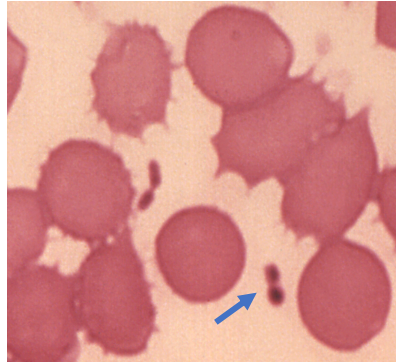


## MicroRogue: Yersi (*Yersinia pestis*)

(Scott A. Minnich)



Blood smear with *Y. pestis* bacteria.

Note the characteristic bipolar, safety-pin-like appearance. CDC/ Dr. Jack Poland.

### **Claim to Fame: cause of bubonic plague, “The Black Death”, or simply “plague”**

*Yersi*, the cause of plague, is the deadliest bacterium for humans. In recorded history, it is estimated that it has killed over 300 million people. Mortality rates can exceed 80% in humans if untreated.

***History of Plague.*** Three major plague pandemics have been recorded.

- The first, starting in the 6<sup>th</sup> century, occurred when Justinian ruled Rome, and is referred to as the Justinian Plague. Some historians have argued this disease contributed to the fall of the Roman Empire.
- The second pandemic, which occurred in Europe between 1347 and 1352, spread rapidly along the trade routes of central Asia, through the Mediterranean, and up into central Europe, the British Isles and Scandinavia. It is estimated that this pandemic reduced the population of Europe during this five-year stretch by a quarter to a third. Outbreaks continued in Europe sporadically over the ensuing centuries.
- The third pandemic began in China in the late 1800’s and continued into the first decade of the last century. It was during this third pandemic that plague was transferred from Asia to North America along the shipping routes. The disease is still endemic in the American Southwest where it affects rodent populations and occasionally infects humans.
- Recent advances in paleobiology have recovered the DNA of *Y. pestis* from skeletons buried during the Neolithic and Bronze Ages showing *Y. pestis* emerged sometime in the last 10,000 years.

***Identification of Yersi as the cause of plague.*** The period of the third pandemic, often referred to as the ‘Golden Age of Bacteriology’ finally yielded the cause of this dreaded disease. Alexander Yersin, who was trained in microbiology in Paris by Louis Pasteur, was dispatched to Hong Kong to study the plague outbreak in this major city. In competition with a group trained by Robert Koch

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from Berlin, Yersin was able to isolate the bacterium, show it was the cause of disease, and finally show it was being transmitted by rodent fleas.

**The Bacterium.** Yersi is a Gram-negative facultative anaerobic (it can grow with or without oxygen) rod-shaped bacterium. It has a distinctive ‘safety pin’ appearance when stained and viewed under the microscope (see above).

It lives in the environment in rodent fleas, which serve as transmission vectors, and in mammalian hosts where it causes acute disease. Fleas acquire Yersi when feeding on infected mammals such as rats. Yersi in the blood meal causes the blood to clot in front of the flea’s digestive tract. This phenomenon is referred to as ‘flea blockage’. This blockage prevents absorption of nutrients from the blood meal, causing a starvation effect.



This enlargement of a rat flea, *Xenopsylla cheopis*, displays what is known as a proventricular plague mass. Centers for Disease Control.

Consequently, the fleas go into a ‘feeding frenzy’. When they try to take another blood meal, they regurgitate the blood clot teeming with plague bacilli, allowing Yersi access to the blood of a new host. This increased feeding behavior helps spread the organism to other rodents or humans.

**The Disease.** When Yersi is introduced into the human blood stream by a flea bite, it migrates to the closest lymph node and begins to multiply. This causes a noticeable swelling of the lymph node, referred to as a bubo, which gave the name bubonic plague. Within a day or two the lymph node can burst, releasing the bacteria which then spread throughout the body. When they reach the lungs, they can access the airway which then allows them to be spread by sneezing or coughing (pneumonic plague), and thereby bypass the need for a flea vector to transmit the bacterium.

***Yersi is a mighty awful MicroRogue!***

### The importance of Yersi for us.

Because the second plague pandemic hit so quickly and spread across all social strata, it had a decimating effect on the European economy and arguably contributed to the rise of the modern middle class. Suddenly, survivors with skills, previously locked into a life of serfdom, had bargaining power to raise their living status.

Basic studies on plague disease have taught us much on how bacteria in general make people sick. This includes an understanding at the molecular level how Yersi can evade our first lines of

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defense, the 'innate' immune response. Surprisingly, part of this ability was derived by mutations that disrupted surface structures on the bacterium that our immune cells look for, such as the filament of flagella and a change in lipopolysaccharide structure in the bacterial membrane. Yersinia changes its face so that we no longer recognise it!