Death, destruction and...pollen?!

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Not so many years ago, humanity battled for survival with a threat described by scribes as a divine punishment for the sins of mankind. But what was the aftermath of this peril, which was shared by everyone? Did it linger on a continental-scale? Were some voices left unheard? The dead can still tell their tales.

You're sauntering through a damp, dreary alley. Apart from a few rats, which leap from a sack of grain and onto the dirt path, you've no company. Not any more. Church bells cease to toll. Unkempt grasses and weeds brush against your ankles. Doors to abandoned houses are slathered with moss. But you know that with your trusty bouquet of lavender hanging from your belt that you'll be able to scare away the malodorous miasmas. That is, until a sudden swelling pain creeps out from your armpit.

Welcome to 14th century Italy.

Once a bustling port off Sicily, now half of the population has been snuffed out by what we now have coined as the "Black Death" - a not-so-endearing term stirred from the descriptions of oozing black buboes* which plagued the skin of those suffering from the bubonic strain of the Yersinia pestis bacterium.

Now hang on a moment – isn't this, a science magazine, for science-stuff?

Well, my reader, I'll have you know that sometimes science can give us better snapshots of history than some written historical records could ever!

Whilst the written accounts of some writers have been immortalised for their vivid narration of the 1346 siege of Caffa, when the Tatar army catapulted plague victims over the city walls, we're handed only one piece of a very dusty jigsaw puzzle (Barker, 2021). Yes, these records provided a slightly traumatic glimpse into how strains permeated through large medieval settlements (this was also one of the first recorded cases of biological warfare) but we're still to see the bigger picture (Wheelis, 2002).

But what if you're an illiterate medieval peasant farming in a pleasant village, tucked away into a nice temperate corner in western Europe? Were you quite cosy amidst the far-off destruction? Or were you just

another body thrown into a mass grave? Perhaps by questioning Peter's Pence records we could get an idea of how smaller settlements were affected – but to truly unearth the ways in which the Black Death infiltrated its way across Izdebski et al. (2022) provides us with a possible answer, thanks to fossils buried across Europe.

Fossils? Like dinosaurs? **Ish-!**

Welcome to the world of micropalaeontology! Time to talk with the dead. The very, very small dead.

They're the tiny little things which can be used to point out real from fraudulent honey. These little cellular clusters can be used to turn the tide in a murder case. And of course, the living forms of these fossils are the culprit responsible for that horrendous hay-fever you get every year.

Without fail.

Pollen!

Pollen? How's that relevant?

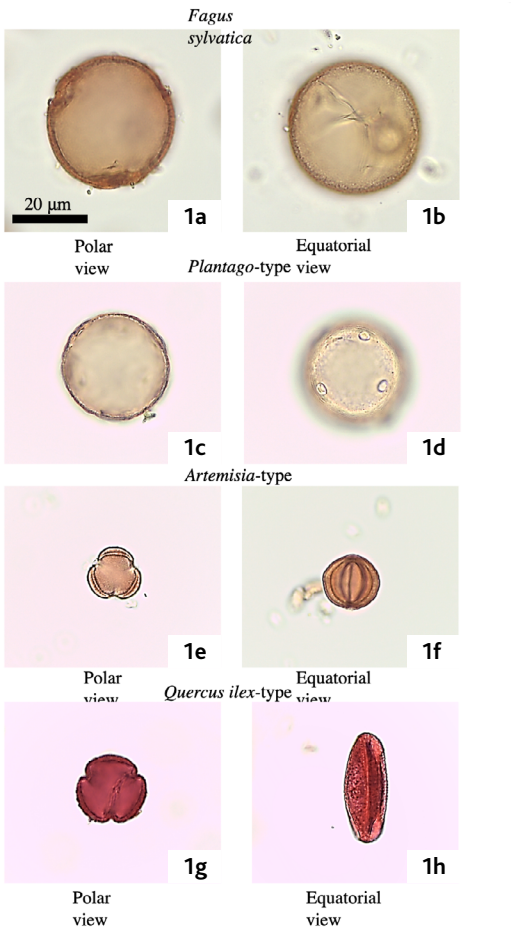
Pollen is preserved exceptionally well in sludgy, peaty soil. And even better – pollen only a few thousand years old is rather accessible! It's dispersed from the anthers of flora, and glides onto soil - and thanks to its solid outer structure of its cell wall – once it's quite snug in the soil, it gets buried. And dispersed. It gets buried. It gets preserved. And again. Repeat this for years on end and you've got layers of soil which are rich in gorgeous microscopic fossils – with the youngest fossils sitting comfortably in the uppermost layers of the soil column.

