, but it must have been before 1672, for in a letter in December of that year Petty could assume that it was then widely acknowledged (44). Petty clearly did not approve of this change in religion. ‘As for differences in religion’, he wrote on 18 January 1673, ‘you have done amiss in sundry particulars which I need not mention because yourself may easily conjecture my meanings. However we leave these things to God and be mindful of what is the sum of all religion, and of what is and ever was true religion all the world over.’ Graunt must have reacted, prompting Petty to write, on 22 February 1673, ‘I think I understand what puts you out of humour, and know tis your own fault severall wayes. If you are willing to throwe mee off, you therein do me an unkindness, I shall never doe the like towards you. My wife is landed in England, but fallen sick by the way. I hope through her there may be yet a right understanding.’ The breach was not healed and shortly afterwards Petty told his friend, Dr Woods: ‘Captain Graunt is now an open and zealous champion for Popery, wherefore I have not so much intimacy with him as formerly’ (45).

But Graunt now had other urgencies than Petty’s friendship with which to occupy himself. The marriage of the Duke of York, and his decision to live openly as a Catholic at St James’s Palace, set off a series of accusations of recusancy (46) under the Elizabethan Statutes, and Graunt was involved in one such prosecution. He appeared twice in court, early in 1674, pleading not guilty, and was granted bail (47). The adjourned case did not, however, come to trial, for when the proceedings were reopened at the end of April, Graunt’s death was reported. He had died on 18 April, of jaundice, according to Richard Smyth (48), and was buried in St Dunstan’s in the West—‘under the piewes (*alias* hoggsties) of the north side of the middle aisle’, wrote Aubrey; ‘what pitty ’tis so great an ornament of the citty should be buryed so obscurely’. ‘His death is lamented by all good men that had the happinesse to knowe him; and a great number of ingeniose persons attended him to his grave. Among others, with teares, was the ingeniose great virtuoso, Sir William Petty, his old and intimate, acquaintance . . .’ (49).

With Graunt’s death, the Crown renounced its rights, under the Recusancy Acts, to his property. But there was in any case little left of his former wealth (50). Fitzmaurice said that Petty provided for Graunt’s widow (51).

She would have needed that provision, for she had had to apply to the Drapers' Company for a pension. The pension agreed—four pounds a year—could scarcely have supported her in any great luxury (52).

## 2. THE NATURE OF GRAUNT'S WORK

Each age looks at a 'classic' in terms of its own interests and problems and the points of emphasis differ accordingly. Hull, for example, in evaluating Graunt's work, drew attention to the finding that the proportion of total deaths resulting from certain specific causes appeared to be fairly constant; as well as to Graunt's estimate of the extremely high infant and childhood mortality in London. Some modern demographers, on the other hand, would be especially attracted to those features which—as is confirmed by current data and analyses—are characteristic of pre-industrial populations and of relatively uncontrolled fertility. But whatever the particular and varying emphases, demographers in general would agree that probably the most outstanding qualities of Graunt's work are first, the search for regularities and configurations in mortality and fertility; and secondly, the attention given—and usually shown explicitly—to the errors and ambiguities of the inadequate data used in that search. Graunt did not wait for better statistics; he did what he could with what was available to him. And by so doing, he also produced a much stronger case for supplying better data (53).

There had, of course, been a long prior history of thought and writings on population questions and some collection of population statistics. Graunt's own period was one in which, partly because of the visible demographic consequences of the Thirty Years War, concern with population growth became much sharper. Some writers displayed an almost Malthusian view of the relationship between population growth and resources (54). But in the main the period was noisy with laments of depopulation and—until the late eighteenth century—with Mercantilist demands for population increase (55). Graunt, however, shows little of this concern with broader issues. His generalizations are those of the technical demographer and are based upon a detailed consideration of the data for two areas—London and the country town of Romsey, in Hampshire. It was with these data that he undertook the first analytical study of mortality and fertility statistics.

Though, in the Epistle to Lord Roberts, Graunt is vague as to what originally prompted him to think about the Bills of Mortality, he is entirely explicit in his remarks in the Preface. He had long observed that little use



was made of the Bills and had considered that other uses might well be made. Looking at a number of Bills at hand, he was encouraged in this view and he therefore set out to collect as many Bills as were available, visiting the Hall of the Company of Parish Clerks for that purpose. The information thus gathered he then reduced to a series of Tables in order to test 'the Conceits, Opinions, and Conjectures' which he had formed on the basis of the few Bills. And he published the Tables at some length, so that 'all men may both correct my *Positions*, and raise others of their own' (56).

To carry out the kind of analysis Graunt had in mind—as well as to allow others to assess the truth of his findings—required a discussion of the history of the Bills, of the reliability of the information contained in them, and of the appropriateness of the ways in which he had manipulated the data. Graunt met these requirements in full. He showed how the contents and coverage of the Bills had changed over time. This provided a background for his Tables, in which he summarized statistics for the years from 1604 to 1661, presenting the data both for single years and for such groups of years as he considered would constitute an aid to generalization (57). And before drawing conclusions from the Tables, he explained how the numbers and causes of deaths were ascertained by the 'searchers'—'ancient Matrons, sworn to their Office'—who, by looking at the corpse and by other inquiries, determined from which '*Disease, or Casualty, the Corps died*'.

Unlike Bell, the clerk to the Company of Parish Clerks, he had no high regard for the searchers (58). Nevertheless, he considered that much of their reporting would be sufficiently reliable for his purposes. Some of the causes reported would have been determined by the physician in attendance and communicated by friends of the deceased. In other cases, the observations of the searchers themselves would be sufficient, or even lay judgement would be reasonably adequate—miscarriages, stillbirths, the deaths of the aged. With respect to some causes of death, he was more concerned to assess the age-group involved than the specific disease. Thus he stressed the importance of knowing whether, in referring to infants, the searchers meant those who had not yet learned to speak. For it would be at least of some value to know—as he put it in anticipation of his later section on the life table—'how many die usually before they can speak, or how many live past any assigned number of years' (59). And errors in reporting as such might not always destroy the possibilities of meaningful analysis. Thus he was not too concerned if the searchers ascribed to 'consumption' those corpses which were 'very lean, and worn away'—even if the disease were not always the same as that defined in medical texts.

On the other hand, he was very critical—and in a constructive way—of other errors of reporting which he considered might substantially distort the assessment of specific cause mortality. The reporting of plague was a case in point. He found that in a plague year, deaths from other causes increased sharply and concluded that about a quarter more died from plague than were so recorded (60). Because of that, he argued, even if the incidence of plague could be regarded as a satisfactory indicator of the health of London, it would still be necessary to examine deaths from other causes in order to arrive at a reasonably accurate estimate of plague mortality as such (61).

Under-reporting also appeared to account for the surprisingly small number of deaths from syphilis. Here Graunt apparently carried out a special inquiry and found that patients dying of syphilis in hospital (and especially in the Kingsland and Southwark Lock hospitals) were returned as dying from ulcers and sores. Those reported as dying of syphilis were all returned by clerks of St Giles and St Martin-in-the-Fields—the parishes with the worst brothels. It was also not unlikely that some cases of syphilitic mortality were recorded as consumption. The corpses would be equally emaciated and the ‘Old-women *Searchers* after the mist of a Cup of *Ale*, and the bribe of a two-groat fee, instead of one, given them’, would confuse the one cause of death with the other (62).

In examining one category in the Bills—abortives and stillbirths—a scrutiny of the data suggested to Graunt that it was not the deficiencies in reporting deaths but the increasing incompleteness of reporting births (i.e. of baptizing children) which caused the error. The raw data indicated a constant number of abortives and stillbirths with a falling number of christenings. But the growing excess of total burials over christenings after 1642, and especially after 1648, convinced him that ‘there hath been a neglect in the Accompts of the *Christnings* . . .’. Taking 1631 as the basis for calculation and assuming a constant ratio of abortives to christenings, there should have been 8500 christenings in 1659, instead of the 5670 reported (63). A check might be obtained from the numbers of women dying in childbirth, such cases being better reported than abortives and stillbirths. In 1631, there were 112 women so dying, while the number in 1659 was 226. Again, assuming that childbed mortality was constant, this would imply a true number of christenings more than twice as high in 1659 as in 1631. And if this were the case, then the true ratio of burials to christenings would also become about the same at the two points of time (64). Of course, these estimates all involve further untested assumptions. But the assumptions are at least explicit and fairly realistic—far more realistic than would have been the blind acceptance

of the excess of burials over baptisms as evidence of the declining population of London (65).

Having constructed his critical apparatus—and it was a characteristically statistical one—Graunt proceeded to the stage of analysis. A few examples will have to suffice, for although Graunt claimed that his ‘pamphlet’ required less than ‘two-hours’ reading, it is in fact studded with conclusions, of varying generality and validity, drawn from his statistical inquiries.

On the more general side, he attempted to distinguish two broad categories of cause mortality, basing himself on the data for his twenty-year, relatively normal period. The ‘chronical’ diseases, which he reckoned as accounting for some 70 000 out of a total of 229 000 deaths, formed the substructure of mortality and were an index of the state and disposition of a country in respect of health or, rather, of possible longevity. Men ‘being long sick and always sickly, cannot live to any great age . . .’ (66). Mortality from such diseases, and from the most common diseases in London, bore a fairly constant proportion to total mortality. Acute diseases (excluding the plague) accounted for about 50 000 deaths. These, so to speak, superimposed themselves in great ‘epidemical sweeps’ upon the normal level of health. If plague were included, the sweeps would be very wide, the numbers being ten times greater in peak periods than in others. It was these two broad categories of acute and chronical diseases which constituted the major causes of death. The ‘more formidable, and notorious’ causes which filled many people with fear and apprehension, played little part. Few died of apoplexy or of the falling sickness or leprosy and few from starvation. What is included under each of Graunt’s broad headings is far from clear. But if plague is added to the acute diseases, the total accounts for some 30% of the reported deaths. For England and Wales, in the period 1848/72, infectious diseases, including tuberculosis, accounted for some 33% of all deaths (67).

Other broad generalizations include attempts to assess the general, crude levels of mortality in London and in Romsey. In turn, this meant estimating the total population in each area and thus the overall possible errors are so much the greater. The attempts are less interesting in the figures to which they led—crude death rates of 31 per 1000 in London and 20 per 1000 in Romsey—than in their conception of measuring the relative mortality of urban and rural areas, a matter which (though with different statistical indicators) has continued to interest demographers and public health officials up to the present (68). The study of his rural district also prompted Graunt to measure the relative fluctuations in mortality as between town and country. He concluded that though the general level of rural mortality was lower, the

fluctuations were wider than in London—a conclusion with which Greenwood found himself in fair agreement, so far as the purely statistical aspect was concerned (69).

