Medical academy named by S.I.Georgievsky "CFU named by V.I.Vernadskiy

Structure and life cycle of fleas. The epidemiological importance of human fleas

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Morphology

- The body is laterally compressed and the first segment on each leg (the coxa) is large and provides incredible power for jumping; lateral compression allows ease of movement through the hairs on the host; being a good jumper allows them to effectively move from one host to another
- The antennae of males are nearly always longer than those of females; during copulation, the male takes up a position beneath the female and holds her firmly with his antennae from below

- The male body has an upward tilt posteriorly, but the female body is evenly rounded terminally

Morphology cont.

- Fleas are encased in a suit of armor; each segment of the thorax may be regarding as a membranous ring of adjoining plates
- The notum of the prothorax is often armed with a row (comb) of heavily pigmented spines (one row on each side), the **pronotal ctendium;** this structure, plus setae are important for maintaining position on host

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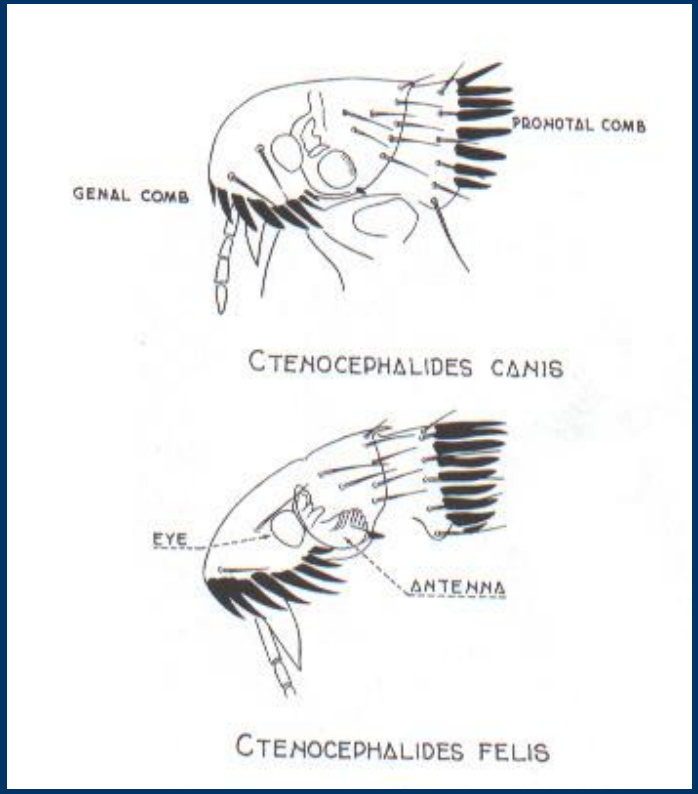


Morphology cont.

- The abdomen consists of ten segments, and each segment has a dorsal and ventral sclerite; these plates overlap on the abdomen, permitting considerable flexibility of the abdomen
- Dorsal sclerite 9 of the male is modified to form a clasping apparatus used during copulation with the female
- The 9th segment of both males and females has on its dorsal sclerite a dorsal sensory plate called the **sensilium (pygidium);** this structure is believed to function in the detection of air currents and thus may assist the flea in finding a host that may be moving about

