WHAT CAUSED THE BLACK DEATH?

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At any given point in time various scientific beliefs are regarded as absolute truths: the Earth is the centre of the universe; the species evolved according to the principles established by Charles Darwin; anthropogenic factors are causing climatic change; and so on. Some of our former 'truths' are now known to be wrong, so the problem is to establish which of our present beliefs are true and which are false but not yet proven to be so. This is more difficult than one might assume. There are lots of 'sociological' reasons for scientific inertia: academics who have spent their careers collecting evidence to support a particular belief tend to dismiss any evidence to the contrary as an aberration or an exception that can be accommodated by a minor change to their theory; these senior academics tend to be the ones that sit on the boards that allocate research funding, this ensuring a flow of research that supports rather than questions the status quo; young researchers, whose careers depend on funding, quickly realise that it is more beneficial to go with the flow than to challenge it; and so on. However, you do not need to resort to conspiracy theory to explain scientific inertia. It may simply relate to the way in which we think.

To illustrate, consider this little experiment from a book by the mentalist Derren Brown (Brown, 2007). Suppose I place four cards on a table, each of which has a letter on one side and a number on the other. I announce that 'every card with an A on one side always has a 3 on the other side'. If the four cards read:

A D 3 7

how many cards would you need to turn over to prove whether the statement was true or false? Decide on an answer before reading on.

The obvious starting point would be to turn over the A. If the number on the other side is anything other than 3 then you have proved the statement to be false. However, if the other side was a 3, then this would be consistent with the statement being true, but it does not prove A always has a 3 on the other side. To prove the statement to be true you need to turn over a second card. Most people would probably opt to turn over the 3 to see if the other side was A. This, however, is irrelevant. The statement specifies that A always has 3 on the other side, not that 3 always has an A on the other side, so it does not matter what is on the other side of the 3. The correct answer is that you need to turn over the 7. If this has an A on the other side, then the statement is false, whereas if it is any letter other than A then the statement is true.

If you got this correct, well done. However, most people do not think of turning over the 7. The reason is that we instinctively tend to search for evidence to confirm that something is true, not that its opposite is false. Brown further suggests that believers (whether it be in a religion, alternative medicine, the occult, or whatever) subconsciously select evidence that reinforces their belief rather than seek evidence to contradict it. Thus, relatively few people ever question their current beliefs. This is especially the case in academia if that belief is in some way seen to be 'radical' or 'critical' or 'progressive'. As humans, we like to conform with our peers yet be different from broader society, like spotty teenagers wearing the same clothes to prove they are 'rebellious', so we are less likely to question whatever theories are currently 'in fashion'.

Scientific research, in my opinion, only becomes interesting when the findings challenge the established beliefs (or sometimes, due to personal ignorance, my own preconceptions). Reading about yet another model based on the same assumptions predicting the same outcomes does not do it for me. In fact, given that the essence of the scientific method is to disprove the opposite of what you wish to prove (like turning over the 7 above), it is arguable to what extent many models can even be regarded as scientific. The example I want to discuss here is the cause of the Black Death.

The 'Black Death' refers to a devastating epidemic which swept through Europe in the 14th century. It is traditionally assumed to have begun in the Caucasus and Steppes in 1346, spread to Constantinople and then to Sicily by sea in 1347, and then to the mainland in western Europe later that year, from

where it diffused in a vaguely clockwise wavelike manner northwards and eventually eastwards over the next 6 years. It was traditionally assumed to have killed between one quarter and one third of the entire population of Europe (or about 25 million people), although some newer estimates suggest the overall death rate may have been between 45 and 50 per cent, and as high as 80 per cent in some areas, such as southern France and Spain. Many of the major cities lost half to three quarters of their population.

Europe was not the only area affected. The Middle East lost between 25 and 38 per cent of its population during the same outbreak. The initial outbreak in China killed an estimated 5 million people (or 90 per cent of the population) in Hubei province in 1334, whilst a more extensive outbreak in 1353-54 may have killed a further 25 million. Disease, famine and atrocities by the Mongols are thought to have reduced the Chinese population from 125 million in 1200 to 65 million by the late 14th century. Unspecified millions also died from plague in India in the 1340s, possibly introduced via maritime trade from China. Thus, while we usually think of the Black Death as a European disaster, it may have been part of a global pandemic.

Although the first wave was the most severe, most parts of Europe were revisited by smaller epidemics every decade or so through to the 17th century. The term 'Black Death' was only used for the first time in 1833. Contemporary accounts referred to the first wave as the Great Pestilence, Great Mortality or Great Plague. Later epidemics were usually referred to simply as the Plague.