Morbidity, and its link to mortality, also interested Graunt. To take a slightly frivolous example, he noted what he regarded as a not unrealistic statement which he had heard physicians make, that they had two women patients for every male patient. But looking back at the burial statistics for males and females, he concluded that either the women were generally cured by their physicians or else that men died just as much from their vices as women did from the infirmities of their sex and presumably without recourse to physicians (70). More seriously, however, and more specifically, he tried to estimate the case fatality associated with an outbreak of malignant fever in Romsey in 1638. Comparing the deaths with the reported shortage of hands for the wheat harvest in a population which he had assessed as about 2700, he concluded that ‘seven might be sick for one that died’. This result also helped to convince him that it was really a different disease from the plague, of which ‘more die than recover’ (71).

At the more particular level, Graunt considered methods for assessing which years were the most sickly—taking only those years in which plague deaths were not above 200—as well as of measuring the years in which plague contributed most to total mortality. His years of highest mortality were not those with the largest numbers of deaths but those in which the ratio of burials to baptisms was maximal (72). Probably his best-known study of cause mortality, was, however, that of rickets. Here his problem was to determine whether the disease, which first appeared in the Bills in 1634, was genuinely a new one or whether there had simply been a renaming of an old illness. Again, he approached the question statistically, not referring to Glisson’s work, though he said that ‘the Pretenders to know it’—presumably physicians—thought that livergrown was the other disease most like rickets. He confirmed this from the Bills, at least to the extent that in some years livergrown, spleen and rickets were put together in one group. Hence to see if rickets as such added to the total number of deaths, he took the deaths from livergrown and rickets in 1634—amounting to 91—and compared this figure with the deaths from livergrown alone in 1633—amounting to but 82. This was suggestive, though he acknowledged that it was ‘but a faint Argument’. To test his hypothesis more effectively, he looked for larger numbers of cases. He recognized, in scrutinizing the Bills, that when deaths from rickets were very numerous, those from livergrown were few. Yet accepting the probability of some confusion as between the two causes, the

Bills showed that only in one single year, 1630, were there above 100 deaths attributed to livergrown. By contrast, in 1660 the total deaths allocated to the two causes numbered 536. He was thus convinced both that rickets was a new disease and, moreover, that deaths caused by it had been generally increasing since 1649 (73).

Of still greater interest—because it led finally to the construction of his life table—was Graunt's examination of mortality in infancy and childhood. Graunt had already stressed the value of knowing 'how many die usually before they can speak, or how many live past any assigned number of years', and he approached the question from the two extreme ends of the age-span. First, in respect of the early years of life, he had no information whatever on ages at death. But he selected those causes of death which he guessed would all affect children 'under four or five years old'—thrush, convulsion, rickets, teeth and worms, abortives, chrysoles, infants, livergrown and overlaid. This accounted for 71 124 out of a total of 229 250 deaths in his twenty-year 'normal' period, or about a third. To these he added half of the 12 210 deaths from small-pox, swine pox and measles, and from worms without convulsions, on the assumption that this proportion would fall upon children 'under six years old'. Finally, he added some—about 5000 in fact—of the 16 000 deaths from plague. He concluded that 'about thirty-six *per centum* of all quick conceptions, died before six years old' (74). This conclusion is, of course, valid only if the population is stationary, so that births and deaths are constant from year to year. There is no evidence that Graunt was aware of the other approach used later by Halley—of constructing a child population from the births and infant deaths. In any case, he had emphasized the under-reporting of births. Yet in the outcome, as Greenwood pointed out, his 36% mortality before age 6 was at least fairly realistic as compared with the mortality experience of London in the late nineteenth century, according to which the proportion of live-born children dying by their sixth birthday was some 32% (75).

Secondly, at the other end of the life span, Graunt had only the searchers' reports of deaths of the 'aged'—some 7% of all deaths were allocated to that category. Graunt assumed that the searchers were likely to have restricted this to people aged 70 or more, 'for no man can be said to die properly of *Age*, who is much less . . .' (76). As in the case of childhood deaths, he treated the data as meaning that only 7% of persons survived beyond age 70, a much less realistic result (in nineteenth-century terms) than his instructed guess at childhood mortality (77).

It was with reference to his discussion of the population of London that

Graunt brought together the two ends of his table and inserted an arbitrary middle term. He had made an estimate of total numbers and of males and females, but he wanted—without any hard facts at his disposal—to guess at the age composition. With this in mind, he sought to compute the numbers surviving to each age from a cohort of 100 live births, having estimated that 36% would die by age 6 and 1% after 76 (presumably one-seventh of those he had envisaged would die at 70 years or over). It is clear that he worked with the deaths in each successive decade, for he first gives the computed numbers dying in the ‘seven *Decads* between six and 76 . . .’ and only thereafter the survivors. Equally clearly he rejected the idea of fractions in his results but did not mind if the proportions dying were not precisely the same throughout—‘for men do not die in exact Proportions, nor in Fractions’. His numbers dying and survivors are given in Table I (78). They can be reproduced more or less exactly by various methods of calculation (79).

But whatever the method used, over most of its range, the life table shows clearly that the deaths in each specified age period amount to about three-eighths of the survivors at the beginning of the period. This constant rate of mortality is curiously unrealistic, and for adult life, this yields remarkably high mortality rates. Taking the table as a whole, the expectation of life at birth derived from Graunt’s data would be only about 17·5 years (80), in contrast to the 27·5 years which would be yielded by the table which Halley later constructed for Breslau, on the basis of much firmer data (81). The figure of 17·5 years would be somewhat below that estimated for India for 1911–21, when the influenza pandemic was taking its toll (82). Farr’s table for London in 1841 gives an expectation at birth of 37 years, though for Liverpool the figure is only 26 (83).

TABLE I

exact age	deaths	survivors
0		100
6	36	64
16	24	40
26	15	25
36	9	16
46	6	10
56	4	6
66	3	3
76	2	1
80	1	0

TABLE II

LIFE TABLE AGE STRUCTURE BASED ON GRAUNT'S TABLE

	(a) derived from $l_x$ column, as given by Graunt (%)	(b) derived from $L_x$ column (%)
below 16	60	54.0
16 and over	40	46.0
26 and over	25	27.5
16 to 56	34	42.2
26 to 66	22	26.2

Graunt himself did not compute the expectation of life from his table. He was concerned to use his results to estimate age composition and this he did directly, and incorrectly, from the survivors ( $l_x$ ) column. Thus he argued that of all conceived, 'There are now alive 40 *per Cent.* above sixteen years old . . .', while the numbers between 16 and 56 were, by his calculation, '40, less by six, *viz.* 34'—in other words, simply the numbers surviving to age 16 but not to beyond age 56, or the numbers dying between 16 and 56. Using Graunt's life table, but working with the appropriate life table population ( $L_x$  columns), the results would be rather different, and both sets are given in Table II. But the differences are not radical. And the 'corrected' figures would not be startlingly unrealistic as compared, say, with some present-day, underdeveloped societies. This is not because of any special intuition on the part of Graunt, but simply because a stationary population, given the high mortalities specified in Graunt's table, implies an extremely high fertility (84). And it is the level of fertility which is the primary determinant of the long-term age structure. Such a country as Egypt, with a gross reproduction rate (GRR) of about 3 and an expectation of life at birth of some 40 years, would (assuming the persistence of those circumstances) ultimately have about 43% of its population under 15 years of age. For Graunt's table, the corresponding proportion would be around 52%. In present-day societies with high fertility, the actual proportion is often around 40%. Incidentally, Graunt was much nearer to reality in his guess at the age structure of Romsey in respect of which he assumed that there would be 'near as many under 16 years old, as there are above'—translated in his calculation to around 45 to 46% (85).

To sum up. Graunt's life table was based on one relatively realistic set of

mortalities and one much less so, linked by an explicitly arbitrary set of probabilities—as Graunt said, ‘we sought six mean proportional numbers between 64, the remainder, living at six years, and the one, which survives 76 . . . , and finde that the numbers following are practically near enough to the truth; . . .’. The total result could not be very realistic. In addition, Graunt was technically incorrect in the way he used his table to estimate age-structure. Nevertheless, the concept of a life table was an outstanding innovation and it lay ready for Halley’s use when he later determined to obtain more realistic data to which to apply the concept. And Graunt realized—as Petty did not when he tried to apply the table to his assumed population for Ireland—that the table must be self-checking, in the sense that the deaths should add up to the radix (86).

Enough has been given, by way of example, to show the pioneer and exciting approach of John Graunt to a series of demographic problems. But the examples by no means exhaust the interest of his work and the discussion would be incomplete if it did not at least mention some of the other questions with which Graunt concerned himself. They include what is perhaps his best-known contribution—the establishment of a slight excess of males over females at birth and in the total population (87). I agree with Greenwood that, in itself, this is less stimulating than some other observations of Graunt, but it certainly provoked an intellectual chain-reaction which spread to Derham and Süßmilch, and thus ultimately to Malthus and Darwin and the theory of evolution. The discussion of the relative levels of fertility in town and country also had long-term repercussions, though it was left to Francis Galton to make the first serious attempt to measure urban and rural replacement (88).

Not all of Graunt’s cogitations were equally happy. His assumption—for he says that he ‘imagined it’—‘that here were about eight Persons in a Family, one with another, *viz.* the Man, and his Wife, three Children and three Servants, or Lodgers’, is certainly excessive—very much higher than the more realistic estimate arrived at by Gregory King in 1696 (89). No less excessive is his estimate that ‘the number of *Child-bearing women* might be about double to the *Births*’, for that would yield an overall fertility rate of 500 per 1000. But at least one basis of that view was not so unrealistic—that childbearing women, ‘one with another, have scarce more than one childe in two years’—provided that it is fertile married women who are being considered in an era of relatively uncontrolled fertility (90). For Louis Henry has shown that for sample European populations for which such data are available, the age-specific fertility rates of women who continued to be



fertile average around 494 per 1000 in the 20/24 year age-group; and do not fall below 400 until the 35/39 year group. Moreover, over the age-groups from 20/24 to 30/34 years, the average birth interval varies only from 24 to 27 months (91). Equally, Graunt's method of measuring marital fertility—by relating births to marriages in the same calendar years—is valid only if a population is stationary, with constant numbers of births and marriages and unchanging birth-spacing. But the method itself can be—and has been—modified to yield more meaningful results. And the study of fertility might have made more rapid—or at least earlier—progress if more attention had been given to the concept of the productivity of marriages as put forward by Graunt and as elaborated a generation later by Gregory King (92). As it is, only since the 1930's have demographers returned to that concept and with its amplification have greatly extended the study of fertility patterns and trends (93).

To conclude, Graunt's work created the subject of demography. But it also did much more. Though focused upon population questions and especially upon mortality, the work as a whole, involving a critical study of the available information and the development of relevant concepts and techniques for the analysis of that information, contributed to statistics in general. John Graunt worked with poor basic data and with techniques which were self-taught, for they did not form part of the existing stock of knowledge. The impact of his work continues to the present day, visible both in the subject which he founded and no less in the wide and growing use of statistics in research and administration in the modern world.

