



GRESHAM
COLLEGE

The Mathematical Life of Florence Nightingale

Professor Sarah Hart

Gresham Professor of Geometry



ENGRAVED BY T. COLE.

Florence Nightingale

FLORENCE NIGHTINGALE

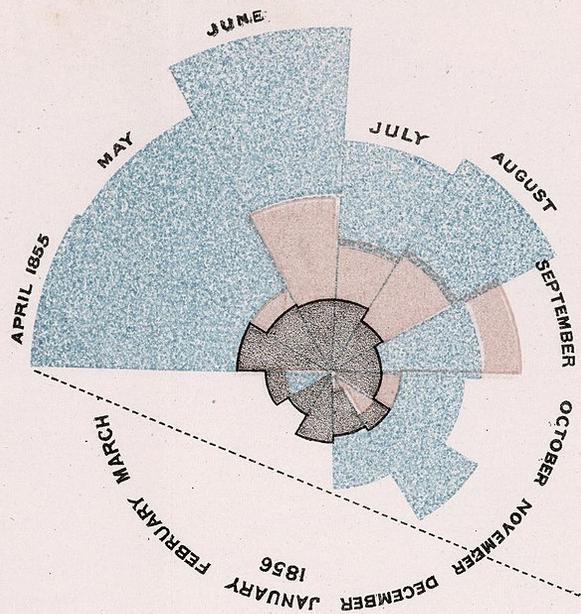
A LADYBIRD BOOK
An Adventure from History



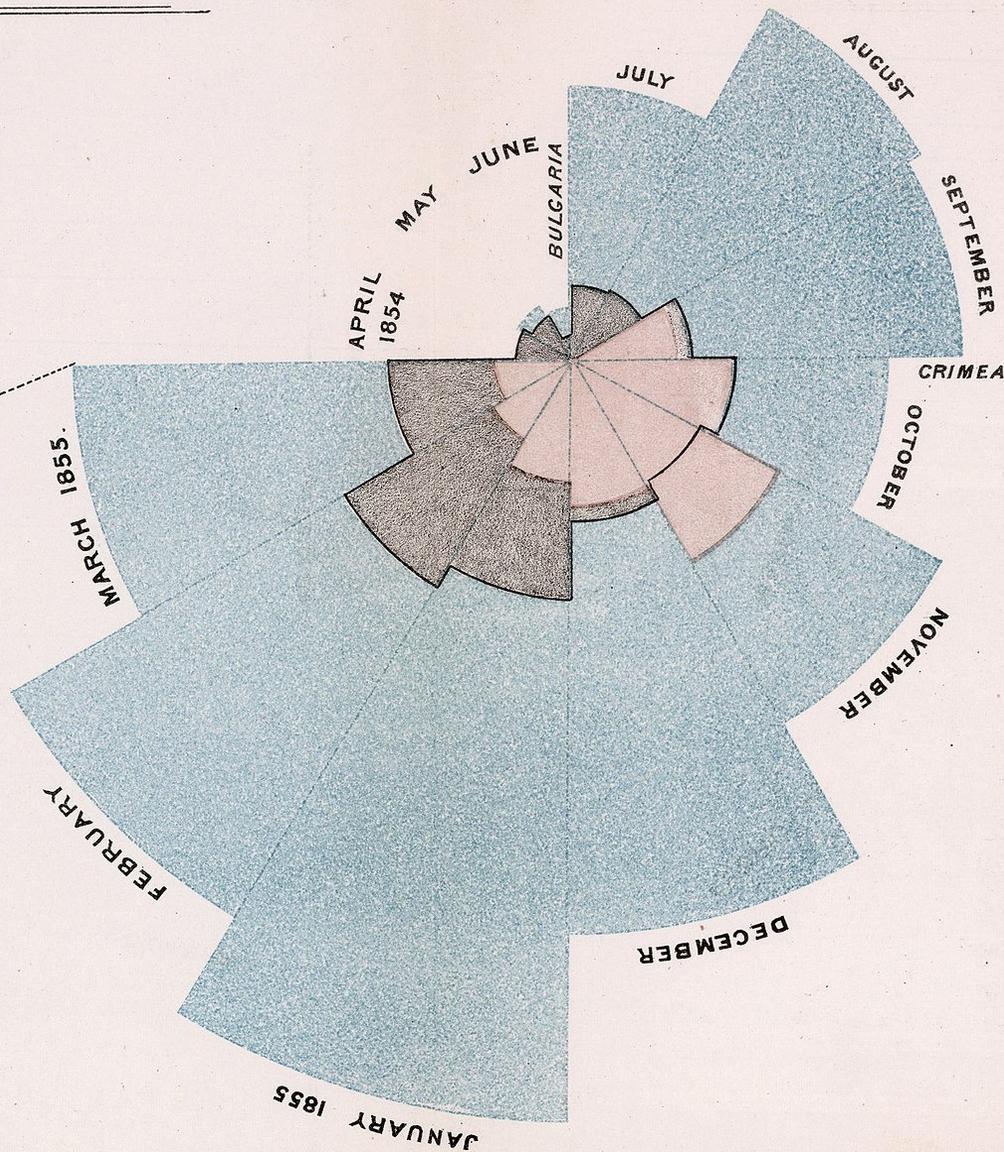
DIAGRAM OF THE CAUSES OF MORTALITY

IN THE ARMY IN THE EAST.

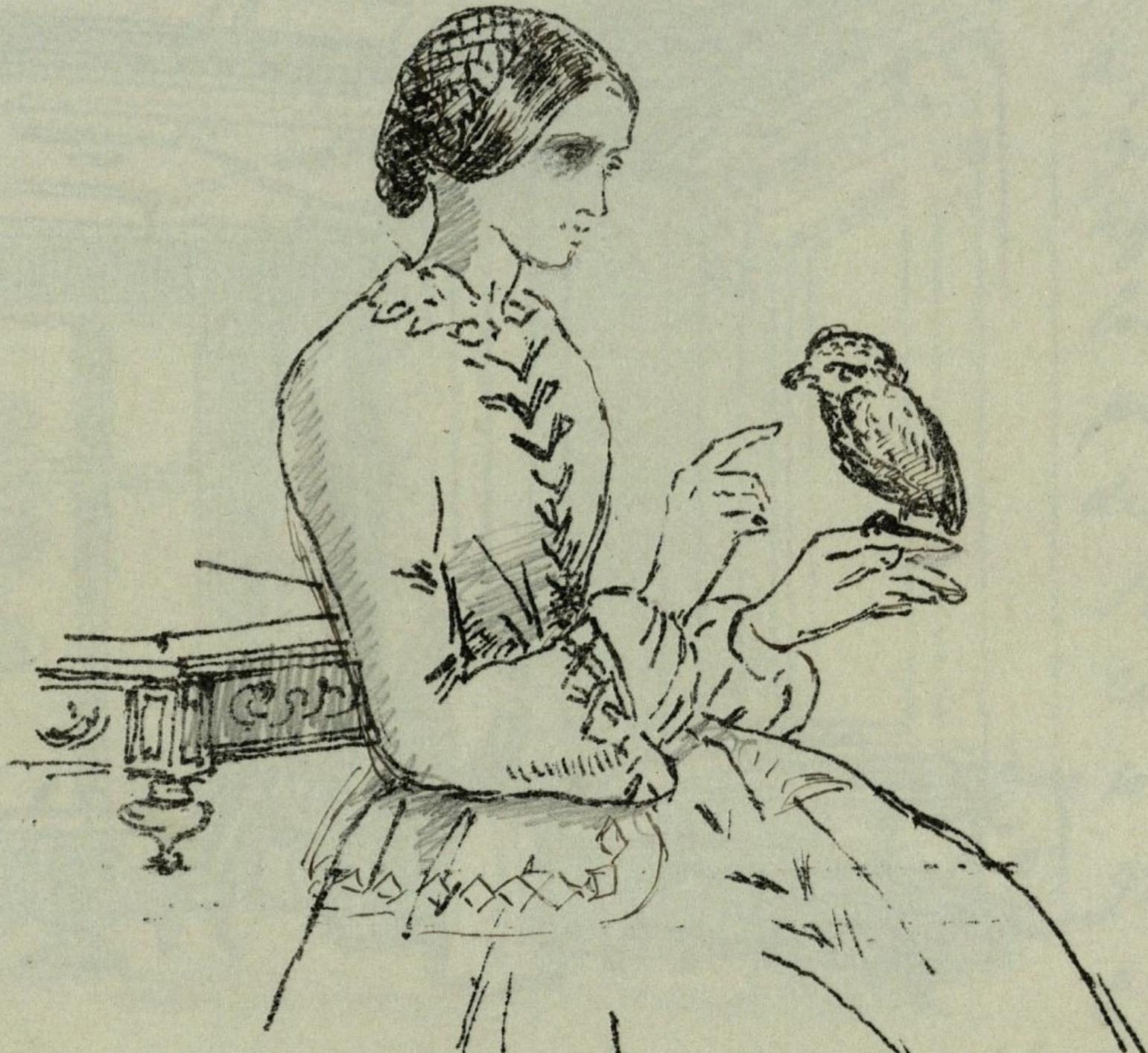
2.
APRIL 1855 TO MARCH 1856.



1.
APRIL 1854 TO MARCH 1855.



The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex.
 The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic diseases; the red wedges measured from the centre the deaths from wounds; & the black wedges measured from the centre the deaths from all other causes.
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 In October 1854, & April 1855; the black area coincides with the red; in January & February 1855, the blue coincides with the black.
 The entire areas may be compared by following the blue, the red & the black lines enclosing them.



Dear Grandmama.

The baby is pretty. I have been to the Zoological Society twice. There are 2 leopards, 2 bears, 2 parrots, 2 emeus (which are very large birds). 2 rabbits. 1 lion, 2 cockaatoos, 3 squirrells, 4 kanguroos, 6 monkies, (3 in a cage, 3 chained to a pole with a little house at the top). 1 rattel, (a very fierce creature). several Esquimaux dogs, Captain's Parry's Esquimaux dog, 1 guinea pig, 1 Costi Monti, 3 lamas, (1 brown one, 1 white one, & a small brown one), & other creatures that I forget the name of.

Vegetable	Fruits
Little cones Potatoes	Horse Peaches Chesnuts
Long cones Cucumbers	Dif- le- Straw-berries
Kind of Potatoes Peas	Kind of Goose-berries
	Long Currants

We intend to make a ^{-hopper} order. We have made 3 other parts to different parts of our house. We have made a parlor and a summer-house, and are making



FLORENCE NIGHTINGALE IN THE MILITARY HOSPITAL AT SCUTARI.

Scutari. — Night, when that excellent & benevolent young lady is going her round among the brave wounded & sick soldiers, to see that their wants have been properly administered to. —

NOTES ON MATTERS

AFFECTING THE

MORTALITY

OF THE

BRITISH ARMY

What would Florence Nightingale do?

- Get good data
- Interpret the data correctly
- Choose the perfect image

LONDON :

PRINTED BY HARRISON AND SONS, ST. MARTIN'S LANE, W.C.

1858.

LONDON :

PRINTED BY HARRISON AND SONS, ST. MARTIN'S LANE,

1858.