And vice versa!

Eventually, a curious team of scientists will hike up to the site and stick a corer into the ground – sometimes into structures like kettle-holes or even the bottom of a lake.

Past fieldwork experience has told me that you can very well expect to have three (or more) fully-grown palaeontologists hang onto the sides of the corer's handles to tempt the equipment to sink a mere few centimetres into certain soil types! Once the corer sinks with a final push, it gets twisted and yanked back up and the material is wrapped up immediately to prevent any contamination and oxidisation. And just like that, you have you very own home-made core!

To keep the samples in pristine condition, the core needs to be refrigerated as soon as possible, so the scientists will haul this material back to a laboratory for processing before using some rather aggressive acid-based techniques so that these fossils can be placed onto a slide. And by using all sorts of different microscopes, we can begin to unfurl otherwise silent historical mysteries. And it's all in the looks. Botanical palaeontologists will employ light microscopes, but thanks to advancements in high-resolution machinery, we can see even more detail and get new insights from scanning electron microscopes with images like the one shown in Figure 1.



^ *Figure 1: Fagus sylvatica-type (1a-1b), Plantago-type (1c-1d), Artemisia-type (1e-1f) and Quercus ilex-type (1g-1h), photographed using LAS V4.12 using a Leica DM2000 light microscope. Figures 1a, 1c, 1e and 1f show the polar view of labelled pollen types and Figures 1b, 1d, 1f and 1h show the equatorial views of pollen.*

Do you notice anything peculiar about the pollen grains in Figure 1?

All these pollen grains have very specific structures. Some have wonderful shapes; others are peppered with pores; some are even lined with apertures. Or both. Or none! By playing Snap! with pollen identification descriptions and what we see on the microscope stage, palynologists can identify age-old pollen types and make inferences about the past environments in which the parent plants lived.

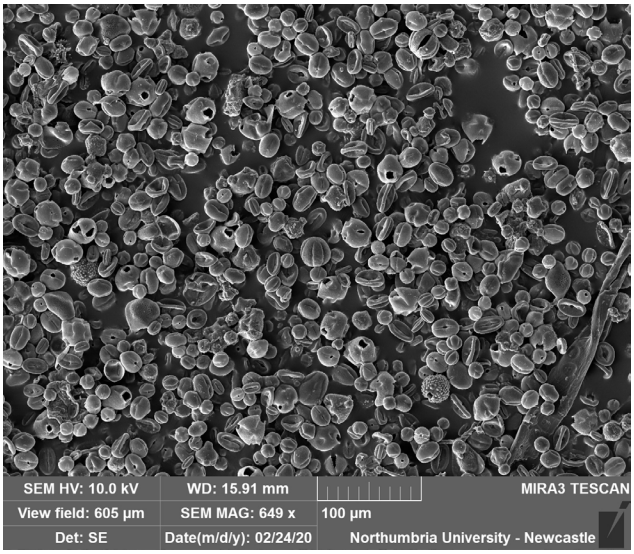
But back to medieval Europe...

Sanitation. Treatment of the infected. The strain of the plague. These were just a few of the many factors possibly affecting a rural community. But to understand the effects of plague on rural communities, Izdebski et al. (2022) incorporated their approach otherwise known as "big data palaeoecology".

Where rural communities were hugely impacted, scientists assumed fields were converted to pastureland or were left to the whims of nature and succession as villagers ran away or died from the oncoming wave of disease (Izdebski et al., 2022). In areas that were able to withstand the plague, or were indeed just very lucky, the 14th century carbon-dated (14C) pollen record should give evidence of a nice, cultivated field (Izdebski et al., 2022).

