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Recognition of historic influenza epidemics from parish burial records: a test of prediction from a new hypothesis of influenzal epidemiology

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SUMMARY

On the current conception of the epidemiology of epidemic influenza, as caused by a mechanism of direct spread of the virus from the sick, epidemics must have travelled much more slowly in former times than at present. In contrast, a new hypothesis involving virus latency with seasonal reactivation predicts that in previous centuries influenza epidemics would have spread across the country at much the same speed as in the twentieth century. The study of burial registers in Gloucestershire parishes reported in this paper shows that lethal influenza epidemics at least as early as the sixteenth century can be recognized and dated as at present by the characteristic brief but large excess mortality that they cause. Examples are given showing that the character of the excess mortality caused by lethal influenza has not changed significantly over the centuries, a finding that supports the prediction of the new hypothesis but would not be expected on the current conception of influenzal epidemiology.

In each century, influenzal excess mortalities in Gloucestershire parishes coincided with the date of the relevant influenza epidemic as recorded from widely different parts of Britain, thus further supporting the prediction of the new hypothesis as against current conceptions.

INTRODUCTION

Influenza viruses cause illness almost every year (Glezen *et al*, 1982) and vast epidemics in many years. These usually occasion some deaths especially among the infirm and the elderly. From time to time a more lethal epidemic results in a characteristic elevation of the general mortality figures, causing them to rise abruptly within two or three weeks far above the value expected for the time of year and allowing them to return to the expected level almost as rapidly. The peak of this brief 'excess general mortality' caused by lethal epidemic influenza is usually two or three times the expected value for the time of year and may be far higher (Housworth & Langmuir, 1974; Alling, Blackwelder & Stuart-Harris, 1981; Glezen *et al.* 1982).

Careful examination of the phenomenon of influenzal excess mortality has hitherto been confined to twentieth-century epidemics. The study reported in this paper was undertaken to determine whether lethal influenza epidemics in previous

centuries similarly imposed a specific pattern upon the general mortality figures, and might therefore be used for dating such epidemics even in the absence of diagnoses of cause of death. The method seemed unlikely to succeed if our current conception of the epidemiology of influenza were correct. If, as is commonly believed, epidemics are caused by influenza virus spreading directly from the sick, the slower and more scanty transport among the smaller and sparser population of previous centuries would have protracted the epidemic process and blunted its impact upon mortality. This impeding effect must have operated most powerfully in winter, when the weather combined with the appalling roads to make travelling even more difficult and dangerous. Moreover many other lethal diseases, now negligible, would then have confused the picture.

A recent hypothesis proposes that type A influenza does not spread directly from the sick, but that epidemics have the opportunity to arise when, under a seasonally mediated influence, latent influenza virus is reactivated in symptomless carriers who suffered the disease in a previous season, and that the reactivated virus is transmitted from them to susceptible companions (Hope-Simpson, 1979; Hope-Simpson, 1981). Such an epidemic mechanism attributes most of the geographical spread of influenza to the seasonal movement of the reactivation influence, much less to human travel. The new hypothesis therefore predicts that in previous centuries lethal influenza epidemics would have imposed a pattern on the general mortality not widely dissimilar to that found in the twentieth century. Contemporary records, especially the few that record local morbidity (e.g. Fothergill, 1784), encourage the expectation that, at least as far back as the eighteenth century, the method may be valid. It was therefore decided to attempt to examine the pattern of general mortality in previous centuries, comparing years of recorded epidemic influenza with neighbouring years, and so test the prediction of the new hypothesis, namely that the pattern would be found not to differ widely from the present pattern.

The first stage of the work was to determine if lethal influenza epidemics in previous centuries did in fact elevate general mortalities in the characteristic manner described above, and for this purpose it was decided to examine burial registers of parishes in the county of Gloucester. The results in this paper, suggest that the method is valid at least as early as the mid sixteenth century when parish registers were begun.

METHOD

Parish registers

The study of mortality in earlier centuries relies on the burial records in parish registers begun in this country by Act of King Henry VIII in 1538 and stimulated to better performance in 1558 by Act of Queen Elizabeth I. Skill and vigilance are needed in order to obtain accurate information. The handwriting in the earlier registers differs so greatly from current usage that even the numerals must be learned anew. Some registers, not only the early ones, are illegible, others defective and occasionally erroneous. Many are beautiful. Appendix 1 lists the registers examined.

Key years

From the historical literature of influenza, 'key years' were selected in which an influenza epidemic or an epidemic almost certainly of influenza was recorded. Some epidemics were said by contemporary writers to have been highly lethal, others to have been widespread but non-lethal. Both sorts were studied and examples of each are given in this paper. One example of a lethal influenza epidemic in each century (sixteenth to nineteenth) is illustrated in Fig. 1.

The most useful source for choice of key years was 'Annals of Influenza or Epidemic Catarrhal Fever in Great Britain from 1510 to 1837', an anthology of verbatim accounts, mostly contemporary, prepared and edited by Theophilus Thompson and published by the Sydenham Society in 1852 (Thompson, 1852). Appendix 2 gives data from which graphs of key years in the figures have been derived.

Study-periods

The aim was to obtain dates of all burials from each chosen register for eleven-year periods including each key year. For several such study-periods it proved impossible in some parishes to obtain data for the whole eleven-year period because of defective registers. The average three-weekly totals for the study-period (less the key year and divided by the remaining number of years) are graphed, moving weekly for comparison with key years and for estimation of excess mortalities. (Data in Appendix 2).

Analyses

The dates of all burials in the study-periods were copied from the parish registers. Analysis sheets allowed boxes for 52 weekly totals on each horizontal row, each year being allotted a row. The 31st December of each year was entered as an eighth day in week 52 and February 29th each leap year in week 9, the errors introduced thereby being negligible. Data concerning parishes mentioned in the text but not in the Figures are available from the author, as are those concerning epidemics omitted from this paper for reasons of space.

Each study-period for each parish was allotted an analysis sheet. The analysis sheets were also used for combining the experience of numerous parishes for a single year.

RESULTS

A few characteristic examples of the results are presented in this paper.

The findings for each key year are prefaced by a brief extract from contemporary accounts of the epidemic, or from later historical records, in order to authenticate the epidemic as one of influenza. For most epidemics examined it has been possible to include only a small proportion of the available contemporary comment. The sixteenth century epidemics are the only ones concerning the nature of which some doubt must remain, but Creighton, a judicious medical historian, considers the epidemic of 1558 to have been influenzal (Creighton, 1891, p. 401).

