

JOHN GRAUNT AND THE SCIENCE OF STATISTICS

BY

PETER PETOCZ

*Ring a-ring a-roses,
A pocketful of posies,
Atishoo, Atishoo,
We all fall down.*

(Nursery Rhyme 17th Century)

INTRODUCTION:

The science of statistics is just over 320 years old. It was born in London, a few years before the great plague and fire, with the publication in 1662 of a small book, "the whole Pamphlet not two hours reading", entitled

"Natural and Political Observations, mentioned in a following Index, and made upon the Bills of Mortality. By John Graunt, Citizen of London, With reference to the Government, Religion, Trade, Growth, Ayre, Diseases and the several Changes of the said City".

The Bills of Mortality were records of deaths and their causes (also of christenings) kept in all the London parishes since earlier that century, apparently in response to the increasing number of deaths due to the Plague. Their pages contain a fascinating catalogue of the diseases and mishaps of seventeenth century London: "King's Evil", "Rising of the Lights", "Strangury", "Bit with a mad dog", "Stopping of the stomach", and the enigmatic "Suddenly".

Although bubonic plague was the reason for starting these records, the worst outbreak was to come in three years' time, when over 100,000 Londoners died from a population of less than half a million. The nursery rhyme describes the course of the disease, from the rosy rash and sneezing to the final collapse. And this calamity was not all: in the following year, two-thirds of the city was burnt to the ground in the great fire.

JOHN GRAUNT:

John Graunt, the eldest of 8 children, was born in 1620 to Henry Graunt, a Hampshire man but a citizen of London, who carried out the business of draper at the sign of the Seven Stars in Birchin Lane. John was early apprenticed to a merchant of smallwares, and success in this business gave him the opportunity to indulge his more intellectual interests. A contemporary writer, Aubrey, describes him as:

"A very ingenious and Studious person, who rose early in the morning to his study before shoptime" (Brief Lives).

Samuel Pepys, the diarist, writes of Graunt's collection of prints:

"Indeed the best collection of almost anything that I ever saw, there being prints of most of the greatest houses, churches and antiquitys in Italy and France, and brave Cutts" (20th April, 1663).

It is not known why Graunt began his examination of the London Bills of Mortality. As a shopkeeper and a self-educated person he first describes his studies in a casual, apologetic way. But later he speaks of a "Long persual of all the Bills of Mortality which this great city hath afforded for almost four score years."

Although data had been collected and summarized before, Graunt's book is the first to show evidence of statistical method. He shows a patience in investigation, a care in checking results, and a reserve in inference which are the hallmarks of successful statistical investigations.

The preface to his book is dated 25th January 1662: by 24th March Pepys was buying a copy at Westminster Hall, and the work was so well received that a new edition was needed within the year.

But the greatest compliment that Graunt received, and the one that meant the most to him, was election to the Royal Society, newly incorporated by Charles II.

"In his election it was so far from being a prejudice that he was a shopkeeper of London that his Majesty gave this particular charge to his society, that if they found any more such tradesmen, they should be sure to admit them without any more ado."

(History of the Royal Society - Sprat).

Graunt's business suffered from both the Plague and the Fire, and went downhill until his death in 1674. A contemporary, (Anthony Wood) wrote:

"A great number of ingeniose persons attended him to his grave. Among others, with teares, was that great ingeniose virtuoso, Sir William Petty."

It was Petty who wrote of Graunt's work:

"The observations upon the London Bills of Mortality have been a new Light to the World",

and as evidence of his sound judgement, this is what he had to say of another book of his day:

"Poor Mr. Newton... I have not met with one man that putt an extraordinary value on his book. I would give 500 pounds to have been the author of it".

THE "OBSERVATIONS"

Graunt gives an idea of the scope of his work in the dedication, where he writes:

"It doth not ill-become a Peer of the Parliament or Member of his Majesties Council, to consider how few starve of the many that beg: That the irreligious Proposals of some, to multiply people by Polygamy, is withal irrational, and fruitless: That the troublesome seclusions in the Plague - time are not a remedy to be purchased at vast inconveniences: That the wasting of Males by Wars and Colonies do not prejudice the due proportion between them and Females: That the opinions of Plagues accompanying the Entrance of Kings, is false, and seditious: That London, the Metropolis of England, is perhaps a Head too big for the Body ... All which being new, to the best of my knowledge, and the whole Pamphlet no two hours reading".

