



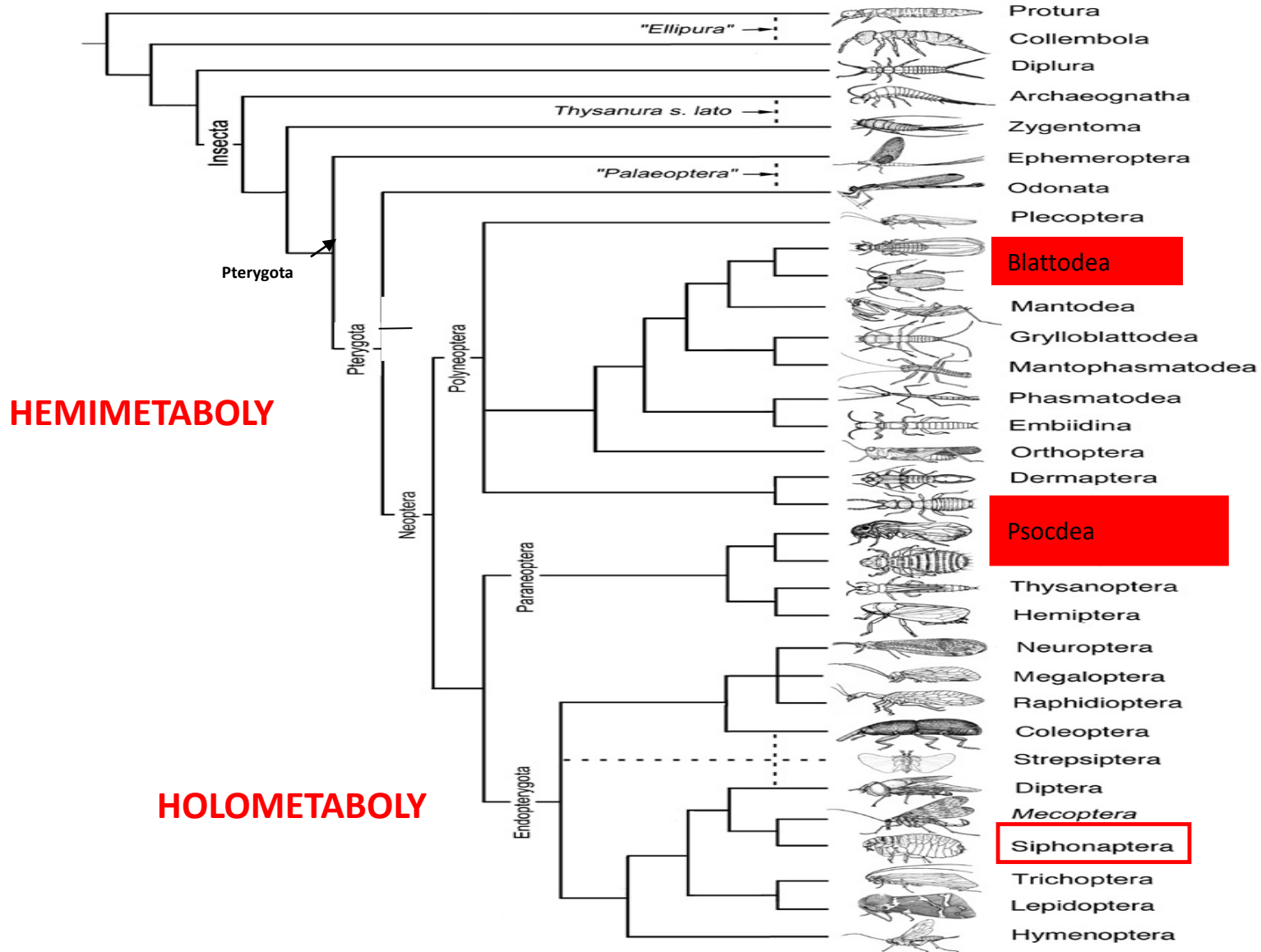
MEDICAL AND VETERINARY ENTOMOLOGY

Siphonaptera

Assoc. Prof. Marija Ivković
marija.ivkovic@biol.pmf.hr

Medically significant Arthropoda - Insecta

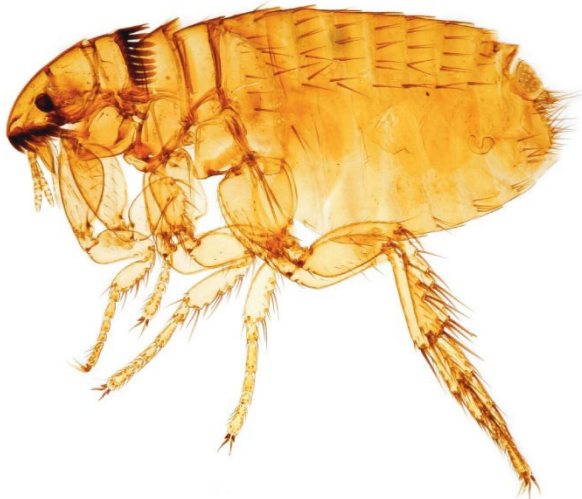
SIPHONAPTERA



Order Siphonaptera - Fleas



- Wingless and laterally flattened insects, highly chitinized, rear legs enlarged and adapted for jumping, holometabolous, monophyletic, morphologically unique insects
- ~ 2500 species - 94% of species are ectoparasites of mammals (several species on humans), 6% ectoparasites of birds
- Male fleas have one of the most complex genitalia among animals



Family Pulicidae:

Cediopsylla simplex (rabbit flea)
Ctenocephalides canis (dog flea)
Ctenocephalides felis (cat flea)
Echidnophaga gallinacea (sticktight flea)
Echidnophaga larina
Echidnophaga myrmecobii
Euhoplosyllus glacialis
Hoplosyllus anomalus
Pulex irritans (human flea)
Pulex simulans
Spilopsyllus cuniculi (European rabbit flea)
Xenopsylla astia
Xenopsylla bantorum
Xenopsylla brasiliensis
Xenopsylla cheopis (Oriental rat flea)

Family Tungidae:

Tunga monositus
Tunga penetrans (chigoe)
Tunga trimamillata

Family Pygiopsyllidae:

Uropsylla tasmanica

Family Ctenophthalmidae:

Stenoponia tripectinata

Family Vermipsyllidae:

Dorcadia ioffi
Vermipsylla alakurt (alakurt flea)

Family Leptopsyllidae:

Leptopsylla segnis (European mouse flea)

Family Ischnopsyllidae:

Myodopsylla insignis

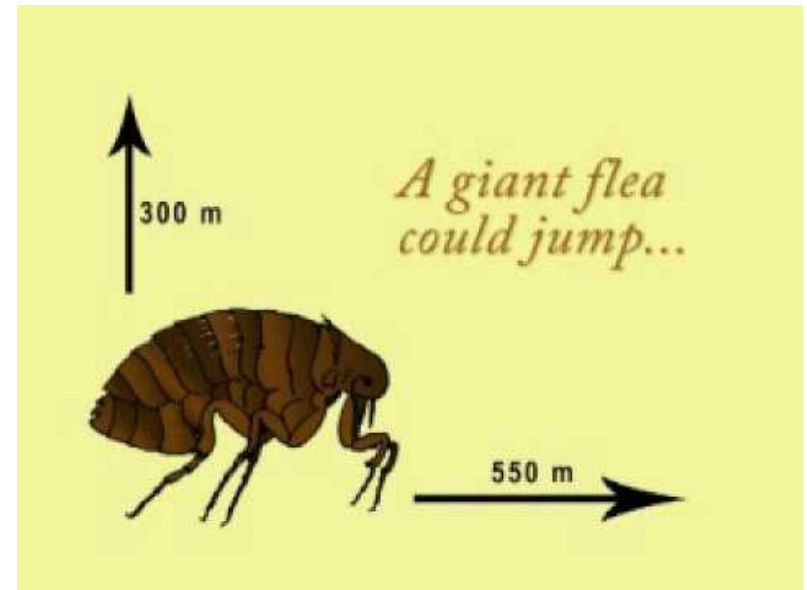
Family Ceratophyllidae:

Ceratophyllus gallinae (European chicken flea [hen flea in Britain])
Ceratophyllus niger (western chicken flea)
Nosopsyllus fasciatus (northern rat flea)
Orchopeas howardi (squirrel flea)
Oropsylla montana

Modified from Lewis (1993a) and Zhu et al. (2015).

