London Plague Statistics in 1665

D. R. Bellhouse[1]

Weekly Bills of Mortality for the City of London were published from the beginning of the seventeenth century. The impetus for the collection and publication of these data came from periodic outbreaks of the bubonic plague in the city. John Graunt, the father of statistical science, based his work *Natural and Political Observations upon the Bills of Mortality* on the published statistics. For the plague of 1593 in London, it is shown here that all published data, except for perhaps some yearly totals, have been constructed. Examination of the constructed data provides some insight into statistical thinking in the seventeenth century. Some aspects of the accuracy of the Bills of Mortality are also discussed as well as the statistical insights into the Bills of Mortality by some of Graunt's contemporaries.

Key words: Data collection; history of statistics; reporting errors; scientific fraud; undercounting errors.

1. Introduction and Background

John Graunt (1620–1674) is generally acknowledged as the father of statistical science for his *Natural and Political Observations upon the Bills of Mortality*. The book went through four editions in his lifetime (Graunt 1662a,b; 1665a,b), the last two published during an outbreak of the bubonic plague in London. Graunt based his findings on the mortality statistics that had been regularly collected in London by the Company of Parish Clerks.

The collection of mortality statistics, especially those relating to the plague, in the City of London date from the early sixteenth century. Possibly the earliest known reference to this activity is in 1519 at which time a Mr. Lark received payment from the City of London for a compilation of data on plague deaths (Adams 1971, p. 48). Before the seventeenth century, it has been reported that detailed collection of mortality data usually commenced at the outbreak of a plague. Some data for the latter half of the sixteenth century are given in Anonymous (n.d., 16th century), Creighton (1965, pp. 341–344), Gairdner (1880) and Petty (1899, pp. 433–435). Near the beginning of the seventeenth century, data were gathered and mortality statistics were published regularly by the Company of Parish Clerks. The published statistics are known as the Bills of Mortality. Descriptions of the origins and development of the London Bills of Mortality are given in Adams (1971), Christie (1893), Ogle (1892), and Walford (1878).

During the plague of 1665, several London printers turned out publications containing death counts on the current plague as well as the plagues of 1593, 1603, 1625 and 1636. These publications were in the form of books, including Graunt's, and broadsides, defined as single sheets of typeset paper. Presumably the data were all based on the Bills of Mortality published by the Company of Parish Clerks.

Several issues will be addressed here regarding these data. The first issue, which is not new, is whether or not some of the data sets have been constructed rather than collected and compiled. Given that some of the data were constructed, the next issue is how the construction was done. This provides some insight into the statistical abilities of some individuals in the mid-seventeenth century. Some of Graunt's contemporaries also used these published plague data so that a third issue is how their statistical insights compared to Graunt's. A final issue is the accuracy of the Bills.

The word ''constructed'' has been used rather than ''forged'' since the latter word is stronger, implying malicious or illegal intent. This begs the question of the motive for data construction. In discussing the why and wherefore of literary forgery in medieval and renaissance times, some scholars contend, although it is not universally accepted, that early writers, ''simply tried to provide authorities to support doctrines and practices they considered valid, but for which they lacked written evidence or charters.'' (Grafton 1990, p. 37) This assessment reasonably transfers over to the current context of data construction. Published plague data were ephemeral and it may be reasonably assumed that the broadsides on which the data were published were not kept like books. Writers or publishers knew that there had been a plague in a specific year, but the data were not easily available. It would be justifiable to the people of this era to make up a reasonable facsimile to the real data.

With regard to data construction it will be argued that none of the surviving published weekly data or data by parish from the plague of 1593 is genuine. Weekly data for 1593 were probably constructed in September or October of 1636 and data by parish were probably constructed in 1665. Those who constructed sets of data did a reasonable job either on their own or by mimicking other, presently unknown, data. The weekly data followed the general trends that are expected in epidemics. In accordance with the statistical thinking of the day the construction of the data by parish relied on the assumption of the stability of certain ratios. There were some others who had some statistical insights into the Bills of Mortality other than Graunt. However, none of these individuals reached the depth and breadth of Graunt's analysis. Finally, it will be argued that some of the criticisms of the accuracy of the Bills of Mortality in the seventeenth century have been misguided, in particular excessive and unfair criticisms of the female searchers who reported the cause of death.

2.   Data Description

Graunt (1662a) states that the weekly Bills of Mortality began in the plague of the 1590s but were discontinued at the end of that plague and then were resumed after the plague of 1603. Data were collected on parishes within the walls of the City of London, outside the city walls and from some parishes in the suburbs (out parishes). The published data contain the total number of deaths and deaths due to the plague. Yearly summaries of

the weekly Bills of Mortality were often published. The yearly Bills that have survived can contain two types of data. The first is a count of the number of deaths for the year, in total and due to the plague, for each parish. The second is a count of the number of deaths, again in total and due to the plague, every week for the year preceding publication.

There exist published data, both weekly for approximately ten months and yearly by parish, for the plague of 1593. The earliest surviving publication of the yearly death totals by parish is found in *Reflections on the Weekly Bills of Mortality* shown under [Graunt, J.] (1665a,b) in the list of references. For weekly death totals, the earliest publication that could be found was an anonymously published broadside published in 1636, probably October of that year (Anonymous 1636d). The broadside contains plague data for the years 1593, 1603, 1625, 1630, and 1636, with the first entry of 1593 dated March 17. Hand-written entries of death totals appear in the Guildhall Library copy of the broadside beginning October 13, 1636. The same data for the 1593 plague appear in a 1637 broadside (Anonymous 1637), but the year of the plague is given as 1592. It will be demonstrated that all surviving data for 1593 have been constructed, probably at least forty years after the fact.

Weekly data for the year and yearly data by parish also survive in a broadside for the plague of 1603 (Anonymous 1603). They are attributed by the printer of the broadside to the Company of Parish Clerks. These data appear to be genuine. The 1603 broadside containing the weekly data was printed by John Windet who became the official printer to the City of London in 1603 (McKerrow 1968).

What appear to be reliable data, since they were transcribed from source material, for the plagues of 1625 and 1636, both weekly and yearly by parish, appear in Bell (1665). During 1665 weekly plague data for 1593, 1603, 1625, and 1636 appeared in broadsides printed for Peter Cole (Anonymous 1665a) and Francis Coles (Anonymous 1665b) and in books by Graunt (1665a,b), [Graunt] (1665b) and Gadbury (1665). Bell (1665) contains weekly data for 1625 and 1636 as well as several other years from 1606 on. Yearly data by parish for 1625 are found in Graunt (1662a,b and 1665a,b) and Bell (1665) and for 1636 in Bell (1665). [Graunt] (1665a,b) contains yearly data by parish for 1593, 1603, 1625, and 1636; all but the 1625 data have been constructed.

3. Data Construction

John Bell, the Clerk of the Company of Parish Clerks in 1665, appears to have been the first and only one in the seventeenth century (and perhaps until the nineteenth century) to question the verity of some of the historical plague statistics that were published in London during the plague of 1665. In the preface to his book *Londons Remembrancer* Bell (1665) wrote:

''Having observed with some trouble, the many and gross mistakes which have been imposed upon the World, by divers Ignorant Scribblers about the weekly Accompts of former Visitations; I thought it some part of my duty to rectifie those Errours, out of the undeniable Records of those times; and I have accordingly drawn from the Register of the Company of Parish Clerks an exact Computation since the year 1592 to this present year, to satisfie their curiosity that desire to be better informed, and to prevent the inconvenience of false Papers for the future. There have been several Pamphlets Printed

upon this Argument, which have all been faulty more or less, and would not be worth the while to Descant upon; but there is one amongst the rest, which I cannot let pass without a mark, in regard that it bears the face of a Sober Discourse, and is Intituled, *Reflections on the Bills of Mortality*. In this Pamphlet the Reader will find a greater number set down in some years to die of the Plague, than the Clerks Register took notice of to die in all. I therefore have put this small Treatise to view for publick satisfaction and prevention of false Papers; which is the only intention of John Bell.''

The only false publication which Bell mentions directly, *Reflections on the Weekly Bills of Mortality* ([Graunt, J.], 1665a,b), has often been attributed to John Graunt. The title appears under Graunt's name in the British Library Catalogue, the National Union Catalogue and in Wing's (1948) catalogue of English books published between 1641 and 1700. Certainly when one reads this book, it is readily apparent that many passages are taken directly from Graunt's *Natural and Political Observations*. The true status of Reflections is summed up by C.H. Hull (Petty 1899, p. 660), ''All that is of value in either of them [the two editions of *Reflections*] was filched from Graunt, but their compiler appears to have drawn liberally from his own imagination also.'' Evidence against Graunt's authorship of *Reflections* is presented in Appendix I. There is, however, some value in delving into the liberal imagination of this anonymous author of *Reflections* and plagiarist of Graunt.

Bell's warnings of false data appear generally to have been ignored until the late nineteenth century. Acceptance of some of Bell's warnings appears, for example, in Hull's examination of the data in Petty (1899). Earlier, however, Birch (1759) reprinted the 1593 data in *Reflections* without question and Walford (1878) appears to have accepted the 1593 data in *Reflections* as genuine.

3.1.   *Yearly data by parish*

There are four sets of yearly deaths and deaths due to the plague which appear in *Reflections*. In each set, the London parishes are listed by name and the deaths in each parish are recorded.

The first data set appearing in *Reflections* relates to the plague of 1625. The time period for which the data have been collected is given as December 16, 1624, through December 15, 1625. With the exception of a couple of what appear to be typographical errors in *Reflections*, these same data, with the same dates of collection, also appear in both Graunt (1662) and Bell (1665). A broadside published by the Company of Parish Clerks with these data is also preserved in the Guildhall Library in London. With the existence of at least two reliable publications of these data from the Company of Parish Clerks, there is no reason to doubt that these data are genuine.