Early Statistics

- Statistik: “political arithmetic”
- Statistics (John Sinclair, 1791)

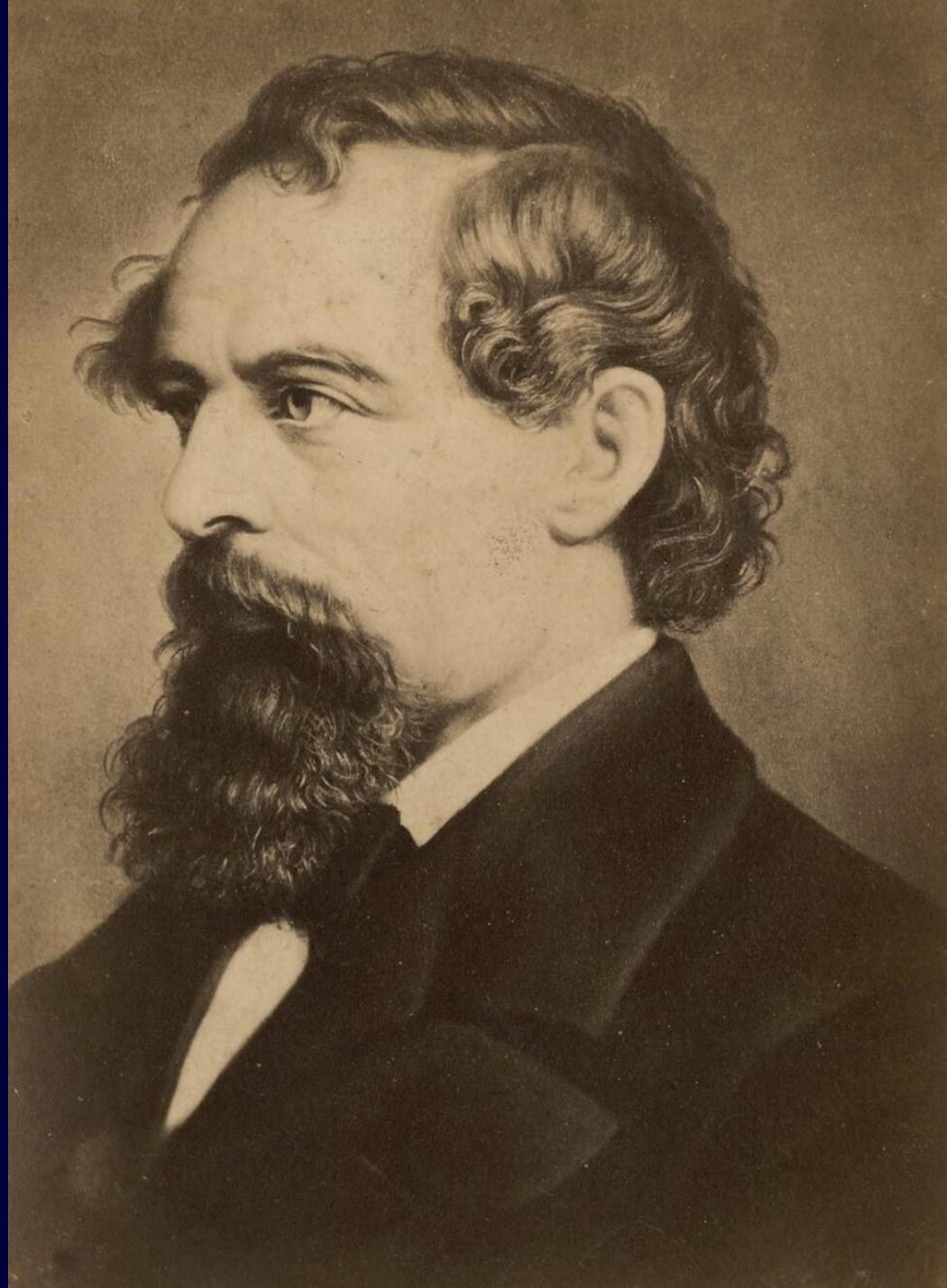


Early Statistics

- Statistik: “political arithmetic”
- Statistics (John Sinclair, 1791)
- “Vital Statistics” in the UK
 - 1801 Census
 - 1836 Registration Act
- “Moral Statistics”
 - André-Michel Guerry
 - Adolphe Quetelet



If the number of people killed so far
this year is below the annual average,
“is it not dreadful to think that
before the last day of the year some
forty or fifty persons must be killed –
and killed they will be.”





It is “no more wonder that quantities should remain the same than that qualities should remain the same, for in relation to society numbers are qualities - the number of drunkards is a quality in society - the numbers are an index to the qualities, and give us no instruction, only setting us to consider the causes of difference between social states.”

(from Daniel Deronda)

Are we measuring the right thing?



Train nurses? Pah! The death rate's higher under trained nurses!

You idiot, who do you think we assign all the sickest patients to?!

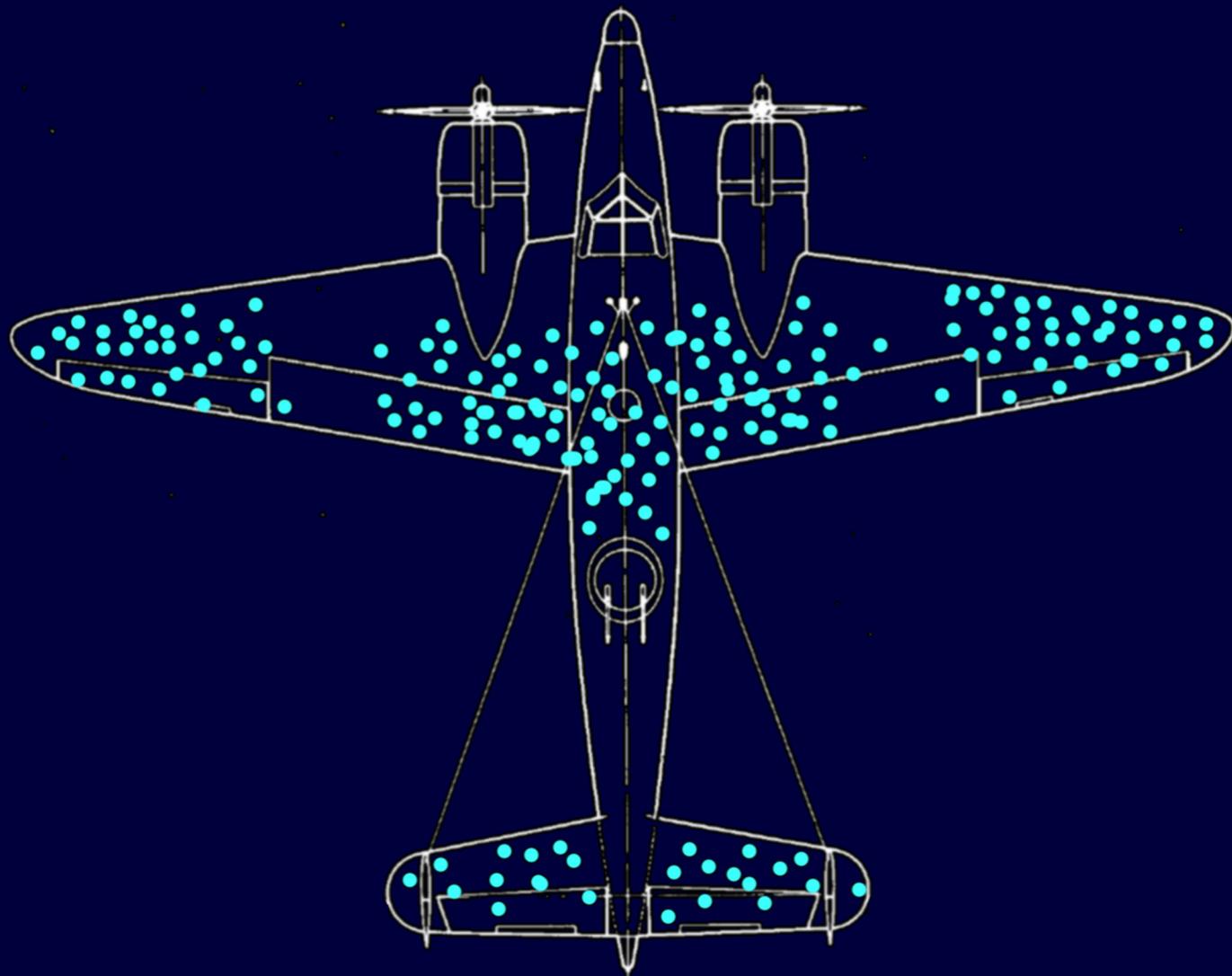


I must say I have been rocked by some of the data on Covid fatalities. The median age is 82 – 81 for men, 85 for women. That is above life expectancy. So get Covid and live longer.



You idiot, 81 and 85 are life expectancy AT BIRTH! A man at 81 has life expectancy of 89, a woman at 85 has life expectancy of 92.





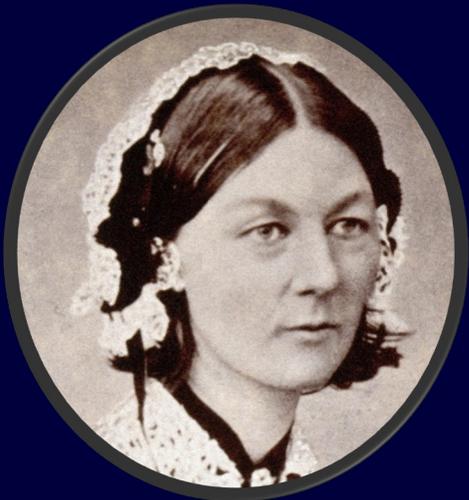
Interpreting the numbers



“Brigadier-General Lord WILLIAM PAULET to Lord PANMURE.