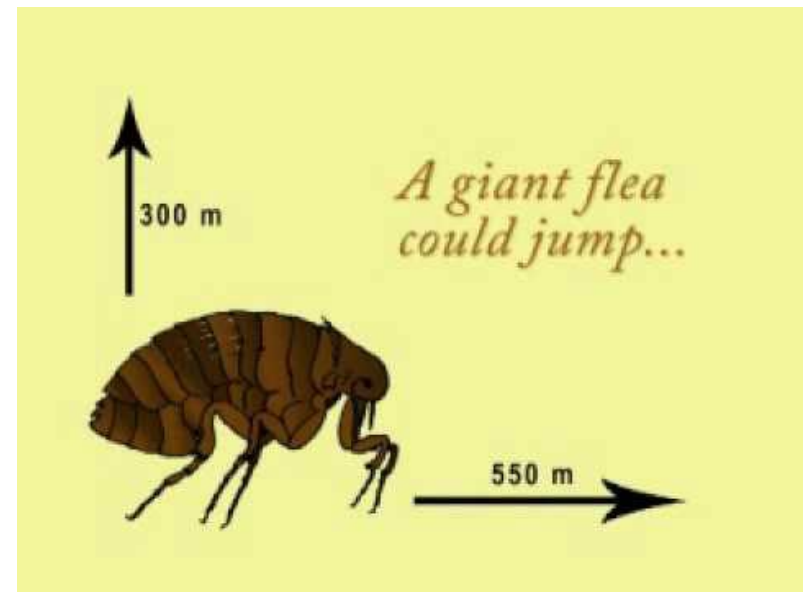
Order Siphonaptera - Fleas

- Many species have a "comb" or ctenidae (cheek and pronotal comb) - sclerotized bristles
- Organ sensillum – for detecting hosts...
- The hind legs are enlarged and adapted for jumping - muscles originating from the muscles for flight (subalar and basilar muscles) - jump related to the protein RESILIN



Order Siphonaptera - Fleas

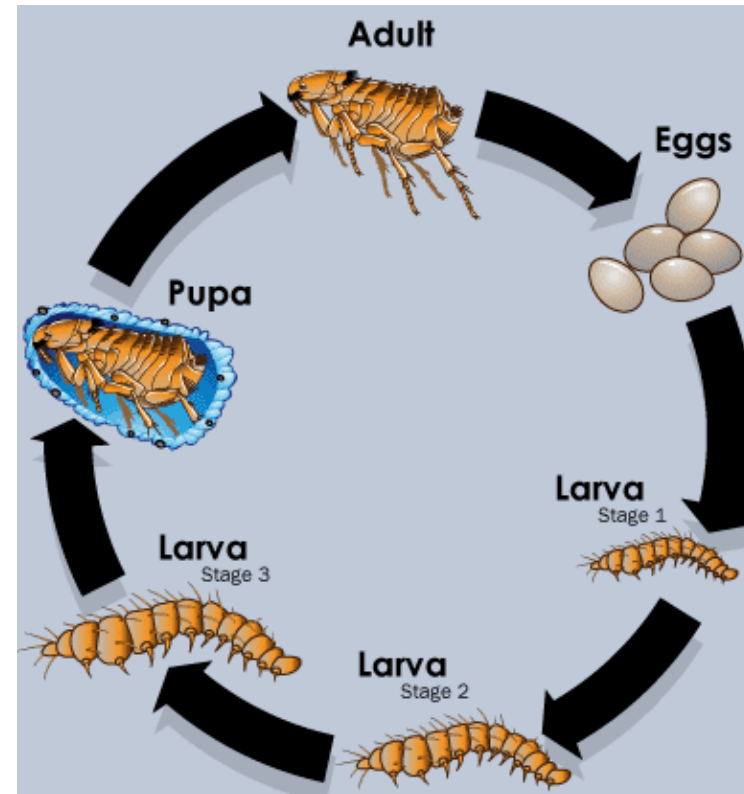
- The hind legs are enlarged and adapted for jumping - muscles originating from the muscles for flight (subalar and basilar muscles) - jump related to the protein RESILIN
- Miriam Luisa Rothschild - one of the greatest flea researchers - discovered how flea jumping works and the flea's hormonal dependence on the host



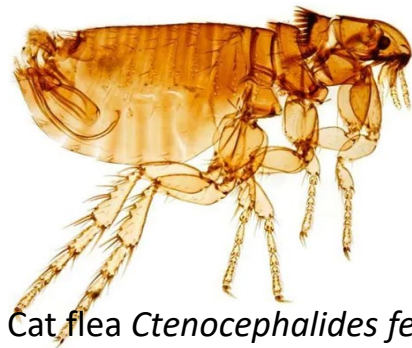
Order Siphonaptera - Fleas



- Larvae are found in the host's "nest" or on the ground, in the dust, but always in the dark (THE LIFE CYCLE DOES NOT TAKE PLACE ENTIRELY ON THE HOST)
- The emergence of an adult requires a stimulus (mechanical compression, vibrations), without which the pupa can last up to 12 months
- Adults survive up to 6 months without feeding
- Fleas are much less attached to a specific host than lice



Human flea *Pulex irritans*



Cat flea *Ctenocephalides felis*



Rat flea *Xenopsylla cheopis*

Order Siphonaptera - Fleas



- An intermediate host for several tapeworm species and an important vector of bacteria that cause diseases such as murine (endemic) typhus and plague
- Host behavior very important to life cycle and therefore life cycle synchronized with host life cycle (often via host hormones)
- Bites of most species are red-purple and slightly swollen and itch for several days, sensitivity to flea saliva can lead to intense papular urticaria
- Feces and flea remains are known allergens, especially in asthmatics
- **Autogeny** is not present in fleas (laying of fertile eggs without feeding on blood), a blood meal is mandatory for egg development - **Anautogeny**



Order Siphonaptera - Fleas



- Rat flea (*Xenopsylla cheopsis*)
 - The primary vector of transmission of the bacterium *Yersinia pestis* (the causative agent of the plague) and the bacterium *Rickettsia typhi* (the causative agent of murine (endemic) typhus)
 - The primary host is the rat, but fleas will also feed on cats, humans, dogs, even poultry
 - Worldwide distribution, but most common in warmer climates

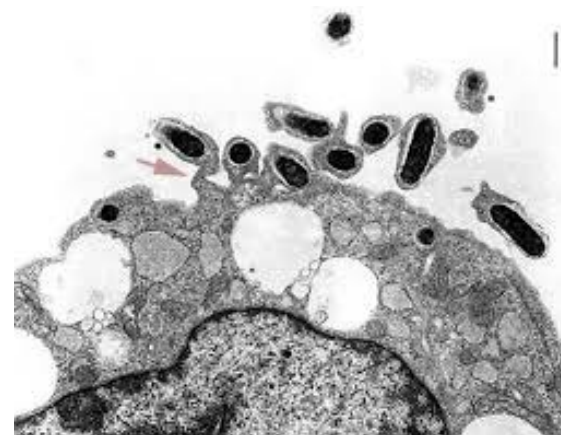
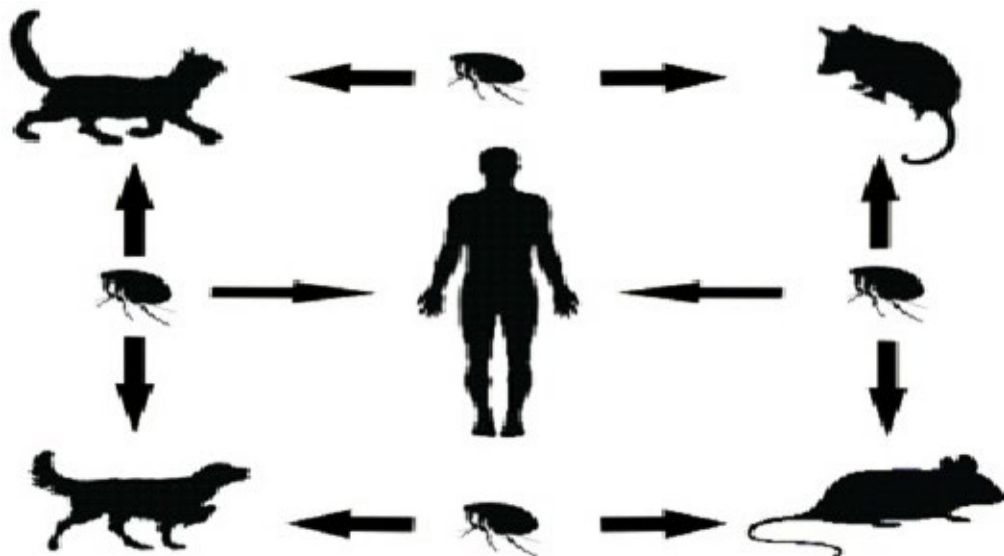