References to original sources have, if available, been included in the bibliography even when the extract had been obtained from a later author.

Square brackets include interpolations into an extract by the present author.

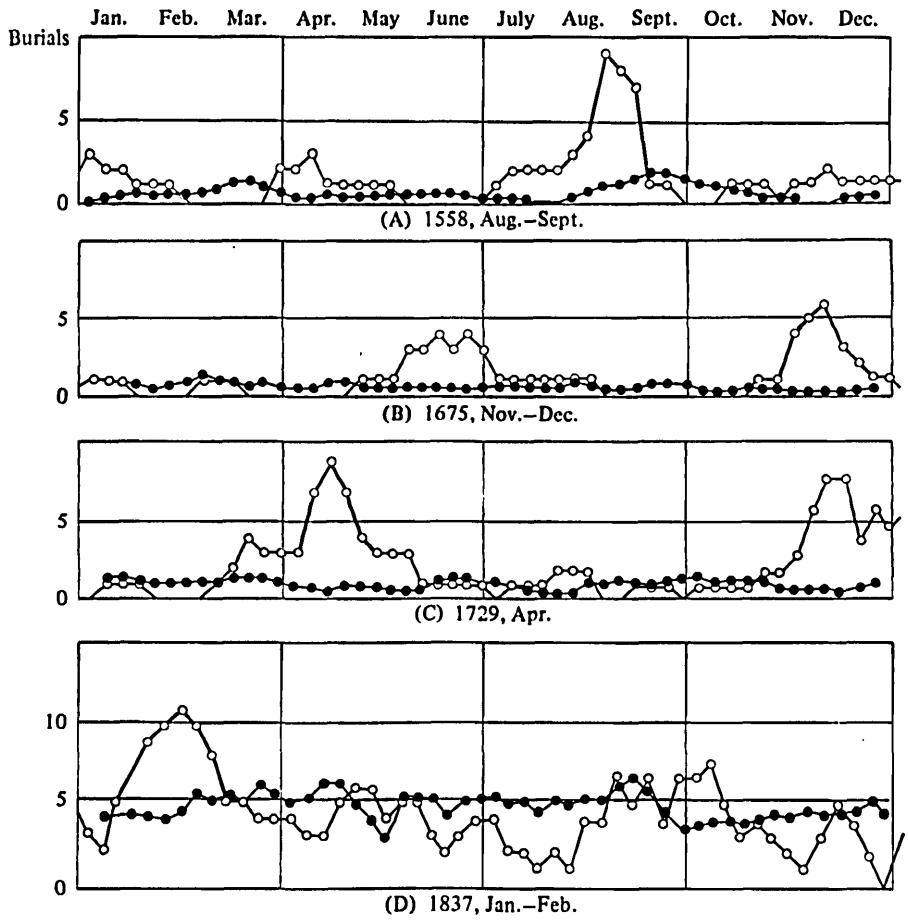

Fig. 1. Burials from Gloucestershire parish records to show in each century, from sixteenth to nineteenth, an example of characteristic excess mortality caused by a 'lethal' influenza epidemic. The records of the epidemic of influenza in the key years came from many parts of Britain, but none from Gloucestershire. The graphs for the key years (O-O-O) show three weeks' totals of burials from the parish register, moving weekly, compared with similar treatment of the average figures of burials from the same register during the appropriate decennium (●-●-●). Parishes and dates as follows. (A) Holy Trinity, Gloucester: 1558 compared with average for 1557–67 less 1558: severe epidemic in records about September 1558. (B) Bibury: 1675 compared with average for 1670–80 less 1675: severe influenza in records November and December 1675. (C) Awre: 1729 compared with average for 1727–37 less 1729: severe influenza recorded in Exeter in April 1729. (D) St Nicholas, Gloucester: 1837 compared with average for 1830–40 less 1837. Severe influenza recorded throughout Britain in January and February 1837.

Epidemic of 1558, studied in the period 1557–67

Extracts from historical literature:

In the beginning of the mayor's year [September 1558] died many of the wealthiest men all England through, of a strange fever [Fabyan's Chronicle, date uncertain].

Harrison, canon of Windsor, says [Harrison in Furnivall, 1890] that a third part of the people of the land did taste the general sickness, which points to influenza [Creighton, 1891].

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It is possible... to collect a few particulars of the prevalent sickness of 1558 in England from casual notices of it. [Necessary because of the remarkable paucity of records made by medical men in Tudor times.] Thus it comes into a letter to the Queen, of September 6, by Lord St John, governor of the Isle of Wight... sickness affected more than half the people in Southampton, the Isle of Wight and Portsmouth (those places being filled with troops under St John's command) and the captain of the fort at Sandown was dead [State Papers, Record Office, quoted in Creighton, 1891, p. 403].

Curiously enough we get an intimate glimpse of this epidemic from a book published some years after... Dr Jones, the author, himself suffered an attack... He then proceeds to compare the sweat, almost certainly the epidemic mentioned in St John's despatch of 6th September 1558, with the sweating sickness of 1551: 'So, in our days, even in King Edward VI's reign, it brought many to their long home, as some of the most worthy, the two noble princes of Suffolk, imps of honour most towardly, with others of all degrees infinite many...' [Jones, ?1564].

The next we hear of this epidemic of the autumn of 1558, is in a despatch from Dover, 11 p.m. 6th October: the writer has 'learnt from the mayor of Dover that there is no plague there, but the people that daily die are those that come out of the ships, and such poor people as come out of Calais, of the new sickness' [Calender of State Papers, 1558]... Here we have the same term 'new sickness' and 'new burning ague' as in... the year before... The very general prevalence... suggests influenza.

A high death rate is, indeed, demonstrable for the year 1558, from parish registers... [Creighton, 1891].

Parish registers studied (annual average of burials 1557–1657 in brackets): Adlestrop (4), Ashchurch (14), Avening (5), Great Barrington (5), Bibury (5), Holy Trinity at Gloucester (11).

Result. Figure 1 A illustrates the abrupt brief excess of burials characteristic of a lethal epidemic of influenza for five weeks in late August and September in the parish of Holy Trinity. Burials in the peak week were nine times the expected value. The registers of Avening and Ashchurch show a similar excess of burials in August and September 1558, as do the six parishes combined.