His complete figures are given in the table of casualties, and he also gives a listing for the year 1632. To summarise, in a period of 20 years (1629-36, 1647-58) 229, 250 people died, of which 36% were less than six years of age. About 22% died of acute diseases (except the Plague) and 32% of chronic diseases. Even before the great attack of 1665, 7% of people were dying of the Plague. For the worried contemporary reader, Graunt gives a table of notorious diseases and casualties.

"That the respective numbers, being compared with the total 229, 250, those persons may the better understand the hazard they are in".

Graunt's reasons for undertaking the study are aptly summed up in the conclusion:

"It may be now asked, to what purpose tends all this laborious bustling and groping? ...

I might answer, that there is much pleasure in deducing so many abstruse and unexpected inferences out of these poor despised Bills of Mortality.

And there is pleasure in doing something new, though never so little, without pestering the World with voluminous Transcriptions.

... I conclude that a clear knowledge of all these particulars, and many more, where at I have shot but at rovers, is necessary, in order to good, certain, and easie Government".

GRAUNT'S STATISTICAL METHOD:

By means of quotations from the "observations", Graunt's work will be examined from a statistical viewpoint. It will be seen that he shows evidence of sound statistical method: in this he was more advanced than his contemporaries or predecessors.

1. Graunt describes carefully the method of information collection:

"When any one dies, then either by tolling, or ringing of a Bell, or by bespeaking of a Grave of the Sexton, the same is known to the Searchers... The Searchers here upon (who are ancient Matrons, sworn to their Office) repair to the place where the dead Corps lies, and by view of the same, and by other enquiries, they examine by what Disease or Casualty the Corps died."

2. He considers carefully the accuracy of the sources:

"Now, to make these corrections upon the, perhaps, ignorant and careless Searchers Reports, I considered first of what Authority they were of themselves, that is, whether any credit at all were to be given to their Distinguishments.

...In many of these Cases the Searchers are able to report the Opinion of the Physician, who was with the Patient, as they receive the same from Friends of the Defunct: and in very many cases, such as Drowning, Scalding, making away themselves ... etc, their own senses are sufficient.

3. He shows a careful and thorough checking of suspect information:

"We find one Casualty in our Bills, of which, though there be daily talk, there is little effect, ... and this Casualty is the French Pox. The Bills of Mortality

would take off these Bars which keep some men within bounds, as to these extravagancies: for in the aforementioned 229 250 we find not above 392 to have died of the Pox, Now, ... it is not good to let the World be lulled into a security and belief of Impurity by our Bills ... Forasmuch as by the ordinary discourse of the World it seems a great part of men have, at one time or another, had some species of this Disease, I wondering why so few died of it, especially because I could not take that to be so harmless, whereof so many complained very fiercely: upon enquiry, I found that those who died of it out of the Hospitals were returned of Ulcers and Sores. And in brief, I found, that all mentioned to dye of the French Pox were returned by the Clerks of Saint Giles's and Saint Martin's in the Fields only ... I concluded, that only hated persons, and such whose very Noses were eaten off, were reported by the searchers to have died of this too frequent Malady."

4. Graunt uses his data as a basis for conclusions and observations, without going beyond them into flights of fancy:

"My first observation is, that few are starved ... The observation which I shall add hereunto, is, that the vast number of Beggars, swarming up and down this City, do all live, and seem to be most of them healthy and strong; whereupon I make this question, whether, since they do all live by begging, that is, without any kind of labour; it were not better for the State to keep them, even though they earned nothing ... and by being imployed in some work (not better undone) might be accustomed and fitted for labour?"

"My next observation is, that but few are Murdered, ... whereas in Paris few nights scape without their Tragedy. The Reasons of this we conceive to be two: One is the Government and Guard of the City by Citizens themselves, and that alternately. No man setting into a Trade for that employment. And the other is, the natural customary abhorrence of that inhuman Crime, and all Bloodshed, by most English men."

GRAUNT'S DISCOVERIES:

Graunt made several noteworthy discoveries and innovations from his work on the Bills of Mortality.

1. He was the first to notice the regularity in large samples of social phenomena which appear to be due to chance:

"Among the several Casualties, some bear a constant proportion unto the whole number of Burials; such are Chronical Diseases ... as for Example, Consumptions, Scurvy, Rising of the Lights, and Bloody Flux: nay, some Accidents, as Grief, Men's making away themselves, and being Kill'd by several Accidents ... etc, do the like".