Rat flea *Xenopsylla cheopsis*



Order Siphonaptera - Fleas

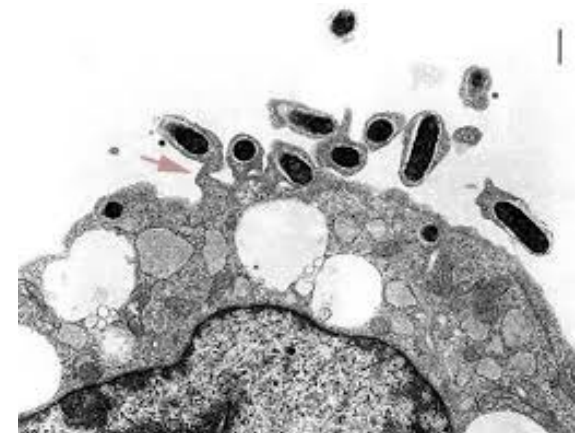
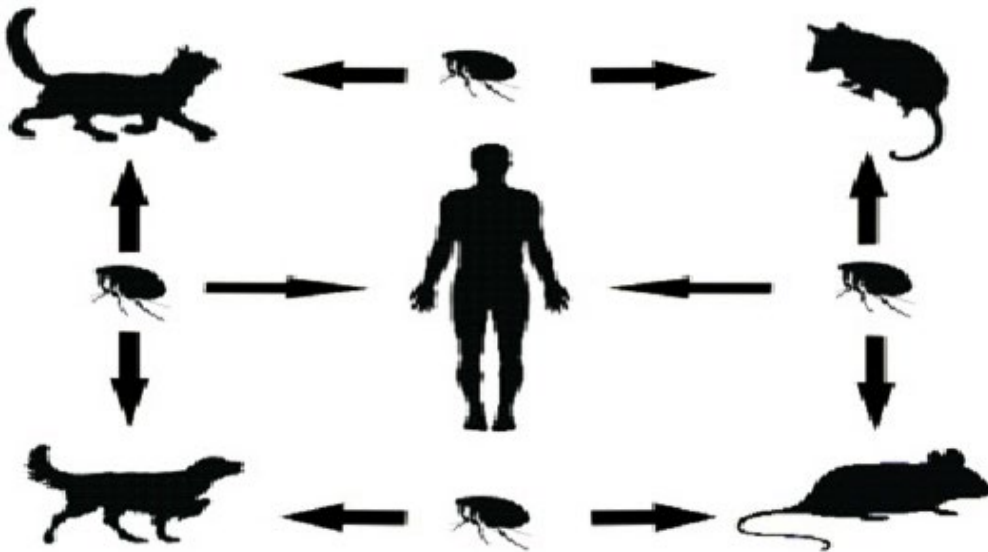
- Rat flea (*Xenopsylla cheopsis*) - **Murine (endemic) typhus (rat plague, Malayan typhus)**
 - It is caused by the intracellular bacterium *Rickettsia typhi* (it can also be transmitted by the cat flea (*Ctenocephalides felis*) and the human flea (*Pulex irritans*))
 - Infection occurs by rubbing (when scratching the skin) flea feces into the skin itself (as with *R. prowazekii*)
 - Strains in North and South America are less virulent (2% mortality), while some strains in the Old World are very virulent (70% mortality).



Order Siphonaptera - Fleas



- Rat flea (*Xenopsylla cheopsis*) - **Murine (endemic) typhus (rat plague, Malayan typhus)**
 - Symptoms very similar to epidemic typhus (fever, headache, sore muscles), only slightly milder and with a less pronounced rash (worldwide mortality up to 5%)
 - Common in tropical and subtropical regions (often misdiagnosed)
 - Zoonosis with the rat as the primary reservoir of the bacteria (cats and opossums in some areas), but the rat flea can also be a reservoir (the bacteria does not kill the flea)



Order Siphonaptera - Fleas



- Rat flea (*Xenopsylla cheopsis*) - **Plague (Black Death, pestis) – „la peste”**
 - It is caused by the bacterium *Yersinia pestis*
 - The multiplication of bacteria in the flea's digestive system leads to blockage of the digestive system and to the "vomiting" of the flea during feeding
 - Hungry fleas bite aggressively and blockage of the digestive system can lead to the death of the flea
 - The most important vector is the rat flea, but the flea *Diamanus montanus* can also transmit it in forest ecosystems



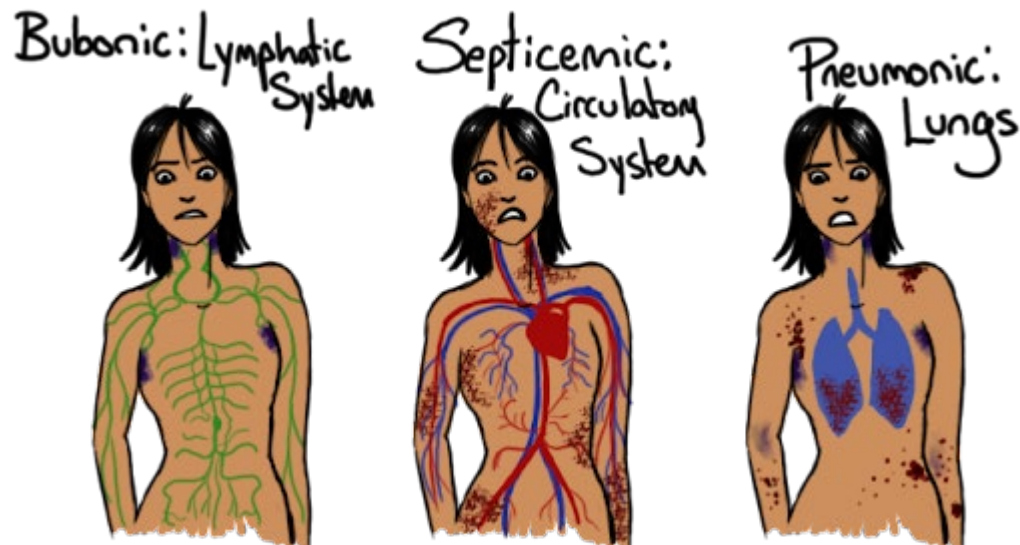
Order Siphonaptera - Fleas

- Rat flea (*Xenopsylla cheopsis*) - **Plague (Black Death)**
 - It is caused by the bacterium *Yersinia pestis* - a gram-negative coccobacillus bacterium
 - Transmission also via the human flea (*Pulex irritans* !!!!) – the last plague epidemic in Madagascar in 2017-2018. (> 2500 people, 9% mortality)
 - Zoonosis (More than 200 hosts) and transmitted by more than 100 species of flea



Order Siphonaptera - Fleas

- Rat flea (*Xenopsylla cheopsis*) - **Plague (Black Death)**
 - It was isolated by A. Yersin in 1894, the origin from the Central Asia from a gerbil rodent
 - In urban areas in rodents such as black and brown rats
 - Three forms of plague with distinct pathologies: bubonic, septicemic and pneumonic



Order Siphonaptera - Fleas



- Rat flea (*Xenopsylla cheopsis*) - Plague (Black Death) – **Bubonic plague**
 - After a flea bite, the bacterium infects macrophages, where it multiplies and is transported to the nearest lymph nodes, macrophage lysis occurs and bacteria are released into the lymph node, where they multiply extracellularly and release various proteins and toxins that cause inflammation and swelling of the nodes (lat. "bubo" = swelling) and interfere with the body's immune response