There is a further independent comparison that can be made, but only on a sample of the London parishes. Transcriptions of twenty-six London parish registers (listed as within the city walls in the Bills of Mortality) have been published. Unfortunately, the burial registers for many of these parishes do not record the cause of death. There are only a few that indicate when death was due to the plague. Consequently, only a comparison between the total number of deaths in the registers and in the Bills of Mortality was attempted. The numbers of deaths as recorded in the twenty-six London parish registers for the

time period December 16, 1624 through December 15, 1625 are given in Table 1 under the column labeled 1625. With one exception there appears to be fairly close agreement between the death counts in the registers and those in the Bill of Mortality. The one exception is St. Mary Magdalen Milk Street, or St. Maudlins Milkstreet as it appears in the Bill. For this parish the Bill of Mortality shows 401 deaths while the parish registers show only 38 deaths. Some inaccuracies and inconsistences in the data for 1625 are

Table 1.   Total number of deaths from all causes as reported in (A) Reflections on the Weekly Bills of Mortality, (B) London Parish Registers* and (C) Published Yearly Bills of Mortality†

Parish	1593			1603			1625			1636		
	A	B	C	A	B	C	A	B	C	A	B	C
1	21	7	–	9	15	12	18	18	18	13	3	3
2	207	35	–	37	33	32	62	63	62	56	26	24
3	51	–‡	–	118	–‡	199	226	229	226	309	114	112
4	506	32	–	43	53	48	87	85	87	57	15	18
5	44	89	–	45	126	112	††149	102	99	113	11	17
6	25	67	–	63	128	98	136	135	136	7	29	29
7	307	84	–	42	103	88	91	118	91	154	25	26
8	107	35	–	16	73	70	37	33	37	55	22	24
9	79	43	–	91	100	81	126	102	126	16	15	35
10	104	67	–	43	93	90	92	93	92	20	39	39
11	194	23	–	15	32	26	35	32	35	75	–‡	14
12	229	15	–	200	39	33	401	38	401	62	9	9
13	29	27	–	37	49	51	76	83	76	35	–‡	18
14	110	206	–	109	88	197	270	265	270	45	84	83
15	207	35	–	24	59	52	58	60	58	127	17	18
16	42	37	–	41	114	99	82	81	82	54	23	24
17	25	–‡	–	44	–‡	90	88	88	88	11	20	20
18	40	24	–	12	28	16	24	21	24	103	14	14
19	141	121	–	94	166	141	199	186	199	37	32	45
20	204	108	–	59	149	130	††155	158	159	109	37	27
21	47	57	–	1091	44	41	33	33	33	970	17	16
22	64	140	–	780	220	201	266	265	266	1505	102	67
23	38	18	–	1219	19	20	17	15	17	554	6	7
24	57	–‡	–	516	–‡	97	97	93	97	1995	20	29
25	21	60	–	121	89	86	141	138	141	831	27	27
26	107	98	–	61	110	94	149	147	149	123	38	40

*Data were obtained from the following parishes: (1) Allhallows, Honey Lane (2) St. Antholin, Budge Row (3) St. Bene't, Paul's Wharf (4) St. Clement, Eastcheap (5) St. De'nis (Dionis) Backchurch (6) St. Helen's, Bishopsgate (7) St. Lawrence Jewry (8) St. Margaret Moses, Friday Street (9) St. Mary Aldermanbury (10) St. Mary Aldermary (11) St Mary Le Bowe, Cheapside (12) St. Mary Magdalen (St. Maudlins), Milk Street (13) St. Mary Mounthaw (14) St. Mary Somerset (15) St. Mary Woolchurch (16) St. Mary Woolnoth (17) St. Martin Orgar (18) St. Matthew, Friday Street (19) St. Michael Bassishaw (20) St. Michael Cornhill (21) St. Nicholas Acons (22) St. Olave, Hart Street (23) St. Pancras, Soper Lane (24) St. Peter, Paul's Wharf (25) St. Thomas the Apostle (26) St. Vedast (St. Foster's), Foster Lane. See Bannerman (1904–1933), Brigg (1890), Brooke and Hallen (1886), Chester (1878–1883), Clarke (1937–1945), and Littledale (1903–1912).
†Anonymous (1603) was used for the 1603 data and Bell (1665) was used for the 1625 and 1636 data.
‡The Parish registers have not survived from this time period.
††This number appears to be a typographical error. The number under Column C appears in both Bell (1665) and Graunt (1662).
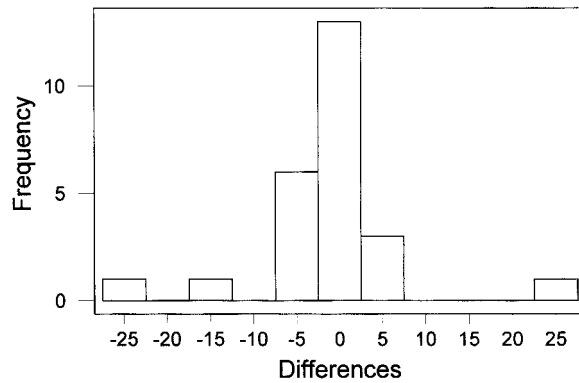
Fig. 1. Differences between the registers and the Bill for 1625

discussed in Appendix II. When the St. Mary observation is treated as an outlier and removed, the correlation between the deaths in the registers and in the Bill of Mortality is 0.99 for the remaining parishes. A histogram of the differences between the registers and the Bill is given in Figure 1.

Since much of the text in *Reflections* has been plagiarized from Graunt (1662a,b) or Graunt (1665a,b), Graunt's work was probably the source of the 1625 data for the anonymous author. The three other yearly sets of data, for the plagues of 1593, 1603 and 1636, appearing in *Reflections* have almost certainly been constructed. The first hint that these three sets of data are constructed, rather than transcribed from other source documents, is given by the initial description of the data prior to the lists of death by parish. As noted already, exact dates are given for the time period in which the data were collected for the 1625 plague. In all the other three sets of data, only the year in which the plague occurred is given.

The data for 1636 in *Reflections* are given for 96 of the 97 parishes within the walls of the City of London; Trinity Church is missing. These data are perhaps one of the cases that Bell (1665) alludes to as having more deaths due to the plague than deaths from all causes that occurred in the year. The anonymous author of *Reflections* shows a total of 22,867 deaths of which 13,737 were due to the plague. This may be compared to 4,025
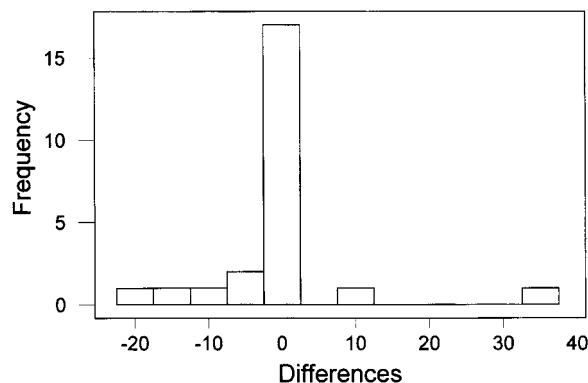

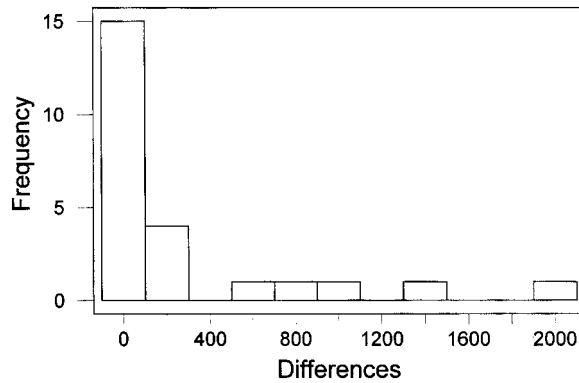*Fig. 2. Differences between the registers and the Bill for 1636*

Fig. 3. *Differences between the registers and Reflections for 1636*

and 3,244 given in the Bills of Mortality for 1636 for the 97 parishes within the city walls.

Calculation of the correlation between the parish registers and the Bills or the parish registers and the data in *Reflections* is revealing. The data are shown in Table 1 under 1636. The dates of data collection in the Bills of Mortality are given as December 16, 1635 through December 15, 1636. The same time period was used for the counts of the deaths in the parish registers. The correlation between the deaths recorded in the parish registers (Column B) and the deaths in the Bills of Mortality (Column C) is 0.95. The correlation between the parish register deaths and the numbers in *Reflections* is 0.14. It might be reasonably assumed that the 1636 data in *Reflections* are spurious. Histograms of the differences between the registers and the Bills and between the registers and *Reflections* are given in Figures 2 and 3 respectively.