### 3. THE DISPUTED AUTHORSHIP ONCE MORE

It is hardly surprising, having regard to Petty's fame and to his close association with Graunt, that the question of authorship has from time to time been raised—the question of whether Graunt was in fact—or at least essentially—the author of his book. On several occasions, since the end of the nineteenth century, there have been detailed discussions of the competing claims of Petty and Graunt to the authorship of the *Natural and political observations*, the last comprehensive review being that by Greenwood in 1948 (94). Little new information bearing immediately and unequivocally upon the question has emerged since that review. But it is not inappropriate to consider the question once more. Surveying the various contributions to the controversy from Hull to Greenwood may provide a clearer assessment of what is and what is not significant. And such new information as there is may then make it possible at least to narrow the margin of indeterminacy.

The first full analysis of the authorship problem was undertaken by Hull (95). The main points may be summarized as follows:

(a) Some contemporaries or near-contemporaries of Graunt attributed the work solely or primarily to Petty. The individuals in question are Evelyn, Halley and Bishop Burnet, while John Aubrey, in an entry in his notes on Petty, commented that the 'Observations on the Bills of Mortality were really his'. But Halley was not elected to the Royal Society until five years after Graunt's death and is unlikely to have had first-hand knowledge of the authorship. Burnet is in general inaccurate on Graunt and there is no reason to believe that he was more accurate in respect of the authorship. Evelyn's comment was made after Graunt's death and after supping at Petty's house. And Aubrey's comment was probably made after Petty's death and was thus not approved by Petty. The reference which Petty was more likely to have seen and approved—since it was probably in 1680 that 'Sir W.P. perused my copie all over & would have all stand'—was that he had been elected Professor in Gresham College with the aid of his friend, John Graunt, 'who wrote The Observations on the Bills of Mortality' (96). In his notes on Graunt himself (and these notes were the basis of Anthony Wood's biography) (97), Aubrey had written: 'He wrote Observations on the bills of mortality very ingeniously (but I beleeve, and partly know, that he had his hint from his intimate and familiar friend Sir William Petty), to which he made some *Additions*, since printed. And he intended, had he lived, to have writt more on the subject' (98).

(b) In the first edition (1683) of Petty's *Observations upon the Dublin-Bills of Mortality*, the title page, instead of carrying the name of the author, reads: 'By The Observator on the London Bills of Mortality.' This appears to be a direct claim to the authorship of Graunt's book. However, Hull argues that it might equally have been a device of the publisher, Mark Pardoe, to sell the volume (99); a similar claim was made in an advertisement contained in the first edition (1683) of *Another Essay in Political Arithmetic*. But the claim was dropped in subsequent editions of these books; authorship of the Dublin Observations was then attributed explicitly to Petty, with no further reference to the London Observations.

(c) On the side of Graunt, there is the existence of the weighty committee appointed to consider his election to the Royal Society, as well as the reference of Oldenburg to Graunt's work. Bell, clerk of the Company of Parish Clerks, whose hall Graunt had said he had visited in search of data, appeared to have no doubts concerning the authorship (100). And Petty himself frequently

referred to the London Observations and, when he named an author, cited Graunt (101). In a letter to Southwell (his most persistent correspondent) in 1681, Petty again twice referred to Graunt as the author (102), and he was equally explicit in a letter written in 1663 to Lord Brouncker (103). The nearest to a direct claim to authorship was contained in a chronological list of his writings, one item in which was entitled: '1660 Observations on the Bills of Mortality' (104) and this is in conflict with all the other references.

(d) Hull also considered the question of parallels in the writings of Graunt and Petty. He argued that, where they occurred, they were not in essential parts of Graunt's book. (Some of the parallels were of doubtful significance.) The references by Graunt to diseases were not of a kind which showed a knowledge of medicine, while the references to Ireland betrayed no personal acquaintance with that country. The essential parts of Graunt's book exhibited a statistical approach and a patience and care not characteristic of Petty's acknowledged writings.

(e) Hull recognized that Petty had probably made contributions to the book—the fifth edition of which he is said to have edited (with further additions) in 1676 after Graunt's death. But on balance, Hull concluded that Graunt was 'in every proper sense the author of the "Observations"' (105).

With this assessment of the probabilities, the matter rested until the 1920's, when Lord Lansdowne published a collection of Petty's manuscripts and once again raised the question of authorship, concluding that there could be 'no reasonable doubt that the Observations on the London Bills were in all essential respects' Petty's own work (106). In thus reversing Hull's findings, Lansdowne used two lines of argument. First, he listed a much larger number of parallels between passages in Graunt's book and others in both the published and hitherto unpublished writings of Petty. Secondly, he presented some new material which appeared to bear much more directly upon the question of authorship. Four items were involved:

(i) A reference by John Aubrey, in a list headed 'Register Generall of People, Plantations, & Trade of England. Direction from Sir William Petty to me heretofore (sc. 1671)'. The reference is: 'Mr Michael Weekes of the Customehouse, might easily make a most usefull Booke of Observation on the Customehouse bills, as, Sir W. Petty hath donne of the Bills of Mortality.'

(ii) A seemingly independent additional reference in John Houghton's *A Collection of Letters for the Improvement of Husbandry and Trade*, Vol. 1, London 1681, namely: 'Major Graunt, or rather that learned and ingenious virtuoso, Sir William Petty, in his admirable Observations of the Bills of Mortality of London . . .' Houghton was a member of the Royal Society

and the kind of economic ‘busybody’ who might well have collected the ‘inside story’ in respect of various questions.

(iii) A letter from Petty’s close friend and correspondent, Sir Robert Southwell. On 25 November 1682, Petty had sent Southwell an advance copy of the *Dublin Observations*, the first edition of which was attributed to the ‘Observator on the London Bills of Mortality’. In thanking Petty, Southwell wrote: ‘Herein I first congratulate that you take home the prodigall son (I should indeed have sayd it of the Father) and that you lett the world see plaine, what they still suspected, that the spiritt of Sir William Petty and not of John Graunt presided in those Bills of Mortality. Poor John, tho in his purgatory, can hardly drive such points as (by your allowance) he ventured on while here, in his State of Fudling and of frailty. The good man was herein like a dwarfe mounted on an Elephant’ (107). No reply to Southwell is extant and there are no references to this question in Southwell’s subsequent letters.

(iv) Lansdowne refers to four letters from Graunt. Three of the letters were to John Petty and one to Sir William, together with a petition in Graunt’s hand, ‘From the Roman Catholics of Ireland to the Parliament.’ These writings of Graunt, according to Lansdowne, were ‘matter-of-fact’ in style, showing ‘no trace of the originality in thought and expression which characterizes almost every line of Petty’s writing, whether epistolary or otherwise’ (108).

Lansdowne completed his assessment by arguing that Petty was the moving spirit, though he called in Graunt to help him. ‘Graunt’, he says, ‘at all events, did most of the actual work in collecting and collating the Bills. He says so himself in the Preface, and his statement is corroborated by John Bell, Clerk of the Company of Parish Clerks’ (109). The authorship was attributed to Graunt, Lansdowne believed, partly because Petty was diffident in putting forward ‘new ideas’, partly because of immersion in business affairs, and partly also, perhaps, because Graunt may have ‘had an ambition to belong to the new formed Royal Society . . .’. ‘What would have been simpler than to make a present to Graunt of the *London Observations*, as just written in the rough, to suggest to him that they should be worked up into a book and printed with the tables (on which Graunt had spent so much time), and that the whole might be dedicated by him to the President of the Royal Society—with perhaps happy results’ (110).

Though Lansdowne’s reassessment appears to have been accepted by a number of literary reviewers, this was by no means the case so far as Major Greenwood was concerned. Speaking in particular from his experience as a

medical statistician, he accepted, as very likely, some assistance on the part of Petty—drafting the introductory passages and generally touching up the manuscript throughout. In essence, however, the work was new, displaying the kind of approach which must have been self-taught. And the approach consisted in applying the critical method to the field of medical and vital statistics. Graunt's work showed a 'caution in weighing evidence and a habit of collating different methods and results . . . almost absent from the enthusiastic jottings of Petty'. This was displayed in the discussion of rickets as a new disease, as well as in collating the various methods of estimating the population of London. It was this—leaving aside the life table for London—which constituted Graunt's distinctive contribution. As for the parallels between the writings of Graunt and Petty, Lansdowne had cited forty-one of these. But ten were of the kind inevitable when two men work on the same subjects; and twenty-one were not parallels at all. Of the remaining ten, not one was relevant to the methods of inquiry which distinguished Graunt from Petty, and six of them were in any case to be found either in the conclusions or the Appendix, on both of which Petty no doubt helped Graunt. 'In other words', Greenwood concluded, 'Lord Lansdowne's evidence from parallels amounts to a confirmation of what was already probable, viz. that Graunt's manuscript was submitted to his friend before publication, no doubt before formal communication to the Royal Society, and was touched up by him' (III).

Greenwood's criticism did not convince Lansdowne, who returned to the question in the introduction to his edition of *The Petty-Southwell Correspondence 1676-1687* (II2). Lansdowne claimed that Greenwood had 'dismissed somewhat lightly' the evidence of Petty's and Graunt's contemporaries, as well as the private note by Petty. He referred to Petty's awareness of the usefulness of population and vital statistics and to his stated desire that such statistics should be collected regularly. And he emphasized the parallels once more. These would not be so important, he explained, if Graunt had ever written anything more on the same subject. At the same time he believed that the detailed discussion of the 'French Pox' in the *Observations* was less likely to have been written by Graunt, a layman, than by Petty, a physician who had in any case written a treatise on the subject, *De Lue Venerea*. The comments on rickets, equally, could scarcely have been written by a layman. Finally, the scanty extant correspondence between Graunt and Petty contained none of the 'ratiocination' on problems of political arithmetic and similar questions which might have been expected if Graunt had really been the inventor of a new kind of statistical analysis.

The essential parts of Greenwood's forcible reply may be summarized very briefly (113). First, Petty's reference in a list of his works to some writing on the Bills of Mortality could scarcely be regarded as serious evidence—more especially in that he attributed to it a different date from that of Graunt's book and in that he did not include it in any of the other three lists published by Lansdowne. Secondly, Graunt's comments on particular diseases were indicative of the statistician's approach, not of the physician's. His information on the aetiology and symptomatology of syphilis was no greater than might have been picked up in coffee-house conversation; Petty would have known more. And on rickets, Graunt mentions explicitly that he had consulted people who were supposed to know what other disease was most like rickets—scarcely a claim to medical expertise. Thirdly, on statistical awareness, the important point, as illustrated by the life table, was that Graunt had tried to use the existing, inadequate data to construct a life table, whereas Petty simply continued to demand unattainably better statistics. And finally, so far as the scanty published correspondence was concerned, it was not surprising that, two years before Graunt's death and with his fortunes failing, neither Petty nor Graunt should exhibit an interest in scientific problems in the letters cited. At that point the Greenwood-Lansdowne controversy ceased, neither participant—as far as one can tell—having persuaded the other to modify his views.