Order Siphonaptera - Fleas



- Rat flea (*Xenopsylla cheopsis*) - Plague (Black Death) – **Bubonic plague**
 - Incubation lasts 2 to 6 days, symptoms include swollen lymph nodes (buboes), fever (up to 41 °C), shivering, headache
 - Local hemorrhages and necrosis often occur
 - More than 60% of untreated people die
 - If not treated with a wide range of antibiotics, the bacteria moves from the lymph nodes to the blood, where the disease progresses to septicemic plague



Order Siphonaptera - Fleas



- Rat flea (*Xenopsylla cheopsis*) - Plague (Black Death) – **Septicemic plague**
 - The bacterium enters the blood (secondary) or bypasses the lymph nodes (primary) and spreads throughout the body through the circulatory system
 - Incubation 2 to 5 days - flea bite or by eating infected meat
 - The toxins released by the bacteria lead to hemorrhage, the formation of blood clots, which leads to the dark color of the tissue under the skin (hence the name "black death")
 - It occurs as a complication of bubonic plague or as a primary disease
 - Without prompt treatment, mortality is 50 to 75% (often within 24 hours)
 - The bacterium can move to the lungs, causing pneumonic plague



Order Siphonaptera - Fleas



- Rat flea (*Xenopsylla cheopsis*) - Plague (Black Death) – **Pneumonic plague**
 - Incubation 1-4 days, symptoms high fever, shivering, rapid heartbeat and often severe headache and severe pneumonia
 - Inhalation of aerosol particles of bacteria that are expelled by coughing from infected patients (or domestic cats - rarely) or by the spread of septicemic plague to the lungs
 - The most severe form of the plague, if not treated the mortality is 95% and within a few days (1-3)



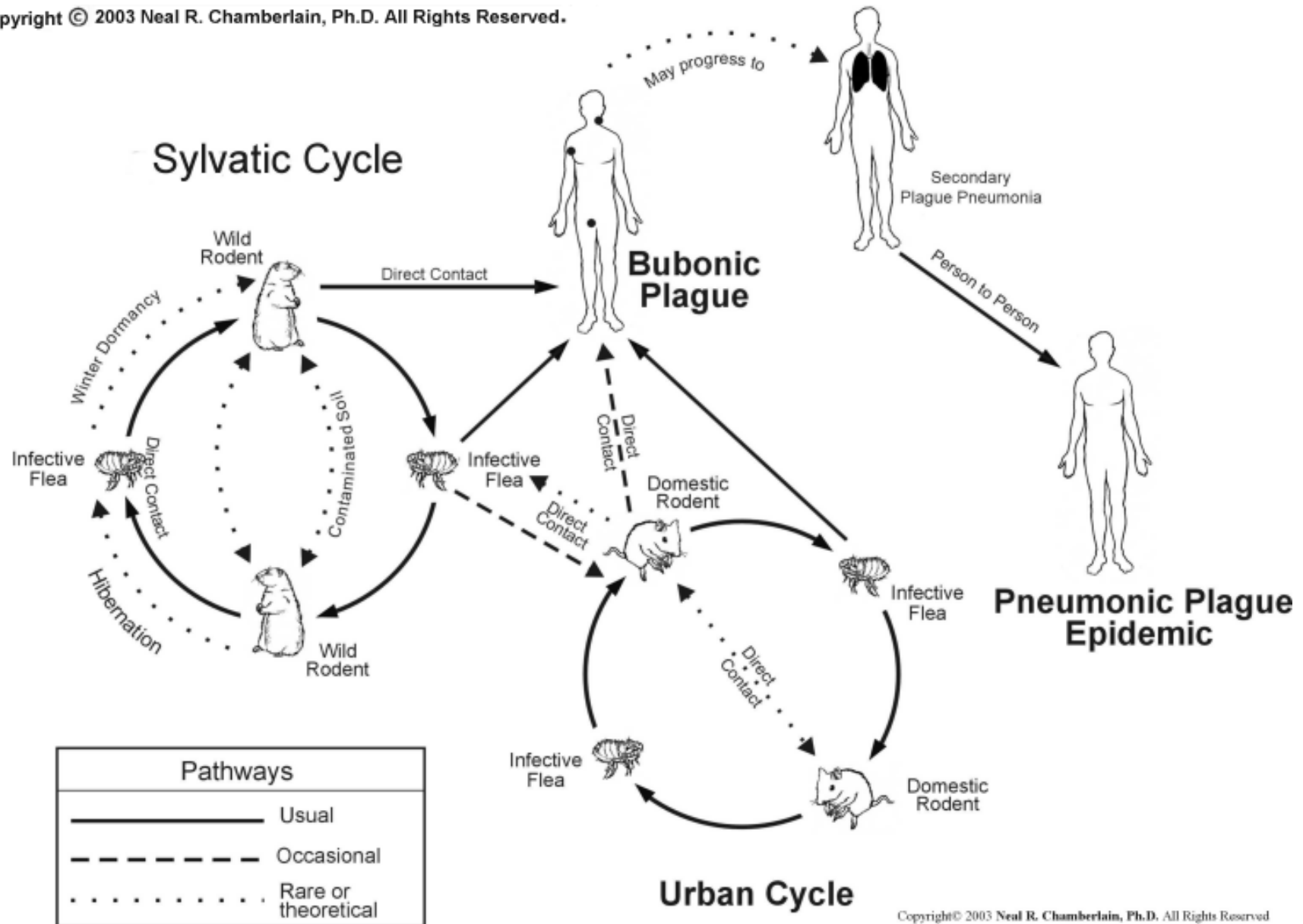
Order Siphonaptera - Fleas

- Rat flea (*Xenopsylla cheopsis*) - Plague (Black Death) – Pneumonic plague



Order Siphonaptera - Fleas

Copyright © 2003 Neal R. Chamberlain, Ph.D. All Rights Reserved.



Copyright© 2003 Neal R. Chamberlain, Ph.D. All Rights Reserved

Order Siphonaptera - Fleas



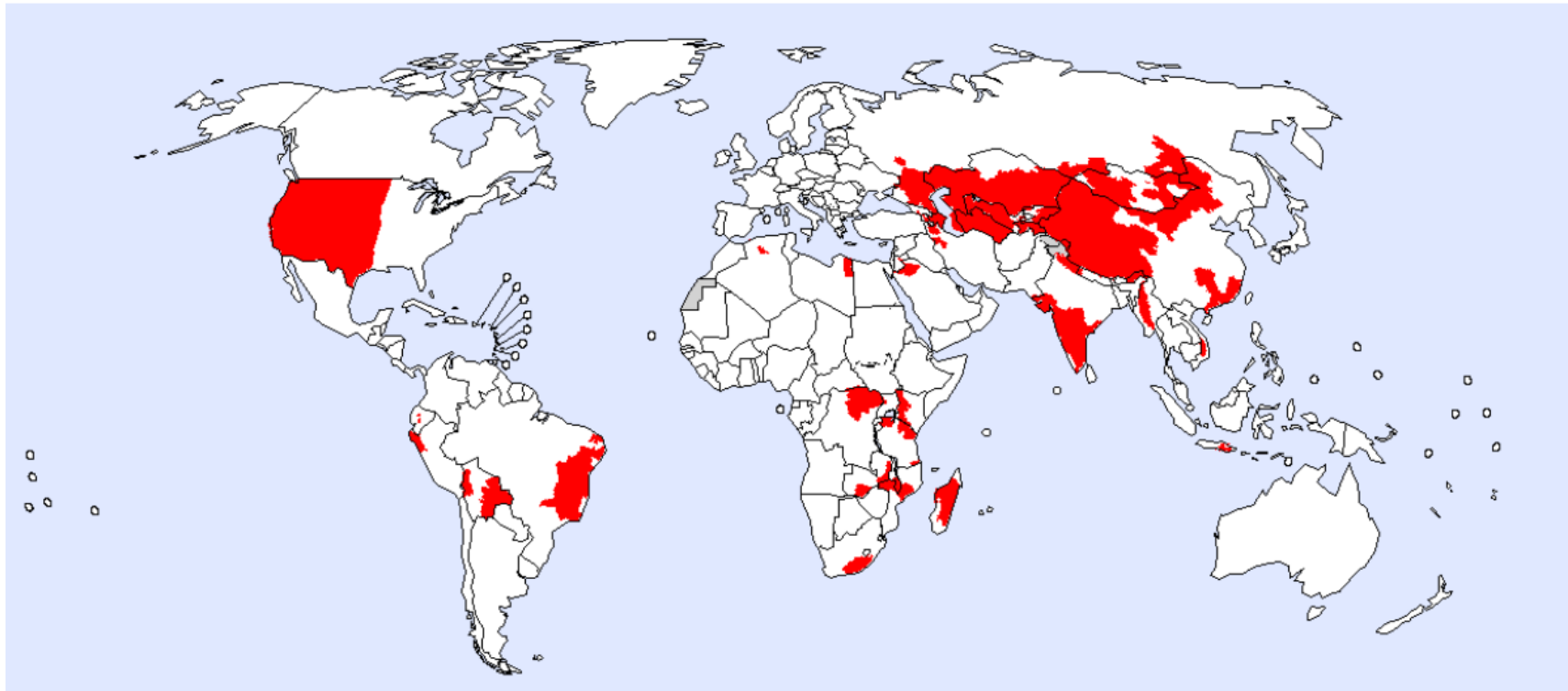
- Rat flea (*Xenopsylla cheopsis*) - **Plague (Black Death)**
 - The treatment is for at least 10 days intravenously with broad-spectrum antibiotics (streptomycin, doxycycline), the sooner the treatment is started, the greater the chance that the patient will survive
 - There is a vaccine, but too many bad side effects and it doesn't work on the pneumonic form
 - Prophylactic antibiotics are given to people who are in contact with sick people