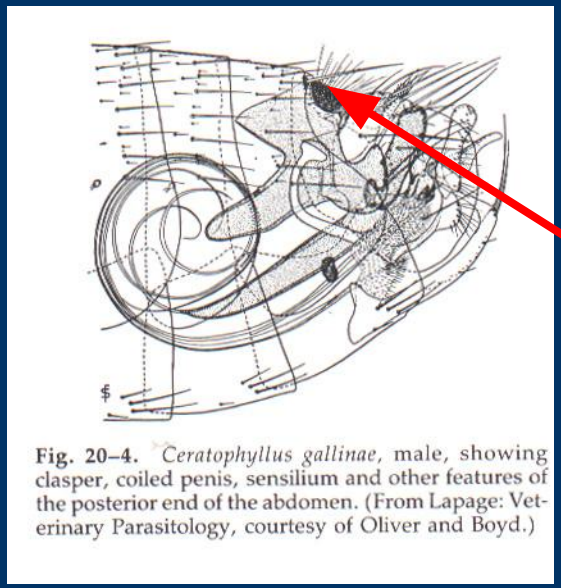
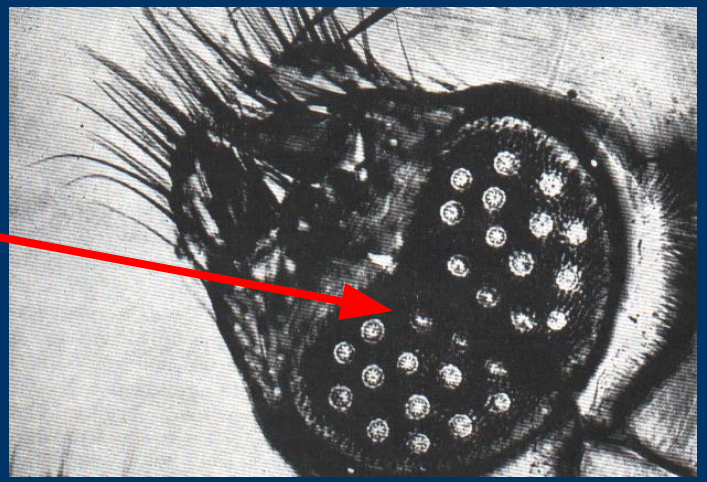


Fig. 20–4. *Ceratophyllus gallinae*, male, showing clasper, coiled penis, sensilium and other features of the posterior end of the abdomen. (From Lapage: Veterinary Parasitology, courtesy of Oliver and Boyd.)

pygidium



Morphology cont.

- The **spermatheca** is taxonomically the most important genital structure of the female flea

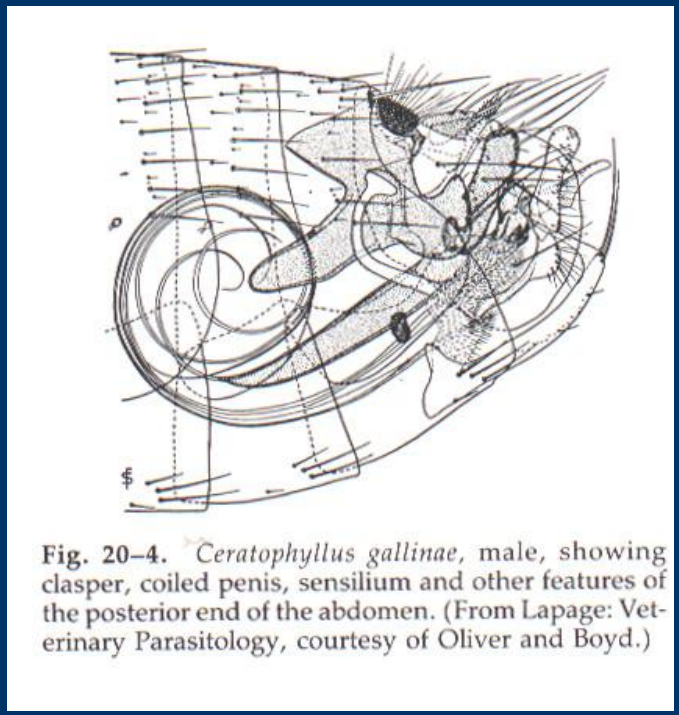


Fig. 20–4. *Ceratophyllus gallinae*, male, showing clasper, coiled penis, sensilium and other features of the posterior end of the abdomen. (From Lapage: Veterinary Parasitology, courtesy of Oliver and Boyd.)