2. He was the first to notice the excess of male over female births. In the years 1628-62 exclusive, about

209,000 males and 190,000 females were buried,
140,000 males and 131,000 females were christened.

Graunt concludes from this that:

"The Christian Religion, prohibiting Polygamy, is more agreeable to the Law of Nature, that is, the Law of God, than Mahumetism, and others, that allow it: for one Man his having many Women, or Wives, by Law, signifies nothing, unless there were many Women to one Man in Nature also."

Also:

"There are more Males than Females, ... the one exceeded the other by about a thirteenth part. So that although more Men die violent deaths than Women, ... moreover, more Men go to Colonies ... and lastly, more remain unmarried, ... yet the said thirteenth part difference bringeth the business but to such a pass, that every Woman may have an Husband."

3. He noticed the excess of urban over rural death rate, although he examined only a fairly small country parish. The reasons he proposed for this were overcrowding and pollution:

"It follows therefore from hence, that the Country is more healthful than the City .. I considered, whether a City, as it becomes more populous, doth not, for that very cause, become more unhealthful: and inclined to believe that London now is more populous, but chiefly because sixty years ago few Sea-Coals were burnt in London, which are now universally used."

4. He noticed the very high infant mortality rate:

"We shall find that about thirty six per Centum of all quick conceptions died before six years old."

This, together with his estimation that only 1 in a 100 survived to 76, enabled Graunt to construct (somewhat crudely) the first life table based on survival rates.

Here is Graunt's table, with figures in brackets representing approximate survival rates for the present day.

<u>Age</u>	<u>Survivors per 100</u>
6	64 (96)
16	40 (96)
26	25 (95)
36	16 (93)
46	10 (91)
56	6 (84)
66	3 (68)
76	1 (44)
86	0 (12)

These figures represent a life expectancy at birth of about 18 years (as opposed to about 70 years today!).

Most of Graunt's discoveries and observations are statistically demonstrated by his large sample (for instance, the excess of male over female births). This idea of (statistical) proof is one of the characteristic features of Graunt's work.

Sometimes, however, he does fall into error by not understanding the significance of the size of a sample. He writes, for example:

"That in this [country] Parish there were born 15 Females for 16 Males, whereas in London there were 13 for 14, which shows that London is somewhat more apt to produce Males than the Country."

However, in the Country Bill there were less than 6½ thousand christened, as compared with about 270 thousand in London, and this difference in males and females is not a statistically significant one.

CONCLUSION:

Although he was writing in the mid-seventeenth century, John Graunt shows a surprisingly good use of statistical method - certainly better than his contemporaries or predecessors

Graunt had no academic training, but he was a pioneer in the new philosophy of his time which looked to observation rather than speculation. He was thus a forerunner of the British empiricist tradition in science, statistics in particular.

His work had a great influence on writers of "political arithmetick" and demography; firstly on Sir William Petty's pioneering demographic works, then on Edmund Halley's tables of life insurance. His influence can be traced to the population studies of Malthus, and to much of modern demography, social science and economics.

REFERENCES:

John Graunts's "Observations" are reprinted in

"The Economic Writings of Sir William Petty" ed. C.H. Hull, Kelley
NY 1963-4.

Selections appear in

"The World of Mathematics Vol 3" ed. J.R. Newman, Allen and Unwin
London 1960.

On the following pages we reproduce some interesting prints from John Graunts's
"Observations"

1. Title Page.
2. Bill of Mortality.
3. Diseases & Casualties.
4. London During the Plague.
5. The Great Fire 1666.
6. A Plague Doctor.
7. Burying Plague Victims.
8. Table of Casualties.
9. A contemporary Scene.
10. Title Page of a Bill of Mortality.
11. Weekly Bill of Plague Victims.

Natural and Political OBSERVATIONS

Mentioned in a following INDEX,

and made upon the

Bills of Mortality.

By JOHN GRAVY,

Citizen of
LONDON.

With reference to the Government, Religion, Trade,
Growth, Decay, Dissolution, and the several Changes of the
said CITY.

— Non, me ut mirum Turba, laboro.

Centenas passis Libertibus —

L O N D O N,

Printed by Tho: Roycroft, for John Martin, Gunns Alley,
and Tho: Dineal, at the Sign of the Bell in St. Pauls
Church-yard, MDCLXXII.

1. TITLE PAGE.

The Diseases, and Casualties this year being 1632.