Order Siphonaptera - Fleas



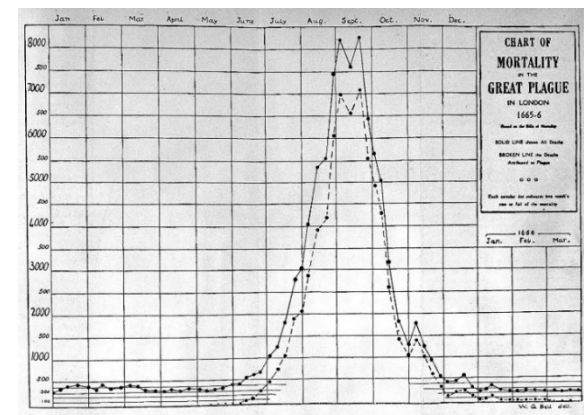
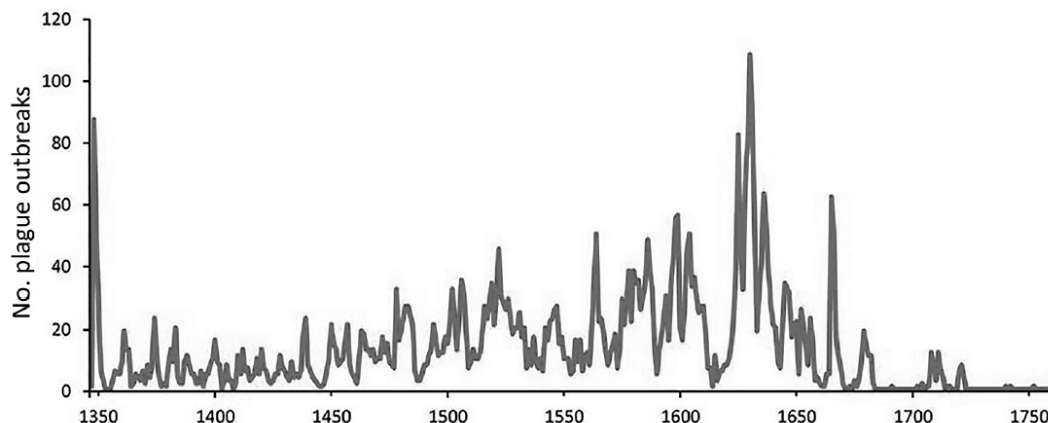
- Rat flea (*Xenopsylla cheopsis*) - **Plague (Black Death)**
 - Some individuals are naturally immune to the bacterium *Yersinia pestis* and survivors usually develop sterile immunity
 - With the use of antibiotics, mortality is still high (11%)



 Areas* with potential plague natural foci based on historical data and current information

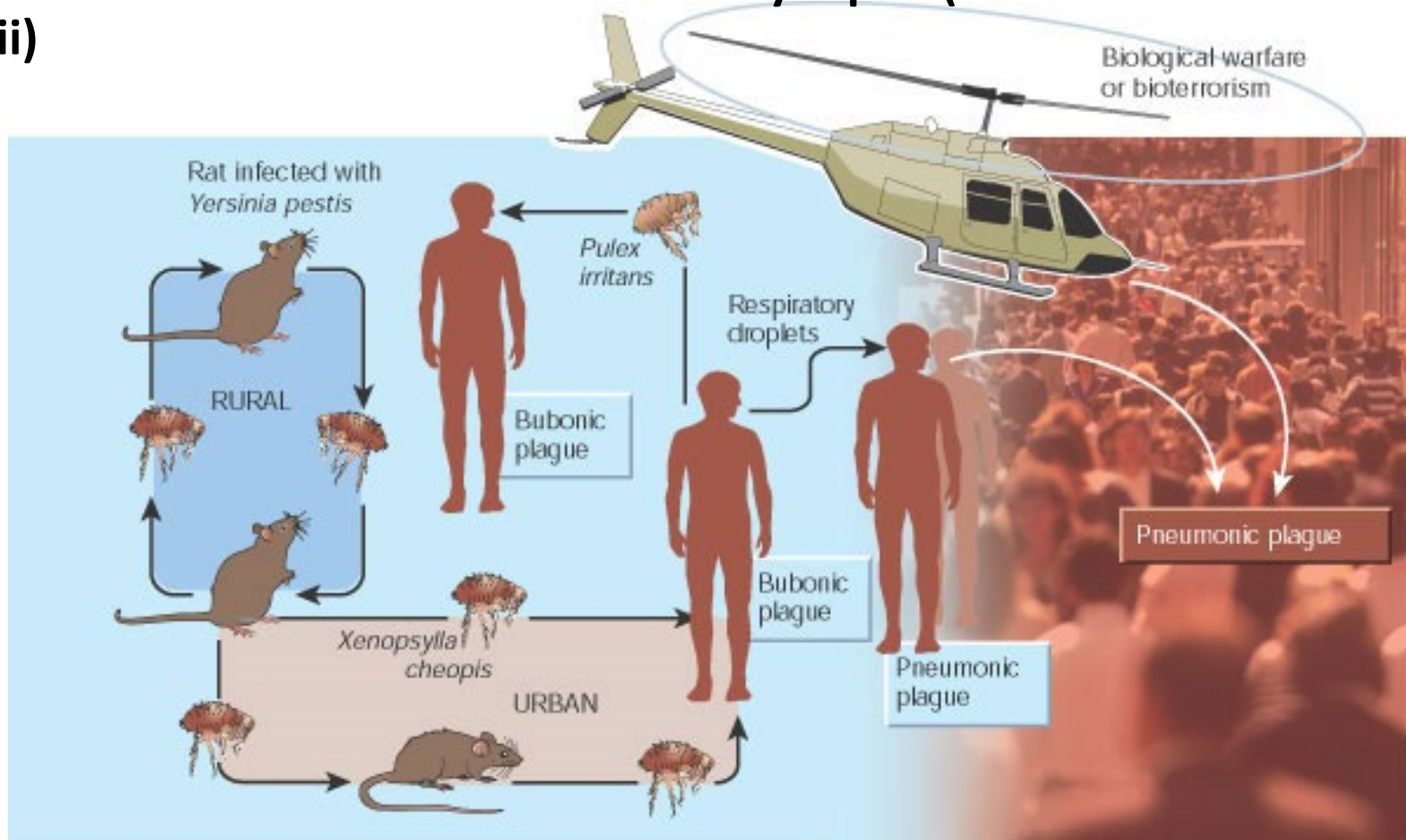
Order Siphonaptera - Fleas

- **Plague (Black Death)** – 6 major epidemics
 - Plague of Justinian (6th and 7th century AD) – started in North Africa in 541 and spread throughout the Mediterranean - killing between 25 and 40 million people
 - 1347-1353 - entered Europe through Italian merchants (due to ignorance, Jews were persecuted) - killed about 50 million people in Europe, half of the population at that time
 - 1629 - In Italy, it started in the city of Mantua and spread throughout Italy - better prevention of the epidemic - killed about 280,000 people
 - 1665-1666 – The Great Plague of London – killed up to 100,000 people
 - 1720-1722 – The Great Plague of Marseille – killed around 100,000 people
 - 1855 - Third plague pandemic or modern plague - started in China's Yunnan province - from 1896 to 1948 this pandemic killed about 12 million people in India alone
- The plague killed more people than all the wars combined