The Black Death is generally believed to have been caused by bubonic plague. However, bubonic plague was only proposed as the cause of the Black Death around the beginning of the last century (or approximately 550 years after the event). Nevertheless, the idea was faithfully repeated in textbook after textbook, until it became regarded as established 'fact'. The main reason for supposing that the Black death was bubonic plague is that that the symptoms appear similar: the appearance of buboes (or very painful swollen lymph glands), aching limbs, intense fever, red skin rash which turns black, internal bleeding, vomiting blood, coughing, and terrible pain as the skin decomposes while the victim is still alive. It is not difficult to understand why Plague generated so much fear throughout the ages.

Thanks to the some amazing detective work by French microbiologist Alexandre Yersin, working in Hong Kong in 1894, the cause of bubonic plague is now known to be a bacterium originally named *Pasturella pestis* by Yersin in honour of Louis Pasteur, but now known as *Yersinia pestis*. It is a commensal in many types of wild rodent, but it can be transmitted to rats and other rodents by fleas (*Xenopsylla cheopis*) where it results in disease causing the rats to die and for the fleas to seek an alternative food source, namely humans. Humans then become infected from the fleas and develop bubonic plague. Outbreaks of bubonic plague are generally preceded by lots of dead rats.

A number of researchers in recent years have cast doubt on the assumption that the Black Death was in fact bubonic plague. Scott and Duncan (2004), for example, report a detailed study that one of the authors (Sue Scott) did of a plague outbreak in Penrith in northern England in 1597-8. Carefully scrutinising parish records she was able to establish that the disease had a latent (i.e. non-infectious) period of 10-12 days, followed by an infectious period of 20-22 days during which the victim still showed no symptoms but was able to infect others. The total incubation period (i.e. the gap between initial infection and developing symptoms) was therefore approximately 32 days. Death generally occurred within 5 days after the appearance of symptoms, giving a total of about 37 days between initial infection and death.

These estimates were replicated in other studies conducted by the authors. They also correspond closely with the practice of quarantine initially developed by Dubrovnik to control plague, but subsequently adopted elsewhere throughout the Mediterranean. The word quarantine is derived from the Venetian word *quarantena* (meaning forty days). To prevent plague being introduced from outside, the city state of Dubrovnik insisted that visitors had to remain on nearby islands for 30 days without developing symptoms before being admitted to the city. When 30 days did not prove sufficient, the quarantine period was extended to 40 days. Ships entering Venice and other ports had to remain at anchor for 40 days before their crew or cargo would be allowed onshore. This figure of 40 days, established empirically, corresponds very closely with Sue Scott's estimate of 37 days.

The Black Death disappeared in the 17th century, but bubonic plague is still with us. It has an incubation period of only 4-6 days (i.e. about one month less than the Black Death). This alone would

suggest it is highly improbable that the Black Death was bubonic plague. However, Scott and Duncan put forward numerous other arguments. Rather than discuss these in detail, I will simply summarise a sample as bullet points:

- Contemporary accounts did not report a die off of rats, but persistently reported that disease followed contact with an infected person.
- The plague spread to areas (e.g. Iceland) where there were no rats.
- In the case of Britain, there is evidence to suggest that the only rats in the 14th century were black rats (*Rattus rattus*) which originated in India and like warm climates. It is unlikely they would have ventured far from the south coast, yet the Black Death occurred in all parts of Britain (and Ireland). The predominant rat today, the brown rat (*Rattus norvegicus*), only arrived in the 1720s after the Black Death had disappeared.
- The Black Death often moved 100 miles in a few days. Bubonic plague rarely travels more than a few miles per year. The reason it moves so slowly is that rats rarely move more than a hundred yards from their home.
- The weather in England, at the beginning of what is referred to as the Little Ice Age, was not warm enough for *Xenopsylla cheopis* fleas to hatch.

Scott and Duncan argue that the Black Death was not bubonic plague and suggest instead that it may have been a viral haemorrhagic fever (similar to present-day Ebola or Marburg) which they refer to as 'haemorrhagic plague'. Like Ebola and Marburg, they suggest it may have had an East African origin and then moved down the Nile to Egypt, where it would have been diffused by trading links throughout the Mediterranean. This alternative explanation is highly speculative, but if true it could have serious ramifications. Bubonic plague is caused by bacteria which are susceptible to antibiotics. It can therefore be readily contained and therefore should no longer cause us undue alarm. However, in the absence of a vaccine, we have few defences against viral diseases. Ebola and Marburg are the stuff of nightmares, but they generally depend upon a transfer of bodily fluids for transmission and can therefore be contained, albeit with difficulty. An air-borne equivalent, such as Scott and Duncan's hypothesised haemorrhagic plague, if it were to occur would not only be lethal but unstoppable. Establishing what happened in the 14th century is therefore much more than an obtuse academic debate.

At a more general level what can we learn from this? I think the main point is that you should never unquestioningly believe everything that your lecturers present to you as fact. It is not that we set out to tell you lies. However, you should always question how we know what we think we know.

References:

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Scott, S. and Duncan, C. (2004) *Return of the Black Death. The World's Greatest Serial Killer*. Wiley, London.