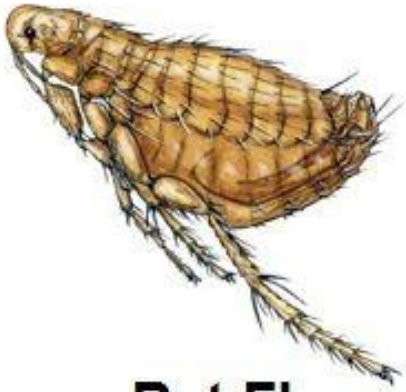
- Possess cutting-piercing mouthparts; the mouth leads to a thick-walled pharynx equipped with pumping muscles, then to a narrow esophagus, which enters a pear shaped proventriculus, which is provided internally with a series of spines that project backward in front of the entrance of the stomach
- These spines presumably help to crush the blood cells of the host

Morphology cont.

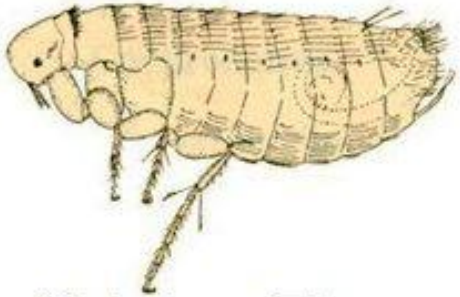
- Between the proventiculus and the stomach is a valve that prevents the food in the stomach from being regurgitated during the process of digestion
- A salivary gland lies on each side of the stomach and a duct leads from these glands to the pharynx
- During the process of biting and feeding, the piercing mouthparts enter the host skin, and the flea thrusts its head downward, elevating the abdomen and the hind legs; after feeding the mouthparts are withdrawn with a sudden jerk
- When a flea bites, the salivary pump pours out a stream of saliva that eventually reaches the host blood vessels; at the same time, the pharyngeal pumps works to draw up the host blood, mixed with saliva and forces it into the esophagus and stomach where it is digested