Epidemic of 1675, studied in the period 1670–80

Extract from historical literature:

In the year 1675... summer weather... lasted... even to the end of October. However it was succeeded by weather very different, viz., sudden cold and moisture. Then it was that coughs prevailed in greater number than at any other time in my remembrance.

No one escaped them, whatever might be his age or temperament; and they ran through whole families... the coughs paved the way to fever... [Sydenham, quoted in Thompson, 1852].

Parish registers studied (annual average of burials 1670–80 in brackets): Ashchurch (7), Alderley (3·5), Avening (1·5), Great Badminton (3), Cirencester (91), Great Barrington (4), Bibury (11·5), St Nicholas at Gloucester (43).

Results. Excess mortality in November and December was evident in the burial registers of all the parishes except St Nicholas. Figure 1 B illustrates the effect of the influenza epidemic on the burials at Bibury where, at the peak, the excess was more than 15-fold the expected value.

Epidemic of 1792, studied in the period 1727–37

This epidemic is of particular interest because it was not discovered from the literature. During preliminary exercises an excess of burials in April 1729 was noticed in the register of a small parish. Much later, during study of the well-documented epidemic of 1775, confirmation was found of a severe epidemic in 1729. Dr John Fothergill had circulated a questionnaire on the 1775 epidemic

(Fothergill, 1784). Dr Thomas Glass of Exeter, answering the request for his views on the hypothesis that the disease in 1775 was contagious, wrote as follows:

> Nor does this distemper seem to arise, which is, I think, the more general opinion, from contagion. For in this city [Exeter], in the year 1729, it was conjectured that two thousand persons at least were seized with it in one night [Glass, quoted in Fothergill, 1784, and Thompson, 1852, pp. 96–7].

I have not yet discovered further notice of the 1729 epidemic.

Parishes studied (annual average of burials 1727–37 in brackets): Adlestrop (6), Ashchurch (14), Alderley (5), Avening (20·5), Great Badminton (6), Awre (22·5), Great Barrington (7), Bibury (14·5), Cirencester (101·5), Cheltenham (41), Gloucester, St Nicholas (43).

Results. Almost all the registers show a sharp peak of excess burials in March and/or April. The smaller parishes show great excess over expected values at the peak, e.g. Awre ninefold, Bibury sevenfold, Great Barrington ninefold, Ashchurch 15-fold. The large parishes – Cirencester, Cheltenham, St Nicholas – show peaks of four- or fivefold the expected values. Figure 1 C shows the excess of burials in the village of Awre with the peak in April 1729. Figure 2 illustrates the near-simultaneity of the wave of excess burials in several of the parishes.

Epidemic of 1837, *studied in the period* 1830–40

Extracts from the historical literature:

> All accounts...coincide in referring its greatest prevalence to a period extending from the middle of January to the end of the first week in February [1837].
>
> I never knew an epidemic to prevail so extensively.
>
> ...the proportional mortality of the epidemic was about one in fifty of those attacked.
>
> ...the funerals in the different parish churches of Sunderland were doubled in January [1837], during the height of the epidemic...
>
> In Bolton, however, this increase in the number of burials occurred for the most part during the month of February...[Table given] [Streeter, 1838].
>
> Between Monday, January 9, and Saturday, February 4th, 414 cases of influenza were admitted to the outpatient home list of the Marylebone Infirmary...[Table shows peak in week ending 14th January]...so that the epidemic would appear to have begun with January, and declined about the usual period of from five to six weeks [Clendinning, 1838].

Parish registers studied (annual average of burials 1830–40 in brackets): Ashchurch (14), Avening (24), Great Barrington (9), Bibury (15), and St Nicholas at Gloucester (85).

Results. Only the registers of St Nicholas (Figure 1 D) – peak excess more than twice expected value – and Avening with a 12-fold peak excess, showed the impact of the 1837 influenza epidemic.

Epidemic of 1775, studied in the period 1773–83

The four previous examples were epidemics of some lethality. This is an example of a 'non-lethal' epidemic.

Extracts from literature

> About the beginning of the last month [November], it was mentioned to me in many families, that most of the servants were sick; that they had colds, coughs...
>
> In the space of a week these complaints became more general...
>
> The disease now claimed the attention of the faculty, and, for the space of three weeks, kept them, for the most part, universally employed...

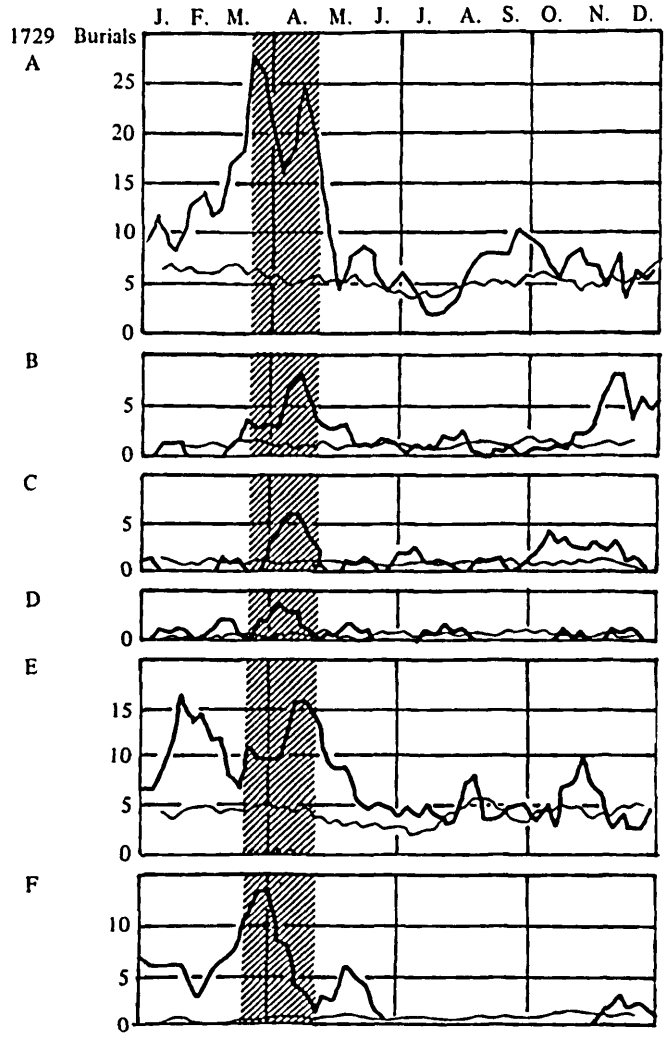

Fig. 2. Burials in 1729 (thick lines) from the registers of parishes widely dispersed in Gloucestershire to show in each the date of excess mortality from the influenza reported from Exeter as occurring in April (Glass, 1775). Averages of decennium (thin lines) 1727–37 less 1729 from each register for comparison. (A) Cirencester, (B)Awre, (C) Bibury, (D) Great Barrington, (E) St Nicholas, Gloucester, (F) Ashchurch. Shaded area gives approximate date of recorded influenza epidemic in Exeter.