The data for 1593 and 1603 in *Reflections* contain anachronisms that point to these data being constructed. The total number of deaths and the number of deaths due to the plague are given for St. James Duke's Place in both 1593 and 1603. This church did not exist until the reign of James I. It was consecrated in 1622 (Godwin 1839). Bell (1665) states that St. James Duke's Place was added to the Bills of Mortality in 1626. The date given by Bell
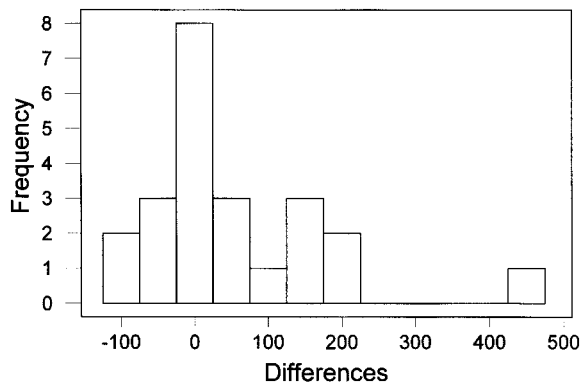

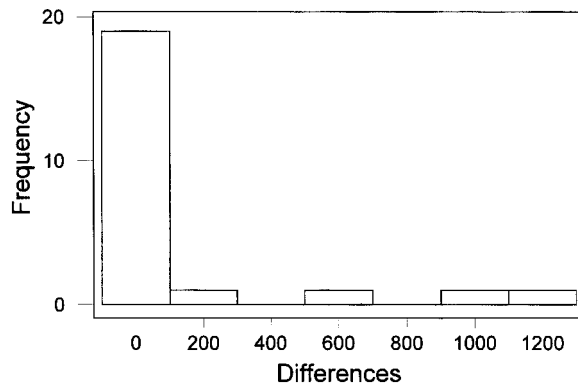Fig. 4. *Differences between the registers and Reflections for 1593*

Fig. 5.   Differences between the registers and Reflections for 1603

must be slightly in error since Bell includes in his own book a yearly Bill for 1625 published by the Company of Parish Clerks in which data are given for this parish. Further support for the non-existence of data for this parish prior to at least 1604 is the 1603 Bill (Anonymous 1603) published by John Windet, printer to the City of London. In this bill there is no entry for St. James Duke's Place. A second anachronism in the 1593 data is the reference to deaths at the Pest House or plague hospital. Wilson (1927, pp. 77–82) provides a short history of the building of the Pest House in London. The building site was not chosen until December of 1593. Construction was not finished as late as April of 1595.

Correlations were calculated in a manner similar to what was done for the 1636 data in *Reflections*. The correlations that were obtained do not instill any confidence in the genuineness of the data reported in *Reflections*. The data from the parish registers are given in the column labeled B under the appropriate year in Table 1. Since no date is given in *Reflections* for the 1593 data, the deaths in the parish registers were counted from January 1, 1593 through December 31, 1593. The dates of collection in the 1603 Bill of Mortality (Anonymous 1603) are December 23, 1602 through December 22, 1603. The same dates were used to count the deaths in the parish registers. The data from *Reflections*
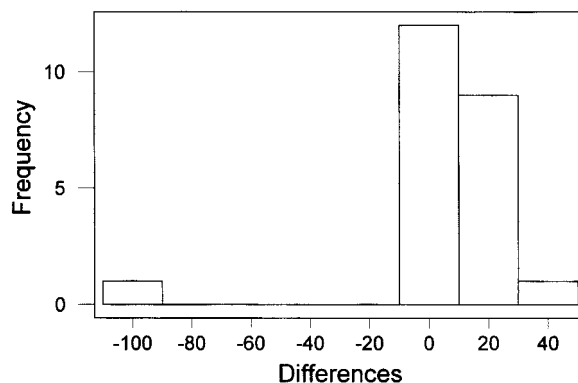

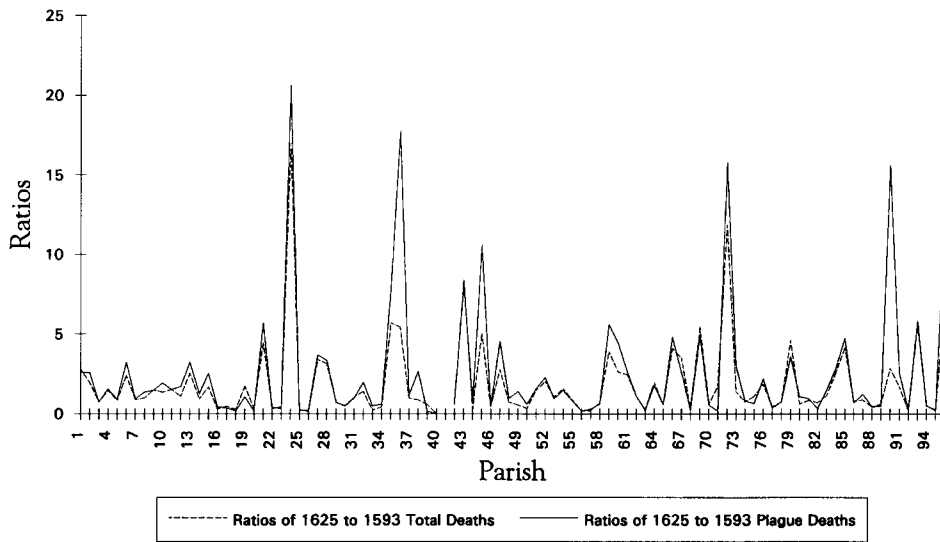*Fig. 6.   Differences between the registers and the Bill for 1603*

Fig. 7. Death ratios – 1625 to 1593

are given in Column A of Table 1. The correlation between the 1593 data in *Reflections* and the data from the parish registers is −0.04 and the same correlation for the 1603 data is −0.03. Histograms of the differences between the registers and *Reflections* for 1593 and 1603 are given in Figures 4 and 5 respectively. In the Bill for 1603 (Anonymous 1603), there is one outlying observation, 197 deaths at St. Mary Somerset. When this outlier is removed, the correlation between deaths in the registers and the Bills is 0.99. Such close agreement between this yearly Bill and the parish registers enhances the belief that
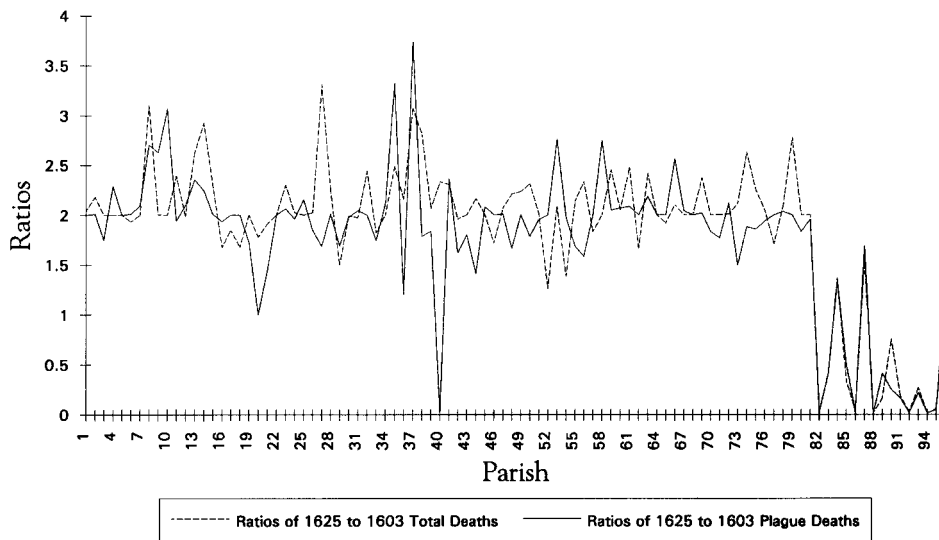

Fig. 8. Death ratios – 1625 to 1603

the Bill is genuine. A histogram of the differences between the registers and the Bill is given in Figure 6.

It is of interest to try to discover how the false Bills of 1593, 1603, and 1636 in *Reflections on the Weekly Bills of Mortality* were constructed. This may give some insight into the statistical abilities of the individual whom C.H. Hall (Petty 1899, p. 660) described as "having drawn liberally from his own imagination." Since the 1625 Bill of Mortality is the only genuine Bill in this publication, it is reasonable to look to it as the source of the subsequent constructions. Figures 7, 8 and 9 show plots of the ratios

$$\frac{Total\ deaths\ in\ 1625}{Total\ deaths\ in\ year\ x} \quad and \quad \frac{Plague\ deaths\ in\ 1625}{Plague\ deaths\ in\ year\ x}$$

where *x* is 1593, 1603 and 1636 respectively. The parish numbers on each graph are the order in which these parishes occur in *Reflections on the Weekly Bills of Mortality*. The ratios between parishes have been joined with a line to make the graph more readable. One observation has been left out of Figure 7 (St. John Zachary). Since the ratio for the total number of deaths was high (almost 100:1), it made the remainder of the graph look very flat. It may be noted that there is a fairly close correspondence between the death ratios and the plague death ratios for both 1593 and 1636. For 1603, the ratios hover around 2, with many exactly 2, for the first 81 parishes. Then there is a significant drop in the ratios. One plausible reconstruction is that the author of *Reflections* started to construct the 1603 data by approximately halving the results from 1625. A little variability was thrown in for good measure. When his results for 1603 were nearly complete he changed his strategy. The data for 1593 and 1636 were then constructed by picking some value for either total deaths or plague deaths and solving approximately for the other by equating the two ratios. In one sense, the unknown author of *Reflections* was working in the spirit of Graunt. In order to construct his data, this author had faith in the stability of
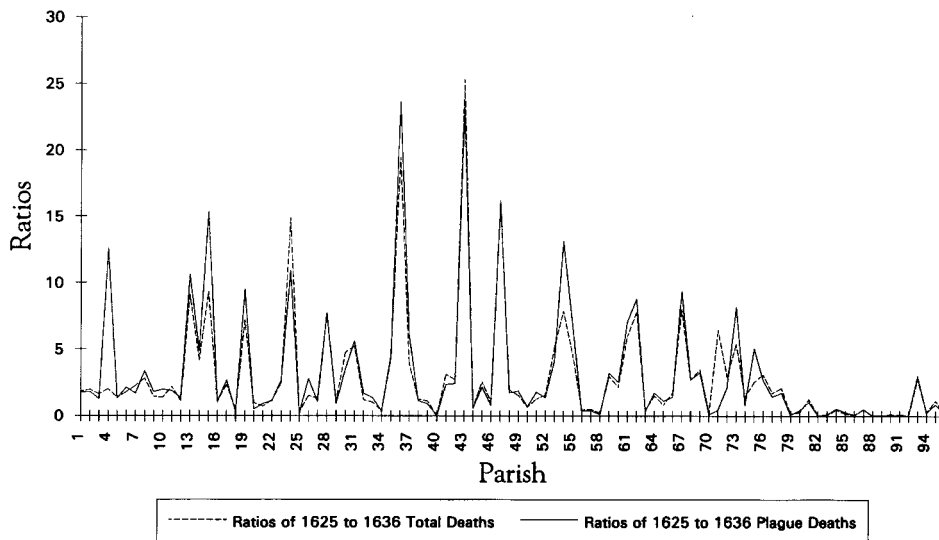

Fig. 9.   *Death ratios – 1625–1636*

ratios. As noted by Sutherland (1963), most of Graunt's analyses were based on the study of ratios.