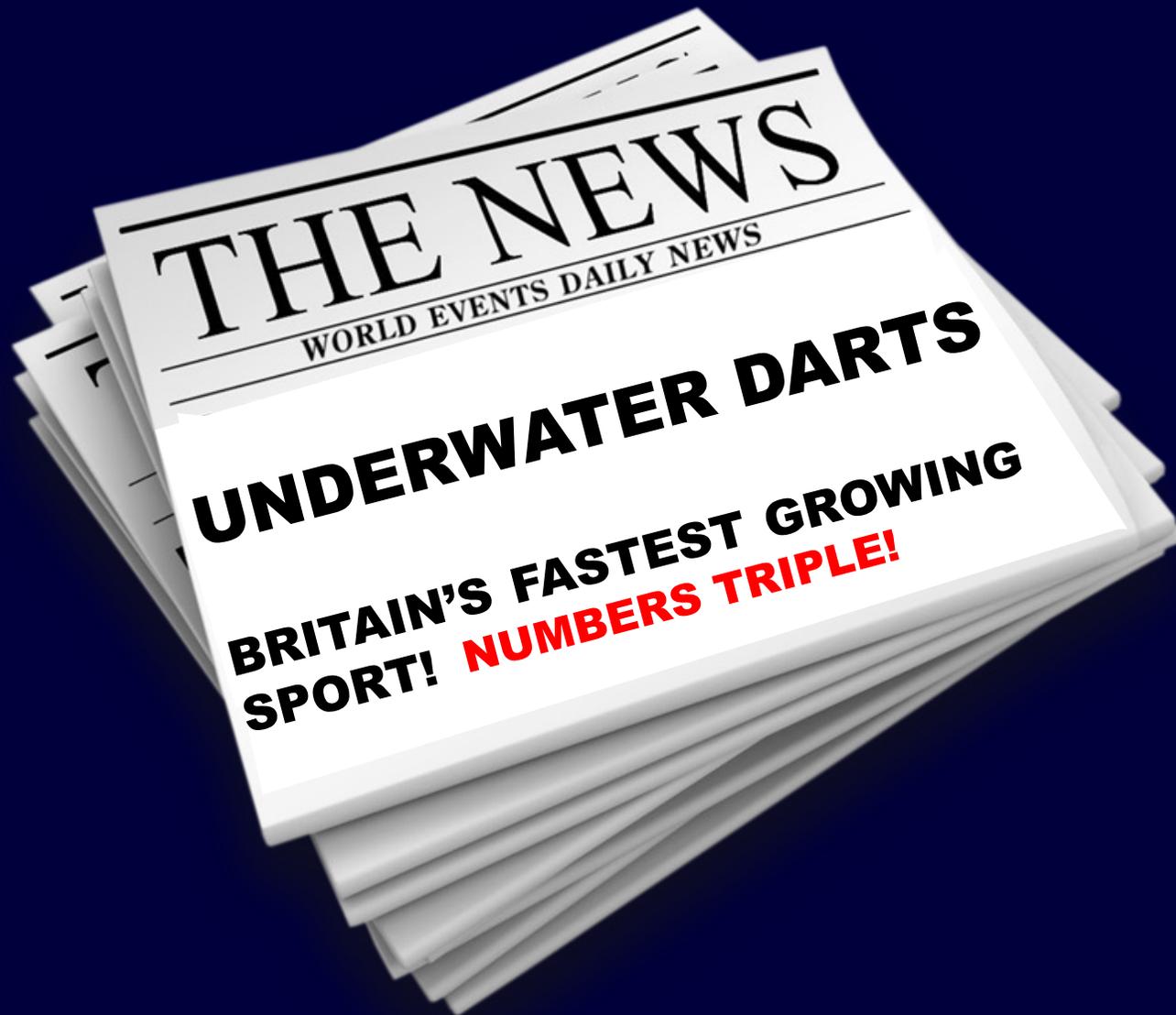
“*Scutari, 25 April, 1855.*”

“I have much pleasure, my Lord, in reporting that everything under my command is progressing as favourably as I could wish. Sickness has very much diminished, and so has the mortality. In January last the number of deaths was 1,480, in February 1,254,



You idiot! The numbers in the hospital had decreased more than the numbers dying – mortality was actually increasing on your watch!

The numbers behind the headlines



The numbers behind the headlines

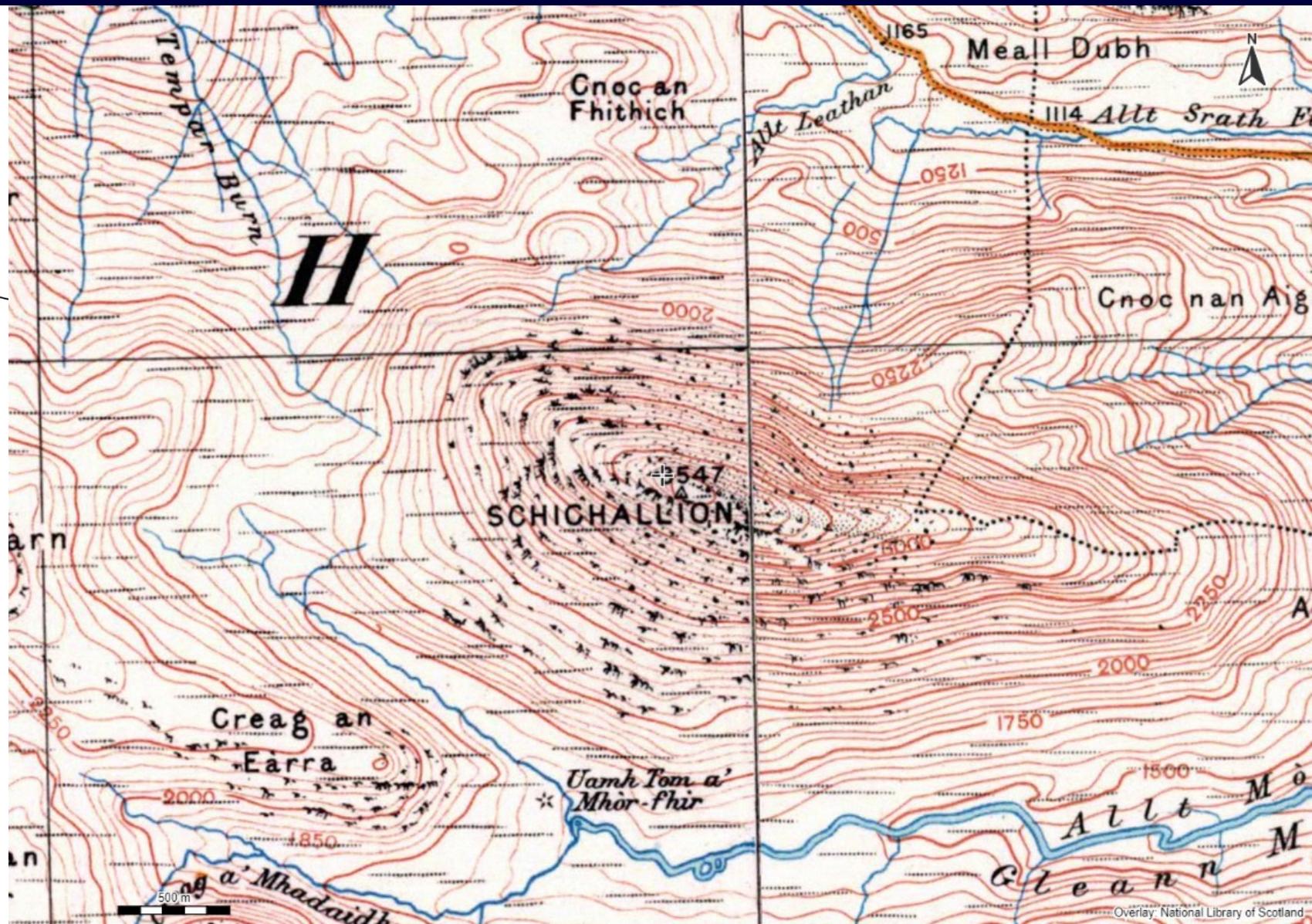
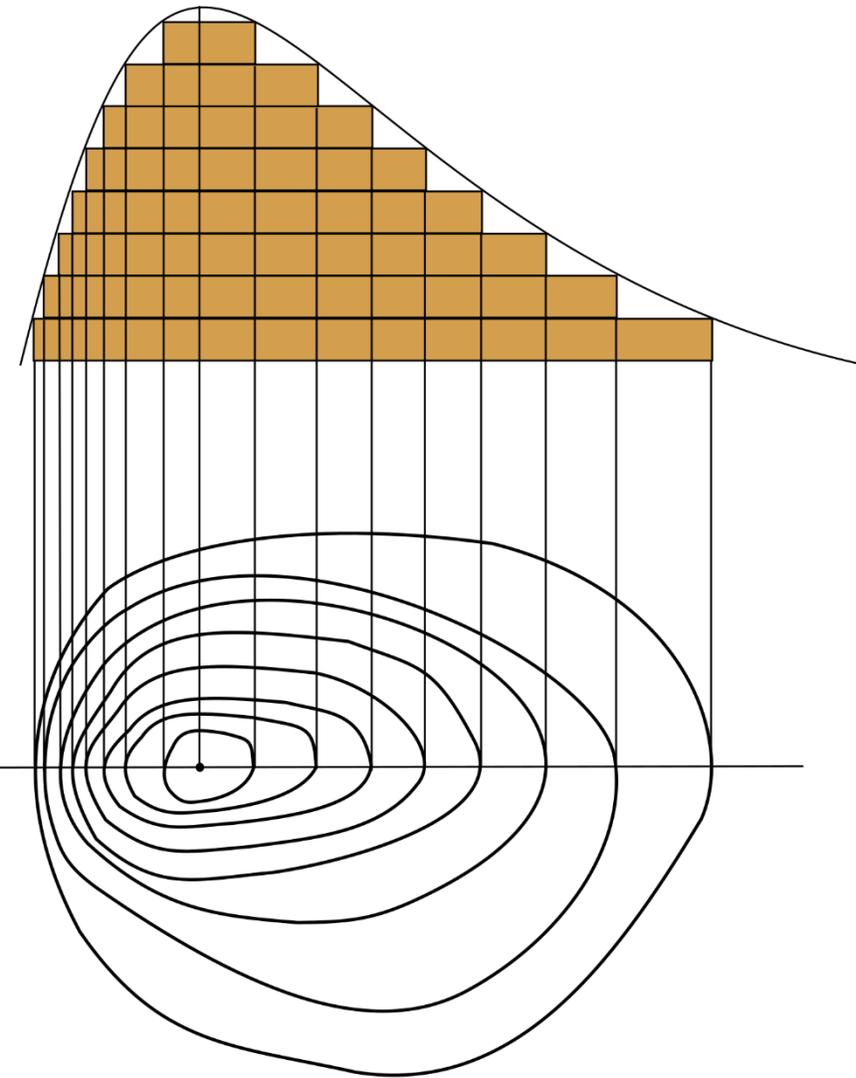


- 2 rashers/day increases bowel cancer risk by 18%
- Baseline risk about 6%
- Daily bacon increases risk to about 7%