...there is scarcely an instance to be met with, of any epidemic disease in the city [London], where so may persons were seized, and in so short a time, and with so little comparative mortality [Fothergill, 1784].

...Many people, both in this town [?London] and its neighbourhood, were attacked...some days preceding the 20th October...[Baker in Fothergill, 1784, and Thompson, 1852, pp. 96–7].

From the middle of October...several individuals complained of colds...but it was not, I think, till after the 10th of November that the malady became general [in and around Dorchester, Dorset]...[Cuming, 1775].

From the 8th November the number of people who were continually coughing increased so fast...The disease appeared to be at its height here [Exeter] from the 18th to the 24th of the same month, and attacked very few after the 4th of December (Glass, quoted in Fothergill, 1784, and in Thompson, 1852, pp. 96–7].

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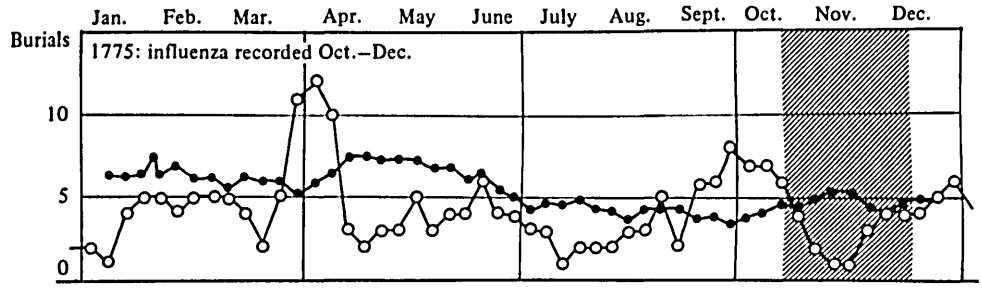

Fig. 3. Burials in Cirencester parish in 1775 compared with average of 1773–83 less 1775 from same register. This graph supports contemporary observation that the widespread influenza epidemic, reported around October–December from all over Britain, caused few deaths (e.g. Fothergill, 1784). Cirencester typified the other registers examined. Symbols as in Fig. 1. Shaded area represents recorded date of influenza epidemic.

...fewer died during the prevalence of this disorder than during the same space of time since the opening of this house...[the House of Industry in Dublin, founded for the suppression of beggars and sturdy vagabonds] [Rainey, quoted in Thompson, 1852, p. 115].

Parish registers studied (eleven-year annual average of burials in brackets): Arlingham (9), Adlestrop (4·0), Ashchurch (7·5), Great Badminton (9·5), Awre (17·5), Great Barrington (8·5), Bibury (12), Cirencester (76), St Nicholas at Gloucester (70·5).

Results. None of the nine parish registers examined showed any significant excess of burials between October and the end of December 1775. It is unlikely that Gloucestershire escaped this influenza epidemic. The answers to Dr Fothergill's questionnaire by 15 physicians from widely scattered parts of the United Kingdom all testify to the universality of the epidemic. No Gloucestershire doctors were questioned, but the disease was said to be rampant in reports from Chester, Worcester, Birmingham, Exeter, Dorchester, Blandford, York, etc. The most likely conclusion is that Gloucestershire did not escape, and that the findings of this study support the contemporary observations of the non-lethality of the 1775 influenza. Fig. 3 shows the burials recorded in the Cirencester register. Although it confirms the lack of any excess of mortality in the last quarter of the year, the chart shows a moderate brief excess, suggestive of influenza, in late March and early April, a finding echoed in the registers of the Parish of St Nicholas, Gloucester.

DISCUSSION

Excess mortality from lethal influenza epidemics in previous centuries

The main question to which an answer was sought in the present investigation was: can severe influenza epidemics in previous centuries be recognized by an effect on the general mortality similar to that recorded for twentieth century epidemics? That they should produce a similar pattern of excess mortality seemed inherently unlikely. The characteristic effect caused by severe twentieth century epidemics is very abrupt, the high peak of excess mortality usually being reached within two or three weeks, declining to average values almost as rapidly. Figure 4 which depicts the mortality from the 1918 influenza epidemic, shows a larger and longer

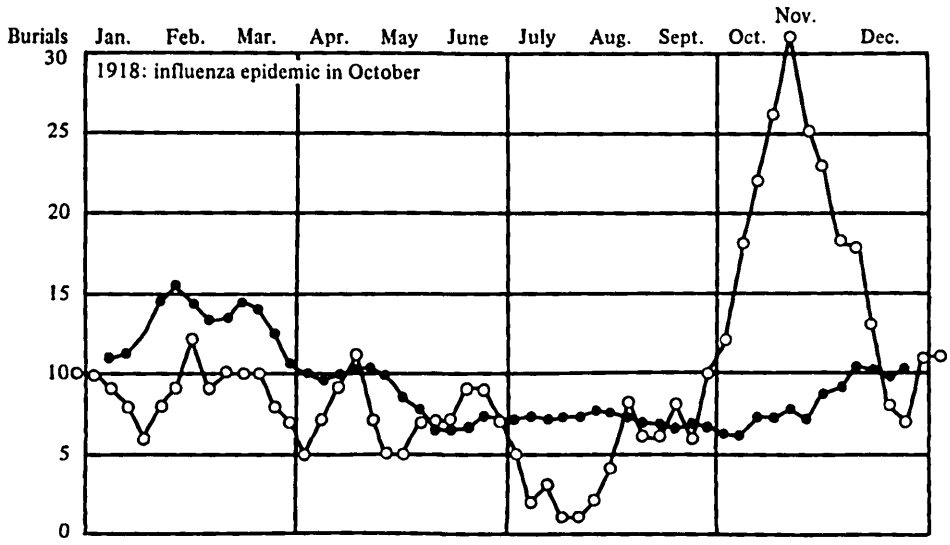

Fig. 4. Example of excess mortality from a twentieth-century influenza epidemic. Deaths registered in Cirencester in 1918 compared with the average mortality for 1913–23 less 1918. Symbols as in Fig. 1.

excess than usual. One might reasonably predict that a lower and protracted elevation of general mortality would have followed earlier epidemics because of the impediments to direct transmission of the virus from the sick offered by a much smaller and sparser population and the slow and difficult means of communication. Moreover other causes of surges of increased mortality were abundant in past times. Plague, typhus, tuberculosis, cholera, smallpox, famine, accident and warfare were among the agencies that took toll of lives during the periods examined, and they might have been expected to have raised the decennial average weekly mortality to values high enough to obscure or confuse the excess mortalities caused by influenza, especially if the influenzal mortality curves were less abrupt and with lower peaks.