3.2. Weekly time series of deaths

The series of weekly data from 1593 or 1592 was also constructed. C.H. Hall, in his notes on Petty (1899, pp. 426–427), concluded that the data were spurious after pointing out three problems with the data. The first problem was that the number of deaths from causes other than the plague and the number of christenings were both too high when compared to available data for the years that straddled 1593. Secondly, the final digits in many successive pairs of the weekly counts of deaths and plague deaths sum to 10. Finally, the sum of the weekly figures does not add up to the total that is printed. One other problem, not noted by Hull, can be spotted. The data series in each of the years 1593 (or 1592), 1603, 1625, and 1636 all begin on Thursday, March 17. Thursday was the day, as noted in Graunt (1662a), on which the Bills of Mortality were printed and published. On checking a perpetual calendar constructed by McCready (1897), it may be noted that March 17, 1592 was a Friday and March 17, 1593 was a Saturday. March 17, 1603, 1625 and 1636 were all Thursdays. The dates given here are all in the new style or modern dating system. In the old style English calendar, the new year began, and hence the year changed, on March 25.

Despite the telltale signs that the 1593 data are spurious, the series was actually fairly well constructed. In view of the ''goodness'' of the construction, it is possible that the series were based on some real data that have yet to come to light. The 1593 data illustrated here are the data that appear under 1592 in Graunt (1665a,b) with the 258 plague deaths on July 21 replaced by the more reasonable 958. The data are shown in Table 2. A plot of the cumulative totals of deaths due to the plague is given in Figure 10. There is an obvious change point from week 16 to 17 or equivalently June 30 to July 7. The cumulative plague deaths plotted for the data series for 1603, 1625, and
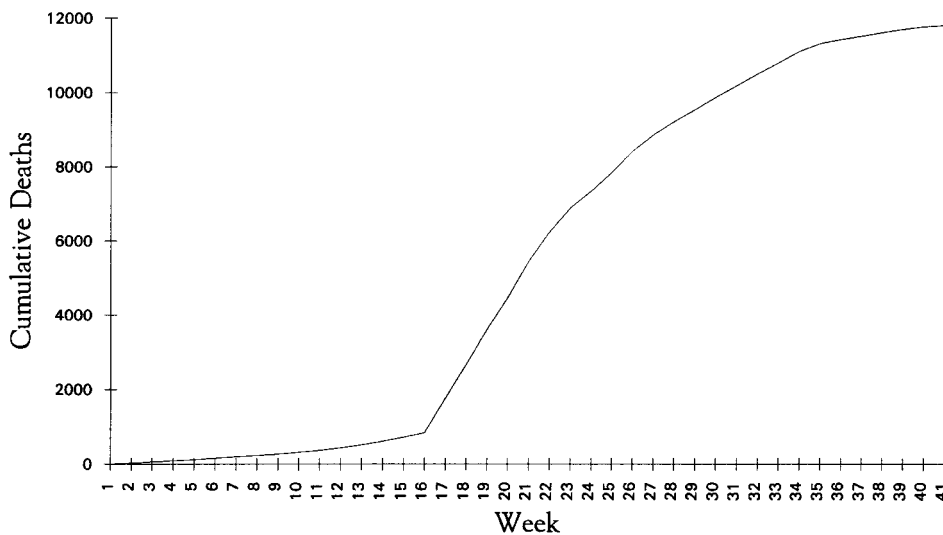

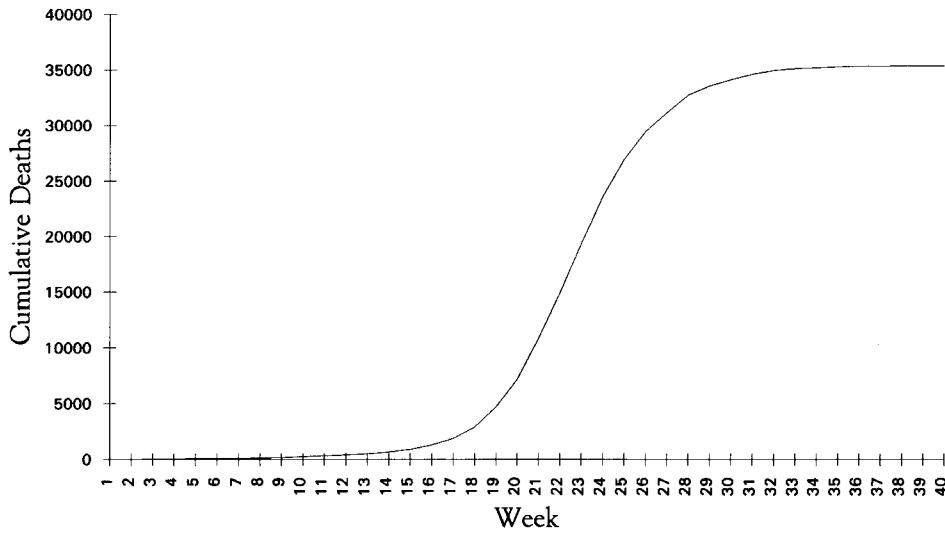*Fig. 10.   Cumulative plague deaths in 1593*

Fig. 11. Cumulative plague deaths in 1625

1636 all show the same basic S-shaped curve without the change point. The same is true for plots of plague data from 1665, taken from Graunt (1665b), among others. An example plot is for the 1625 series shown in Figure 11.

Several models are available which may be fit to the cumulative deaths. The model that appears to fit the data best is part of the extended Richards family of growth curves, in particular

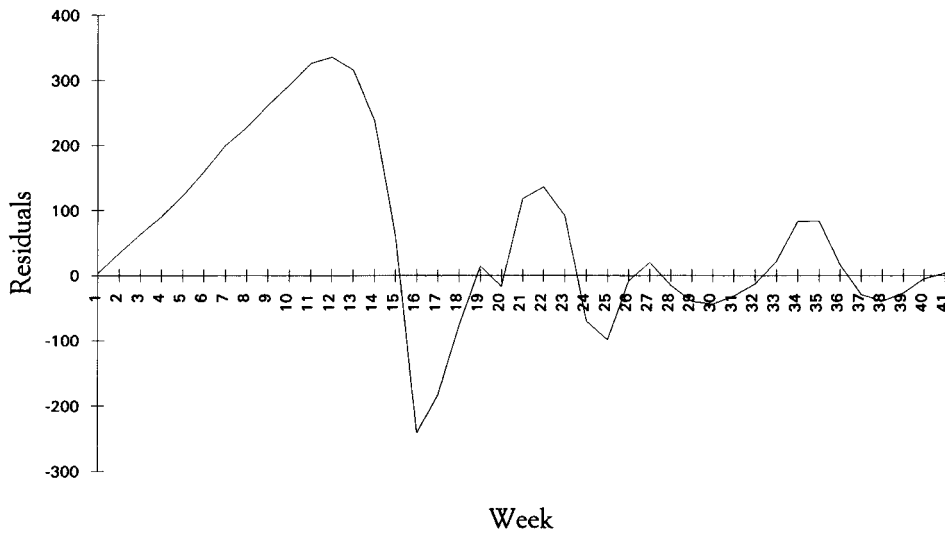$$y_t = \beta\{1 + \exp(\alpha_0 + \alpha_1 t + \alpha_2 t^2 + \alpha_3 t^3)\}^{-1} \tag{1}$$
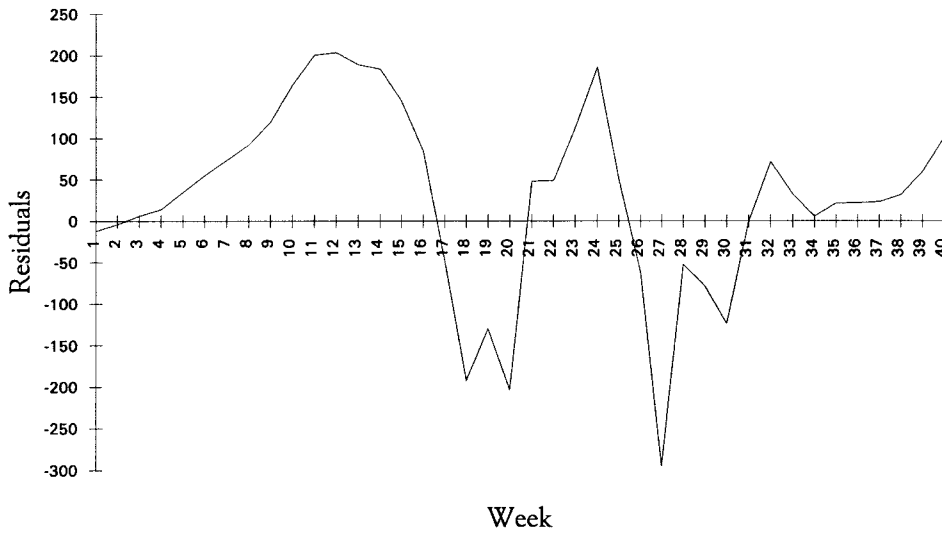