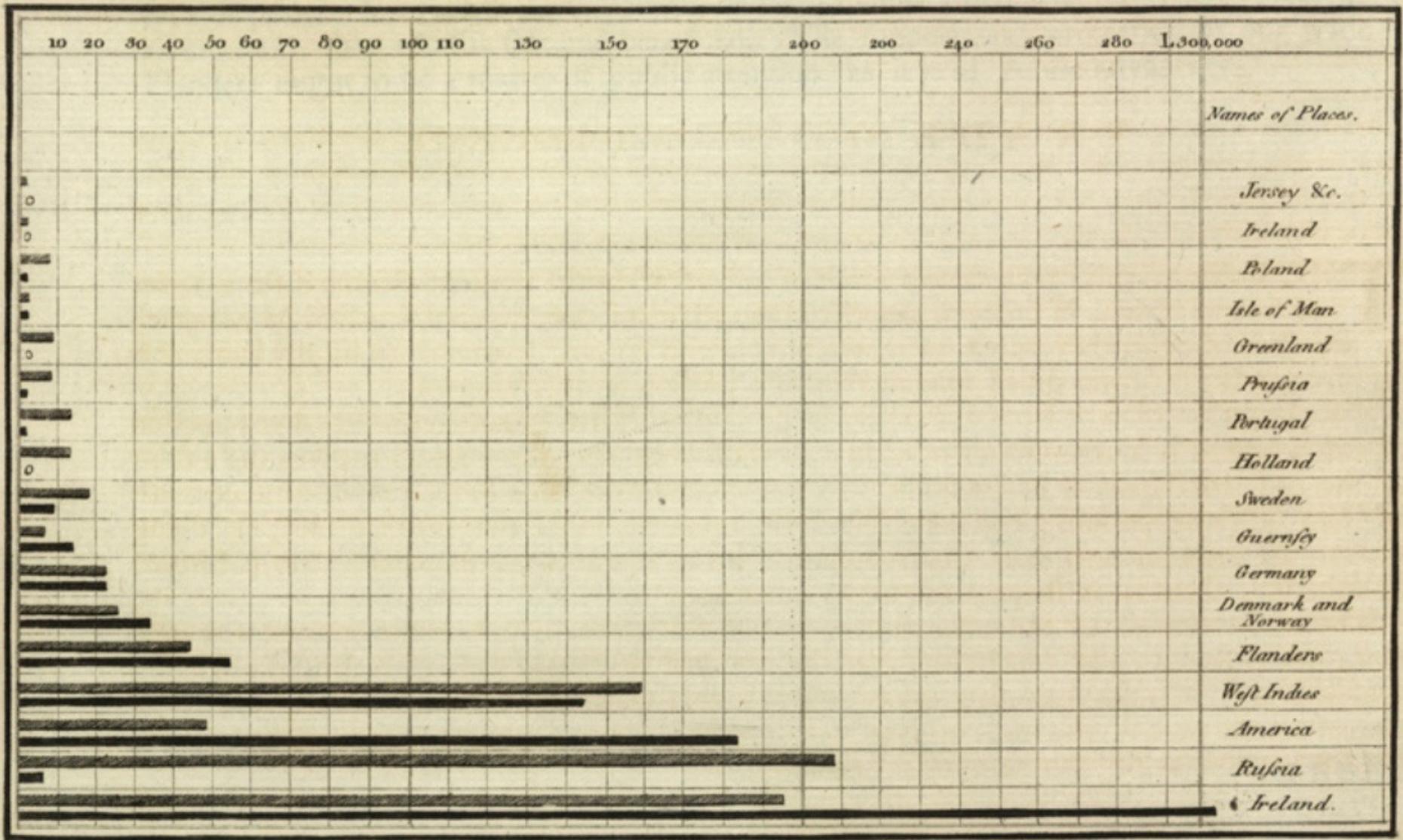
A picture is worth a thousand words



A picture is worth a thousand words

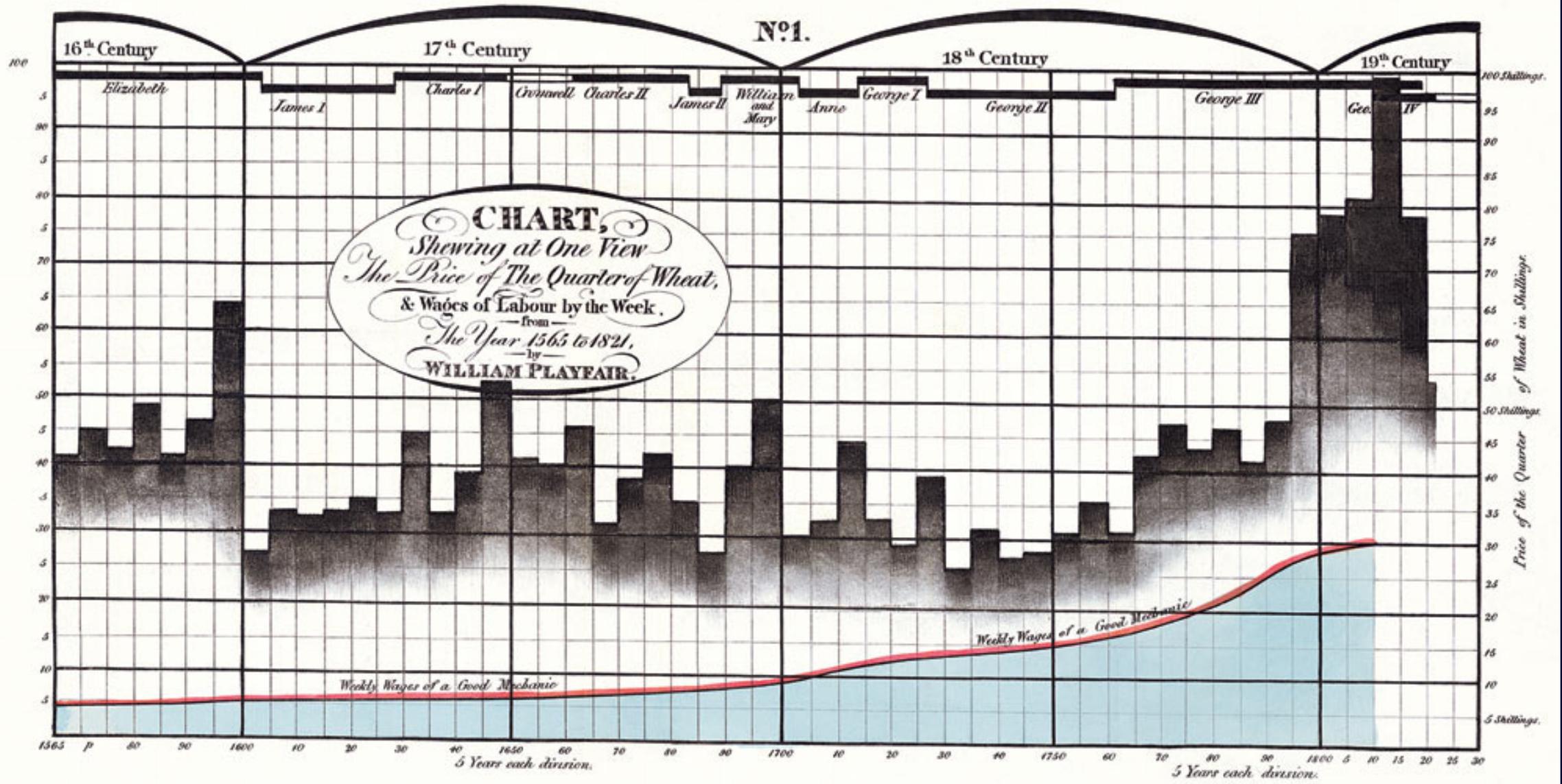


Exports and Imports of SCOTLAND to and from different parts for one Year from Christmas 1780 to Christmas 1781.



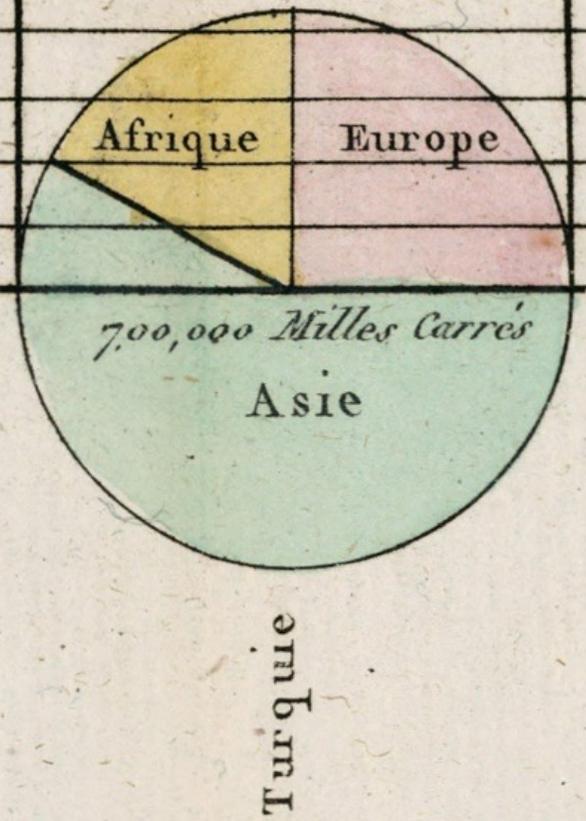
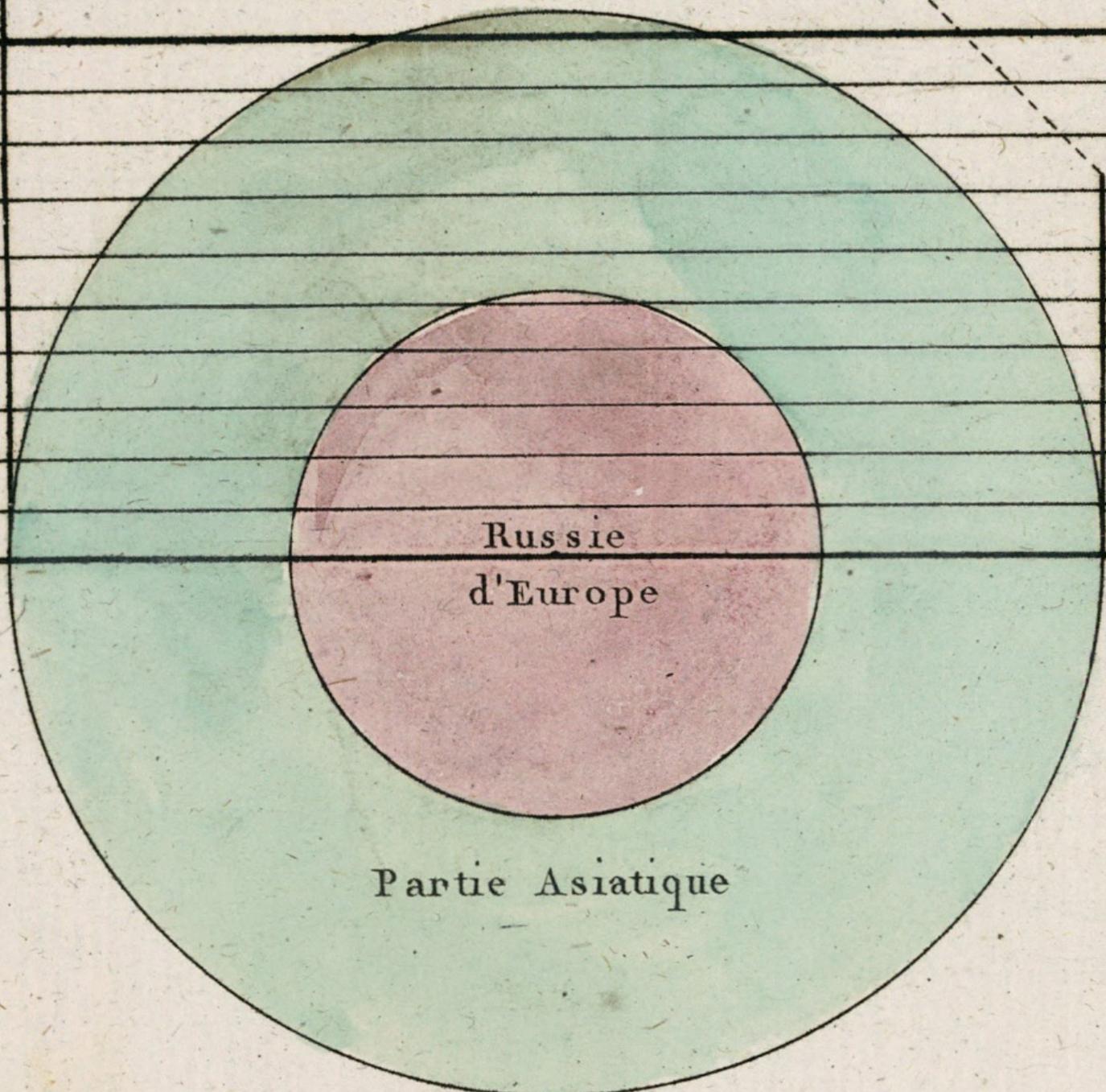
The Upright divisions are Ten Thousand Pounds each. The Black Lines are Exports the Ribbed lines Imports.

William Playfair's Commercial and Political Atlas (1786)



This [...] has struck several persons as fallacious, because geometrical measurement has not any relation to money or time; yet here it is made to represent both.