The results of this investigation, however, seem clear. Excess mortalities caused by severe influenza epidemics recorded in the annals of four centuries seem to be similar to those of the twentieth century. The characteristic curve of excess burials in Holy Trinity parish, Gloucester (Fig. 1A), accords with an epidemic of September 1558 considered by Creighton to have been influenza, and has a peak nine times that of the decennial average for that week. In the example from the seventeenth century in Fig. 1B the typical curve of excess burials at Bibury with a 15-fold peak coincides with the influenza epidemic recorded by Sydenham as occurring in November 1675.

The example for the eighteenth century comes from the burial register of Awre parish on the west bank of the river Severn. A curve of excess burials characteristic of lethal epidemic influenza was found from the entry in April 1729 (Fig. 1C), a date at which no mention of influenza could be found in the annals of the period. Later, during the study of the 1775 epidemic, mention was found in a letter from Glass to Fothergill of an April 1729 epidemic of remarkable severity in Exeter. He writes in 1775 as if it were still a matter of common knowledge. Fig. 2 shows how

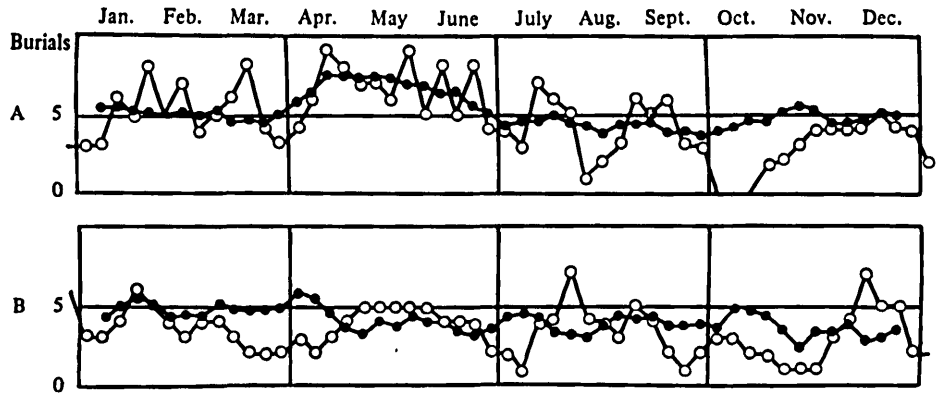

Fig. 5. Examples from two parishes in a year without excess mortalities. Symbols as in Fig. 1. (A) Burials from Cirencester parish register in 1782 compared with the average 1773–83 less 1782. (B) Burials from register of St Nicholas parish, Gloucester, in 1782 compared with the average 1773–83 less 1782.

nearly contemporaneous were the excess mortalities from this epidemic in widely separated Gloucester parishes. One would not find a closer concordance in the present century. In two of the parishes other causes of death may have complicated the curves.

The example from the first half of the nineteenth century (Fig. 1 D) again shows the curve characteristic of influenza although in the parish of St. Nicholas, Gloucester, this epidemic of January and February 1837 seems to have been less lethal than the other examples, the February peak of the excess burials amounting to only two and a half times the decennial average for that week.

The interpretation of other causes of excess mortality

Figure 5 illustrates mortalities in two parishes in one of the few years that showed no significant excesses above the decennial average. The causes of most excess mortalities, many of which were large and sustained, were not identifiable. Few resembled the curve described earlier as characteristic of influenza. Sometimes it was possible to assign the excesses to plague, typhus or smallpox from evidence in contemporary literature or in the burial registers themselves, and it was evident that these and the other conditions mentioned previously did not produce excess mortalities that mimicked the typical influenzal curve. Cholera alone might sometimes occasion confusion, but by 1832, when cholera first reached Great Britain, cause of death was usually included in the burial record. Cholera should not cause a mistake if it is remembered that it was epidemic in Britain only during the periods 1832–33, 1846–62 and 1864–73 (Wilson & Miles, 1948). Figure 6 shows vividly the impact of cholera upon burials in the parish of St Nicholas at its first introduction, presumably by sea into the port of Gloucester, in 1832.

The recording of epidemics in the contemporary literature of previous centuries is haphazard. Only a small number of the epidemics of influenza that must have occurred have been recorded and the documentation even of these is usually inadequate and often by non-medical authors. The experience given here concerning the 1729 epidemic serves as a warning that a characteristic mortality excess may be influenzal even in the absence of any record of an epidemic.

Most influenza epidemics are not highly lethal. Fig. 3, depicting burials in Cirencester parish in 1775, confirms the statement of several observers that the widespread influenza of October–December that year caused few deaths, and indeed supports the comment of one of them that fewer deaths than usual occurred during the epidemic period. No explanation can be found in the annals for the three-week excess of burials in March–April of that year, but it is a brief excess with a peak only twice the decennial average for that week.

Excess mortality as a tool for the historical study of influenza

The finding that severe influenza even in past ages imposed such a characteristic pattern of excess deaths upon the general mortality figures offers an opportunity for studying the behaviour of such influenza epidemics even before diagnoses of death became available, and again later when the diagnoses were unreliable or incomprehensible to modern readers. The typical wave of mortality follows the wave of influenzal morbidity within a week or two, allowing the presence of the influenza in different places to be precisely dated. The only requirement for this useful epidemiological tool is the existence of legible and reliable records of deaths or burials.

Combined with a study of births or christenings, the method might be used to see if particular influenza epidemics harmed the embryo, diminishing the number of live births during the succeeding months.