The next—and most recent—general survey of the authorship question was undertaken by Walter Willcox, dean of U.S. statisticians, on the occasion of a reprint of the first edition of the *Observations* (114). Willcox began by examining the claims to expertise of those who had earlier considered the question. He found that of twelve who had attributed the authorship to Petty, only one—Halley—could be regarded as a statist or economist. But of twenty-seven who had ascribed the work to Graunt, three-quarters were economists or statisticians. On the other hand, there was a general belief that Petty had had some share in the authorship. It was this share which Willcox then attempted to ascertain.

Willcox used two approaches. First, so far as statistical method was concerned, he examined Petty's discussion of two statistical questions on which Petty could have had no help from Graunt—the size of the population of the world and the analysis of the Dublin Bills of Mortality. In neither case did Petty show the critical method characteristic of Graunt's *Observations*—indeed, not even a detailed familiarity with Graunt's work. Secondly, Willcox attempted to remove from the *Observations* those passages which might have been contributed by Petty—assigning to him all 'elegancies' of

style (including the use of Latin phrases), all conjectures put forward without supporting evidence, as well as numerical statements of no importance for science. The result was to exclude almost one-eighth of the work (including the dedication to the President of the Royal Society and the Conclusion), but to leave behind a more coherent text. But the excluded section also involved the life table—by definition, since it was explicitly conjectural for the ages above 6 years. The remainder of Willcox's discussion is based upon the assumption that the life table was Petty's work. And Willcox's argument clearly had some influence upon Greenwood. For when the latter came to publish his Fitzpatrick lectures he wrote: 'Although Prof. Willcox has certainly shaken my previous conviction, I still feel reluctant to surrender Graunt's table to Petty. However, there may be an element of sentimentality in this' (115). Like Willcox, he concluded that the *Observations* as a whole were essentially the work of Graunt.

This, then, was the state of the controversy when Greenwood wrote in 1948. The balance of probabilities was clearly on the side of Graunt, yet there was some—not entirely explained—evidence which spoke for Petty. The question is whether, by re-examining the evidence and by taking into account any further information now available, it is possible to reduce the margin of indeterminacy. I believe that it is possible and the final section of this paper will consist of an attempt to present a more definitive case for Graunt as the primary author.

It is relevant to begin by stressing once again the point made by Hull but barely considered by Lansdowne, namely that the initial testimony in favour of Graunt is extremely powerful. This testimony includes the implied acceptance of him as the author by a committee appointed to consider his election to the Royal Society—a committee consisting of Petty, Needham, Wilkins, Goddard, Whistler and Ent (116). In the small world in which such people moved at the time, there is at least a presumption that they knew Graunt. And unless Graunt had been a peculiarly taciturn man, it is not unlikely that they had heard of his project before his book was published. Similarly, Oldenburg appeared to have had no doubts, when he referred to the new edition of the *Observations*—the reprinting of which was 'ordered' by the Royal Society (117). And it cannot be assumed that Sprat, in his history of the Royal Society published in 1667, was speaking without some first-hand knowledge when he referred to Charles II's comment on the 'judicious' author of the *Observations*, 'in whose Election, it was so far from being a Prejudice, that he was a Shop-Keeper of London . . .' (118). Equally, Pepys, who knew and visited Graunt, appeared to accept the stated author-

ship, both of the first and the 1665 editions (119). It would require very powerful counter-testimony by other contemporaries to dispose of this presumption of authorship. Does that testimony exist?

Hull listed as witnesses against Graunt's claim, Burnet, Halley, Evelyn and Aubrey. To these, Lansdowne added Houghton, further evidence from Aubrey, and Southwell. But though this appears to be a substantial group, the evidence is not really independent, save perhaps in the case of Aubrey. For all save Aubrey, the possible influence of Mark Pardoe's first edition of Petty's *Observations on the Dublin-Bills of Mortality* (1683) has to be taken into account. Burnet, writing long after the event, was in any case more concerned to report the rumour that Graunt, as a 'Papist', bore the responsibility for the spread of the Fire of London. Halley, writing in 1693, specifically refers to the *Treatise on the Dublin Bills* (120). His ascription of authorship would be entirely comprehensible if he had looked at the first edition of that work. Houghton, according to Lansdowne, made his comment in 1681, before Pardoe's edition had appeared. But Lansdowne was citing the date given on the collective title page of Houghton's newsletters, and that title page had presumably been printed to match the date of the earliest newsletter. The specific reference to the authorship of the *Observations* is, however, contained in a subsequent newsletter (no. 13) dated 13 February 1682/3. By that time, the Pardoe edition was available—indeed, an advance copy had been sent by Petty to Southwell in November 1682. The independence of Evelyn's reference is also doubtful. In the diary, it is assigned to 24 March 1675, after Evelyn had supped at Petty's house. But de Beer, in his recent edition of Evelyn's diary, notes that 'Evelyn's evidence is of little independent value for the discussion; it dates probably not from 1675 but from the period of transcription'. This, in the edition in question, is attributed to 1682–83, while correspondence with Dr de Beer suggests that it may even date from the latter part of that period (121). Here, too, then Pardoe may have been the decisive factor. We are thus left only with Southwell and Aubrey.

So far as Southwell is concerned, it is difficult to accept Lansdowne's interpretation. There is no doubt whatever that Southwell's letter was prompted by the receipt of the Pardoe edition. But there is no confirmation by Petty of Southwell's ascription to him of authorship, and no further reference by either Petty or Southwell to that matter, although there are many subsequent references to other publications by Petty (122). In an earlier letter (20 August 1681), Petty had referred to Graunt's work (mentioning a disagreement with his views on the rate of doubling of populations). And there is a reference in a later letter (1686) to a publication by Adrien Auzout:



'His paper did fall most upon what Captain Graunt and myself had ever writ upon these matters' (i.e. on the Bills of Mortality and the population of London) (123). Thus there is no evidence that Petty explicitly accepted the authorship attributed to him by Southwell. On the contrary, what evidence there is—the removal of the 'Observator on the London Bills of Mortality' from the title page of the second edition of the Dublin-Bills and from the advertisement for the book—implies a rejection. And this is in keeping with the frequent references to Graunt's work—often incorrect references, as Hull pointed out—in Petty's later publications. Hence Lansdowne's interpretation of the significance of Southwell's letter cannot be regarded as confirmed.

Nor is an appeal to Aubrey more decisive. At best, there is the obvious conflict between Aubrey's statement in his notes on Graunt and the interjection in his notes on Petty. It was the former statement which gained wide currency in the form in which it was written up by Anthony à Wood, and Wood's decision to digress on John Graunt (who properly had no place in his compilation) must in some degree have been prompted by Graunt's reputation as 'the most ingenious Person (considering his Education and Employment) that his time hath produced' (124). And in Aubrey's notes on Petty, the conflicting reference to the authorship was made after Petty had seen the earlier sections. Perhaps here, too, Pardoe's publication had intervened—by no means impossible in respect of timing, for the interjection is close by other notes which were undoubtedly written after Petty's death (125). Aubrey's note that a book of observations might be made on the Custom House bills 'as Sir W. Petty hath donne of the Bills of Mortality' might well refer to the work included by Petty in one of his lists, especially as both the note and the list are dated 1671 (126). But that work has not been found, and a mere reference to it does not constitute any identification of the work with Graunt's treatise. On the contrary, it might be argued that since Aubrey must have known of Petty's 'Book of Observations' when he wrote the notes on Graunt and the first section of the notes on Petty, Graunt's book was *not* the same as Petty's.

In sum, the direct testimony to Petty's authorship is scanty. Most of what there is may derive from Pardoe's publication. And as a whole, the testimony is far less significant than Lansdowne—or even Hull—assumed it to be. That being so, it is necessary to consider the internal evidence—the parallels between Graunt and Petty and the nature of the *Observations* themselves.

A re-examination of Lansdowne's reference to the parallels in Petty's unpublished writing leads me to the conclusions reached by Greenwood. Many of the references do not involve more than the vaguest similarity.

One example will suffice. Lansdowne suggests that some of Graunt's discussion of the ratios of males to females is paralleled in Petty's queries relating to the 'natives of Pensilvania'. But those queries are indeed nothing but questions; there is not a single fact. The 'material' on the male/female ratio consists simply of the question: 'What is the proportion between their males & Females?' (127). Moreover, the document itself was endorsed '1686', long after the publication of Graunt's work. This *post-hoc* circumstance also applies to some of the instances of much closer similarity, such as Petty's observation that 'there be more males than females in nature. Besides a man is prolificq 40 years, a woman but 25 or thereabouts; which compensates the losse of men by the Sea, War, Exercises &c.' (128). That observation dates from 1671, by which time four editions of Graunt had appeared. The argument from similarities is thus at best extremely slender. It would almost be easier to make a case for Petty's lack of familiarity with Graunt's findings (and hence a lack of similarity), for Hull supplies several instances, from Petty's published works, of incorrect citations from, or references to, the *Observations* (129).

The question of authorship is thus pushed back, finally, to the character of the *Observations* themselves, and to a consideration of whether they are distinctive and exhibit an approach different from that found generally in Petty's known published and unpublished writings. Here, again, I find no reason to differ from the conclusions reached by Major Greenwood. Lansdowne's contention that he found no fundamental differences in style between the *Observations* and Petty's work is irrelevant for, as Greenwood explained, it is not a matter of comparative 'elegance' of language but of 'statistical style'—of the way of dealing with sets of medico-statistical problems. And here the differences seem to me fundamental. Petty, when he quotes 'facts', tends to be dogmatic: he asserts without explaining the bases of his estimates. His 'facts' on Ireland are given in precisely that way (130). When he selects from different sets of estimates, he gives no reasons for his choice. And in his acknowledged published and unpublished materials he presents very little in the way of actual demographic analysis. On the contrary, his emphasis is primarily upon the need for more comprehensive statistics of population and vital phenomena. This is evident in the *Observations upon the Dublin-Bills of Mortality*: the demographic analysis as such is trivial, but there are stimulating suggestions for weekly and quarterly bills of mortality, for a classification of the causes of death, and for an annual account of the population and vital statistics of Dublin (131).

Graunt, on the other hand, tried to extract the maximum of sense from the data actually available to him. He had, so he states, formulated a number

of tentative hypotheses by examining a few Bills and then endeavoured to see how far a more extended analysis would confirm those hypotheses (132). His interest lay in the collection and collation of statistics (so lightly dismissed by Lansdowne) (133), the assessment of their meaning and reliability, and the drawing of relevant conclusions from their analysis. He professed no medical expertise. He obviously canvassed medical opinion when he was investigating the history of rickets, but he was also prepared to draw attention to possible relationships suggested by the statistics themselves, posing those possibilities for consideration by the medical profession (134). And he was generally careful to distinguish between what appeared fairly firmly to emerge from his analysis and what was more conjectural. It is this kind of distinction which is no less critical than the conjecture itself. A demographer is entitled to guess, but his readers are equally entitled to be told when he is guessing.