Fig. 12. Residuals for 1593 data

Fig. 13. Residuals for 1625 data

where y_t is the cumulative number of deaths to week t. Using least squares to estimate the parameters, Model (1) provides a reasonably good fit to data series from 1603, 1625, 1636, and 1665. All series have common but distinctive patterns to the residuals. For the data from 1593, Model (1) was modified to take into account the change point at $t = 17$. The modification which fit the 1593 data the best was to make the following parameter replacements in (1): α_0 by $\alpha_{01} + \alpha_{02}\delta$, α_1 by $\alpha_{11} + \alpha_{12}\delta$, and α_2 by $\alpha_{21} + \alpha_{22}\delta$, where $\delta = 1$ or 0 depending on whether or not $t \leq 16$. Once the change point has been accounted for in the 1593 series, the residuals show the same pattern as all other series. Residual plots
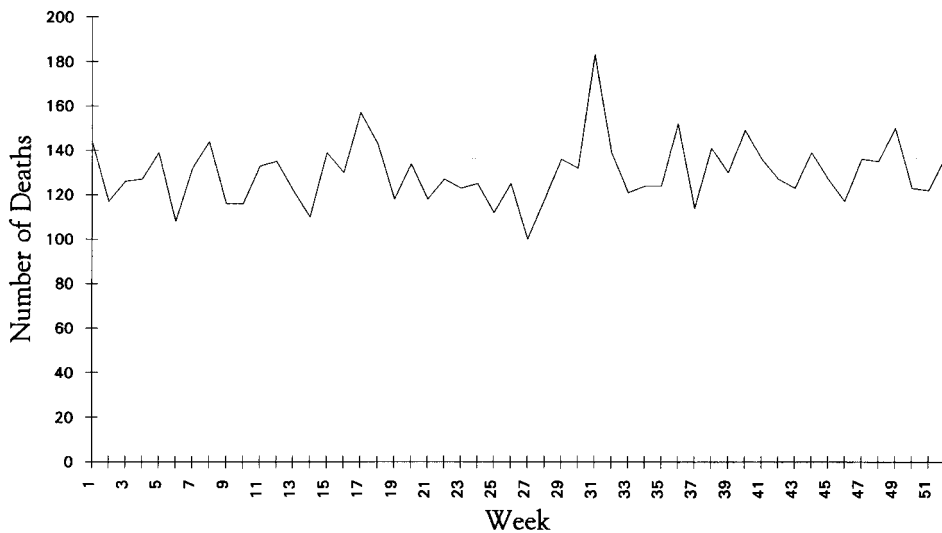
Fig. 14. Non-plague deaths 1608
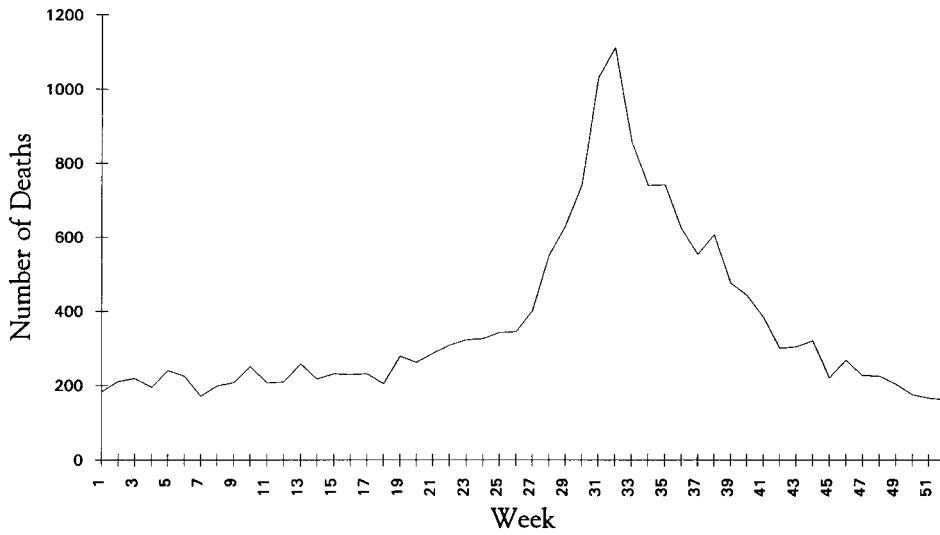
Fig. 15.   Non-plague deaths 1625

for the 1593 and 1625 data are shown in Figures 12 and 13 respectively. The inference from these residual plots is that, with the exception of the change point, the data engineer in 1636 was quite good at reproducing the general pattern of a plague epidemic.

Another indication of the goodness of the general form of the construction is the under-count of plague deaths during the height of a plague. Figures 14 and 15 were obtained from data in Bell (1665). Both show plots of the total number of deaths due to causes other than the plague, i.e., total deaths minus plague deaths. Figure 14 is fairly typical of the time series in years relatively free of the plague. Figure 15 shows that as the plague took

Fig. 16.   Non-plague deaths in 1593

hold in 1625 around week 27 (June 23), the number of reported non-plague deaths rose substantially. This indicates a substantial undercount in the number of deaths due to the plague. Figure 16 shows the same plo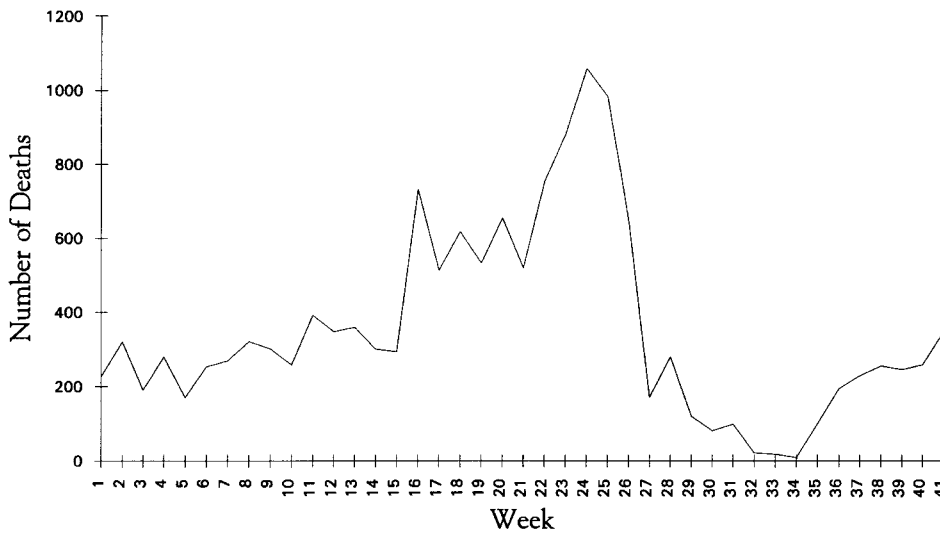t for the data in 1593. The plot roughly parallels what was happening in 1625. The phenomenon of the undercount is crudely present in this plot.

If the 1593 series was not adapted from another data source with a natural change point due to, for example, adding more parishes, the change point at week 16 (June 30) provides one possible clue as to the method of construction of the series. The series can then be divided into two parts, data on or before June 30 and data after June 30. The observation for March 17 can be ignored since it was probably not part of the original series. The plague deaths at July 21 have been set to 958 rather than 258; it is conjectured in Appendix III that 258 was a typographical error copied by authors in 1665. The total deaths and deaths due to the plague for the two sub-series of the 1593 data are shown in Table 2. Here is a conjectured reconstruction. The second series of 25 weekly plague deaths was constructed first. It may be noted that there is a nice symmetry to this sub-series. Starting at the beginning of this series, six successive pairs of final digits in the counts sum to 10

Table 2.   *1593 – Weekly series of deaths and deaths due to the plague*

| Date	Deaths	Plague deaths	Date	Deaths	Plague deaths
March 24	351	31	July 7	1440	927
31	219	29	14	1510	893
April 7	307	27	21	1491	958 (258?)
14	203	33	28	1507	852
21	290	37	August 4	1503	983
28	310	41	11	1550	797
May 5	350	29	18	1532	651
12	339	38	25	1508	449
19	300	42	September 1	1490	567
26	450	58	8	1210	563
June 2	410	62	15	621	451
9	441	81	22	629	349
16	399	99			
23	401	108	29	450	330
30	850	118			
			October 6	408	327
			13	422	323
			20	330	308
			27	320	302
			November 3	310	301
			10	309	209
			17	301	107
			24	321	93
			December 1	349	94
			8	331	86
			15	329	71
			22	386	39
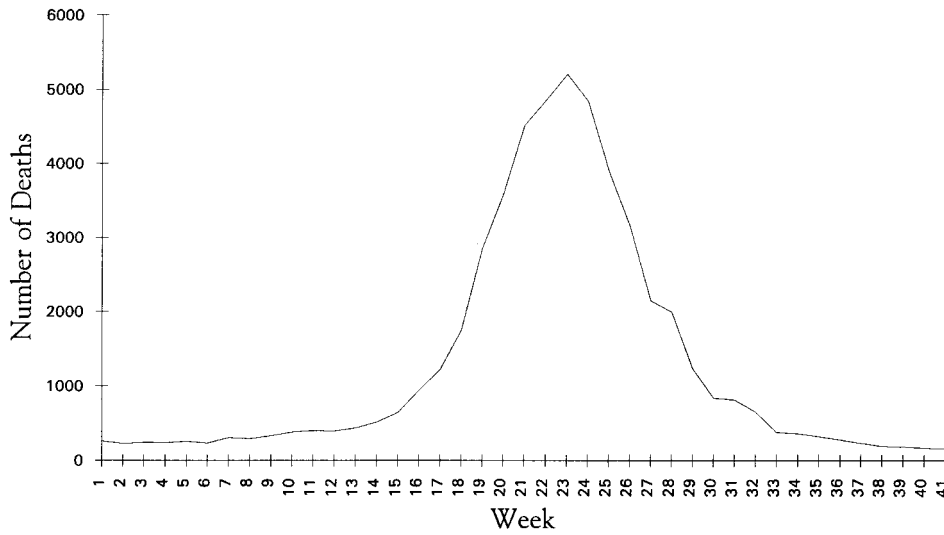
Fig. 17.   Total number of deaths in 1625