Sticktight Fleas

Human Fleas



Rat Fleas



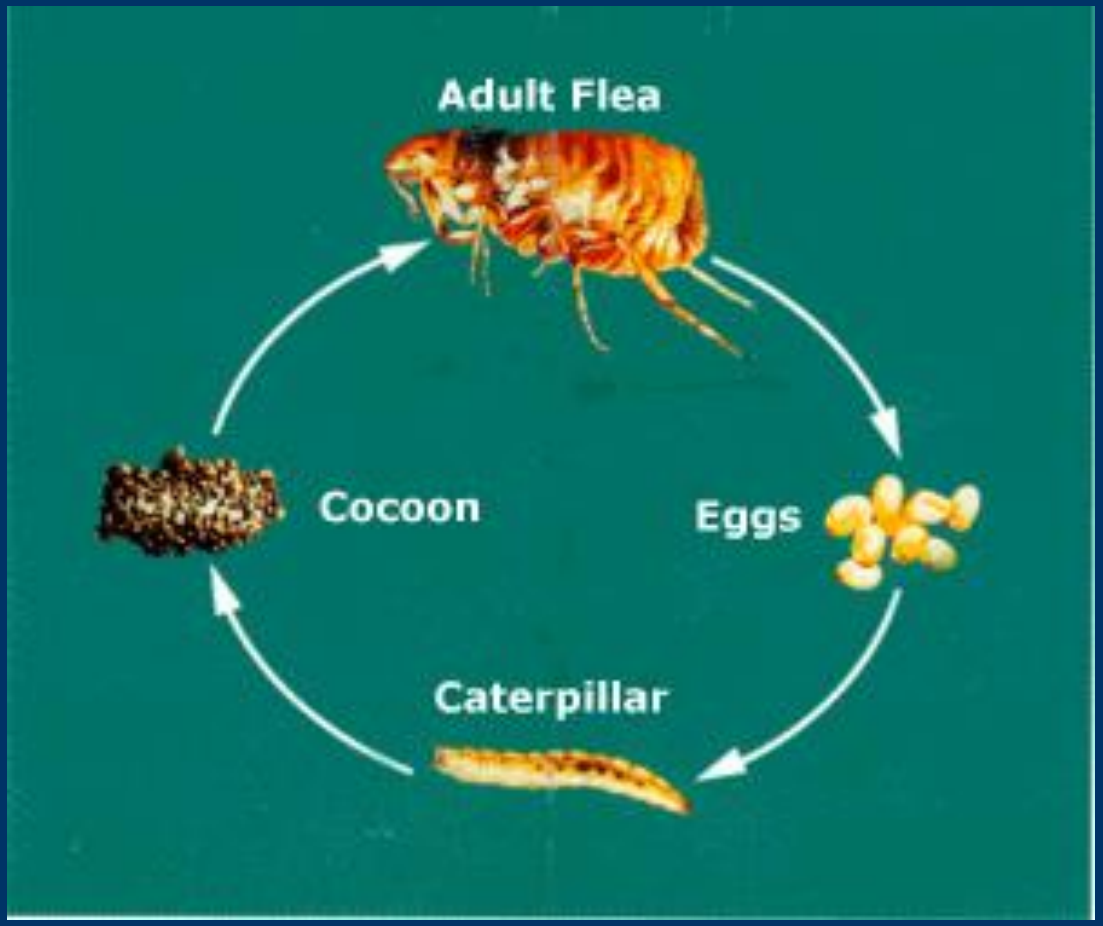
Chicken Fleas

Cat Fleas

Sand Fleas

Life History and Habits

- During their life cycles, fleas pass through a complete metamorphosis from egg to larva to pupa to adult



Life History and Habits cont.

- Eggs are large, smooth and oval and translucent
- In 2-10 days the eggs hatch into eyeless, legless active larvae; the heads are strongly sclerotized
- Under favorable conditions, the larvae may reach their 3rd stage in about 2 weeks, but development may be delayed for 6 months or more
- Larvae feed on organic debris in the host's nest, in crevices on the floor or under rugs; larvae of bird fleas thrive on broken-down sheaths of feathers on the epidermal scales of young birds
- Most fleas have 3 larval stages; each 3rd instar larva spins a cocoon within which it pupates
- Pupae may live for a week up to a year depending on the species and the environmental conditions related to temperature and moisture
- The fully formed adult may lie quiescent for an indefinite period of time before its becomes active and attempt to infect a host

Life History and Habits cont.

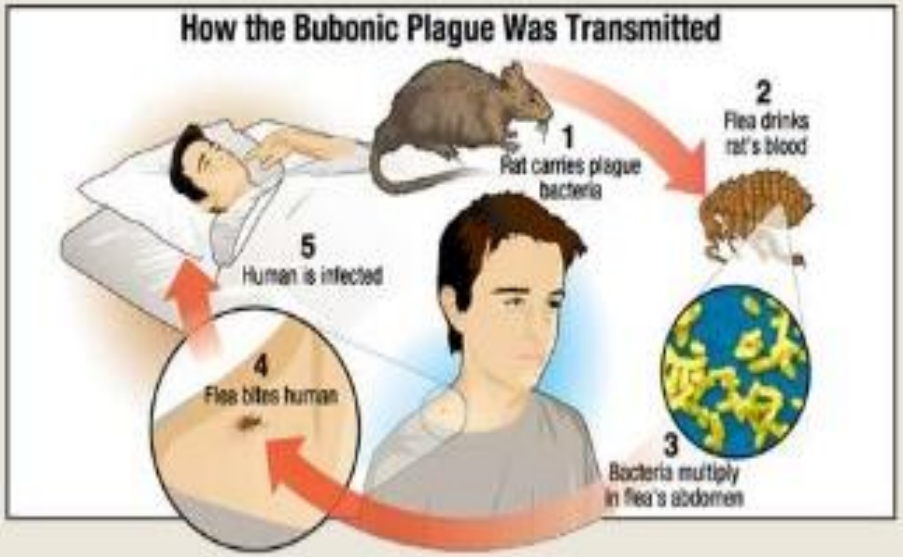
- Fleas are usually equally common on hosts of either sex; however, there are some exceptions
- Bat fleas tend to crowd onto female bats before they migrate to summer colonies
- Fleas of small mammals may be found more commonly on male hosts
- It is not clear why this is the case: larger male size, larger home ranges, mutually groom females
- Females usually require a blood meal before they copulate; males typically die after mating while females live long enough to lay large quantities of eggs