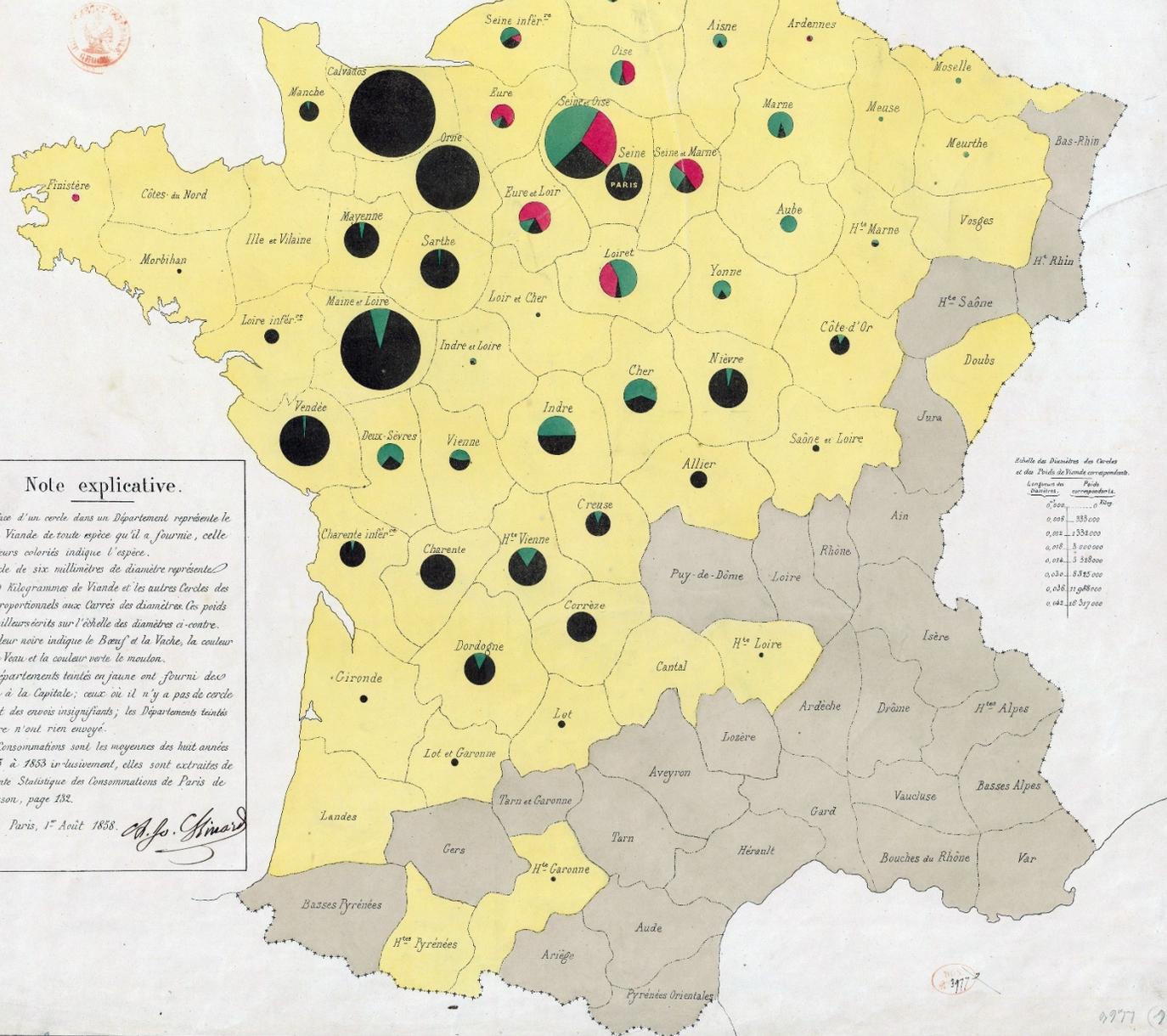
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Statistical Breviary (1801)

CARTE FIGURATIVE et approximative des quantités de Viandes de Boucherie envoyées sur pied par les Départements et consommées à Paris.

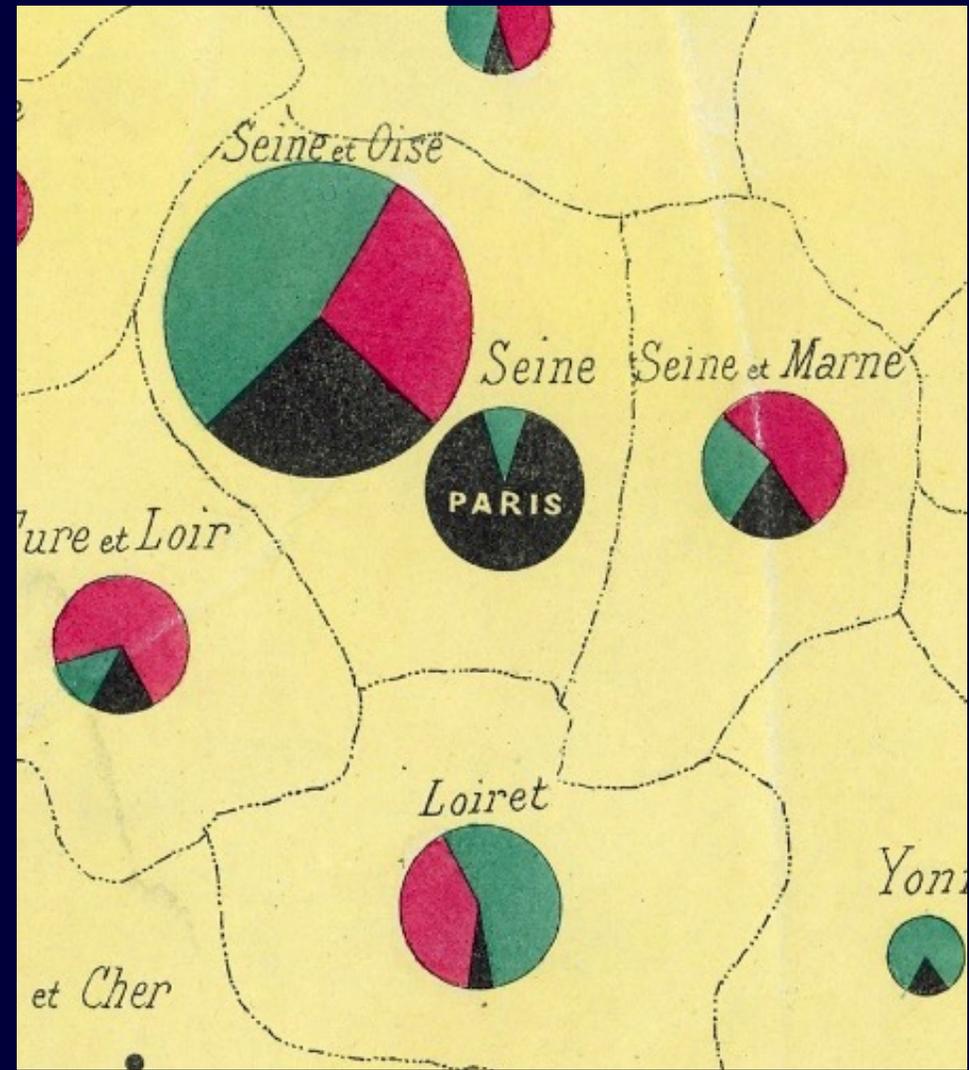
Dressée par M. MINARD, inspecteur Général des Ponts et Chaussées en retraite.



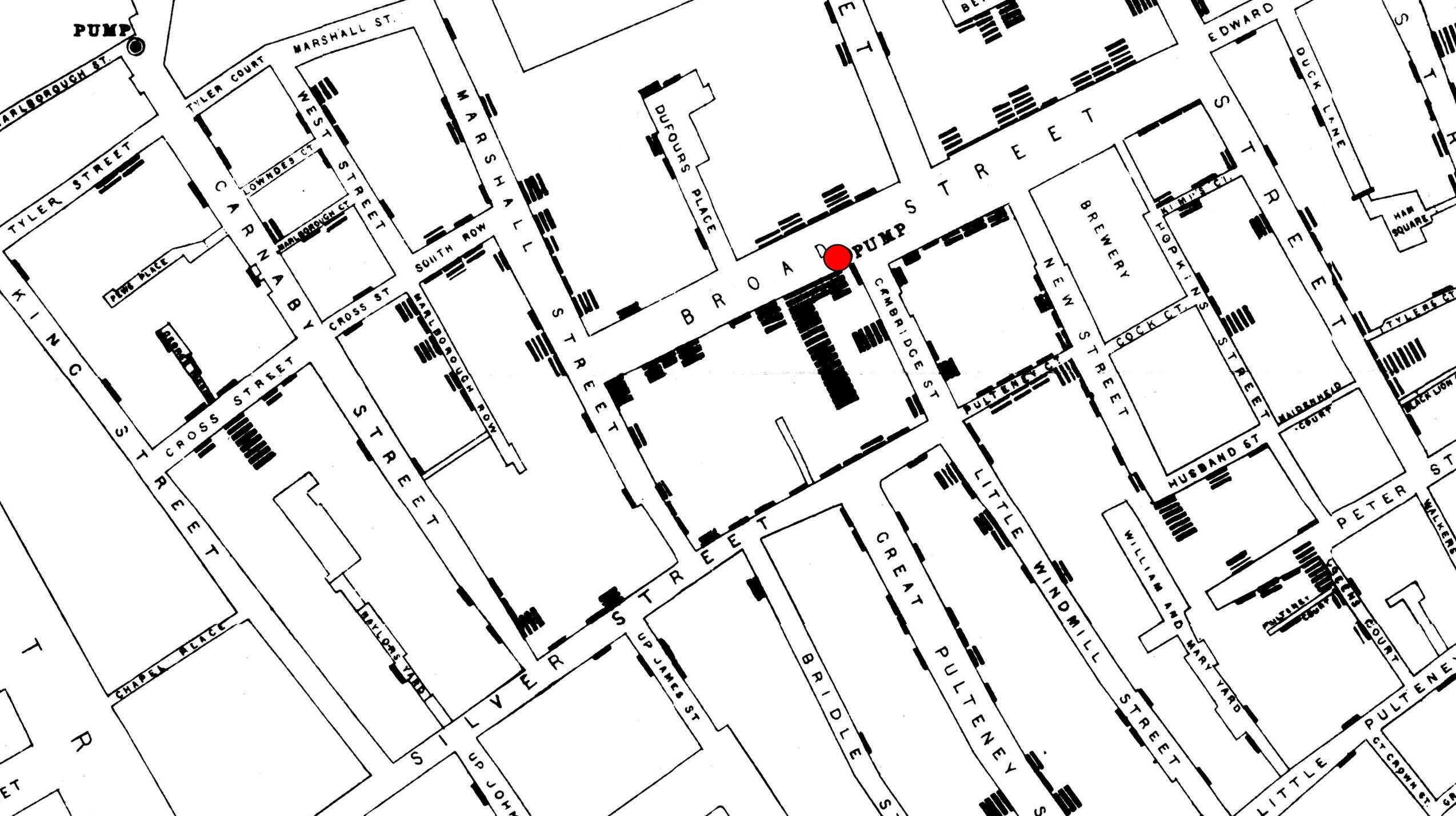
Note explicative.