The famous London life table—which, because it is partly conjectural, Willcox assumes was the work of Petty—shows in fact the differences between Graunt and Petty in their habits of statement. In the *Observations*, Graunt makes clear what is firm and what is guessed at. On infant and child mortality he was fairly firm, having estimated which causes of death and what proportions of all deaths might be attributed to the first six years of life. For the other end of the scale he was less positive. He had found that some 7% of deaths occurred to the ‘aged’ and had argued that the ‘searchers’ would probably define those as David had done—people aged 70 and over. Of those old people, only a fraction would survive the age of 76—‘perhaps but one surviveth 76’, he guessed. That gave him the extreme ends of the scale. For the stages in between, he was conjectural, and frankly so, saying: ‘. . . having seven *Decads* between six and 76, we sought six mean proportional numbers between 64, the remainder, (out of a radix of 100) living at six years, and the one, which survives 76, and finde, that the numbers following are practically near enough to the truth . . .’ (135). Petty, too, used the life table, in *The Political Anatomy of Ireland*, in order to estimate the age composition of the population (136). But he gave no source for the method of computation, or for his figure of the total population. And in using the table he not only made the error found in the *Observations*—that of treating the  $l_x$ ’s as if they were  $L_x$ ’s—but a further error of his own. He did not realize—as Graunt had done—that to compute a total life table population means carrying the computation to the point at which the  $l_x$  has fallen to zero, or that the total deaths must be equal to the radix of the table (137). Petty had not grasped these principles, though they are clearly visible in Graunt’s use of the life table. That being so,

there would seem to be little, if any, justification for the belief that Petty was responsible for the life table in Graunt's *Observations*.

In sum, therefore, neither direct testimony nor internal evidence furnishes much support for the contention that Petty contributed in any substantial measure to Graunt's *Observations*. It may well be, as Aubrey said, that Graunt 'had his hint' from Petty and there is no reason to doubt that Petty himself did write some kind of memorandum or essay on the uses which might be made of the Bills of Mortality. After all, Petty wrote memoranda on almost every question which occurred to him. As a close friend, Petty was also no doubt interested in the progress of Graunt's study and may have given a final 'polish' to it (138). But none of this is equivalent to either joint or sole authorship of the *Observations*. Lansdowne suggested that perhaps Petty furnished Graunt with a rough draft—a 'tumbling composition'—which Graunt then worked up into final form, together with the tables ('on which Graunt has spent so much time') (139). But the essential feature of Graunt's treatise is that it could not have been produced simply by elaborating some first thoughts of Petty, however stimulating they might have been. The treatise embodies—and could not have been written without—a detailed and painstaking statistical examination of a large body of data painstakingly collated, the 'critical apparatus' used in the analysis being freely displayed to the reader. None of Petty's acknowledged works exhibits this combination of characteristics. That being so, there seems little reason to doubt that the volume published under Graunt's name was in all essential respects Graunt's work.

#### NOTES AND REFERENCES

- (1) John Aubrey, *Brief lives*, Clark, A., ed. Vol. 1 (Oxford, 1898), pp. 271-273.
- (2) Wood, A., *Athenae Oxonienses*, 2nd edn. Vol. 1 (London, 1721), col. 311.
- (3) Ellis, H., ed., *The obituary of Richard Smyth* (London, 1849), p. 102.
- (4) Hull, C. H., *The economic writings of Sir William Petty*. 2 vols. Vol. 1 (Cambridge, 1899), pp. xxxiv-xxxviii.
- (5) Lansdowne, Marquis of, *The Petty-Southwell correspondence 1676-1687* (London, 1928), pp. xxviii-xxx.
- (6) Since I am not an historian, I am all the more indebted to the historians and archivists who so generously helped me by locating or providing (often both) new information. Mrs B. R. Simmonds, Archivist to the Drapers' Company, searched the Company's records and supplied me with valuable material on Graunt in his relation to the Company. It is to Mr P. E. Jones, Deputy Keeper of the Records of the Corporation of London, that I owe the data from the Guildhall records on Graunt's residence and on his status on the City Council, as well as the reference to the recusancy proceedings

against him. Further information from the Guildhall records was given to me by Mr A. H. Hall, the Librarian of the Guildhall Library. Notes on other property leased by Graunt from the Goldsmiths' Company were furnished by Mr T. F. Reddaway, Reader in London History (University College London).

Mr J. M. Sims, Librarian of the Society of Genealogists, located the clue to Graunt's marriage. Monsignor D. Shanahan, Chancellor of the Diocese of Brentwood, gave most helpful advice on the sources of information relating to recusants. Miss M. Barratt, of the Department of Western MSS., the Bodleian Library, located the deeds concerning Graunt's property transactions in Romsey. Mr. E. S. de Beer, the editor of Evelyn's diary, gave me his expert view on the probable date at which Evelyn transcribed relevant sections of his notes. The Marquess of Lansdowne gave me access to the collection of Petty's papers at Bowood, and Mr J. R. Hickish (Lord Lansdowne's agent) brought together for my use everything in that collection which might be relevant to the question of Petty's relations with Graunt. I am also especially indebted to Miss Olive Coleman, of the London School of Economics. She translated the relevant sections of the recusancy material and the Somerset House entry regarding Graunt's estate, extracted the data on Graunt's marriage and gave me much good—and very much needed—advice on seventeenth-century records.

- (7) From a note by Miss M. A. Greenwood, former archivist to the Drapers' Company.
- (8) *The parish registers of St. Michael, Cornhill, London . . . from 1546 to 1754*. (Publication of the Harleian Society, Registers, Vol. 7) (London, 1882): pp. 114 (John, baptized 1 May); 116 (Rebecca); 117 (Henry); 119 (Sara); 121 (Judeth): and 122 (Zacary and Elizabeth). The average interval between births (or, rather, baptisms) was around 30 months. Hull (*op. cit.* Vol. 1, p. xxxiv, n. 3) arrives at 8 children, but appears to have attributed to Henry Graunt one of John Graunt's children (Susan, died 1643). According to P. E. Jones (Letter 28 June 1962), Henry Graunt had lived in Cornhill Ward from at least 1629 and probably from 1620 onwards. He died in that ward in 1662 (register, p. 251) and his widow died less than two months later (register, p. 251) both being reported to have died 'aged'. Henry Graunt was around 70 at the time of his death—which may help to explain why John Graunt was fairly confident that the 'searchers' restricted the term 'aged' to those who had reached 70 years.
- (9) Letters from Drapers' Hall, 22 and 24 May 1962.
- (10) Letter from P. E. Jones, 28 June 1962.
- (11) Maitland, W., and others, *The history of London*, Vol. 1 (London, 1756), p. 435. Graunt first served as a trustee for one of the shares belonging to Sir William Backhouse and then, after the latter's death in 1669, as trustee for his widow, Flower Backhouse. She in turn married, in 1670, Lord Cornbury (afterwards Earl of Clarendon), who then joined the New River Company in place of Graunt. Bishop Burnet (as part of his attack on Catholics) had reported a story that Graunt, using his position in the New River Company, had turned off the supply of water and taken away the keys, thus being in part responsible for the spread of the fire of London in 1666 (see O. Airy, ed., *Burnet's history of my own time*, Part 1, Vol. 1 (Oxford, 1897), pp. 413-414). Maitland consulted the minute books of the Company and ascertained that Graunt was not admitted a member until 23 days after the outbreak of the fire. He concluded that there was no basis for the story. (The records of the New River Company were destroyed in a fire in 1769.) Burnet, in his account, had written: 'There was one Graunt, a papist, under whose name Sir William Petty published his observations on the bills of mortality . . .', an attribution discussed in the final section of this paper.

- (12) P. E. Jones. This refers to the assessment (C.L.R.O. Assessment 5.27) on his house on the East Side of Birchin Lane in 1671. The information collected by T. F. Reddaway suggests that Graunt was living in, or possessed, a different house (on the west side of Birchin Lane) in the period 1657–64. In March 1657, he acquired a 90-year lease for his house from the Goldsmiths' Company, at the price of £400. The house was destroyed in the Fire of 1666, but he rebuilt it, obtaining a new 99-year lease at the old beneficial rent of £5 per year. In the 1664 Hearth Tax assessment the house was assessed on 4 hearths. (The references are: Goldsmiths' Co. MSS. 1924, fos. 21–26 and 1917 fos. 67, 109. P.R.O. E 179/252/25 fo. 54<sup>r</sup>.) See also later reference to these houses in the Bowood archives, confirming that there were two houses.
- (13) Pepys, 20 April 1663, cited in Hull, *op. cit.* (Note 4.) Vol. 1, p. xxxiv.
- (14) Register of Marriage Allegations, London Diocese, Guildhall MSS. 10091/21, gives the application for a licence, 3 November 1640, with Graunt's age overstated ('a bashiller aged about 22 years'). His bride was the daughter of a widow, Mary Scott. Parish Register of St Martin Ludgate, 1593–1654, Guildhall MSS. 10212 fo. 64 r., gives the marriage entry, 14 February 1641. Graunt's bride was described in the marriage allegation as of St Botolph Bishopsgate, but the reference cited in n. 15 below suggests that she may have been of Essex origin.
- (15) Catholic Record Society, Vol. 17. *Miscellanea X* (London, 1915), pp. 1–247, R. Trappes-Lomax, ed., 'Records of the English Canonesses of the Holy Sepulchre at Liège'. P. 9—'Mrs. Anne Elizabeth Graunt, Daughter to Mr. John Graunt of London and Mrs. Mary Scott of Essex. English came upon y<sup>e</sup> 16 of 10<sup>r</sup>, tooke y<sup>e</sup> Habitt of Religion up (on) the Purification of O<sup>r</sup> B<sup>d</sup> Lady '67 . . . and Professed upon the 3rd of June 1668.' Gifts are reported (amounting to some 184 florins) as having been made in 1668/9 by Mr and Mrs Graunt to the Community—very probably the same Graunts. An entry (p. 91) reports the death of Mother Mary Elizabeth Grant, 13 March 1701.
- (16) *Register, op. cit.* p. 239 (Susan, 1643): p. 252 (Frances, 1662, of consumption).
- (17) *Observations*, Willcox edn. pp. 43–44.
- (18) Mr G. B. Greenwood was kind enough to give me the reference to Rudyerd—poet, Member of Parliament and Surveyor of the Court of Wards and Liveries—which he found in Elias Ashmole, *The antiquities of Berkshire* (London, 1719). According to Ashmole (who was one of Aubrey's main informants and must have known Graunt), Graunt erected a monument in West Woodhay Church to 'his dear and honoured master', Sir Benjamin Rudyerd (Ashmole, Vol. II, p. 252). Mr P. Newton, of the Barber Institute of Fine Arts, University of Birmingham, who is working on Ashmole's manuscripts, confirms that they contain this reference. Further evidence of Graunt's association with Rudyerd is found in the marriage settlement of Rudyerd's son William, dated 6 April 1648, signed by Graunt as one of the witnesses (letter of 14 May 1963 from Mr W. J. Smith, County Archivist of Berkshire).
- (19) A transcript of the relevant purchase deed is contained in a box of transcripts of various Petty MSS. in the Bowood collection. This box contains transcripts of the letters cited by Lansdowne as well as of additional letters and of the memorandum reported to be in Graunt's handwriting, entitled: 'The humble petition of the Roman Catholiques of Ireland to the Supreme Authority of this Nation, the Parliament of the Commonwealth of England.' This memorandum is questioningly dated as 1650, surprisingly early, since no other equally early manuscripts appear to be extant. There are four letters from Graunt (three to John Petty and one to William Petty) in a manuscript volume at Bowood, entitled *Sir W. P.'s letters to John Petty*, Vol. 6, those to John Petty