Fleas and Human Diseases

- The bacterial causative agent of plague, *Yersinia pestis,* is transmitted by fleas (*Xenopsylla cheopis* and *Nosopsyllus fasciatus)* from rodents to man
- Bacilli in an infected flea so congest its proventriclus and stomach that blood sucked from a mammalian host fails to pass into the stomach
- A "blocked" fleas continues its attempt to feed and bits of bacillary mass break off and are injected into the host
- *Xenopsylla cheopis* and *Nosopsyllus fasciatus* are also vectors of a nonepidemic typhus of man, "murine typhus"
- This fleas borne disease is caused by *Rickettsia typhi,* which normally occurs in rats
- Other diseases that can be transmitted by fleas include tularemia in man caused by the bacterium *Francisella tularensis*
- Cysticercoids stages of several tapeworms (e.g., *Dipylidium caninum*) develop in larva of several species of fleas

Human plague

- Most frequently contracted from
  - *A. bite of infected flea*
  - *B. direct contact with tissues of infected animal*
  - *C. droplet infection from cases of pneumonic plague*
- 3 types of human plague
  - *A. bubonic plague*
  - *B. pneumonic plague*
  - *C. Septicemic plague*



History & Significance

- 14th Century: "Black Death" responsible for >20 million deaths in Europe
- Used as a BW agent by Japan in WW II
- Studied by Soviet and, to a smaller extent, U.S. BW programs
- 1995: Larry Wayne Harris arrested for illicit procurement of culture via mail

Epidemiology

- Caused by *Yersinia pestis*
- Gram negative, non-motile, non-spore-forming bacillus
- Resistant to freezing temperature and drying, killed by heat and sunlight
- Zoonotic infection; Humans are accidental hosts
- Human plague occurs from bite of an infected flea (bubonic)
- Outbreaks are cyclical corresponding to rodent reservoir and arthropod vector populations
- Only pneumonic form of plague is spread person-to-person
  - Last case of person-to-person transmission in U.S. occurred in 1924

Epidemiology

- Transmission
  - Historically, rat-borne urban epidemics
  - Now mostly endemic sylvatic plague with sporadic outbreaks
  - Pneumonic is only form capable of person to person spread
  - Higher risk in overcrowding, indoor contacts, cold/wet weather

