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MINI REVIEW

Plague in Egypt: Disease biology, history and contemporary analysis: A minireview

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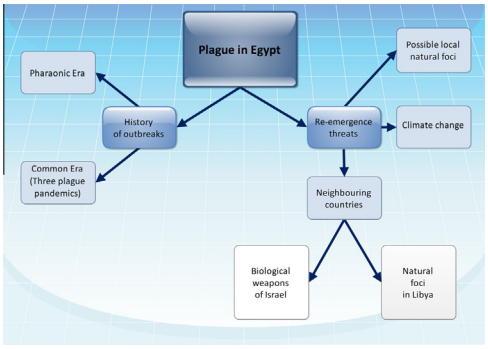
GRAPHICAL ABSTRACT



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ABSTRACT

Plague is a zoonotic disease with a high mortality rate in humans. Unfortunately, it is still endemic in some parts of the world. Also, natural foci of the disease are still found in some countries. Thus, there may be a risk of global plague re-emergence. This work reviews plague biology, history of major outbreaks, and threats of disease re-emergence in Egypt. Based on the suspected presence of potential natural foci in the country, the global climate change, and the threat posed by some neighbouring countries disease re-emergence in Egypt should not be excluded. The country is in need for implementation of some preventive measures.

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Introduction

Plague is a deadly infectious disease which has been responsible for a number of high-mortality epidemics throughout human history. Unfortunately, the disease is still endemic in some parts of the world. Plague natural foci are found in the tropical and sub-tropical latitudes and the warmer parts of the temperate latitudes around the globe, between the parallels 55° North and 40° South. Interestingly, known disease natural foci are found on all continents except Australia [1]. However, the continent suffered many plague outbreaks originating from shipping and eventually disappeared. Most probably the disease did not success to colonise Australia due to its failure to become established in a suitable enzootic host [2]. Worldwide, humans may be at risk of plague re-emergence. Due to the high public health significance of plague, the present work aims at reviewing the disease biology, history of outbreaks, and threats of disease re-emergence in Egypt.

Biology

Etiologic agent

In 1894, during an epidemic of plague in Hong Kong, a French-Swiss bacteriologist Alexandre Yersin discovered the causative agent which is a Gram-negative rod-shaped enterobacterium. The pathogen is a facultative anaerobe that can infect humans and other animals. Yersin named it *Pasteurella pestis* in honour of the Pasteur Institute where he worked. In 1967, the organism was moved to a new genus and renamed *Yersinia pestis* in honour of Yersin [3]. *Yersinia pestis* has gained attention as a possible biological warfare agent [4]. It is one of the first examples of biological warfare in history, when in 1347 plague victims were catapulted by the Mongols over the city walls of Caffa, currently known as Feodosiya which is located in Ukraine [5]. In 1940, during the World War II, a Japanese airplane released rice and wheat mixed with rat fleas infected with *Y. pestis* over Chushien in Chekiang Province of China. A second plane load was released three weeks later. These actions led to a local epidemic that killed 121 persons [6]. During the 1950s and 1960s, the United States and the former Soviet Union biological weapons programs developed methods to directly aerosolise particles containing *Y. pestis*. Soviet scientists manufactured large quantities and allegedly engineered multidrug-resistant strains of the pathogen [7]. It was estimated that 50 kg of *Y. pestis* released as an aerosol over a city of five million could result in 150,000 cases of pneumonic plague, with 80,000–100,000 requiring hospitalisation and 36,000 deaths [8]. *Yersinia pestis* has all the qualities you would look for in a potential biological weapon: a high fatality rate, no vaccine and possible air-borne transmission [7]. Antimicrobial resistance in *Y. pestis* is rare, but constitutes a significant international public health and biodefense threat. In 1995, the first multidrug resistant isolate of *Y. pestis* was identified. This strain was resistant to all first-line antibiotics as well as to the principal alternative drugs for treatment and prophylaxis [9]. The multidrug-resistant plasmid was highly transferable *in vitro* to other strains of *Y. pestis*, where it was stable. Most probably this type of replicon can also be transferred among strains of *Y. pestis* in their natural environment and, therefore, that resistance may spread locally in this species [9,10].

Life cycle

Yersinia pestis has the ability to cause disease in fleas, rodents and humans (Fig. 1). The primary carriers of the pathogen are the Oriental rat flea, *Xenopsylla cheopis*, and infected rodents. *Xenopsylla cheopis* is thought to have originated in Egypt and during the 19th century spread to all parts of the world as parasite of rats infesting ships' cargos [11]. It was reported that fleas from other mammals have a role in human plague outbreaks [12]. Both male and female fleas feed on blood and

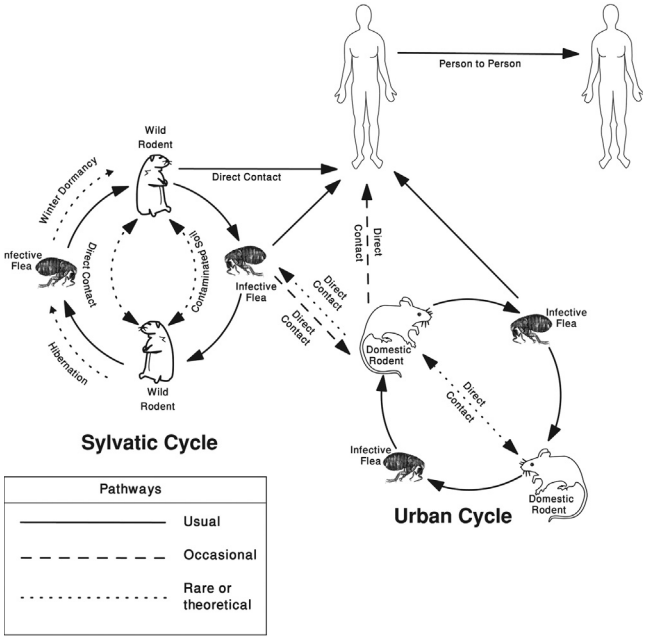

Fig. 1 Classical pathways of plague transmission (modified after Chamberlain, 2004) [19].