- dated 1660, and that to William Petty dated 15 August 1663, but nothing else until 1666.
- (20) Hull, *op. cit.* (Note 4.) Vol. I, pp. xv, xxxiv, xxxvii.
- (21) Letter from Miss M. Barratt, 22 June 1962, referring to deeds in the Bodleian collections.
- (22) *Observations*, p. 17.
- (23) Ellis, *op. cit.* (Note 3.) And of great interest, too, in indicating how heavily plague fell upon a limited group of people. For 1664 and 1666, Smyth recorded forty-five and forty deaths respectively, but for 1665 the total was 155, of whom 102 were reported as dying of plague.
- (24) A comment seen and approved by Petty. See the discussion in Part 3 of this paper.
- (25) The full title is: *Natural and political/observations/mentioned in a following index,/and made upon the/bills of mortality.*
- (26) Hull, *op. cit.* (Note 4.) Vol. II, p. 317.
- (27) Birch, T., *The history of the Royal Society of London*, Vol. I (London, 1756), pp. 75-77.
- (28) Sprat, T., *The history of the Royal Society of London . . .* 4th edn (London, 1734), p. 67.
- (29) The references are given in Birch, *op. cit.* Vol. I, p. 267 (1663); Vol. II, pp. 9 (1665); 21 (1665); 57 (1665, June 20). Also Royal Society Archives, Classified Papers, 1660-1740, XV. Zoology. On the attacks on the coffee-houses and the 1675 proclamation for their suppression (arousing so much indignation that it was withdrawn almost immediately), see Ellis, A., *The penny universities. A history of the coffee-houses* (London, 1956), pp. 86-93.
- (30) Hull, *op. cit.* (Note 4.) Vol. II, p. 317; Vol. I, p. xliii. A fourth edition, reprinted from the third, appeared the same year—perhaps in October. A fifth edition, with some additional material, was published posthumously in 1676. It was said to have been issued under Petty's supervision, but the authority for this statement is somewhat tenuous. By the time Aubrey was writing his notes on Graunt, the book was 'now very scarce'. Aubrey said that Graunt also wrote (but did not publish) some *Observations on the advance of excise* and wondered whether his widow might have the MSS. But there is no trace of this document. An extract from the forthcoming catalogue of Locke's library—communicated to me by Mr Peter Laslett, Trinity College, Cambridge—shows that Locke had two copies of the *Observations*—the 4th impression, Oxford 1665 and the 5th edition, London 1676. Locke also had some of the Paris Bills of Mortality, reputed to have been introduced under the influence of Graunt's book.
- (31) Birch, *op. cit.* (Note 27.) Vol. I, pp. 126 (1662); 167 (1662); 180 (1663); 192 (1663); 407 (1664); 443 (1664); 485 (1664); 498 (1664); 508 (1664); Vol. II, pp. 78 (1666); 96 (1666).
- (32) Graunt was a member of Council from 30 November 1664 to 11 April 1666 (because of plague, no meetings of the Society were held in London from 28 June 1665 to 21 February 1666). Graunt's name is on the printed lists of the Society from 1663 to 1672. The 1673 list is missing and by 1674 he was already dead. (Letter from Mr I. Kaye, Librarian of the Royal Society, 21 May 1962.)
- (33) Fitzmaurice, Lord Edmond, *The life of Sir William Petty, 1623-1687* (London, 1895), pp. 232-234; and Bowood transcripts. This letter was in a Letter Book containing copies of letters written by Petty in 1666-1683. The Letter Book was among the manuscripts belonging to Sir Thomas Phillips and extracts were made by Lord Kerry around 1835 (these extracts are in the Bowood collection). Another Letter Book covering the period 1672-79, is in the Bowood collection and is the source of most of the letters cited in the rest of this section. Having compared the transcripts with this source, I

have made a few minor changes where it seemed clear to me that the transcript was in error.

- (34) Hull, *op. cit.* (Note 4.) Vol. 1, p. xxxvii, n. 2.
- (35) A note contained in the box of Bowwood transcripts reads: 'Petty bought two houses in Birchin Lane from Graunt in November 1671 for £1100. Vide deed.' The deed could not be found but I assume that the houses were those referred to earlier in this section. There is no evidence to suggest that Graunt had other houses in Birchin Lane. Further, the two houses are specified in Petty's will of 1685 (Fitzmaurice, *op. cit.* p. 320) as 'The Seaven Starrs and the Blazing Starr, in Birching Lane . . .'. According to Aubrey, the former house was that in which Graunt was born.
- (36) 12 November 1672, from Dublin.
- (37) 7 December 1672, from Dublin.
- (38) 7 December 1672 from Dublin. 'Wherefore I desire you: (1) to call to the Major for the account of the Midsummer and Michaelmas quarter, which he promised, (2) to make use of the enclosed letter of Attorney to advance the Christmas quarter, desiring him to give you a list of them, which if he refuses you may know it by their last acquittances; and then expressly forbid the tenants to put any more unto him for that his name was used but in trust for me, which he hath declared. Do this in case he be contumacious &c; for I still love him better than he hath of late loved himself.'
- (39) Petty to Graunt, from Dublin, 24 December 1672; 'The last of December' 1672; 18 January 1673; 22 February 1673. The letters refer at the same time to Petty's concern to find a suitable position for Graunt, to Graunt's change in religion and also (24 December 1672) to Graunt's reactions to Petty's *Political arithmetic*. 'I never heard you say anything of the Political Arithmetic, nor whether the world knows or accepts it.' There is a further letter to Brookes, 24 December 1672, referring to the rents: 'For as much as he hath not yet sent me the accounts he promised, and which perhaps he never will. I love him but fear him especially at this juncture.'
- (40) Petty to Graunt, 24 December 1672: 'I have spoken with Sir Henry Ford about you, and have told him that £150 per annum is the least you can have, and I also told him (or rather he me) that you could not well live out of Dublin; both of which are very difficult points.' In suggesting in the same letter that Graunt might become seneschal of Petty's three baronies in Kerry. Petty wrote that Graunt would then 'live very imperiously but in an obscure corner of the world'.
- (41) Petty to Graunt, 'The last of December 1672': 'Sir Henry Ford calls upon me to send for you speedily, though I do not see what provision is made for you when you come. I would have it to mend your condition, and not to breed discontents in you. Mr Burrows must have the Christmas rents.' Again, Petty to Graunt, 18 January 1673: 'Be earnest with Sir Henry Ford to pitch upon some particular before you come hither, for otherwise it were better to solicit business in England, whereunto myself and others I think will contribute whereby to make up what you have to a livelihood, till better may be effected. When you answer my last letter I shall say more.' The correspondence gives the impression that, while Petty was truly anxious to help Graunt, he felt that such help should be conditional upon Graunt's payment of the rents due to Petty. This is suggested by a postscript to the letter of 18 January 1673 (from the *Letter Book*—the postscript is not given in the Bowwood transcript): 'Let me know your impediments you find in satisfying those three Debts of Ald. Morris, Burrows and Sykes. I believe I shall find you business enough when you answer my last letter. God help us all.'



- (42) Graunt was listed in Birchin Lane in the July 1671 assessment but not in that of May or August 1673. He appears in Bolt Court in the February 1673 assessment for the Ward of Farringdon Without (Guildhall MSS. 2969/3, fol. 6 v.) and in the January and May 1674 assessments for St Dunstan's in the West (C.L.R.O., Assessments 15.10 and 26.18). According to P. E. Jones, the St. Dunstan's assessments show Graunt as taxed at the lowest rate, 6*d.*, for one of the small shops built on the north side of Fleet Street. (Letters from P. E. Jones, 28 June 1962; and from A. H. Hall, 30 July 1962.)
- (43) Bowler, Dom Hugh, ed., *London sessions records 1605-1685* (Publications of the Catholic Record Society, Vol. xxxiv) (London, 1934), p. xlv.
- (44) Petty to Graunt, 24 December 1672: '... Sir Henry thinks that your being an Englishman and a Romanist (for that is now universally known) might be of an indifferent nature to solicit a union between the two kingdoms of England and Ireland, whereunto many both English and Irish seem well affected.' The reference was in connexion with the possible appointment in Dublin.
- (45) Lansdowne, *op. cit.* (Note 5) p. xxix. Shorter extracts from some of the other letters quoted here are given on pp. xxviii-xxix. Dr Woods is presumably Robert Wood, F.R.S., physician, mathematics teacher and commissioner of the revenue for Ireland.
- (46) Failure to attend the services of the Anglican church.
- (47) Bowler, *op. cit.* (Note 43) pp. 155; 161-163; 177; 180-181; 183-184; 186. At the gaol delivery sessions, beginning 9 January 1674, Graunt was delivered on bail of £100 and £50 each to two sureties (one was William FATHERNE, stationer of St Dunstan's—probably his brother-in-law; cf. marriage of William Faithorne, stationer, to Judith Graunt, daughter of Henry Graunt, 1654, St Michael Cornhill, *Parish Registers, op. cit.*, p. 33). Graunt pleaded not guilty, apparently unusual for recusants, who more usually did not appear, when they were convicted by default and fined—£20 a month for every month the offender was absent from the Anglican church services. At the adjourned sessions, beginning 25 February, Graunt was again bailed until the next gaol delivery, supposed to take place 10 April but actually further adjourned till 29 April. It was then that Graunt's death was reported. Graunt himself was surety for another recusant, Gerard Bourne, of St Botolph Bishopsgate, whose case was also listed for the gaol delivery of 25 February.
- (48) Smyth, *op. cit.* p. 102.
- (49) Aubrey, *op. cit.* (Note 1) p. 273. These remarks were contained in a letter written by Aubrey to Wood on 26 May 1674 soon after Graunt's death (MS. Wood, fol. 270 in the Bodleian).
- (50) On 4 May 1674, a commission was given to Graunt's widow to administer his estate. (Commissary Court of London, Act Book, Guildhall MSS. 9168/22, f. 161.) A Somerset House entry (Admon 1676) for 17 January 1676 (Prerogative of the Court of Canterbury—perhaps considered appropriate because Graunt may have had, or have been assumed to have, property in more than one diocese) seems almost certainly to refer to the same John Graunt, late of the Parish of St Dunstan in the West, giving his widow Maria a commission to administer his goods and credits. The sworn estimated value of his estate is there stated to be £16.
- (51) Fitzmaurice, *op. cit.* (Note 33) p. 234.
- (52) Court of Assistants, 6 October 1674. 'Upon the humble petition of Mary Graunt, widow and relict of John Graunt, late one of the Assistants of this Company, deceased, and in regard to her low condition, it is ordered that during the pleasure of this Court a pension of four pounds per annum be paid and allowed to her by quarterly payment