La surface d'un cercle dans un Département représente le poids de Viande de toute espèce qu'il a fournie, celle des Secteurs colorés indique l'espèce.
 Un cercle de six millimètres de diamètre représente 333 000 Kilogrammes de Viande et les autres Cercles des poids proportionnels aux Carrés des diamètres. Les poids sont d'ailleurs écrits sur l'échelle des diamètres ci-contre.
 La couleur noire indique le Bœuf et la Vache, la couleur rouge le Veau et la couleur verte le mouton.
 Les Départements teintés en jaune ont fourni des Bestiaux à la Capitale; ceux où il n'y a pas de cercle ont fait des envois insignifiants; les Départements teintés en bistre n'ont rien envoyé.
 Ces Consommations sont les moyennes des huit années de 1845 à 1853 inclusivement, elles sont extraites de l'Excellente Statistique des Consommations de Paris de M. Bussou, page 132.

Paris, 1^{er} Août 1858. *M. Minard*



Charles Minard (1858)



PUMP

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KING STREET

TRINITY STREET

TYLER COURT

MARSHALL ST.

WEST STREET

CROSS ST

CROSS STREET

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UP JOHN

UP JAMES ST

MARSHALL STREET

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PULTENEY

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GREAT PULTENEY

BRIDLE

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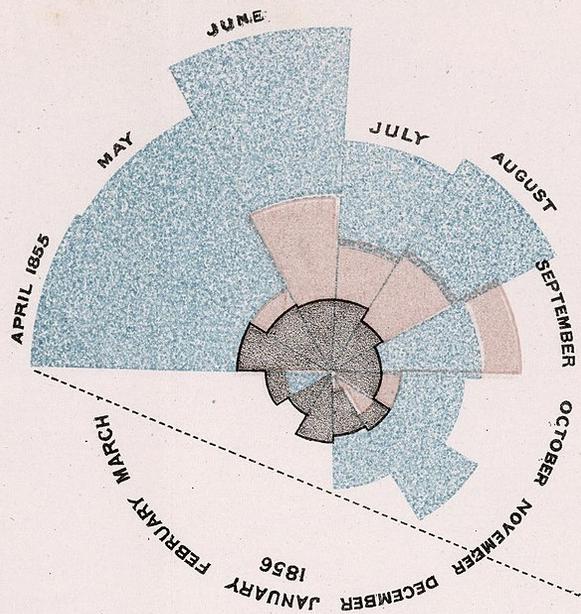
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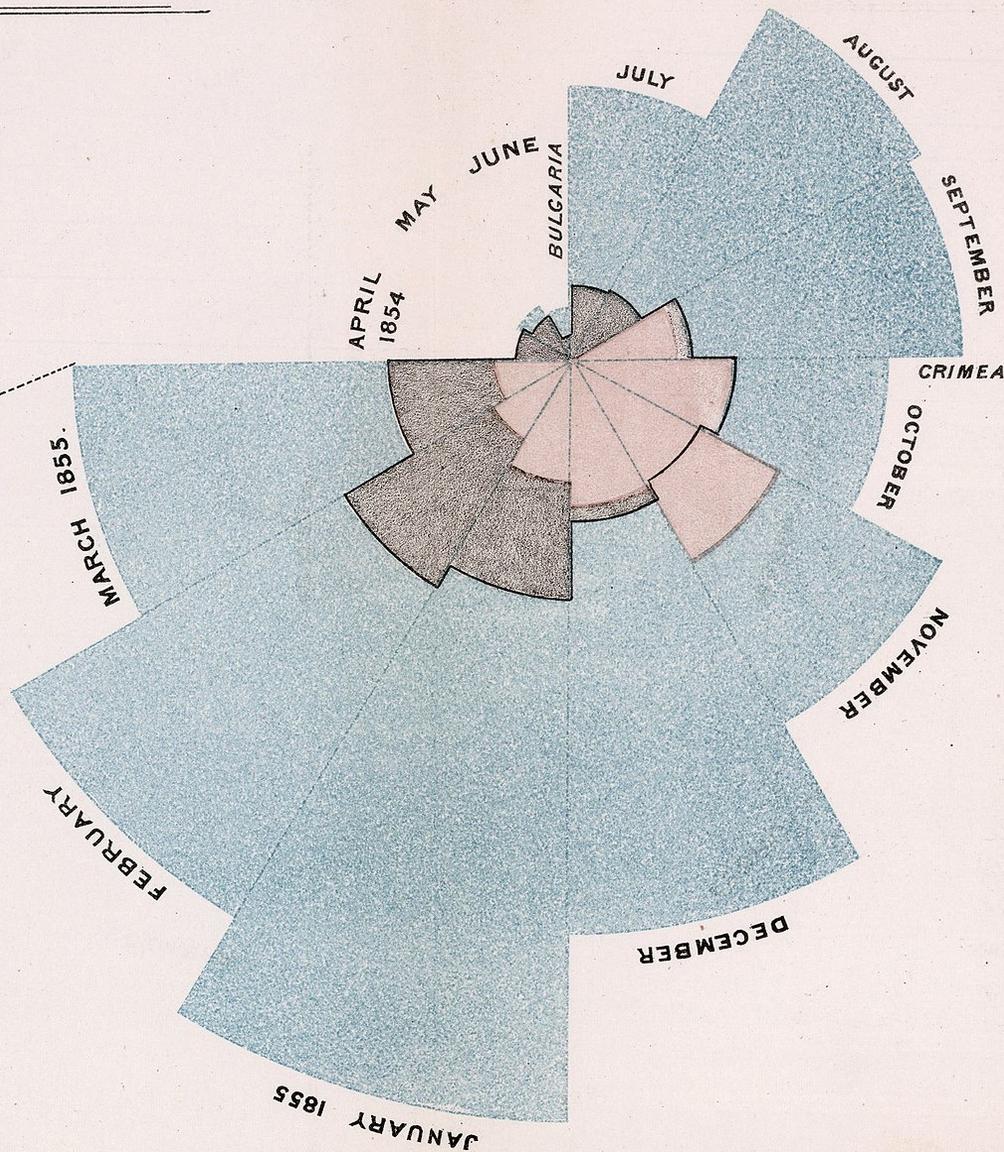
DIAGRAM OF THE CAUSES OF MORTALITY

IN THE ARMY IN THE EAST.

2.
APRIL 1855 TO MARCH 1856.



1.
APRIL 1854 TO MARCH 1855.



The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex.

The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic diseases; the red wedges measured from the centre the deaths from wounds; & the black wedges measured from the centre the deaths from all other causes.

The black line across the red triangle in Nov^r 1854 marks the boundary of the deaths from all other causes during the month.

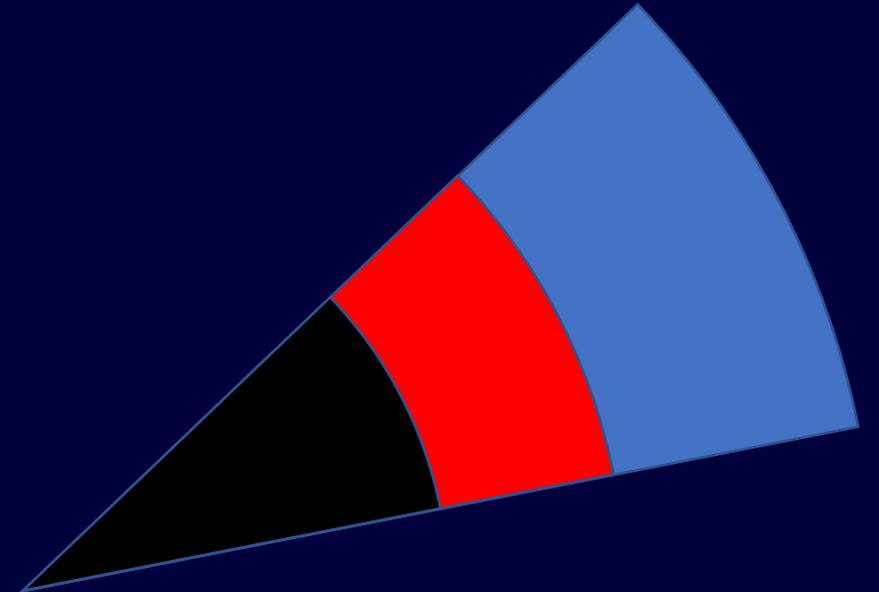
In October 1854, & April 1855, the black area coincides with the red; in January & February 1855, the blue coincides with the black.

The entire areas may be compared by following the blue, the red & the black lines enclosing them.

Constructing a Polar Area Diagram

- Example month, if army is 40,000

Cause	Deaths	Per 1000	Annualised
Wounds	400	10	120
Preventable	800	20	240
Other	200	5	60

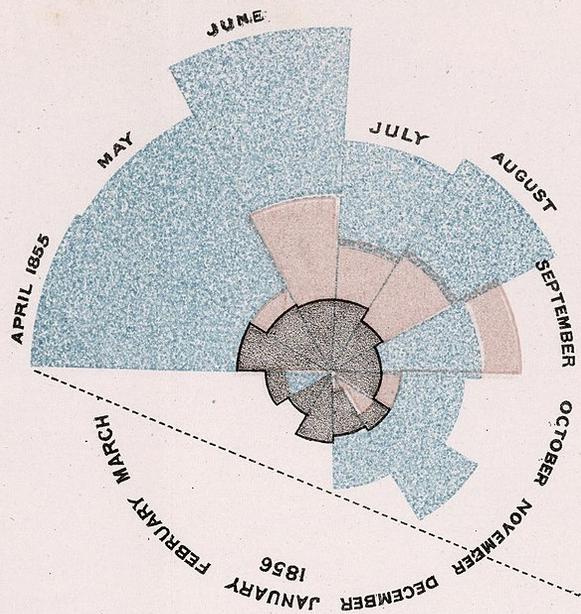


- Area of wedge = $\frac{\pi r^2}{12}$ proportional to number N represented
- Jan 1855: 2,761 of 32,393 died of preventable diseases.
85.234 per 1000, so 1022.8 per 1000 per year.