Order Siphonaptera - Fleas

- **Plague (Black Death)**
- **Category A classification of bioterrorism (by the CDC Center for Disease Control)**
- **"Flea bombs" used in II. World War by Japan (Unit 731 – General Shiro Isii)**



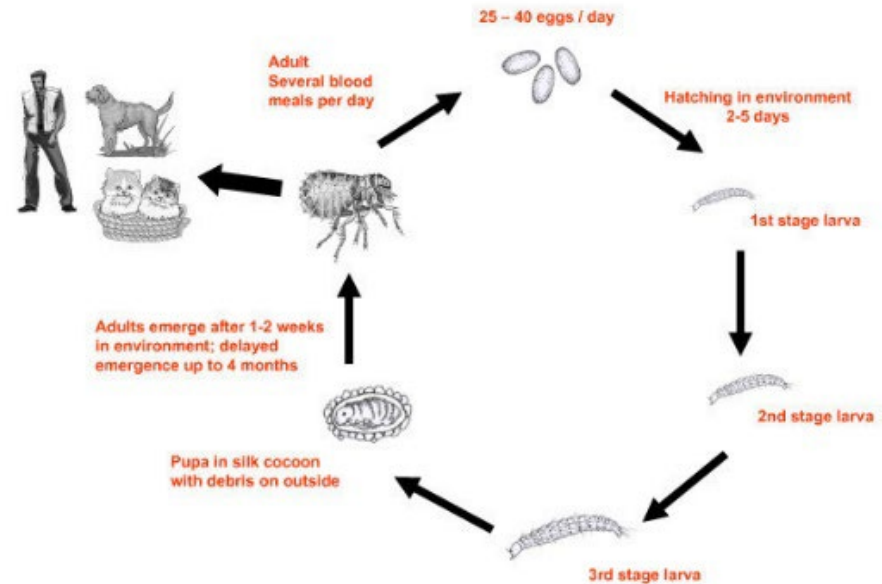
Order Siphonaptera - Fleas



- Cat flea (*Ctenocephalides felis*)
- The most common flea on humans and many other animals (goats, lambs, calves,... - can cause anemia, even death)
- It will feed on humans (especially females), but is more prolific if it feeds on cats
- It is an intermediate host for some tapeworms and murine (endemic typhus)



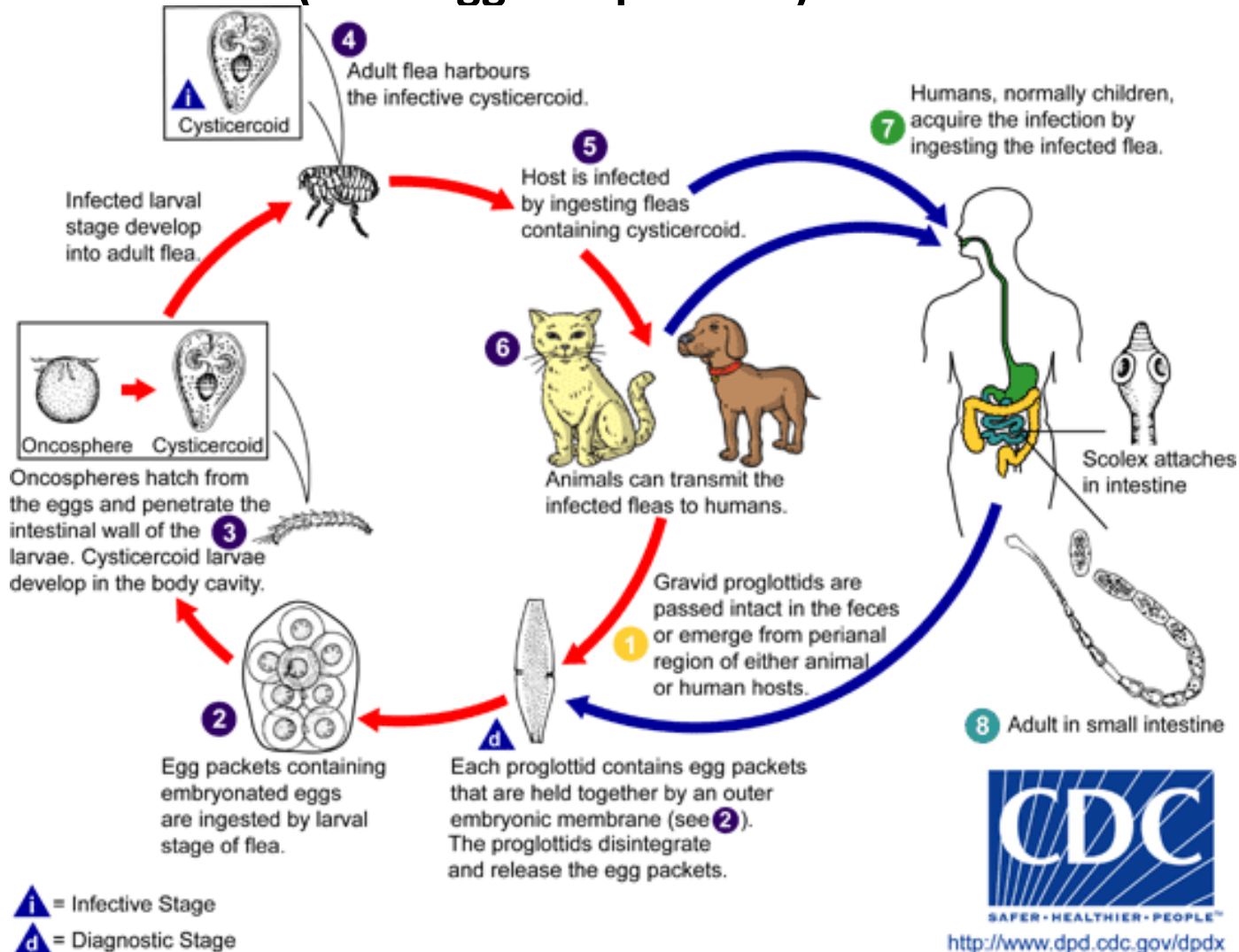
Cat flea *Ctenocephalides felis*



Order Siphonaptera - Fleas

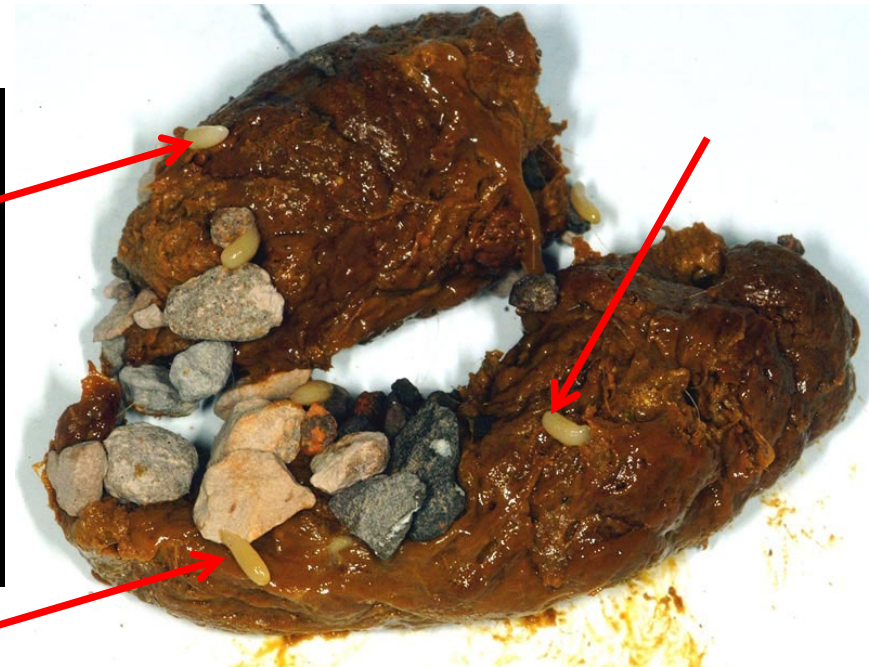


- Cat flea (*Ctenocephalides felis*) – intermediate host of the tapeworm *Dipylidium caninum* (Two-legged tapeworm)