- and the first payment to be made at Christmas next.' (Letter from Mrs B. R. Simmonds, 24 May 1962.)
- (53) It is possible that the provision of Bills of Mortality for Paris was one result of Graunt's work. See Hull, *op. cit.* (Note 4) Vol. II, p. 422, n. 1. The London Bills saw some improvement in scope and classification after Graunt, but not in method of reporting or in reliability of coverage. See also my paper, 'The population controversy in eighteenth-century England', *Pop. Studies* (July 1952), esp. pp. 74-77. There were many proposals for more substantial improvement of the Bills, but none was implemented. So far as mortality analysis is concerned, one of the more interesting proposals was that of Corbyn Morris, who wished deaths to be classified by age and cause and ages at death to be supplemented by reporting the year of birth of those who died. (See [Morris, Corbyn], *Observations on the past growth and present state of the city of London* (London, 1751), pp. 5-6.)
- (54) For example seventeenth-century German vernacular writers like Seckendorff and J. J. Becher. The Cameralist pressure for population increase came in the eighteenth century.
- (55) Not only in the German States (including Austria), but also in France and Spain and to some extent in Sweden.
- (56) *Natural and political observations*, pp. 17-18. I have throughout used the W. F. Willcox reprint of the first edition (Baltimore, 1939) to which the page references refer.
- (57) The main analytical table, reporting deaths by cause, covers the years 1629-36 and 1647-60. The years 1637-46 were 'omitted as containing nothing Extraordinary, and as not consistent with the incapacity of a sheet'. The primary discussion of cause mortality refers to a 20-year, 'normal' period, 1629-36 and 1647-58.
- (58) John Bell, clerk to the Company of Parish Clerks, laid great stress on the care with which the searchers were chosen and on the fact that they were sworn to their office by the Dean of Arches or by a J.P. See Hull, *op. cit.* Vol. I, p. lxxxix, n. 7.
- (59) *Observations*, p. 29.
- (60) *Ibid.* pp. 46-47.
- (61) *Ibid.* p. 27.
- (62) *Ibid.* pp. 36-37.
- (63) Graunt's reasons for believing that births were more seriously under-reported than deaths are given in *Ibid.* pp. 34-44.
- (64) *Ibid.* pp. 41-42
- (65) It was in part just such an acceptance which persuaded some eighteenth-century writers (such as the Rev. Richard Price) that the population of England had been falling since the Glorious Revolution,
- (66) *Observations*, p. 30. Later (pp. 31-32) he suggested, as an index of longevity, the proportion of deaths of old people (aged 70 and over) to total deaths. He found this to be 7% in London and argued that if any country showed more than this 7%, it could be regarded as more healthful than London. Greenwood regarded this as one of Graunt's less happy conceptions and it is of course true that the percentage will depend not only on age-specific mortality but also upon the age structure of the population, in turn influenced much more by the level of fertility than by that of mortality. However, in an era of relatively uncontrolled fertility, differences in age structure between countries would be much smaller than they are today, and differences in Graunt's proportion correspondingly more meaningful. It should be added that today, the proportion of deaths above some high age (say 50 or 60 years) is commonly used as one of

the indicators of differences between less and more developed societies. By the same token, the proportion of deaths from infectious diseases, or its obverse, the proportion of deaths from circulatory diseases and cancer, could equally be used as an indicator.

- (67) Logan, W. P. D., 'Mortality in England and Wales from 1848 to 1947', *Pop. Studies* (Sept. 1950), p. 167.
- (68) *Observations*, pp. 75-76.
- (69) Greenwood, M., *Medical statistics from Graunt to Farr* (Cambridge, 1948), p. 34.
- (70) *Observations*, p. 59.
- (71) *Ibid.* p. 73.
- (72) *Ibid.* pp. 50-51 and 45-47.
- (73) *Ibid.* pp. 38-39.
- (74) *Ibid.* pp. 29-30.
- (75) Greenwood, M., *op. cit.* (Note 69) pp. 31-32. Similar results are shown in Farr's life table London in 1841—see *Fifth report of the Registrar General* (London, 1843), pp. xvii-xxvii, from which  $l_6$  (M and F) would be around 67.6 with a radix of 100.
- (76) *Observations*, pp. 31-32.
- (77) The 1841 life table for London shows 16.3% surviving to age 70.
- (78) *Observations*, pp. 69-70.
- (79) Some years ago, I showed that they could be duplicated (and without rounding) by using the method of differencing—a method employed by Gregory King, though there is no evidence that it was used by Graunt. But my colleague John Hajnal has persuaded me that, though my solution was sufficient, it was not really necessary. Accepting the rounding off of two results, the arbitrary numbers of deaths between 6 and 56 could be obtained by assuming that the deaths in each decade amounted to  $\frac{3}{8}$  of the survivors at the beginning of the decade. This would leave 5 deaths to be allocated, one being by hypothesis after 76: hence allocating 3 to 56/66 and 2 to 66/76 would be an obvious move. This would also fit well with the fact that the initial and fairly realistic 36% mortality is itself close to  $\frac{3}{8}$ . Graunt might presumably have decided to apply the same fraction but to allow for lower mortality after early childhood by applying the fraction to a decade, instead of to a 6-year period.
- (80) In elaborating Graunt's life table, it has been assumed that the curve of mortality from birth to age 6 is closely similar to that of the 1841 London life table, but ending with 64 survivors out of the original 100, in accordance with Graunt's figures.
- (81) Greenwood, *op. cit.* (Note 69) p. 44.
- (82) Estimated at 19.4 years for males and 20.9 years for females in Davis, K., *The population of India and Pakistan* (Princeton, N.J., 1951), p. 240. So far as realism is concerned, it is by no means impossible that the figure of 17.5 years derived from Graunt's life table is nearer to the true level for West European cities than was Halley's figure of 27.5 years. Thus, Westergaard pointed out that Halley's data referred to a period of especially low mortality in Breslau—over the years 1692/1731 mortality seems to have been about 20% higher. (Westergaard, H., *Contributions to the history of statistics* (London, 1932, pp. 35-36).) Graunt's figure is also reached by constructing a life table for Stockholm, 1757, based upon the population and vital statistics presented by Wargentin (the raw data are given in *Tables of mortality based upon the Swedish Population prepared and presented in 1766 by Pehr Wilhelm Wargentin* (Stockholm, 1930). But the data are undoubtedly inaccurate. Wargentin himself suggested that the population was understated. In addition, Dr E. v. Hofsten, of the Swedish Central Statistical Office, suggests (letter of 13 August 1962) that the population data were in error because, for tax

reasons, it was to the advantage of people moving to Stockholm to avoid being registered. At the same time, nineteenth-century statistics show high mortality in Stockholm. Thus even for 1861/70, the expectation of life at birth was only 24·6 for males and 30·7 years for females (as compared with 44·0 and 47·2 years in rural communities). Dr v. Hofsten regards it as not impossible that the true expectation of life at birth in 1757 was around 20 years and this may well have been the order of magnitude for London.

- (83) *Fifth annual report of the Registrar General*, p. xxxiii.
- (84) The GRR implied by Graunt's stationary population would be around 4.
- (85) *Observations*, pp. 75-76.
- (86) Petty, *The Political Anatomy of Ireland*, in Hull, Vol. I, pp. 144-145.
- (87) *Observations*, pp. 57-61.
- (88) *Ibid.* pp. 54-56. Galton, F., 'The relative supplies from town and country families to the population of future generations', *J. R. Statist. Soc.* Vol. xxxvi (1873), pp. 19-23. Galton's paper represented an early attempt to measure what is now called 'replacement'.
- (89) *Observations*, p. 68. Gregory King, see D. V. Glass, 'Gregory King's estimate of the population of England and Wales, 1695', *Pop. Studies* (March 1950), pp. 338-376. King estimated the number of persons per house at 5·0 for London and 4·17 for England and Wales as a whole.
- (90) *Observations*, p. 68.
- (91) Henry, L., 'Some data on natural fertility', *Eugenics Quarterly* (June 1961), pp. 86-87.
- (92) Public Records Office, Bundle T. 64/302, Journal, p. 8, 'Observations touching Marriages, Births and Burials and Persons Living at any one time'. King posed almost all the appropriate questions, viz. 'How many marriages annually; at what ages persons marry; how many widows and widowers; at what ages they become such; how many 2nd., 3rd., 4th., etc. marriages; how many barren marriages; how many teeming women; how many die in childbed; how many die in labour; how many marriages produce only 1 child, 2, 3, 4, 5, 6, etc. children.' He attempted to assess the distribution of marriages with various numbers of children—perhaps basing himself on Graunt's estimated average of four children to a marriage in Romsey, for his average is just over four—and suggested 5½% as the incidence of childlessness.
- (93) An actuary, Charles Ansell, Jr., writing in the 1870's, made some very important contributions to the methodology for studying fertility, including the use of data on birth-spacing. But he had very little influence on contemporary demographers. (See C. Ansell, Jr., *On the rate of mortality at early periods of life . . .*, London, 1874.)
- (94) Greenwood, M., *Medical statistics from Graunt to Farr* (Cambridge, 1948), pp. 36-39.
- (95) Hull, C. H., *op. cit.* (Note 4) Vol. I, pp. xxxix-liv.
- (96) See the discussion in Hull, *op. cit.* Vol. I, p. xl. The attribution to Petty may, indeed, have been added well after 1680, for some of the writing on the relevant folio of Aubrey's work relates to matters after Petty's death in 1687. See later discussion.
- (97) Wood, A., *Athenae Oxonienses*, 2nd ed., Vol. I (London, 1721), col. 311.
- (98) *Ibid.* Vol. I, p. 272.
- (99) It was not a best seller; the unsold sheets were used in the re-issued edition, published with additions in 1686, and then carrying Petty's name as author. See Hull, *op. cit.* (Note 4) Vol. I, p. xlii.
- (100) Indeed, this view appears to have been adopted by the Company of Parish Clerks. Maitland, visiting the Company to see their register, found that the section ending