A Bortive, and Stillborn ..	445	Grief	11
A Afrighted	1	Jaundice	43
Aged	928	Jarvisia	8
Ague	43	Impotume	74
Apoplex, and Meagron ..	17	Kill'd by several accidents..	46
Bit with a mad dog	1	King's Evil	38
Bleeding	3	Letargie	2
Bloody flux, scowring, and flux	348	Livergrown	87
Bruised, Issues, sores, and ulcers,	28	Lunaticke	5
Burnt, and Scalded	5	Made away themselves	15
Burnt, and Rupture	9	Mecenas	80
Cancer, and Wolf	10	Murthered	7
Canker	1	Over-laid, and starved at surge	7
Chibbed	171	Palata	25
Chriomes, and Infants	2268	Piles	1
Cold, and Cough	55	Plague	8
Colick, Stone, and Strangury	66	Planet	12
Consumption	1797	Pleurisie, and Spleen	26
Convulsion	241	Purple, and spotted Fever	38
Out of the Stone	6	Quintane	7
Dead in the street, and starved	6	Rising of the Lights	98
Dropsie, and Swelling	267	Scintia	1
Drowned	34	Scurvey, and Itch	9
Executed, and sent to darts	18	Suddenly	62
Falling Sickness	7	Strife Fox	86
Fever	1108	Teeth	6
Fistula	13	Thrush, and Sore mouth ..	470
Floods, and small Pox	531	Tyranny	40
French Pox	12	Typhick	13
Gangrene	5	Vomiting	34
Gout	4	Worms	1
Christened { Males .. 4994 } Warred, Females .. 4580 } of the In all .. 9584 } Buried { Males .. 4932 } Plague. 8 Females .. 4603 } In all .. 9535 }	8	Increased in the Burials in the 122 Parishes, and at the Pest- house this year	983
Decreased of the Plague in the 122 Parishes, and at the Pest- house this year	268	Decreased of the Plague in the 122 Parishes, and at the Pest- house this year	268 [10]

Table of various Diseases

Apoplex	1305
Cut of the Stone	38
Falling Sickness	74
Dead in the Streets	243
Gout	134
Head-ach	51
Jaundice	998
Letargy	67
Leprosie	6
Lunatick	158
Overlaid and Starved	529
Palsie	423
Rupture	201
Stone and Strangury	863
Sciatica	5
Suddenly	454

Table of Casualties.

Bleeding	69
Burnt and Scalded	125
Drowned	829
Excessive drinking	2
Frighted	22
Grief	279
Hanged themselves	222
Kill'd by several accidents	1021
Murdered	86
Poisoned	14
Smothered	14
Shot	26
Starved	7
Vomiting	51
	136

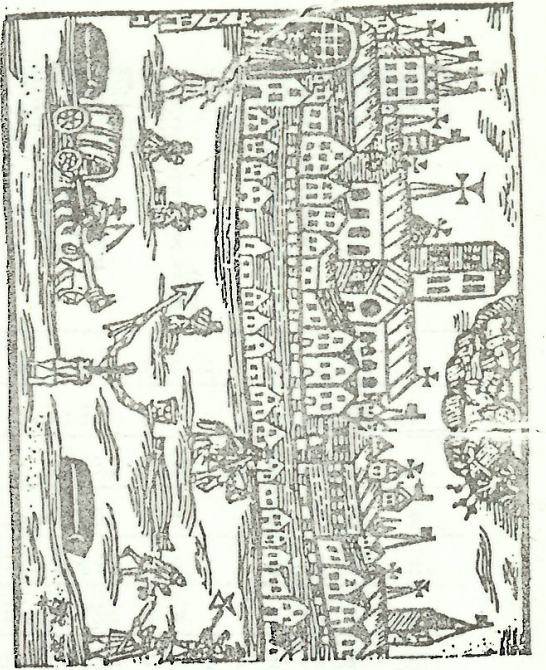
For 20 yrs (1629-36, 1647-58)
of a total of 229250 Deaths.