Epidemiological conclusions: test of prediction

A prediction of a new epidemiological hypothesis was given in the Introduction, namely that in previous centuries lethal influenza epidemics would have imposed a pattern on the general mortality not dissimilar to that found in the twentieth century. The findings in this investigation support the prediction and seem incompatible with the conception of a mechanism of direct spread of infection from the sick as in measles. A mechanism depending on such endless lines of transmission could not have operated with identical speed and efficiency throughout the enormous changes in population and social structure, and in the rapidity and frequency of communications that have taken place during five centuries. Even if domestic crowding in earlier times had caused high attack rates within households – a matter on which we may be harbouring an inaccurate opinion (Macfarlane, 1977) – one would not expect to find the peaks of excess to have been nearly simultaneous in the widely dispersed parishes of this rural county as in Fig. 2.

An indication of contemporaneity over a much wider area can be seen in the fact that the timing of the influenza in the key years, taken from reports in widely different parts of Great Britain, was concordant with the excess mortalities in Gloucestershire.

Although the evidence in this paper is strongly against the current conception that influenza epidemics are produced by direct spread, not all the evidence appears to support the new hypothesis that they are caused by transmissions from ubiquitous symptomless carriers in whom latent virus has been reactivated by an unidentified seasonal stimulus. The stimulus, however mediated, must ultimately, because it is seasonal, be determined by variations in solar radiation. The apparent travelling of influenza would thus be dependent on the annual motions of an

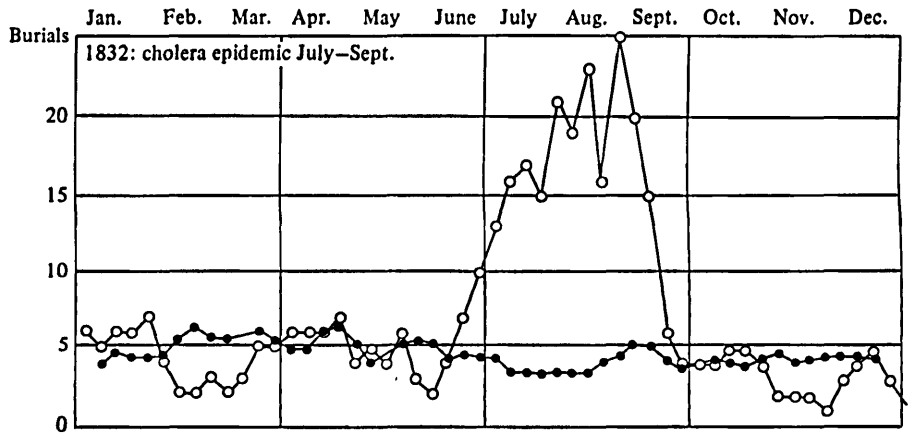

Fig. 6. Burials from the register of St Nicholas, Gloucester, 1832, compared with average 1830–40 less 1832, showing by the excess mortality the impact of the first epidemic of cholera in Britain. Symbols as in Fig. 1.

extra-terrestrial influence and be, with a few exceptions, independent of human travel. Most influenza epidemics in both hemispheres occur in the colder months, suggesting that the stimulus is at work when the solar radiation is minimal. In 1558, however, the epidemic occurred in the months of August and September. International travel at that date was too slow and infrequent to bring recently reactivated carriers from the Southern Hemisphere. There are several possible explanations. Perhaps the 1558 epidemic was not caused by influenza virus. Perhaps the new hypothesis is incorrect, but if so it is urgent that another more adequate hypothesis should replace it. For the present it is important to take note of such anomalies in the hope that they may provide a clue as to the nature of the seasonal stimulus or lead to a better explanation.

Work is in progress to test the prediction over wider distances by applying the same method to different areas of Great Britain.

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Appendix 1. *Dates of burials were abstracted from the following registers for the periods indicated*

Parish	Eleven-year periods for which information was sought							
	1557–67	1653–63	1670–80	1727–37	1773–83	1798–1808	1830–40	1842–52
Adlestrop	1557–67			1727–37	1773–83	1798–1808		
Alderley		1658–61	1670–80	1727–36		1798–1808		
Arlingham		1655–61			1773–83	1798–1808		
Ashchurch	1557–67		1672–80	1727–37	1773–83	1798–1808	1830–40	1842–52
Avening	1557–67	1653–63	1672–79	1727–37		1798–1808	1830–40	1842–52
Awre		1658–63		1727–36	1773–83	1800–1808		
Bibury	1557–67	1653–63	1670–80	1727–37	1773–83	1798–1808	1830–40	1842–52
Cheltenham				1727–37				
Cirencester		1653–63	1670–77	1727–37	1773–83	1798–1808		
Gloucester:								
Holy Trinity	1557 (Nov.)–68							
St Nicholas		1653–63	1670–80	1727–37	1773–83	1798–1808	1830–40	1842–52
Great Badminton		1653–62	1670–78	1727–35	1773–83	1800–1808		
Great Barrington	1557–67	Defective	1670–80	1727–37	1773–83	1798–1800	1830–40	1842–52
Key year:	1558	1658	1675	1729	1775	1803	1837	1847

Appendix 2. *Data used for graphs in Figs* 1 *and* 6

(A) Dates of burials at Holy Trinity, Gloucester, 1557–67.

1557 Nov. 11, 29. Dec. 15, 21.
1558 Jan. 11, 14. Feb. 3. Apr. 2, 6, 20. May 7. July 11, 19. Aug. 1, 10, 16, 20, 26, 27, 27, 27, 29, 29. Sept. 2, 12. Oct. 25. Nov. 24. Dec. 6, 26.
1559 Jan. 17, 24, 27, 29. Feb. 28. Mar. 21, 23. May 24, 24. June 8, 23. Sept. 2, 6, 6, 14, 17, 23, 28, 29.
1560 Mar. 2, 14, 21, 31. June 1, 11.
1561 0
1562 0
1563 Sept. 10. Oct. 4, 11, 20.
1564 Jan. 20. Feb. 12, 17. Mar. 8, 11, 14, 15. Aug. 24. Sept. 20.
1565 Mar. 10. Apr. 21. May 14. June 16. Aug. 10, 16, 18, 26, 29. Sept. 4, 4, 11, 11, 11, 21, 24, 24. Oct. 5, 6, 8, 17, 18.
1566 Jan. 6, 29. Feb. 3, 14. Apr. 27, 28. June 16. July 27. Sept. 6 Nov. 2
1567 Feb. 26. Mar. 18, 20. May 18. June 23. July 10. Aug. 16, 21, 31. Sept. 26. Oct. 16, 23.
1568 Mar. 8, 9. July 14. Sept. 10, 11, 21. Dec. 12.