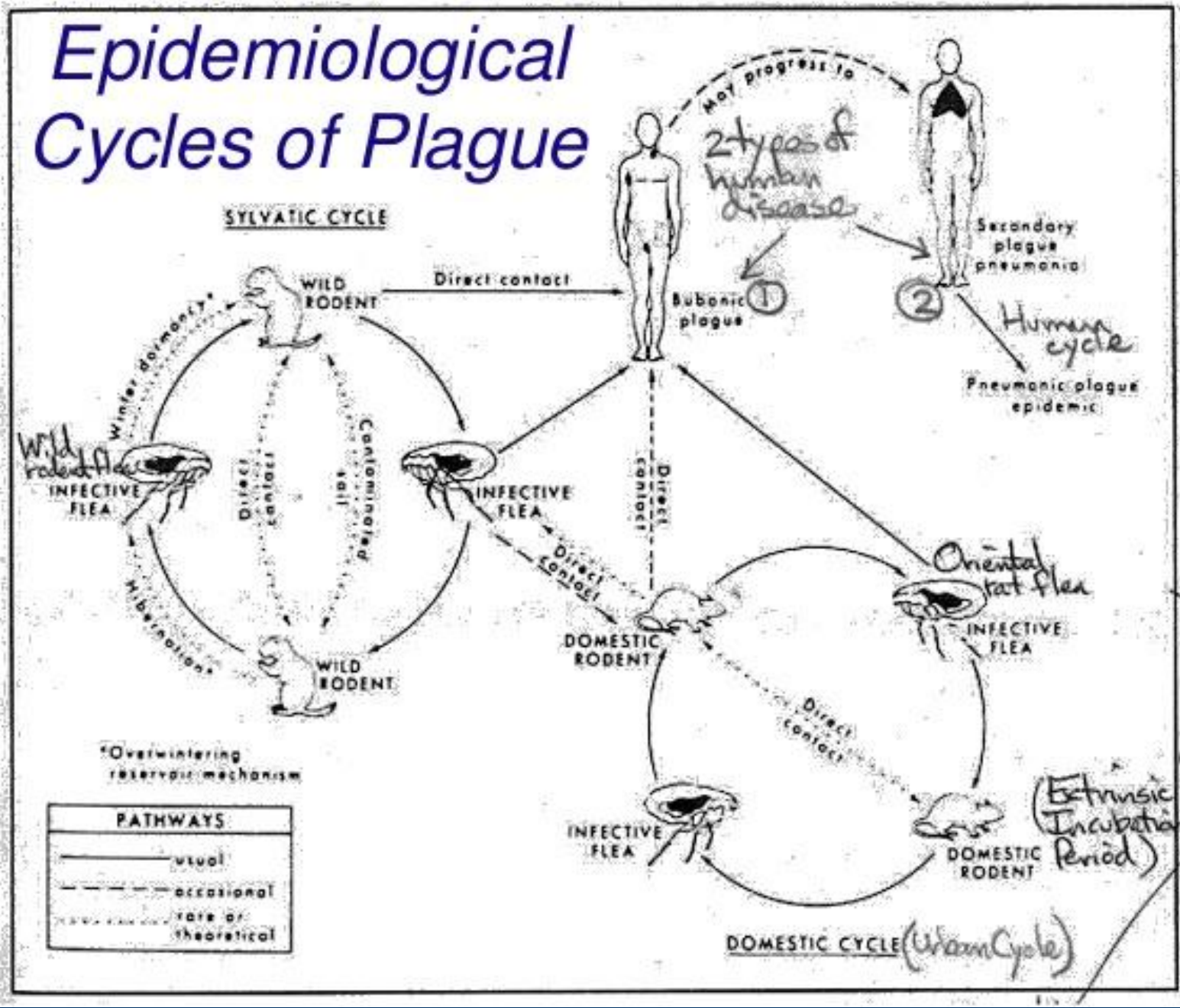
History of Plague

- Plague recorded more than 2000 years ago
- Three pandemics
  - 1st 542AD; 100million dead in 60 years; from N.Africa
  - 2nd 14th century; Black Death; 25million dead in Europe alone (>1/4 of entire population); from central Asia; disease became endemic in urban rat population and smaller epidemics occurred through 17th century
  - 3rd ended in 1990s; Burma to China (1894) & Hong Kong to other continents including N. America via rat-infected ships; 20million dead in India alone; foci of infection firmly established in wild rodents in rural areas
- About 10-15 cases/year U.S.

Epidemiology cycles

- Sylvatic (wild) Cycle of Plague
  - Reservoir (foci) = wild rodents (prairie dogs, rabbits, mice, dogs)
  - Vector = wild rodent flea
- Urban (domestic) Cycle of Plague
  - Reservoir = domestic (urban) black rat
    - √ Over 8 million in NYC = human population
  - Vector = oriental rat flea (*Xenopsylla cheopis*)
- Human Cycle of Plague
  - Bubonic plague acquired from contact with either sylvatic or urban reservoirs or arthropod vector bite and further transmitted in human population by spread of pneumonic plague

Epidemiological Cycles of Plague



Video Links

https://youtu.be/ptHESS4xOkY

https://youtu.be/o0W5eeUqcQQ

https://youtu.be/ynEMFFj-PSM


THANK YOU