2. BILL OF MORTALITY
for 1632.

(FROM "OBSERVATIONS")

3. DISEASES & CASUALTIES.

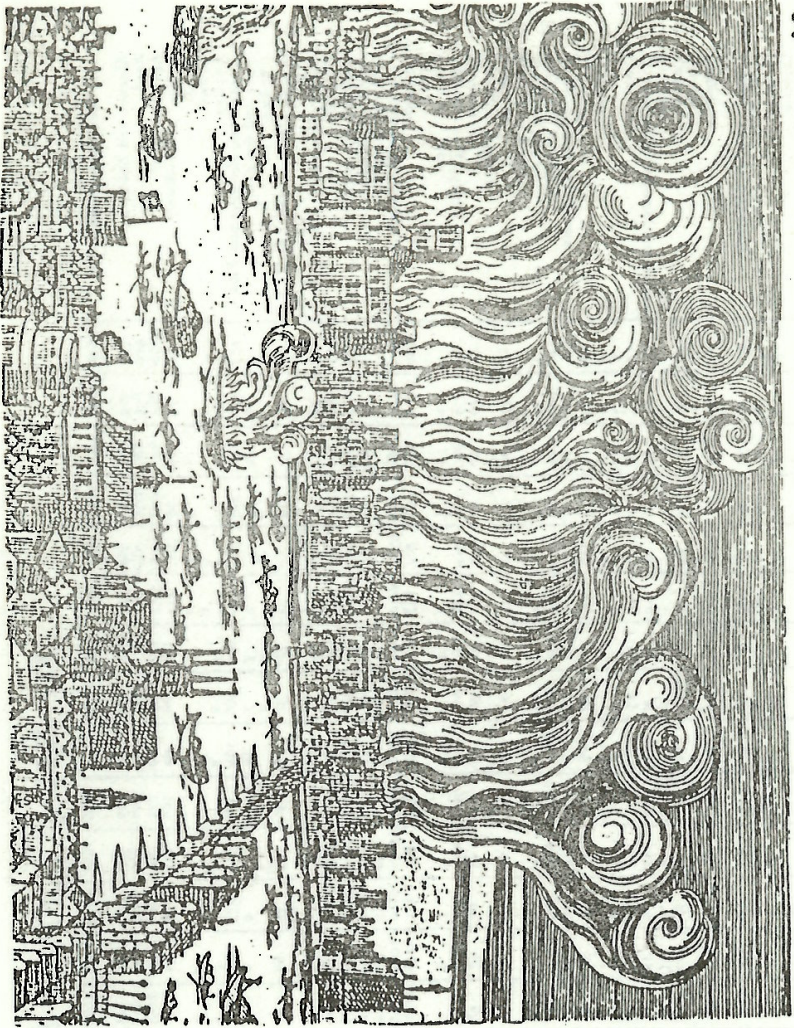
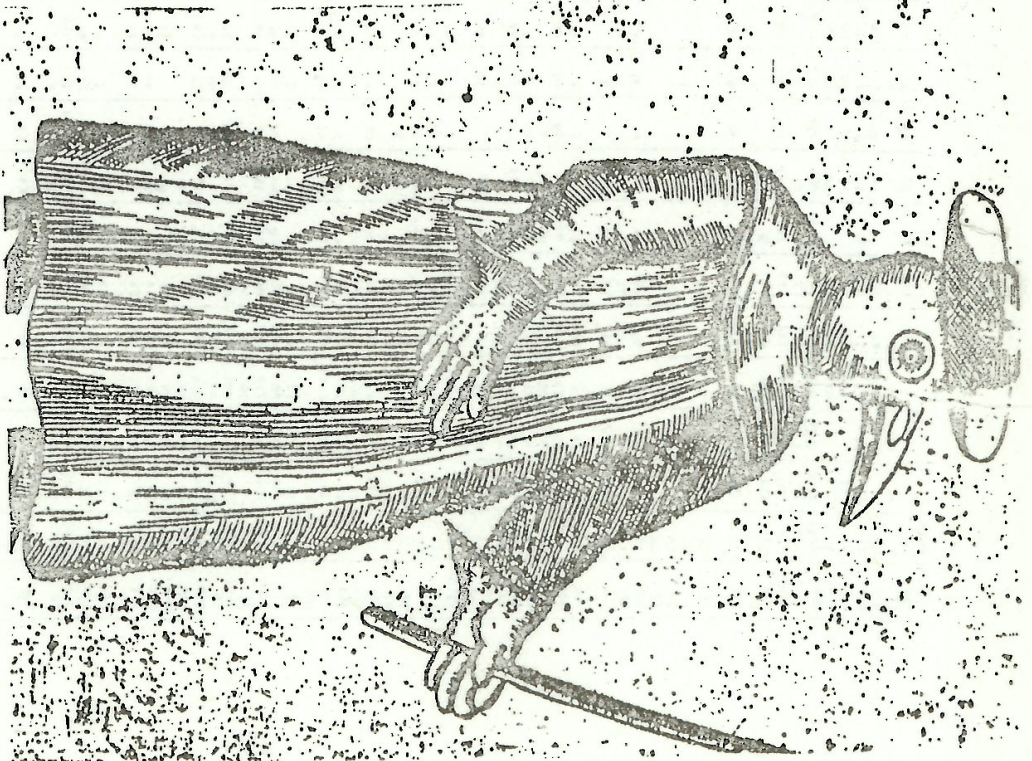
(FROM "OBSERVATIONS")