(B) Dates of burials at Bibury, 1670–80.

1670 Feb. 24. Mar. 13. Apr. 11, 18. May 20. June 6, 10. Aug. 12, 14, 15. Sept. 18, 22, 24. Dec. 24.
1671 Jan. 10. Feb. 13, 28. Mar. 23, 30. Sept. 6, 16. Oct. 24. Nov. 12.
1672 Jan. 9. Feb. 19. May 12.
1673 Jan. 20, 21. Feb. 16, 17, 23, 26. Mar. 2. Apr. 21, 22. July 15, 31. Aug. 9. Sept. 13. Oct. 10. Dec. 17.
1674 Feb. 22. Mar. 4, 15, 23. May 26. June 3. July 12, 14. Aug. 4, 6. Sept. 4.
1675 Jan. 13. Mar. 2. May 13. June 1, 2, 3, 13, 20, 20, 28. July 17. Nov. 9, 19, 21, 23, 29. Dec. 1, 3, 20.
1676 Jan. 25, 29. Feb. 29. Apr. 6, 29. June 17, 28. June 1, 21. Aug. ?date.
1677 Jan. 1, 4, 15. Feb. 3. March 13. Apr. 15, 22, 26. May 3. Aug. 2. Sept. 3.
1678 Jan. 1, 4, 15. Feb. 3. March 13. Apr. 15, 22, 26. May 3. Aug. 2, Sept. 3.
1678 Jan. 7, 19. Mar. 29. May 8. Sept. 21. Nov. 1.
1679 Feb. ?date. Oct. 5, 22, 29. Nov. 10, 24. Dec. 4, 24.
1680 Jan. 4, 8, 28, 29. Feb. 8, 19. Mar. 14, 24. Apr. 28. May 17. July 2, 3. Sept. 19.

(C) Dates of burials at Awre, 1726–36.

1726 Apr. 7, 23. May 18. June 4, 26. July 20. Sept. 12, 21. Oct. 7, 10. 28. Nov. 3, 9, 16. Dec. 22
1727 Apr. 3. May 2. June 11, 30. July 24. Aug. 7, 20, 24, 29. Sept. 3, 7, 9, 10, 18, 25, 28. Oct. 1, 1, 14, 24, 25, 28. Nov. 2, 26. Dec. 5, 8, 26.
1728 Jan. 8, 9, 11, 21, 28, 28. Feb. 3, 8, 11, 24, 25 Mar. 5, 12, 31. Apr. 5. May 4, 13, 19, 21. June 6, 15, 22, 24. July 8, 21, 28. Aug. 13, 19, 21, 25, 31. Sept. 15, 30. Oct. 10, 13, 15, 22, 27, 31. Nov. 7, 21.
1729 Jan. 16 Mar. 5, 16, 20, 24. Apr. 5, 9, 15, 18, 19, 19, 21, 25, 27. May 9, 16, 19, 30. June 18. July 19. Aug. 9, 10. Oct. 13. Nov. 2.
1730 Jan. 6, 10, 12, 15, 28. Feb. 3, 12, 15, 24. Mar. 2, 3, 5, 13, 14, 15, 26. Apr. 8, 26. May 3, 28. June 15. July 2. Aug. 14, 15. Sept. 26. Oct. 18, 26. Nov. 4, 21. Dec. 26.
1731 Mar. 20. May 16. June 17, 28. July 11, 13, 14. Oct. 11, 22. Nov. 18, 19. Dec. 19, 28
1732 Jan. 6, 12. Mar. 7, 13, 25, 31. Apr. 8, 19. June 9, 10, 26. July 7, 29. Aug. 7. Sept. 9, 11, 24, 26, 27, 29. Oct. 5. Nov. 6. Dec. 13, 14, 19, 31.
1733 Mar. 25. Apr. 30. May 4, 22, 25. June 12, 23. July 24. Oct. 7, 23. Dec. 2, 30.
1734 Feb. 6. Mar. 1, 17. Apr. 11. Sept. 7, 25. Nov. 23. Dec. 1, 17, 20.
1735 Jan. 3, 15. Feb. 13, 14. Apr. 28. June 11, 12, 30. July 2. Aug. 21. Sept. 1. Dec. 11.

1736 Jan. 20, 25. Mar. 13. Apr. 18. June 11. July 22. Oct. 6, 6. Nov. 4, 12, 15. Dec. 8, 17, 26.

(D) Dates of burials at St. Nicholas, Gloucester, 1830–40.

1830 Jan. 7, 12, 13, 14, 19, 31. Feb. 9, 11, 17, 21, 24, 26. Mar. 1, 2, 4, 4, 14, 14, 15, 16, 19, 21, 21, 28, 29. Apr. 3, 16, 20, 28. May 6, 9, 19, 20, 27, 27, 30, 31. June 2, 6, 16, 21, 21, 27. July 2, 16, 24, 25. Aug. 1, 10, 11, 23, 29. Sept. 7, 8, 19, 26, 26. Oct. 3, 6, 12, 19, 20, 23, 31. Nov. 2, 3, 7, 9, 10, 11, 14, 24, 24, 24, 26, 28, 29, 30. Dec. 1, 8, 9, 12, 13, 14, 17, 19, 22, 23, 26, 27, 29, 31. (November and December, nearly all children).

1831 Jan. 11, 11, 16, 20, 21, 22, 23, 25, 25. Feb. 6, 6, 13, 14, 18, 20, 20, 27. Mar. 1, 1, 4, 7, 8, 13, 20, 20, 20, 27, 27, 27, 27, 28. Apr. 5, 13, 17, 18, 27. May 16, 28. June 1, 4, 5, 25. July 5, 8, 13, 13, 13, 15, 20, 25, 31. Aug. 10, 10, 11, 15, 19, 30. Sept. 2, 11, 13, 14, 18, 18, 25, 27. Oct. 2, 12. Nov. 1, 12, 16, 25, 29, 30. Dec. 11, 18, 24, 25.