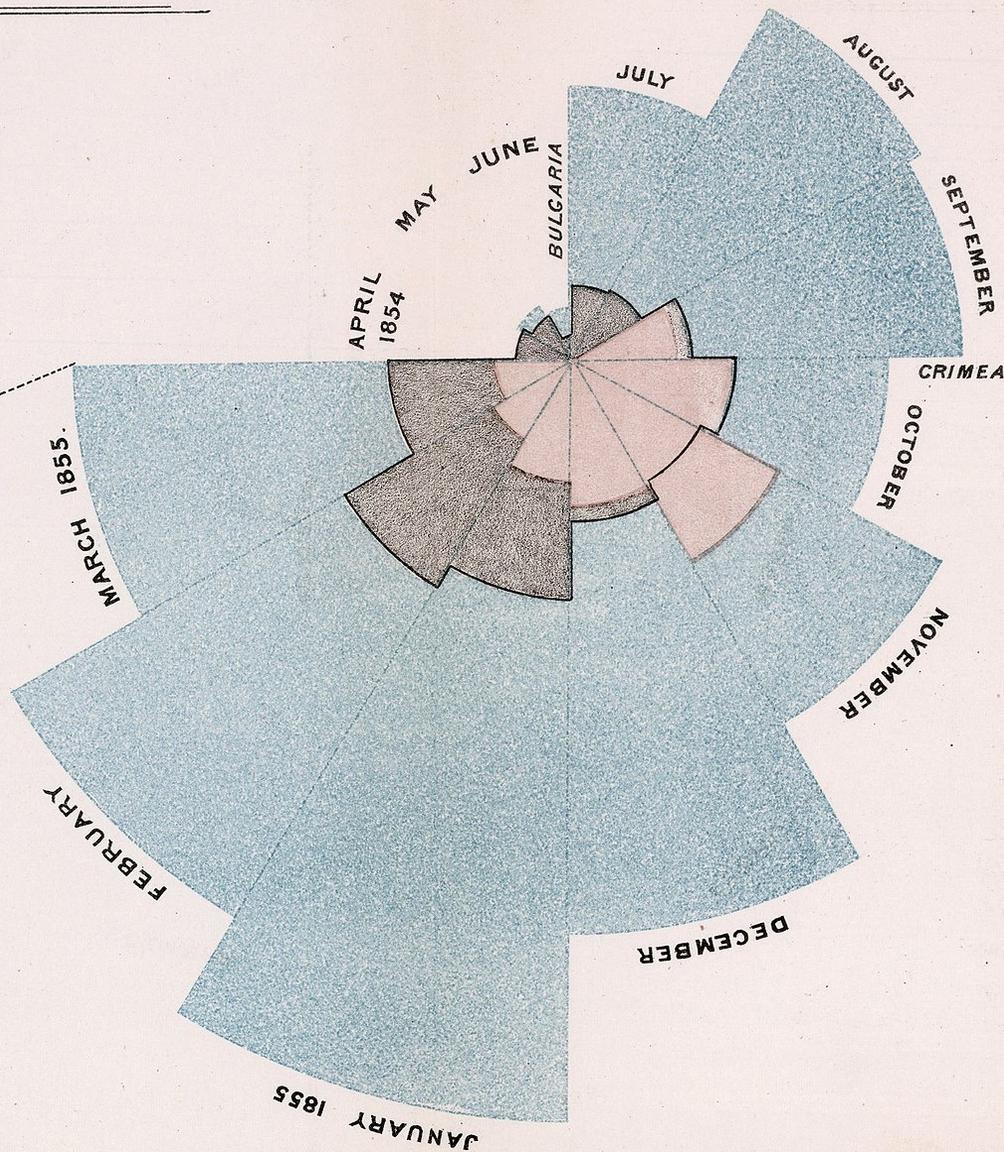
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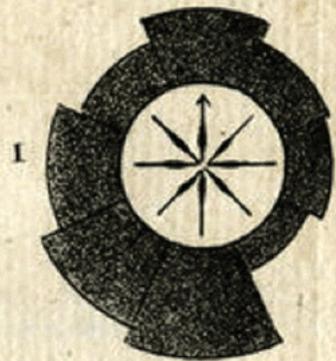
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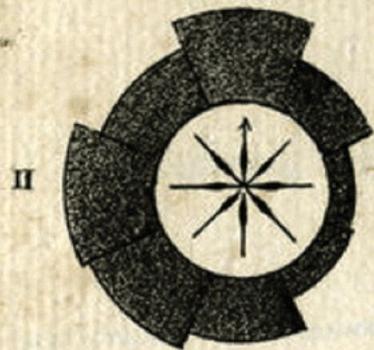
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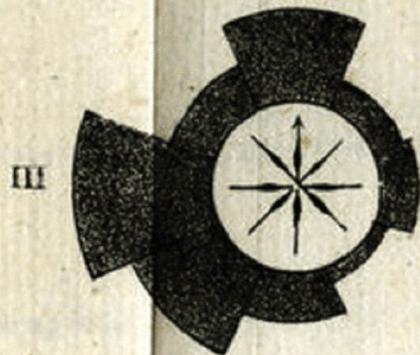
Déc. Janv. Fév.



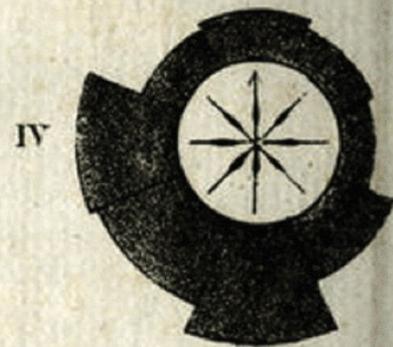
Mars. Avril. Mai



Juin. Juill. Août.

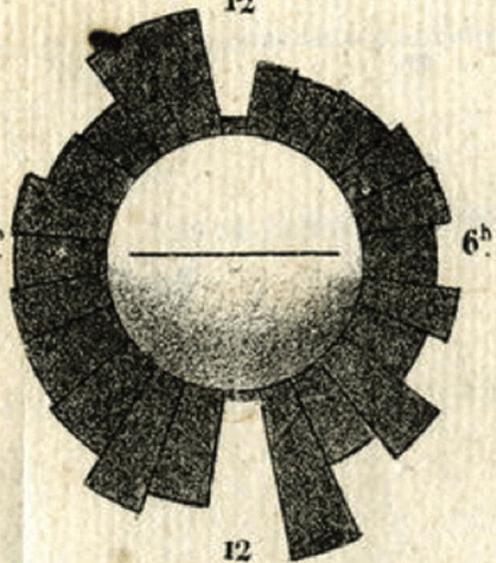


Sept. Oct. Nov.



Midi
12

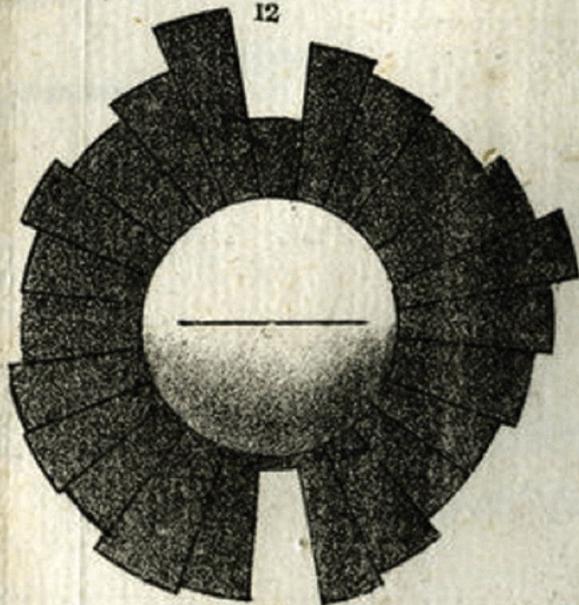
XXIX 6^h



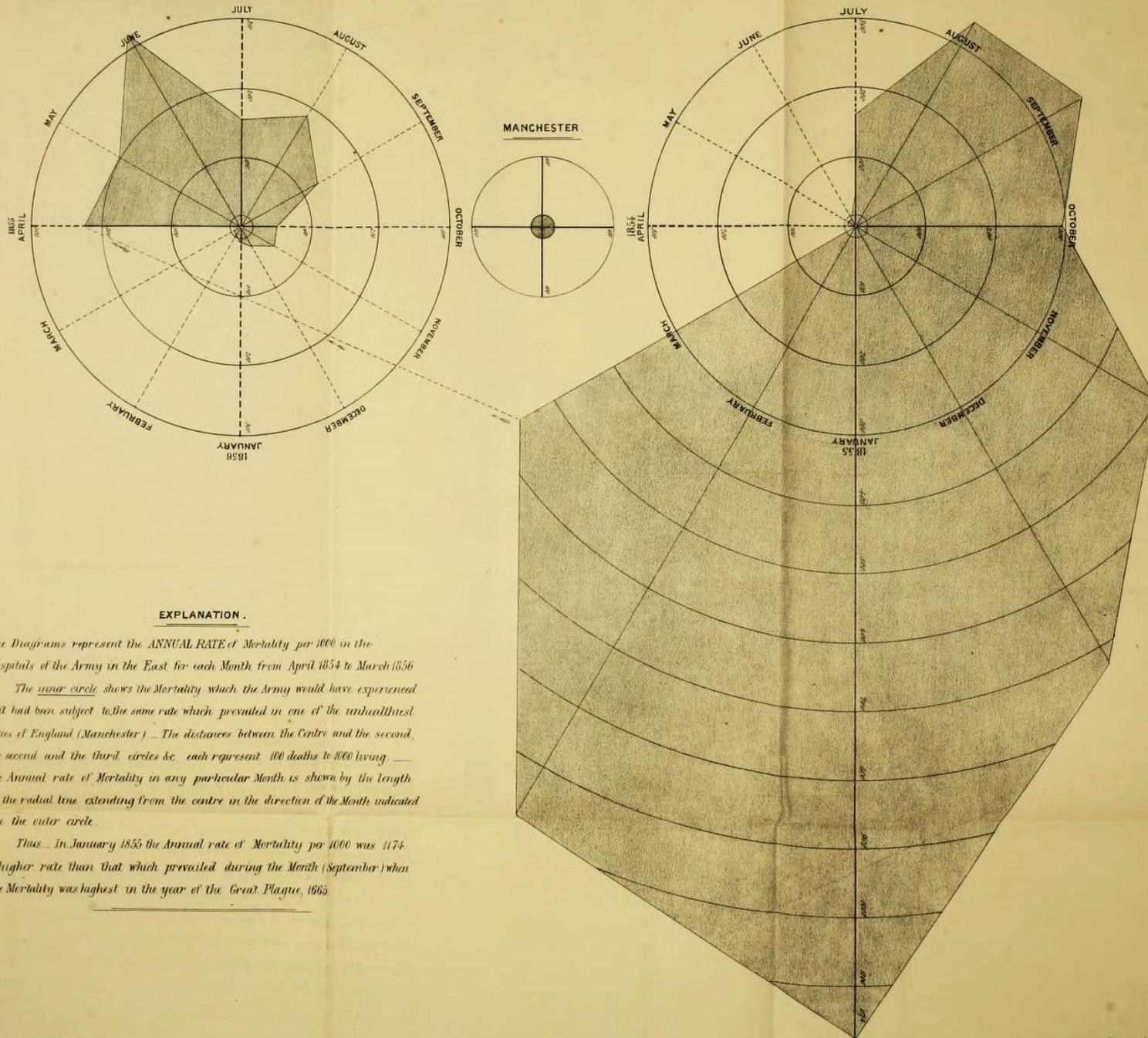
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EXPLANATION .