4. LONDON DURING THE PLAGUE. (and 7.)

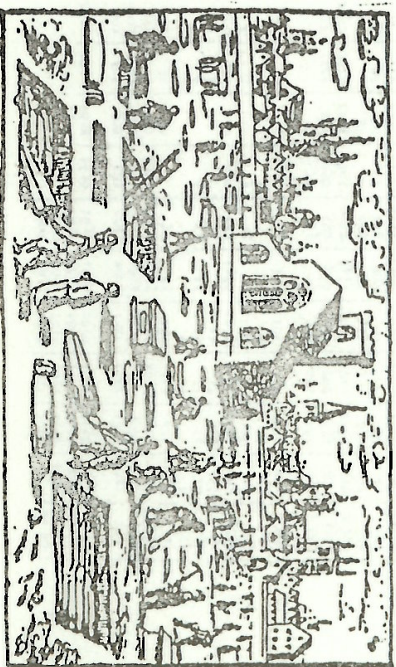
A PLAGUE DOCTOR.
 The bird mask is
 perfumed inside
 to combat
 infection.

6.



5. THE GREAT FIRE 1666.

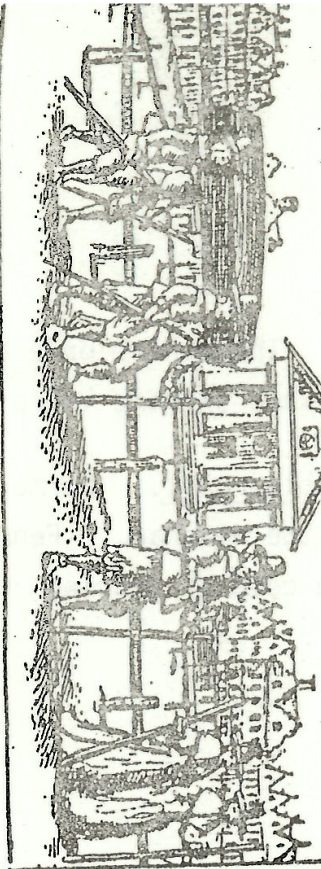
7.



9. A CONTEMPORARY SCENE.

Burying the dead with a bell before them.

Searchers.



11. WEEKLY BILL SHOWING OVER FOUR THOUSAND PLAGUE VICTIMS (1665).

The Diseases and Casualties this Week.

London	8
King'swell	12
Lettery	4
Liverdown	1
Mcgrawm	1
Palke	1
Plague	1337
Purple	1
Quintic	5
Rocazic	33
Rising of the Light	18
Rupraz	1
Senry	3
Shungles	1
Spiced Fever	166
Silber	4
Scourge of the Romach	17
Serangery	3
Steddry	3
Sarkin	74
Teeth	118
Thresh	5
Thick	9
Ulcer	1
Yoursing	10
Wande	4
Wormes	201

Parishes clear of the Plague	27	Parishes infected	103
Interred in the Buriall this Week	27	Males	2777
		Females	2791
		In all	5568
		Plague	4337

The Office of Buriall for this by order of the Lord Mayor and Council of Aldermen, A penny Whorem Load to contain Nise Orances and a half, and three half-penny White Loaves the like weight.

10. TITLE PAGE OF A BILL OF MORTALITY.

LOZDOWNS DREADFUL VIGILANS:
Or, A Collection of All the
Bills of Mortality
For this Present Year:
Beginning the 27th of December 1664, and
ending the 10th of December following:
As also, THE GENERAL or whole year BILL:
According to the Report made to the
Kings Most Excellent Majesty,
By the Company of Searchers of London, &c.

LONDON:
Printed and are to be sold by E. Cotes living in Aldersgate-street,
Printers to the said Company 1665.