1832 Jan. 1, 3, 13, 13, 13, 24, 26, 27, 31. Feb. 1, 3, 7, 22, 27. Mar. 9, 16, 18, 26, 26, 31. Apr. 3, 4, 9, 18, 19, 19, 27, 29. May 1, 2, 16, 17, 18, 27. June 1, 3, 20, 22, 22, 24, 25. July 1, 1, 5, 5, 8, 9, 9, 15, 15, 15, 15, 15, 16, 17, 18, 20, 22, 24, 25, 26, 28, 30. Aug. 2, 2, 3, 5, 6, 6, 6, 6, 6, 7, 8, 9, 9, 9, 11, 11, 13, 15, 20, 22, 23, 23, 24, 25, 25, 25, 25, 26, 25, 27, 27, 27. Sept. 3, 4, 4, 4, 6, 6, 6, 7, 8, 9, 9, 10, 11, 12, 13, 26, 30. Oct. 2, 2, 17, 18, 23, 23, 24. Nov. 5, 18, 27. Dec. 10, 12, 18, 19, 26.

1833 Feb. 4, 5, 10, 17, 24. Mar. 3, 4, 14, 19, 20, 31. Apr. 6, 11, 16, 18, 21, 24, 25, 25, 28, 28, 28. May 28, 29, 30. June 25, 30. July 2, 10, 26, 31. Aug. 4, 9. Sept. 12, 18, 22. Oct. 6, 9, 12, 29, 30, 31. Nov. 12, 16, 21, 25. Dec. 5, 8, 11, 20, 22, 24, 29.

1834 Jan. 5, 15, 26, 26, 27, 31. Feb. 2, 9, 12. Mar. 2, 11, 17, 18, 20, 25. Apr. 1, 10, 17, 17, 20, 23, 25, 27, 27, 29. May 4, 14, 18, 25. June 2, 4, 11, 18, 22, 24. July 4, 4, 15, 16, 22. Aug. 1, 5, 13, 15, 17, 22, 30, 30. Sept. 1, 3, 8, 9, 10, 17, 18, 29. Oct. 5, 8, 8, 10, 13, 13, 22, 26, 30. Nov. 2, 9, 9, 10, 13, 21, 21, 28, 30. Dec. 4, 8, 11, 14, 22, 27.

1835 Jan. 3, 4, 11, 13, 14, 16, 20, 25, 30. Feb. 1, 10, 15, 25. Mar. 1, 3, 6, 8, 15, 20. Apr. 2, 10, 16, 19, 22, 25. May 1, 6, 10, 10, 10, 10, 15, 17, 25, 29, 31, 31. June 1, 1, 3, 17, 19, 26, 28. July 3, 5, 6, 12, 17, 22. Aug. 11, 25, 27. Sept. 4, 4, 6, 8, 16, 20, 20, 28. Oct. 1, 11, 11, 15, 18. Nov. 2, 6, 11, 25, 25, 29. Dec. 2, 21.

1836 Jan. 7, 16, 16, 25, 25, 28. Feb. 7, 16, 16. Mar. 3, 13, 15, 15, 17. Mar. 20, 20, 24, 27. Apr. 3, 5, 10, 21. May 15, 22, 22. June 7, 7, 7, 8, 12, 12, 15, 15, 20, 22, 24. July 1, 6, 13, 17, 24, 24, 27, 27, 27, 31. Aug. 5, 7, 8, 10, 18, 22, 22, 29. Sept. 1, 2, 6, 6, 11, 12, 13, 23, 23. Oct. 9, 9, 17, 19, 23, 25, 26, 26. Nov. 1, 7, 9, 11, 23, 27. Dec. 6, 6, 9, 11, 11, 18, 19, 22, 22, 28, 28.

1837 Jan. 12, 15, 25, 25, 26, 29, 29. Feb. 2, 5, 5, 5, 14, 14, 15, 17, 19, 19, 23, 23, 26, 26. Mar. 8, 9, 16, 24, 24, 30. Apr. 2, 13, 13, 24, 30, 30, 30, 30. May 12, 19, 22, 24. June 1, 2, 6, 19, 30, 30. July 6, 11, 27. Aug. 12, 24, 24, 24. Sept. 1, 3, 3, 7, 10, 18, 20, 21. Oct. 1, 1, 6, 7, 8, 10, 10, 17, 22, 31. Nov. 5, 8, 26. Dec. 5, 6, 10, 10.

1838 Jan. 10, 11, 11, 14, 15, 19, 19, 25. Feb. 11, 15, 21, 23, 25, 25, 25, 25, 25, 26. Mar. 4, 16, 18, 23, 23, 25, 29. Apr. 1, 3, 9, 9, 15, 16, 17, 22, 25, 26, 27, 27. May 2, 11, 21, 28. June 1, 4, 5, 8, 11, 13, 26, 27, 29. July 16, 18, 27. Aug. 10, 16, 19, 27. Sept. 9, 10, 11, 13, 16, 16, 21, 30. Oct. 1, 4, 10, 21. Nov. 8, 15, 18, 25, 28, 30. Dec. 5, 5, 9, 16, 18, 23, 25, 28, 30.

1839 Jan. 9, 18, 22, 31, 31, 31. Feb. 15, 16, 17, 17, 24, 25, 28. Mar. 3, 3, 6, 10, 17, 29, 29, 29. Apr. 16, 18, 18. May 1, 7, 7, 9, 14, 15, 19, 22, 23, 26. June 2, 3, 5, 13, 14, 14, 28. July 7, 9, 12, 21, 28, 29. Aug. 9, 15, 18, 25, 27, 28, 29. Sept. 2, 15, 15, 20, 29. Oct. 2, 6, 11, 27, 31. Nov. 3, 3, 6, 12, 14, 14, 17, 24, 26, 26. Dec. 19, 22, 30.

1840 Jan. 2, 3, 5, 13, 21, 28. Feb. 9, 17, 24, 27, 28. Mar. 1, 2, 5, 5, 15, 15, 24, 29, 30, 31. Apr. 1, 1, 2, 5, 5, 8, 9, 10, 13, 14, 14, 19, 19, 21, 23, 24, 24, 26, 30. May 1, 1, 3, 3, 4, 5, 10, 19, 24, 24, 26, 28, 29, 31. June 1, 4, 7, 11, 17, 21, 22, 23, 26, 26, 28, 28, 30, 30. July 1, 3, 13, 16, 26. Aug. 1, 14, 18, 19, 26, 28, 30. Sept. 9, 13, 13, 23. Oct. 7, 11, 14, 18, 18, 18, 23, 25, 25. Nov. 1, 11, 16, 17, 26. Dec. 3, 3, 16, 23, 24.