Order Siphonaptera - Fleas

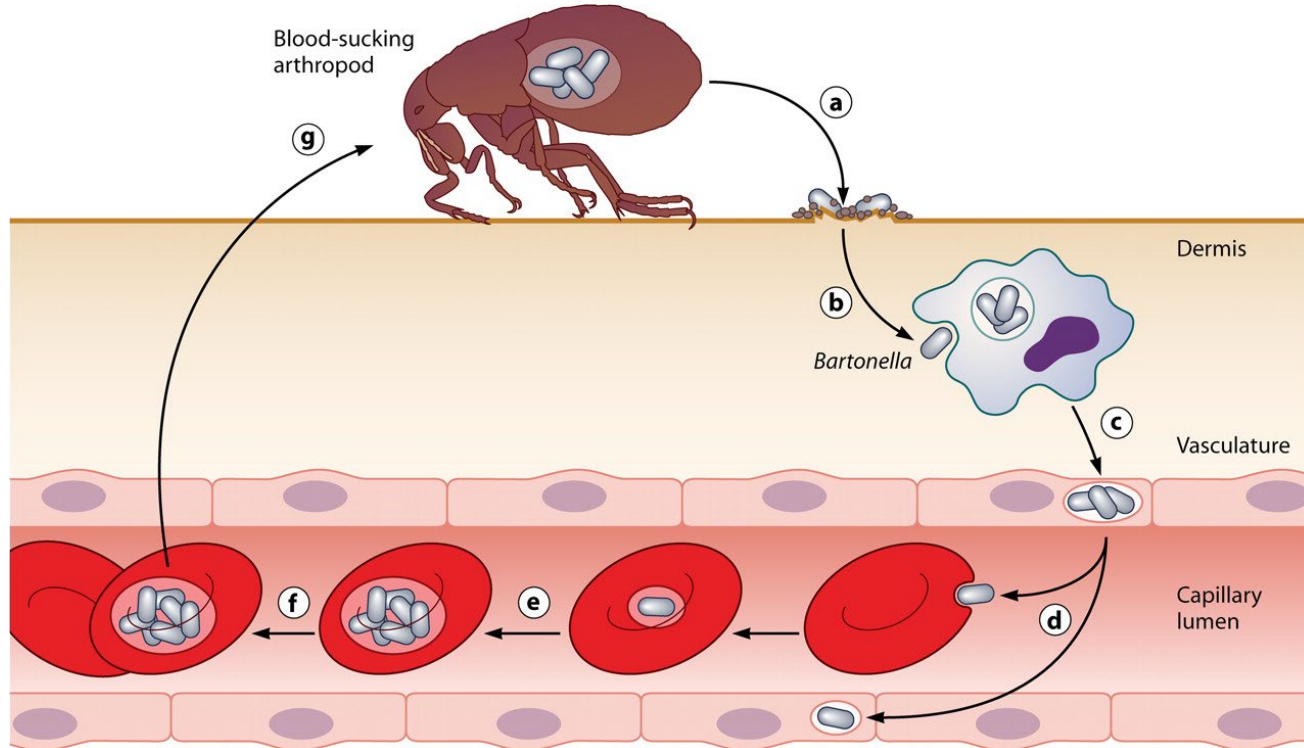
- Cat flea (*Ctenocephalides felis*) – intermediate host of the tapeworm *Dipylidium caninum* (Two-legged tapeworm) – 10 to 50 cm
- Infection in humans occurs rarely, infections are often asymptomatic, but can cause diarrhea and irritability, especially in children
- Tapeworm lives up to 1 year, treatment with anthelmintic drugs (praziquantel and niclosamide - also used in animals)



Order Siphonaptera - Fleas



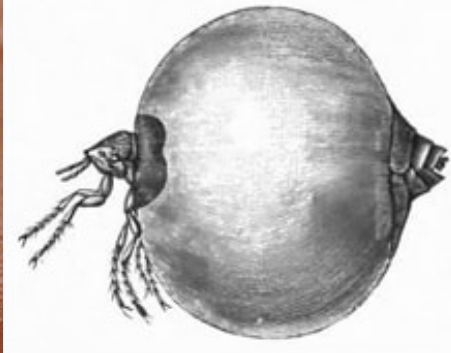
- Cat flea (*Ctenocephalides felis*) – Cat scratch disease
 - The causative agent is bacteria *Bartonella henselae*
 - Swelling of the lymph nodes, fatigue, fever, hepatitis, endocarditis (destruction of the heart valve)



Order Siphonaptera - Fleas



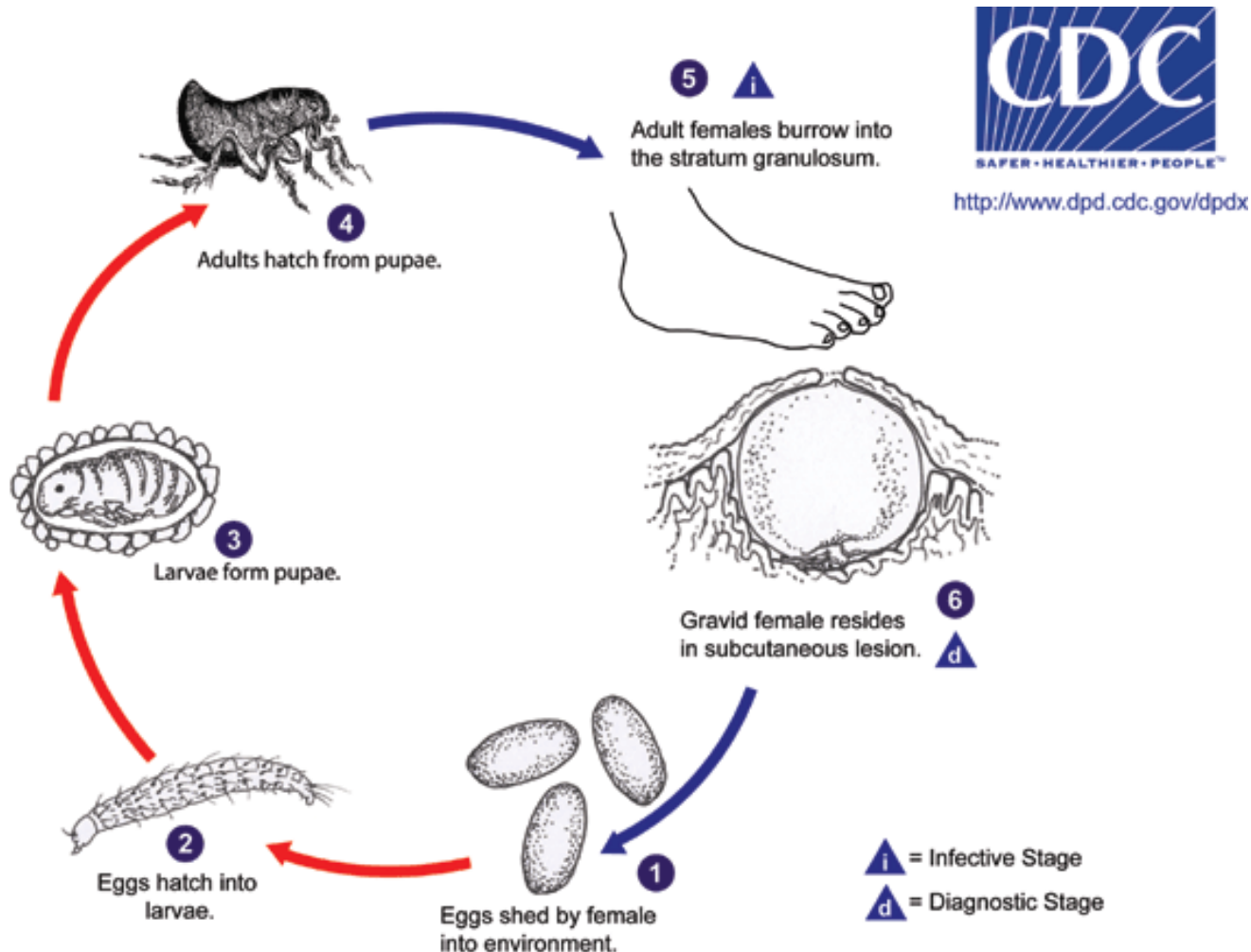
- Sand flea (*Tunga penetrans*) (chigoe flea or jigger) – "bicho de pie"
- It causes tungiasis - an inflammatory skin disease caused by infection with the female ectoparasite *Tunga penetrans*
- The smallest flea in the world (1 mm)
- **Neosomy** - in the genera *Tunga* and *Neotunga*, females burrow into the host's tissue and increase in size up to 100 times