And the palaeontologists got to work on solving the puzzle!

Areas less affected by plague would contain pollen from a selection of cereal-types; these grass-family-types are indicators of European agricultural communities that grow crops (Groenman-van Waateringe, 1992). If keeping herds of animals is the main type of agriculture, then on a microscope slide, you'd see pollen types such as the Artemisia and Plantago-types labelled in Figure 1.



^ *Figure 2: Pollen grains photographed from a present-day sample, using a scanning electron microscope (10 kV) at magnification x649. Scale bar is indicative of 100 µm. Image credit: Matthew J. Pound*

In Figures 1c-1d, do you see more than 3 pores and a granular -looking surface texture running over the pollen grain? Congratulations – you've just identified a pollen grain of the Plantago genus: a common weed!

You're now living out your life-long dream of being a micropalaeontologist!

In not so fortunate areas, that didn't escape the plague and stopped being cultivated not so long before, pollen from quick-succession indicators such as birch-trees, pine-trees and heather-types will be found in the records. Where areas were abandoned and cultivation ceased a longer time ago, the pollen record will show slower succession indicators, such as holm oak, Quercus ilex. These will show the most severely affected regions (Izdebski et al., 2022). Some of these decimated ex-village sites – laden with plague pits, forgotten skeletons and Yersinia pestis proteins – would look no different to a serene forest in the present day.

And what's super interesting is that scientists associated the sharpest human population declines in southern Europe (which were determined by large areas of medieval secondary succession, and likely abandonment of agricultural activities) i.e.: Italy, to their proximity to ports (Izdebski et al., 2022). This was because rat and flea-infested grain shipments frequently brought more plague to these areas (Barker, 2021)! And just like written sources, botanical palynology only lets us see one aspect of the disease's spread.

Right now, it's up to future generations of scientists to continue to unlock the future (and the past) of humanity.

Glossary

Buboes - A swelling of lymph nodes, often a characterising symptom of the bubonic strain of Yersinia pestis

Peter's Pence - Payments made to the Catholic Church in Rome, a common practice in medieval Europe – referenced in Izdebski et al. (2022) [reference list].

Kettle-holes - Depressions of land resulting from glacial processes

Succession (ecological) - Development of ecological structures, generally from grasses and weeds to trees/ complex forest ecosystems.

14C-dating - A method to determine the age of organic material using carbon-14 isotopes.

Find out more

Barker, H. (2021) Laying the corpses to rest: grain, embargoes, and Yersinia pestis in the Black Sea, 1346–48. Speculum, 96(1): 97-126.

Groenman-van Waateringe, W. (1992) Palynology and archaeology: the history of a plaggen soil from the Veluwe, The Netherlands. Review of palaeobotany and palynology, 73(1-4): 87-98.

Izdebski, A., Guzowski, P., Poniat, R., Masci, L., Palli, J., Vignola, C., Bauch, M., Cocozza, C., Fernandes, R., Ljungqvist, F.C. and Newfield, T. (2022) Palaeoecological data indicates land-use changes across Europe linked to spatial heterogeneity in mortality during the Black Death pandemic. Nature Ecology & Evolution, 6(3): 297-306.

Wheelis, M. (2002) Biological warfare at the 1346 siege of Caffa. Emerging infectious diseases, 8(9): 971.

Further reading

Ziegler, P. (2003) The Black Death, New Edition (1 May 2003), Sutton Publishing, ISBN-13: 978-0750932028.

About the author

Hi there! My name is Jessica and I'm a budding palaeontologist based at Northumbria and Newcastle University! My academic projects do not focus on medieval history, and this article focuses on an application of palaeontology, rather than my core research field. My research helps scientists to better understand how the current world is going to change under projected climate change scenarios. Pursuing a career in STEM allowed me to sandwich my passion for writing with running exciting experiments!

Key skills: Aiming high, interdisciplinary research, fieldwork, organisation, writing to publishable standards, team work, delegation of work

Acknowledgements – Thank you to my supervisor, Dr Matthew J. Pound, who reviewed the article and improved its content greatly. Dr Pound created the pollen references slides from which photos for Figure 1 were taken.