until the thirteenth or middle week whose final digit is 0. The remaining six successive pairs of final digits in the counts also sum to 10. In the first 12 weeks of the second series, the first five observations start at a plateau (850 to 980) and then generally decrease. The same is true of the final 12 weeks but with the plateau in the area of 300 to 330 deaths. Once the series of weekly plague deaths were completed for the final 25 weeks, the series for the first 15 weeks was constructed. In this sub-series many, but not all, successive pairs of final digits in the counts sum to 10. Finally, the complete series showing the total number of deaths was constructed. This series has many final digits given as 0 and many successive pairs of final digits summing to 10. The forger of this series got the
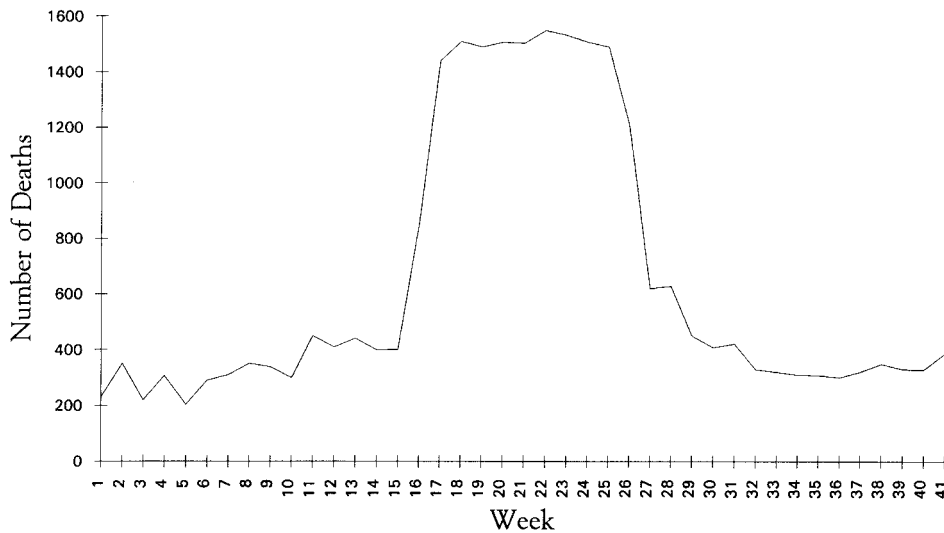

Fig. 18.   Total number of deaths in 1593

general flavour of the trend in the total number of deaths throughout the plague. This may be seen on comparing Figures 17 and 18. Figure 17 shows the deaths during the plague of 1625. Figure 12 shows the same for 1593. The hump in the graph for 1593 is flat at the top, rather than peaked as seen for 1625, and the rise to and decrease from the peak of the plague is much faster in 1593 than 1625.

The 1593 series that appears as 1592 in Graunt (1665a,b) was probably in Graunt's hands as early as 1662. Evidence of this is taken from a curous conclusion that appears in Graunt (1662a, p. 36) without supporting data.

''Which also we prove by the sudden jumps, which the Plague hath made, leaping in one Week from 118 to 927: and back again from 993 to 258: and from thence again the very next Week to 852.''

The series of plague deaths 188, 927, 893 (not 993), 258 and 852 are the reported deaths for June 30 through July 28 of the 1592/3 series as it appears in all 1665 publications. The quotation appears in all editions of Graunt (1662a,b, 1665a,b, 1676); the 1592 (or 3) supporting data on which the quotations are based, including the correct number 893, appear only in Graunt (1665a,b, 1676). The quotation from Graunt (1662a, p. 36) is Graunt's only reference to these data in the text. He does not appear to have used these data for any other purpose so that the spuriousness of these data has not effect on any other of Graunt's statistical inferences. However, based on the inference he did make from the 1593 data, Graunt must have considered these data to be genuine.

4.   Seventeenth Century Uses of the Data

Others, besides Graunt, tried to make some use of the data in the Bills of Mortality. These were Henry Oldenburg (1615–1677), Roger L'Estrange (1616–1704) and John Gadbury (1627–1704). Henry Oldenburg was a natural philosopher and a man of letters who was secretary to the Royal Society from its inception in 1660. Roger L'Estrange was a writer and journalist. He edited and published the newspaper *The Intelligencer* that ran from August of 1663 to early 1666. In 1663 King Charles appointed L'Estrange to the position of the government censor or in the terms of the day ''surveyor of the imprimery.'' John Gadbury was an astrologer. Biographies of these three individuals appear in the *Dictionary of National Biography* (Stephen and Lee 1922).

L'Estrange's (1665) early comments on the plague of 1665 are an attempt to fiddle the published statistics, possibly to assuage people's fears over the growing epidemic in London. An article dated June 24, 1665, states (p. 500):

''Since it hath pleased God to suffer this City to be visited with the Plague, it has been the business of several people to report the mortality to be much greater, and the sickness to be much more general then God be thanked it is; whereas within the walls of London there dyed but 10 of the Plague the last week; There were but 19 Parishes of 130 Infected; and very near two thirds of the whole number dyed out of One of the said Parishes; and according to the discourse of the City, we hope that the next Bill there may be some abatement.''

The problem with this statement is that the total number of deaths for all parishes, not just

parishes within the walls of the city, in the Bill of Mortality for the week to which L'Estrange was referring (June 20) was 168. The number 19 is correct but misleading. The total number 168 is 50% greater than the previous week and almost quadruple the number two weeks previous.

As the plague progressed, L'Estrange (1665, p. 632) became much less biased in his reporting. He made one interesting comment on the data on July 22 of 1665. On that day L'Estrange began to note the relationship between the number of deaths and crowding and filth in the city. He writes:

''The last weeks Bill of the Plague amounts to 1,089; of which number 867 dyed in Ten of the Out-Parishes: Within the Walls of the City there died only 56; and very few of them but in close and blind Allyes.''

A later article dated August 14 (p. 717) is more specific:

''In the City, (that is to say in the Close and filthy Allyes and Corners about it) the Plague is very much Encreased, but in the broad and open streets, there is but little appearance of it. The last Bill reckons 2,817 of the Plague where of 208 within the walls of the City, The main part of the rest in halfe a score of the Out Parishes; and those too, in the sluttish parts of those parishes where the poor are Crowded up together and in multitudes Infect one another.''

A related assessment was made by Oldenburg but not from the published data. In a letter dated August 23 to Robert Hooke, Oldenberg (1966, p. 479) writes:

''The sickness grows still hotter here, though I find all by my own, and other men's observations, that very few of those houses whose inhabitants live orderly and comfortably, and have by nature healthy constitutions, (you must take all these together) are infected; and I can say, (God be praised for it) that as yet not one of my acquaintance, except an under-postmaster, who lived closely and nastily, and had all sorts of people coming to his house with letters is dead; so that, generally, they are bodies corrupted, and persons wanting necessaries and comfortable relief, that suffer most by this contagion.''

John Gadbury made some astrological predictions on the course of the 1665 plague. Today we might dismiss such predictions as coming from some fringe group of quacks and cranks. In the mid-seventeenth century astrology was taken seriously. Astrology was in its heyday during the Civil War and Interregnum (1642–1660) and then went into decline. By the early eighteenth century astrology had gone through a substantial decline and change (Curry 1989). There were two kinds of astrology practiced in the seventeenth century: natural and judicial. Natural astrology dealt with predictions of natural phenomena such as the weather and its effect on agriculture. The prediction of the course of the bubonic plague epidemic made by Gadbury (1665) falls under natural astrology. Judicial astrology was concerned with individuals. This came in the form of precise predictions about certain individuals or advice given to these individuals. Judicial astrology was strictly controlled by the state until official censorship collapsed in 1641. Strict controls were again instituted after the Restoration. The censors were concerned about prophecies of a political or religious nature. Curiously, there was little or no censorship during the Interregnum.

Gadbury was not the first to analyze plagues by the stars. In the ten years prior to the plague of 1665, several astrologers made predictions about coming plagues. Sir George Wharton (1655) correlated outbreaks of the plague in England with the position of Saturn in the sky. He predicted an outbreak of the plague in 1655 that did not occur. William Lilly (1658), a noted English astrologer, made an astrological prediction of plague in 1658 which did not occur. Lilly also noted that plagues accompanied the accession to the throne of James I in 1603 and Charles I in 1625. He stressed that his prediction of plague in 1658 was not related to Cromwell's appointment as Lord Protector by Parliament in 1657. It was possibly Lilly that Graunt (1662a, p. 40) was referring to when Graunt refuted the connection between outbreaks of the plague and the accession of monarchs. Richard Edlin (1664) finally made a correct prediction of plague for the following year. His prediction was based, in part, on two conjunctions of Saturn and Mars in the same sign. It is of interest to note that Gadbury (1665), in interpreting the same astrological data, says that the plague should have begun in late 1664 but this prediction was confounded by severe frosts in late 1664.

Instead of predicting the outbreak of plague, Gadbury (1665) tried to predict the course of the 1665 plague. His predictions were based on an analysis of the weekly plague deaths from the published statistics for 1593, 1603, 1625 and 1636 plagues. For each of these plagues the dates at which they increased, peaked and declined were noted by Gadbury. The increases and peaks of the plague were correlated with astronomical events surrounding the planets Mars and Saturn. The abatement of the plague was correlated with events about Venus and Jupiter. The positions of these planets in the sky in 1665 were used to predict the growth and decline of the plague that year. Had Gadbury picked a different correlate to try to predict the course of the plague, he might not have been relegated to the trash heap of statistical history.