Order Siphonaptera - Fleas

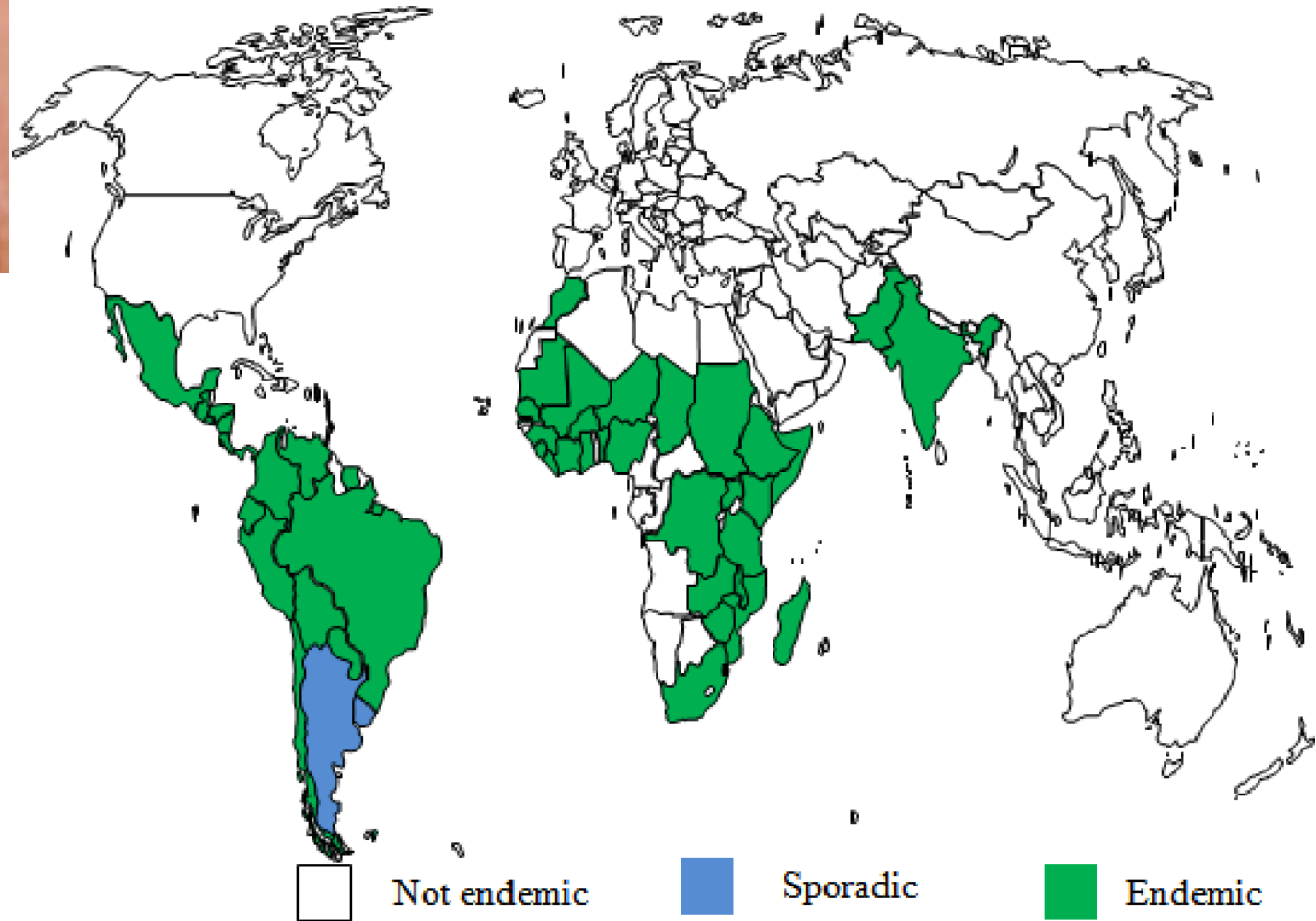
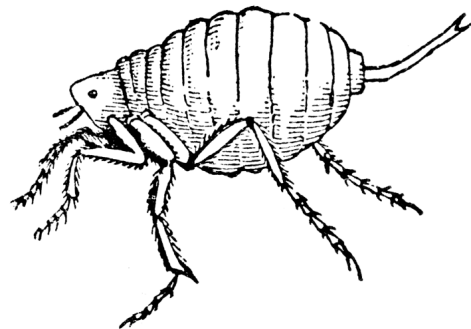
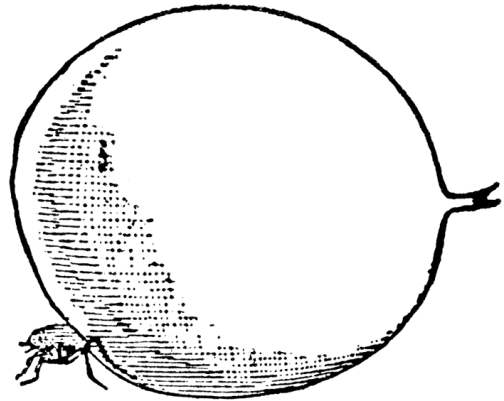


- Sand flea (*Tunga penetrans*) (chigoe flea or jigger) – "bicho de pie"



Order Siphonaptera - Fleas

- Sand flea (*Tunga penetrans*) (chigoe flea or jigger) – "bicho de pie"



Order Siphonaptera - Fleas



- Sand flea (*Tunga penetrans*) (chigoe flea or jigger) – "bicho de pie"
 - Only on tropical and subtropical beaches or sandy areas
 - In some areas, 20 to 50% of infections
 - Infection present in many wild animals
 - Buried females cause inflammation and often secondary infections such as tetanus, gangrene and eventually die *in situ*
 - They can only be removed surgically
 - They do not transmit other diseases



Order Siphonaptera - Fleas

- Human flea (*Pulex irritans*)
- A vector for many pathogens (including *Yersinia pestis*), but never the main vector



500 μ m

Order Siphonaptera - Fleas



- **Veterinary importance:**
 - **Rabbit flea (*Spilopsyllus cuniculi*)**
 - carrier of the Myxoma virus that causes the disease Myxomatosis in rabbits – in rabbits in North and South America causes benign fibromas, but in European rabbits it causes large skin lesions and general viremia (presence of virus in the blood) and eventually death
 - An attempt to control the rabbit population in Australia
 - A rabbit's flea can reproduce only when it feeds on a pregnant rabbit - the matching of a new litter of rabbits with new fleas (M. Rothschild)



Order Siphonaptera - Fleas

- Flea control and prevention
 - Frequent vacuuming and cleaning, especially the area where pets (dogs and cats) and people sleep
 - Using local insecticides for carpets against larvae and eggs (not very effective) - better not to have carpets
 - Treatment of pets against fleas (shampoos, pills, skin drops, collars against fleas,...)
 - Flea control outside homes is extremely difficult