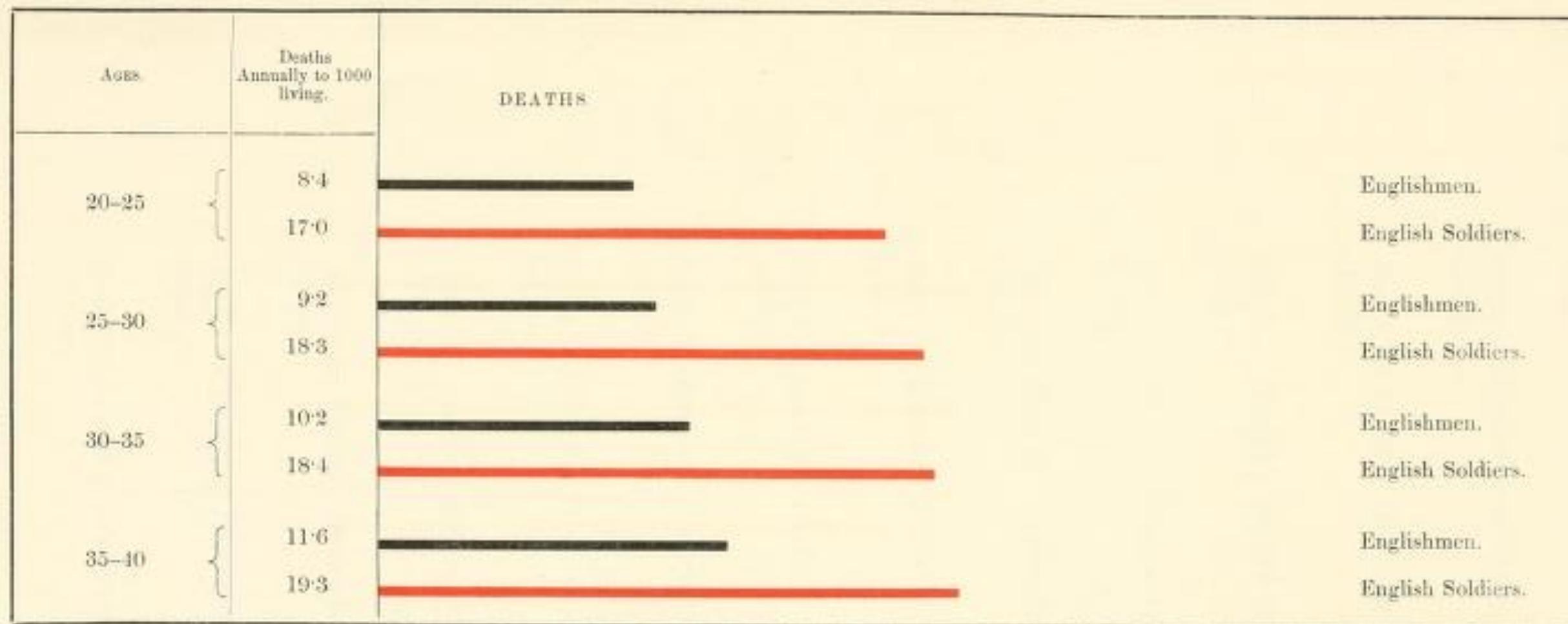
The Diagrams represent the ANNUAL RATE of Mortality per 1000 in the Hospitals of the Army in the East for each Month from April 1854 to March 1856

The inner circle shows the Mortality which the Army would have experienced if it had been subject to the same rate which prevailed in one of the unhealthiest Cities of England (Manchester) — The distances between the Centre and the second, the second and the third circles &c. each represent 100 deaths to 1000 living. — The Annual rate of Mortality in any particular Month is shown by the length of the radial line extending from the centre in the direction of the Month indicated on the outer circle.

Thus — In January 1855 the Annual rate of Mortality per 1000 was 1174 a higher rate than that which prevailed during the Month (September) when the Mortality was highest in the year of the Great Plague, 1665.

Lines

Representing the Relative Mortality of the Army at Home and of the English Male Population at corresponding Ages.



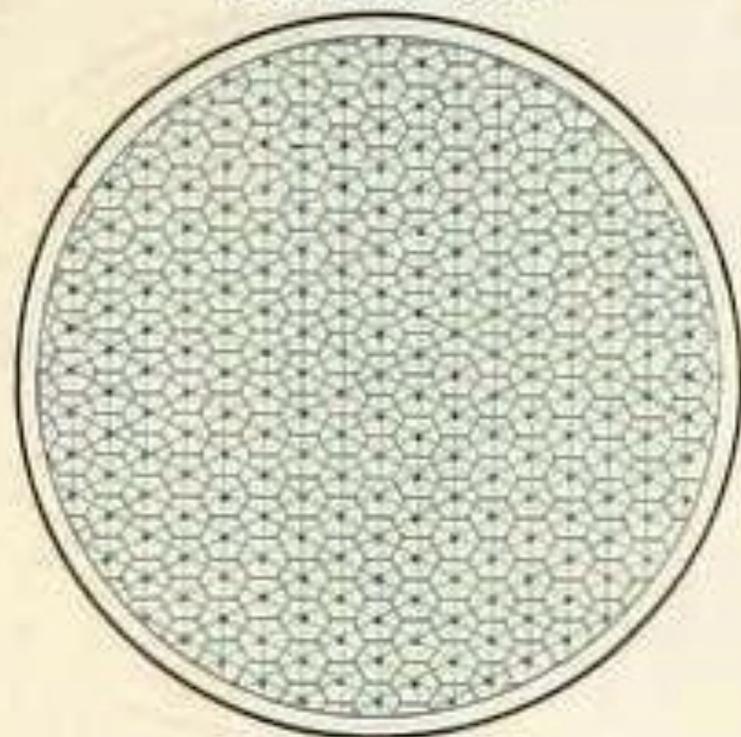
JAMES LEWIS, del.

NOTE.—The Mortality of the English Male Population, at the above ages, is taken from English Life Table (1849-53).

URNISHED BY THE
ENCAMPMENT.

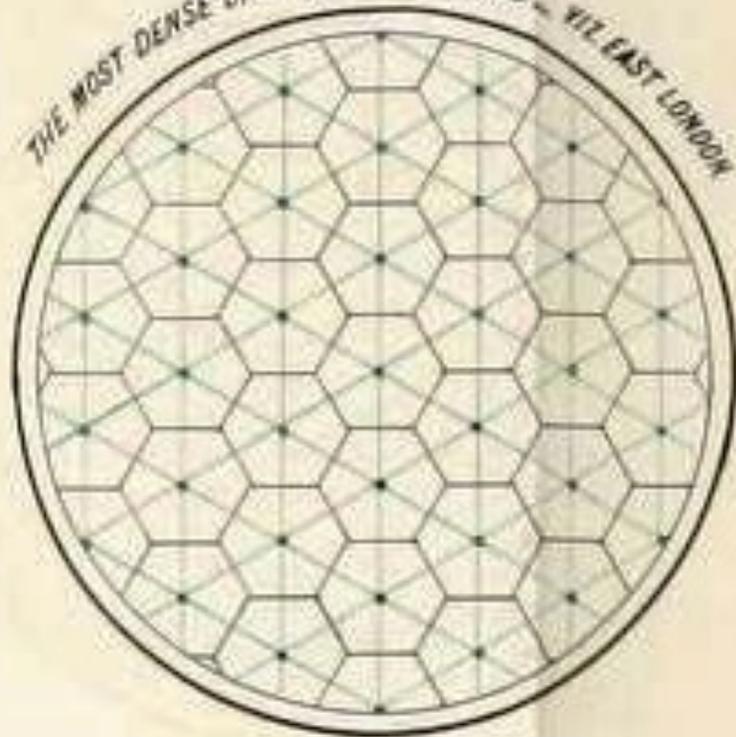
1851.

OCCUPIED AREA.



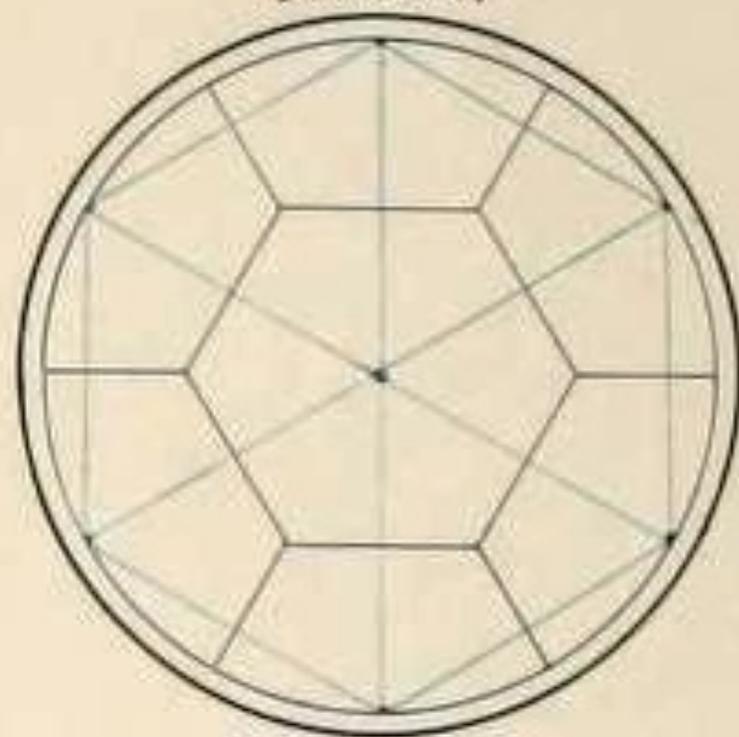
3 · 0 Square Yds to a person
1 · 9 Yds from person to person

THE MOST DENSE DISTRICT IN ENGLAND — VIZ EAST LONDON



17 · 6 Square Yds to a person
4 · 5 Yds from person to person

LONDON



160 · 0 Square Yds to a person
14 · 2 Yds from person to person

the Density of the Population; the six sided Figures represent the average amount of ground to each point indicate the Proximity or mean distance from person to person, including the space occupied by the body

D I A G R A M

representing the relative Annual Mortality from ZYMOTIC DISEASES, CHEST & TUBERCULAR DISEASES, & OTHER DISEASES in the ENGLISH MALE POPULATION aged 15-45, and in the INFANTRY of the LINE, serving at Home, before & since Lord Herbert's Administration.

ENGLISH MALE POPULATION AGED 15-45. 1848-54.	<i>Zymotic Diseases</i> 2·0 to 1000 living	<i>Chest & Tubercular Diseases</i> 4·5 to 1000 living	<i>All other Diseases</i> 3·3 to 1000 living
	Deaths Annually to 1000 living from All Causes 9·8		

THIS IS HOW LORD HERBERT FOUND THE ARMY.

INFANTRY OF THE LINE (SERVING AT HOME) 1837-46.	<i>Zymotic Diseases</i> 4·1 to 1000 living	<i>Chest & Tubercular Diseases</i> 10·1 to 1000 living	<i>All other Diseases</i> 3·7 to 1000 living
	Deaths Annually to 1000 living from All Causes 17·9.		

THIS IS HOW LORD HERBERT LEFT THE ARMY.

INFANTRY OF THE LINE (SERVING AT HOME) 1859-60-61.	<i>Zymotic Diseases</i> 0·96 to 1000 living	<i>Chest & Tubercular Diseases</i> 4·2 to 1000 living	<i>All other Diseases</i> 3·4 to 1000 living
	Deaths Annually to 1000 living from all Causes 8·56		



To understand God's thoughts, we must study statistics, for these are the measure of his purpose.

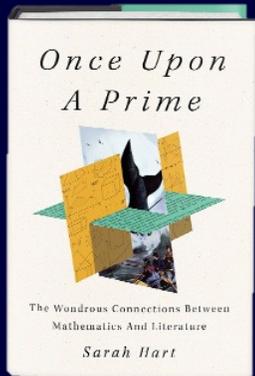
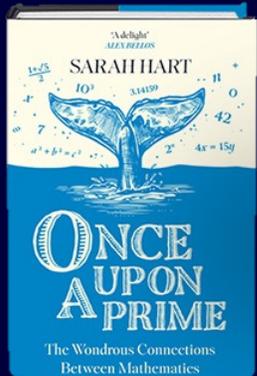
Florence Nightingale
1820 - 1910



GRESHAM
COLLEGE

Alan Turing: Pioneer of Mathematical Biology

6th June 2023, 1pm



Read my book!
Once Upon a Prime: The
Wondrous Connections between
Mathematics and Literature