Gadbury's predictions were in some places vague, as expected, and in other places unexpectedly precise and accurate. Gadbury (1665, p. 20) accurately predicted the peak of the plague in mid-September. He became much more vague about October and then predicted the abatement of the plague throughout November and December. This latter prediction was one that could easily be made independent of the stars. It was well known at the time that the bubonic plague tended to end with the frost of the coming winter. As noted already, Gadbury (1665, p. 19) himself was aware of the effect of frost on the plague.

Gadbury's early accuracy in prediction may be related to the date at which the book was printed rather than his astrological prowess. The book was passed by the censor Roger L'Estrange on August 25, 1665 (Gadbury 1665). This meant that L'Estrange approved the manuscript on that date. It then had to be typeset. On approximately September 26 of 1665, Oldenburg (1966, p. 523) referred to Gadbury's predictions so that the book was in print by that time. It is not inconceivable that Gadbury added some material or corrected his predictions for September at the typesetting stage. Changes to a manuscript at the typesetting stage by another author, after being approved by L'Estrange, is recorded in L'Estrange's entry in the *Dictionary of National Biography* (Stephen and Lee 1922). Oldenburg did not think much of Gadbury's astrological work but commented that (Oldenburg 1966, p. 523) ''he has some natural observations yt make his pamphlet worth the money.''

Graunt's (1665a,b) own prediction of the peak of the plague in 1665 was quite accurate. Graunt estimated that from 1625 the population of London had increased by a factor of 13/8. The total number of deaths in 1625 peaked at about 5,200 so that the expected peak for 1665 could be calculated as 13 (5,200)/8 or 8,450 (Graunt gives 8,400). The total number of deaths actually peaked at 8,297 in the week ending September 19, 1665. The previous week the death count was 7,690 and the week before was 8,252.

5.   A Discussion of the Accuracy of the Genuine Data

Notification that a death had occurred in a parish was made when a message was sent to the church to have the church bell rung or to have a grave prepared (Graunt 1662a, p. 11). The causes of death as they appear in the Bills of Mortality were determined by searchers, appointed by the parish, who viewed the body. These searchers were elderly, poor women. A general description of them appears in Bell (1951, pp. 17–20).

Two criticisms relating to the accuracy of the Bills of Mortality appear in Graunt (1662a) and later editions. These criticisms were highlighted by Ogle (1892, p. 441) in his decision of how untrustworthy the Bills of Mortality were. The first criticism cited by Ogle was that Graunt (1662, p. 35) demonstrated that in a plague year, deaths due to the plague were underreported. The second was that Graunt (1662a, p. 24) noted that in cases where the cause of death is not obvious, the searchers, ''after the mist of a Cup of Ale, and the bribe of a two-groat fee,'' might not provide the correct cause of death. These items in Graunt have been used by various authors, Ogle (1892) and Bell (1951) among them, to criticize the women searchers as incompetent. In a vitriolic attack, Wilson (1927, p. 66) went so far as to say,

''Viewers and searchers may have been ancient, but they were not usually honest, discreet and sober. Respectable women would hardly accept so unpleasant an office, and it must have been given to any old hags who were willing to risk its dangers.''

The searchers were also labeled with the modern stigma of being illiterate. This alleged incompetence in their work led to inaccuracies in the Bills of Mortality. The interpretation of these criticisms appears to be at odds with what Graunt himself says. In the Index to Graunt (1662a) and later editions there is an entry, ''The ignorance of the Searchers no impediment to the keeping of sufficient, and usefull Accompts.'' Upon reading the material related to the index entry, this section of the book appears to be fairly supportive of the searchers. Glass (1963, p. 8) notes that Graunt had ''no high regard for the searchers'' but at the same time cites this section of Graunt (1662a) and notes that Graunt was much more critical of the underreporting of deaths due to the plague. The whole issue seems muddied when Bell, in his book (Bell 1665) and in the yearly Bill of Mortality for 1665 (cited by Ogle 1892), goes to great lengths to defend the searchers against charges of avarice or incompetence and yet, in his book, praises Graunt at the same time.

The whole issue may be resolved when *Reflections on the Weekly Bills of Mortality* ([Graunt] 1665a) is brought into the picture. The anonymous author of *Reflections* picked up on Graunt's observation of the underreporting of plague deaths in a plague year. After lifting some material from Graunt, the anonymous author concluded ([Graunt] 1665a, p. 2):

''Whence we may collect a good rule, viz. That whereas it is doubted we have not a true

account of the number that die at this time of the Plague, the poor Searchers, out of ignorance, respect, love of money, or malice, returning, it's suspected more or less as they are inclined; we may discern the truth, by comparing the number that died of other diseases, and the casualties the weeks immediately before the Plague begun, and the number reported to have died every week, of those diseases and casualties since, and observing the surplusage that die now above what did then of those diseases, are indeed dead of the Plague, though returned under the notion of those other diseases.''

It is probable that Bell (1665) was responding to the author of *Reflections* rather than to Graunt.

What the result of this has been is a general condemnation of the work of the searchers since the 1660s. When the issues are examined a little more closely there has perhaps been a mistaken bias against these poor, elderly and illiterate women. No doubt there were reporting errors. However, the main issues related to the accuracy of the Bills of Mortality are first, and foremost, the sheer volume of work that had to be done during a plague and secondly the problem of competing risks where a person could be weakened by the plague and die from other causes.

Ogle (1892) questioned the accuracy of the Bills of Mortality because, in part, they did not agree exactly with the parish registers he examined. As noted here already, there is a high correlation, though not exact agreement, between the yearly returns in the Bills of Mortality and the yearly death totals in the parish registers. Ogle seems to have put much faith in the accuracy of the parish registers. In spite of Ogle's faith there may be several problems with the registers themselves. The parish registers sometimes record burials in the church or churchyard of those who died in other parishes. As a result, the death could be counted in one parish for the Bills of Mortality and in another for the register of deaths or burials. Other examples of problems are evident. The register of St. Mary Aldermanbury for 1625 states that both the church's minister and clerk died in the plague. A list of deaths without dates is given for the year; whoever wrote the list in the register states that this was the best he could do. Sometimes one finds in the registers a burial date that is out of chronological order. The minister or clerk forgot to record the burial on the day of the event but did it at a later date. It is then not hard to imagine forgotten entries altogether.

That bribes were made and taken to change the cause of death, there is almost no doubt. One encouragement to bribery was the rule that houses infected with the plague would be shut and marked with special signs. All those who were infected or who were associated with the infected were quarantined in the house (Wilson 1927, pp. 55–64). However, the misreporting of plague deaths was not restricted to the searchers. Writing in his diary on August 30, 1665, Samuel Pepys (1972, pp. 206–207) mentions an encounter with the parish clerk of St. Olave's, Hart Stret, in which the clerk stated that there were nine deaths due to the plague that week but that he reported only six. In this case, the searchers, who reported the cause of death to the clerk, were honest and the clerk was not.

With regard to the accuracy of reporting the cause of death, Graunt (1662a, pp. 13–14) admitted that there could be reporting errors but thought ''it matters not to many of our purposes, whether the Disease were exactly the same, as Physicians define it in their books.'' Although, as Graunt noted, it was sometimes difficult for the searchers to

determine the cause of death from the visible or reported symptoms, such was not the case with the bubonic plague. An individual who had succumbed to the plague could be easily identified as such. The symptoms were well known. A very detailed description of the symptoms is given in the *Decameron* by Giovanni Boccaccio (1982, pp. 8–9). The *Decameron* was originally written at least 300 years prior to the 1665 plague in London. The massive underreporting of the plague, estimated by Graunt (1662a, p. 35) to be 11,000 deaths in 1625, could not have been due to incompetence. It also seems unreasonable to attribute it to large-scale bribery.

One of the phenomena present in the underreporting of plague deaths is evident when Figures 14 and 15 are examined. These graphs show weekly deaths due to reported causes other than the plague for the years 1608 and 1625 respectively. On examining the original data in Bell (1665), it may be noted that during 1608 there was a mild outbreak of the plague from about July 31 (week 31) through to the end of the year with the numbers of plague deaths reaching over 100 in September and October (weeks 36 through 45). The approximate stability of the non-plague deaths is apparent in Figure 14. At the other extreme, Figure 15 shows a massive underreporting of plague deaths during a major outbreak of the plague in 1625. Some underreporting is apparent beginning about week 22 and continuing to about week 26. At this point the reported deaths due to the plague climbed to less than 200 per week. Once reported plague deaths reach approximately 400 or more per week, week 28 in this case, then massive underreporting of plague deaths begins to occur. The same phenomenon of massive underreporting of plague deaths, once the weekly death toll has reached approximately 400, is apparent in plots of non-plague deaths from the epidemics of 1603, 1636 and 1665. One interpretation of this phenomenon is that the searchers became grossly overworked, resulting in major reporting errors, once the death toll reached a certain threshold, here estimated to be about 400 plague deaths per week. This interpretation is confirmed to a certain extent by Pepys (1972, p. 208) writing on August 31, 1665:

''Every day sadder and sadder news of its [the plague] encrease. In the City died this week 7,496; and of them, 6,102 of the plague. But it is feared that the true number of the dead this week is near 10,000 – partly from the poor that cannot be taken notice of through the greatness of the number, and partly from the Quakers and others that will not have any bell ring for them.''

In summary, perhaps history has been more than a tad unkind to John Bell, his ''antient Matrons, sworn to their Office'' and their work in the seventeenth century. The office of searcher was abolished in 1836 with the coming of civil registration in England. By that time the searchers were generally viewed as unreliable. Criticisms of them appeared in popular encyclopedias. That problems with the reliability of the searchers were noted in the nineteenth century (Wilson 1927, p. 66) does not necessarily translate into the same problems 200 years earlier.