- in 1663 was lost; 'The Company are of Opinion, that the same was lent to *Mr. Graunt*, to enable him to write his *Natural and Political Observations*, but by some Accident never return'd.' (Maitland, W., and others, *The history of London*, 2 vols. Vol. II (London, 1757), p. 737.)
- (101) As may be seen from the reprints of Petty's writings collected by Hull, there are frequent references to Graunt, sometimes attributing to him statements which he had not made.
- (102) The letter is given in full in Lansdowne, Marquess of, *The Petty-Southwell Correspondence 1676-1687* (London, 1928), pp. 93-94.
- (103) From Dublin, 4 February 1662/63: '. . . When I first landed here some matter presented it selfe whereuppon to make observations uppon Ireland, not unlike those which Mr. Graunt made uppon the London Bills of Mortality.' Hull, *op. cit.* Vol. II, p. 398, n. 2.
- (104) The list was dated 6 October 1671. Hull, *op. cit.* Vol. I, p. liii, quotes from an inaccurate transcription in Fitzmaurice, Lord Edward, *The life of Sir William Petty* (London, 1895), p. 317, wrongly dating the list at around 1682 and referring to the item as 'Observations on the Bills of Mortality of London'. The actual entry is thus less specific and might equally have related to some general comments on the Bills, though Lord Lansdowne subsequently leaned heavily on this item (see later discussion).
- (105) Hull, *op. cit.* Vol. I, p. liii.
- (106) Lansdowne, Marquess of, *The Petty Papers*, 2 vols. (London, 1927), p. 282. The authorship question as a whole is discussed in pp. 273-284.
- (107) Lansdowne, *The Petty Papers*, Vol. II, p. 274; Lansdowne, Marquess of, *The Petty-Southwell Correspondence 1676-1687* (London, 1928), p. 112.
- (108) Lansdowne, *Petty Papers*, Vol. II, p. 279.
- (109) Lansdowne, *Ibid.* Vol. II, p. 280.
- (110) Lansdowne, *Ibid.* Vol. II, pp. 280-281. I have omitted one piece of 'evidence' of the 'dog that did not bark' variety. One of Petty's contemporaries and close friends, Sir Peter Pett, referred, in *The happy future state of England* (London, 1688), four times to the London Observations but without naming an author. Hull argues that Pett, who also specifically referred to Petty in his pamphlet, in connexion with his other writings, probably avoided naming Graunt as the author because Graunt became a Roman Catholic; Pett was trying 'to vindicate Anglesey from the charge of leaning towards Roman Catholicism' at a time when the influence of Titus Oates was still felt. (Hull, *op. cit.* Vol. I, p. xliii.) Lansdowne, on the other hand, claims that Pett's reticence is evidence that, even after Petty's death, he 'wished to preserve the secrecy which his friend had insisted upon when alive'. (*Petty Papers*, Vol. II, p. 281.) At best, these two explanations of a piece of 'non-evidence', so to speak, would appear to cancel each other. At the same time, having regard to the agitation regarding 'Popery' at the time, it is not unlikely that Hull's explanation is a realistic one.
- (111) Greenwood, M., 'Graunt and Petty', *J. R. Statist. Soc. Part I* (1920), pp. 79-85.
- (112) *Ibid.* (London, 1928), pp. xxiii-xxxii.
- (113) Greenwood, M., 'Graunt and Petty—a re-statement', *J. R. Statist. Soc. Part I* (1933), pp. 76-81.
- (114) Willcox, W., ed., *Natural and political observations* (Baltimore, 1939), pp. iii-xiii.
- (115) Greenwood, M., *Medical statistics from Graunt to Farr* (Cambridge, 1948), p. 39.
- (116) Hull, *op. cit.* (Note 4) Vol. I, p. xxxvi.
- (117) *Ibid.* p. xliii.; Birch, T., *The history of the Royal Society of London*, Vol. II, p. 57. 20 June 1665: 'That upon a report of Sir William Petty of his having perused the additions of

Mr. Graunt to his *Observations Upon the Bills of Mortality*, the president be desired to license the reprinting of that book, together with such additions: which was done accordingly.'

- (118) Sprat, T., *The history of the Royal Society of London . . .*, 4th edn (London, 1734), p. 67.
- (119) Wheatley, H. B., ed., *The diary of Samuel Pepys*, Vol. II (London, 1921), p. 209 (24 March 1661/2); Vol. V (London, 1920), p. 25 (25 July 1665).
- (120) 'An estimate of the Degrees of Mortality of Mankind . . .', in Reed, L. J., ed., *Two papers on the degrees of mortality of mankind* (Baltimore, 1942), p. 3. How this attribution spreads can be seen quite clearly in a publication which referred to Halley's work: T.W., 'A Letter to the Rev. Dr William Brakenridge . . .', *Phil. Trans.*, 1761, no. XI. The author writes: 'If we look back, we shall find the first sketch, [of a life table] that of Capt. John Graunt (alias Sir William Petty) . . .' and gives as his authority for that 'alias' Halley's paper in the 1693 issue of *Phil. Trans.*
- (121) de Beer, E. S., ed., *The Diary of John Evelyn*, Vol. IV (Oxford, 1955), p. 60 and p. ix. A letter from Dr de Beer (1 June 1962), draws attention to the difficulties in dating Evelyn's transcription, and concludes: 'And I must remind you that my statement in the note to Evelyn is speculative; my acquaintance with Evelyn's habits of composition leads me to think that the passage in his text is an interpolation, dating from when he was copying his earlier notes, or at least from after they were written. Evelyn's statement about the authorship of the *Bills* does not necessarily date from 1675; it may, and probably does, date from after the middle of 1683.' I am greatly indebted to Dr de Beer for his comment.
- (122) It might be added that even so confident a person as Petty would have been unlikely to refer to his own book in the terms in which he refers to the *Observations* in the opening paragraph of the Dublin-Bills, viz. 'The Observations upon the *London-Bills of Mortality* have been a new Light to the World; and the like Observation upon those of *Dublin*, may serve as Snuffers to make the same Candle burn clearer.'
- (123) *The Petty-Southwell Correspondence*, pp. 92 and 248. Southwell's ascription of authorship (28 Nov. 1682) is at p. 112.
- (124) Wood, A., *Athenae Oxonienses*, 2nd edn, Vol. II (London, 1721), col. 311. The terms of praise are Wood's, not Aubrey's.
- (125) The bulk of Aubrey's biographical notes in the Bodleian are contained in MS. Aubrey 6. In addition, so far as Graunt is concerned, there is a separate letter, written to Anthony Wood and dated 26 May 1674 (MS. Wood fol. 270r. and v.). This letter, written shortly after the death of Graunt, does not raise any questions of authorship but simply states: 'His observations on the bills of mortality hath been printed more than once; and now very scarce.' The authorship question is raised in MS. Aubrey 6. Here the collection of notes is prefaced by a letter to Wood, dated London 15 June 1680. But it is known that Aubrey at some time recalled his notes to add further (and later) information and there are clearly additions to the notes on Petty. Thus at the bottom of fol. 15r, marked with a cross, is the insertion: 'Since his death I have seen in his Closet a great many Tractatiuncli in MS., e.g. . . .' This must have been inserted after 13 December 1687, when Petty died. The reference to the authorship ('Observations on the Bills of Mortality were really his') occurs as a parenthesis on the bottom half of the same page, in a script and ink-density which certainly appeared to my in-expert eye more like those of the datable insertion than of some of the preceding notes on Petty. What in any case seems to me still more suggestive of a post-1680 date for the parenthesis is that the 1680 text on Graunt (at fol. 97 in the same MS. Aubrey 6)

- claims only that ' . . . I believe, and partly know, that he had his hint from . . . ' Petty, and this is not compatible with the insertion in the notes on Petty. And if the insertion had been made after 1680 (and still more if it had been made after Petty's death) then it might easily have been in response to Pardoe's publication.
- (126) *The Petty Papers*, Vol. I, pp. 171-172; Vol. II, pp. 260-262. Aubrey's note occurs in MS. Aubrey 26, a manuscript entitled: 'Faber Fortunaee/by John Aubrey R.S.S.', at fol. 14v, at the end of a series of proposals headed: 'Directions from Sr. Will. Petty to me heretofore sc. 1671.'
- (127) *Ibid.*, Vol. II, p. 115.
- (128) *Ibid.*, Vol. II, pp. 232-233. Observation no. 93 of the 'Political Observations'. The date of 1671 is given in Observation no. 51.
- (129) Hull, *op. cit.* (Note 4) Vol. I, p. 45, n. 2; Vol. II, p. 517, n. 1; p. 535, n. 3; p. 536, n. 1.
- (130) It might be said that many of Gregory King's *Observations* are also assertions. But at least King's manuscript journals are full of evidence of sources and methods which he used. whereas Petty's manuscripts (as published by Lansdowne) contain no such evidence. Incidentally, King (whom I regard as second only to Graunt among the early demographers) was very critical of some of Petty's work, but appreciative of Graunt's work. See his comments on Petty in his *Journal* (MSS.) in the London County Council Collection, p. 49, and his summary of some of Graunt's main points in his *Journal* in the Public Record Office, pp. 6-7 (Public Record Office, T. 64/302).
- (131) In a letter to Lord Brouncker from Dublin, February 1663, Petty implied that he had done a good deal of work on the Dublin Bills. 'I have done so much upon it, as hath cost me some pounds, but not so much as is worth more than a bare mention.' (Hull, *op. cit.* (Note 4) Vol. II, p. 398, n. 2.)
- (132) Willcox edn, p. 18 . . . : 'I did then begin, not onely to examine the Conceits, Opinions, and Conjectures, which upon view of a few scattered *Bills* I had taken up; but did also admit new ones, as I found reason, and occasion from my *Tables*.'
- (133) *Petty Papers*, Vol. II, p. 280. That collection and collation are indeed of the very essence of Graunt's work, and provide the indispensable basis for his analysis and generalizations.
- (134) Willcox edn, pp. 40-41. 'And that what is the *Rickets* in children may be the other [i.e. stopping of the Stomach and rising of the Lights] in more grown bodies; for surely children, which recover of the *Rickets*, may retain somewhat sufficient to cause what I have imagined; but of this let the learned *Physicians* consider, as I presume they have.'
- (135) Willcox edn, p. 69.
- (136) Hull, *loc. cit.*, Vol. I, pp. 144-145. Petty simply asserted that the total population of Ireland was 1 100 000, without giving any source or justification
- (137) For further details, see my note, 'Graunt's life table', *J. Inst. Actu.* (June 1950), pp. 60-64.
- (138) It is generally assumed that Petty supplied the statistics of Romsey, Hampshire, used by Graunt in his chapter, 'Of the Country-Bills'. This is very likely, for Petty came from Romsey and maintained his associations with that town. But it should be noted that Graunt also had business dealings with Romsey. The Bodleian MSS. contain three deeds relating to property transactions in Romsey in 1662-63, John Graunt being involved, though it is not clear whether this was on his own account or as agent for Petty (letter from Miss M. Barratt, Department of Western MSS., Bodleian Library, 22 June 1962).
- (139) *Lansdowne Petty Papers*, Vol. II, pp. 279 and 281.