6. Conclusions

Several general conclusions may be reached from the discussion presented here.

Some of the criticisms of the accuracy of the Bills of Mortality in the seventeenth

century have been misguided. In particular, the Bills in their total death counts conform quite closely to what is recorded in the parish registers. Graunt's criticism of the accuracy of the Bills of Mortality has been misinterpreted by many. The source of this misinterpretation has been Bell's (1665) written reaction to criticisms of the reliability of his searchers. Bell was reacting to the author of *Reflections on the Weekly Bills of Mortality* rather than to Graunt. The misinterpretation of Graunt's criticisms has resulted in unfair and excessive criticisms of the women in the seventeenth century who were appointed to determine and report the causes of death.

None of the surviving published weekly data or data by parish from the plague of 1593 is genuine. The weekly data were probably constructed in September or October of 1636 and the data by parish were probably constructed in 1665. Those who constructed sets of data did a reasonable job. The weekly data followed the general trends that are expected in epidemics. The construction of the data by parish relied on the assumption of the stability of certain ratios. The person who constructed the data by parish and, at the same time, the author or compiler of *Reflections on the Weekly Bills of Mortality* was not John Graunt.

There were some others who had some statistical insights into the Bills of Mortality other than Graunt. However, none of these individuals reached the depth and breadth of Graunt's analysis. Only one small part of Graunt's work was affected by the spurious 1593 data. Graunt's analysis and resulting conclusions were taken from genuine data in other years.

Appendix I. Some Evidence Against Graunt's Authorship of *Reflections on the Weekly Bills of Mortality*

Graunt's authorship of *Reflections on the Weekly Bills of Mortality* is very doubtful. Here are three reasons.

1. Graunt appears to have been fairly careful about his data sources. In the Preface to his *Natural and Political Observations on the Bills of Mortality*, Graunt (1662a) mentions that he looked at all the printed Bills of Mortality that he could find and that he visited the Hall of the Company of Parish Clerks. That Graunt would construct data, especially when the 1636 yearly Bill was available from the Parish Clerks (and later published by Bell (1665) in his own book), seems very much out of character.
2. Bell (1665) praises Graunt and his work, referring to Graunt as ''that worthy and ingenious Gentleman.'' It seems odd to refer to Graunt in that way if Bell believed that Graunt was the author of *Reflections*, the author of which, according to Bell, was one of the ''ignorant scribblers.''
3. A look at the publishers of *Reflections* and *Natural and Political Observations* provides an interesting insight. Brief biographies of the publishers of this time are found in Plomer (1968). Graunt (1662a) and all subsequent editions were published by James Allestry and his partners John Martyn and Thomas Dicas. Allestry was the one of the biggest booksellers in London. From 1660 on he was the bookseller and publisher to the Royal Society. His shop was frequented by the rich and the literati. When the fourth edition of *Natural and Political Observations* (Graunt 1665b) was published at the height of the plague, Allestry had the book printed by William Hall,

the University printer in Oxford. The first edition of *Reflections on the Weekly Bills of Mortality* was published by Samuel Speed. In 1666 Speed was imprisoned for selling law books published during the Commonwealth. The publication of a plagiarized version of Graunt's work for quick profit during the height of the plague seems in character for Samuel Speed.

Appendix II. Data Inaccuracies in the Yearly Bill for 1625

In the yearly data by parish for 1625 a good argument can be made that the observation of 401 deaths for St. Mary Magdalen is incorrect in the Bill of Mortality. Bell (1665) provides a table of weekly death totals for the time period in question as well as yearly totals by parish. The published weekly death totals sum correctly to 54,265. The yearly total, the sum of which is also given as 54,265 is broken into three parts: (1) 14,340 deaths in parishes within the walls, (2) 26,972 deaths in parishes without the walls and (3) 12,953 deaths in the out parishes. Now when the deaths are totaled for the 97 parishes within the walls they sum to 15,277 rather than 14,340. For the yearly totals there must have been some transcription or addition errors by the Company of Parish Clerks at the time of publication of these data in 1625 or 1626. The 401 deaths at St. Mary Magdalen is probably one of these errors. When the ratio of plague deaths to the total deaths is calculated for the 97 parishes within the walls there are two unusually small ratios. These are 0/7 for St. John the Evangelist and 23/401 for St. Mary Magdalen. The first ratio is not unusual in view of the small number of deaths in total. All other ratios are above 0.25.

There are other errors, either in addition or transcription, in the yearly statistics for 1625. These occur in the list of deaths due to the plague. The sum of the weekly plague deaths is given correctly as 35,417. Like deaths from all causes, the yearly sum for plague deaths is broken into three parts: (1) 9,197 plague deaths in parishes within the walls, (2) 17,153 plague deaths in parishes without the walls and (3) 9,067 plague deaths in the out parishes. The problem is that when the appropriate parish statistics are summed in the table the results are: (1) 9,097 (2) 17,063 and (3) 9,066.

Appendix III. Reconstruction of the 1593 Constructed Data

The construction of the false series of weekly data for 1593 probably dates from 1636. A reasonable scenario for the construction might be taken from several surviving broadsides with weekly plague data published in 1636 and 1637. These broadsides can be dated to a particular week since they contain data for the current year. After the last date in the printed series there are often manuscript additions to the data. When a weekly dating of a broadside is given in the discussion that follows, it refers to the last printed date of the most recent entry of data in the broadside. A broadside published in May of 1636 (Anonymous 1636a) contained a short series of weekly data ending May 26. Throughout June, as death toll continued to rise, several broadsides (Anonymous 1636b,c) appeared which contained not only data for the current year but also weekly series from earlier plagues in 1603 and 1625. Then in early October of 1636 a broadside (Anonymous 1636d) appeared with a weekly series dated 1593 as well as the series from 1603, 1625 and 1636. The 1593 series begins on March 17 with 31 deaths due to the plague. It continues with: March 24 – 29 plague deaths, March 31 – 27 plague deaths, April 7 – 33

plague deaths, and so on. Of importance is that the plague deaths for July 14 is recorded as 958. The 1593 series next appear (along with data from 1603, 1625, 1636/7) in a broadside from late March or early April of 1637 (Anonymous 1637). There are three changes to the 1593 series in this broadside. The entry for July 14 is 258 plague deaths instead of 958 and the entry for September 22 is 130 plague deaths instead of 330. Finally, the year of the series is given as 1592 instead of 1593. The 1636 broadside with the 1593 series was sold by Thomas Lambert and the broadside from the next year was sold by Richard Harper. Both were booksellers who dealt extensively in broadsides (Plomer 1968).

In the 1665 publications of the 1593 series there are some important similarities between and differences from the two versions of the series published in the 1630s. In 1665, all the published series begin with 3 reported plague deaths on March 17. Then this is followed by the counts of plague deaths 31, 29, 27, and 33 for March 24, 31, April 7 and 14 respectively. In other words the series is reproduced in 1665 with an initial observation of 3 plague deaths and the remaining observations the same as reported in the earlier broadsides, but reported one week later. The 958 or 258 plague deaths for July 14, as reported in the 1636 broadside or 1637 broadside respectively, are consistently reported as 258 plague deaths for July 21 in all 1665 publications. However, the 1637 broadside was not the source for the 1665 publications. All 1665 publications consistently show 330 plague deaths for September 29, previously September 22 in the 1630s broadsides. Some 1665 publications show the plague year as 1592 and others show it as 1593. In the published books Graunt (1665a,b) reports data for 1592 and Gadbury (1665) uses 1593. In the surviving broadsides, Anonymous (1665b) has 1592 as the date of the earliest plague. Several versions of this broadside survive. They may be dated by the latest week for which data are printed for the 1665 plague. Copies in the British Library, the Guildhall Library and the University of London were printed in various weeks from July through November of 1665. There are two versions of another 1665 broadside, this one published for Peter Cole (Anonymous 1665a). The first version contains no data for 1665 and has the 1590s plague year as 1593. A second version contains data for 1665 and dates the 1590s plague as 1592. One explanation for this change in the year of the earliest plague might be due to the publication of Bell (1665). After chastising the ignorant scribblers and then running through a short history of the Bills of Mortality, Bell (1665) quotes Graunt as saying that 1592 was a ''very pestilential year.''

The evidence thus far points to source material for the 1665 publications which has not survived. Two plausible reconstructions of the source material are presented. The first reconstruction is that Anonymous (1636d) is the original construction. This broadside was copied with a typographical error – 258 plague deaths replacing 958 for the entry of July 14, 1593. This broadside, now lost, was copied by someone else. Since other sources from 1603, 1625 and 1636 show a small number of plague deaths at the beginning of the series, someone else decided to insert three plague deaths at the beginning of the series and redated the rest of the series. This version, now lost, became the source material for Graunt (1662a) and other publications in 1665. The first lost broadside was also copied with another typographical error by Anonymous (1637). Another plausible reconstruction is that between July and October of 1636 someone constructed the 1593 series and published it in a broadside. The series began with 31 plague deaths on March 17. The writer of Anonymous (1636d) decided that 258 plague deaths for July 14 (later July 21)

was unreasonably low (he was correct in his decision) and changed it to 958. The original construction was copied in 1637 (Anonymous 1637) with a typographical error for the entry of September 29. Someone else decided to insert three plague deaths in the original construction at the beginning of the series. This broadside, which has not survived, was the source for Graunt (1662a) and for all other publications in 1665.

7. References

Note: Most English books published before 1701 are available on microfilm in many academic libraries. These books may be found on the microfilms via their catalogue number. In the reference list below, the Pollard and Redgrave (1976) number is given for books published prior to 1641 and the Wing (1948) number is given for books published between 1641 and 1700.

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