



REDUCING DEATHS AND SUFFERING
FROM TROPICAL DISEASES

Ectoparasites



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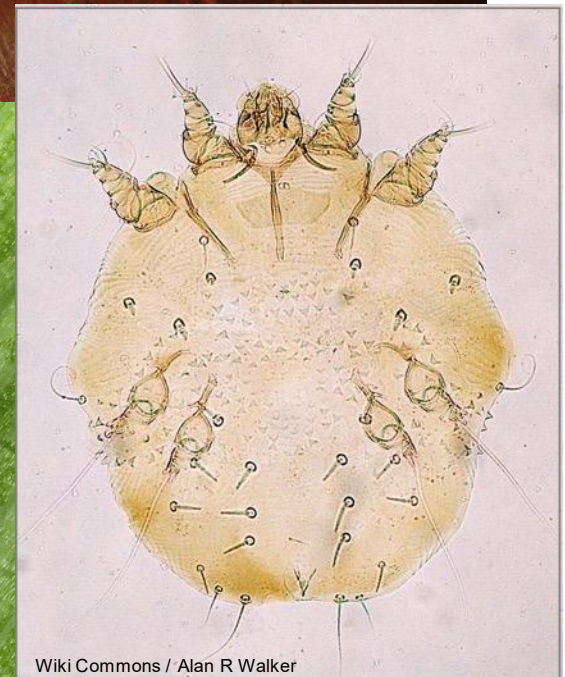
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REDUCING DEATHS AND SUFFERING
FROM TROPICAL DISEASES

“Something that lives right on the thing it lives off of...”

- Roger M. Knutson

Ectoparasites

Ectoparasites that are known to transmit diseases:

- Ticks
- Body lice
- Fleas
- Kissing bugs

Other ectoparasites:

- Fly larvae
- Bedbugs
- Mites

Ticks

- Ticks are currently considered to be second only to mosquitoes as vectors of human infectious diseases worldwide
- Each tick species has preferred environmental conditions and biotopes that determine the geographic distribution of the ticks
- Approximately 10% of the currently known 867 tick species act as vectors of a broad range of pathogens of domestic animals and humans

Ticks

- Two families of ticks:

Hard ticks (Ixodidae)



Soft ticks (Argasidae)



Ticks

Diseases for which ticks serve as vectors:

- Rickettsioses
- Ehrlichiosis (US)
- Lyme disease
- Relapsing fever borrelioses
- Tularaemia

Ticks – Rickettsioses

- Rickettsial infections are caused by various bacterial species from the genera *Rickettsia*, *Orientia*, *Ehrlichia*, *Neorickettsia*, *Neoehrlichia*, and *Anaplasma*
- *Rickettsia* spp. are classically divided into the typhus group and spotted fever group
- *Orientia* spp. make up the scrub typhus group

Ticks – Rickettsioses

Tick-borne rickettsiae – Species identified as pathogens

- North and Central America: 10 species
- South America: 7 species
- Europe: 11 species
- North Africa: 9 species
- Sub-Saharan Africa: 6 species
- Asia: 16 species
- Australia and the Pacific: 6 species

Ticks – Rickettsioses

Tick typhus

- Also known as Spotted Fever
- Spotted fevers and typhus are different clinical entities
- Spotted fevers can range from mild to life-threatening
- Presents as fever, headache, and rash in most cases



Ticks – Rickettsioses

Tick typhus

- Several types of spotted fever, such as Rocky Mountain Spotted Fever, Thai Spotted Fever, Thai Spotted Fever, Flinders Islands Spotted Fever...



Ticks – Rickettsioses

African Tick Bite Fever

- Vector: *Amblyomma hebraeum* and *A. variegatum* ticks
- Bacteria: *Rickettsia africae* and *Rickettsia parkeri*
- Multiply in tick salivary glands and ovaries of tick



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Ticks – Rickettsioses

African Tick Bite Fever

- Once injected in host, initially spread via lymphatics, then travels to vascular endothelial lining cells of CNS, lungs, and myocardium
- Symptoms include fever, headache, muscles pains, and rash

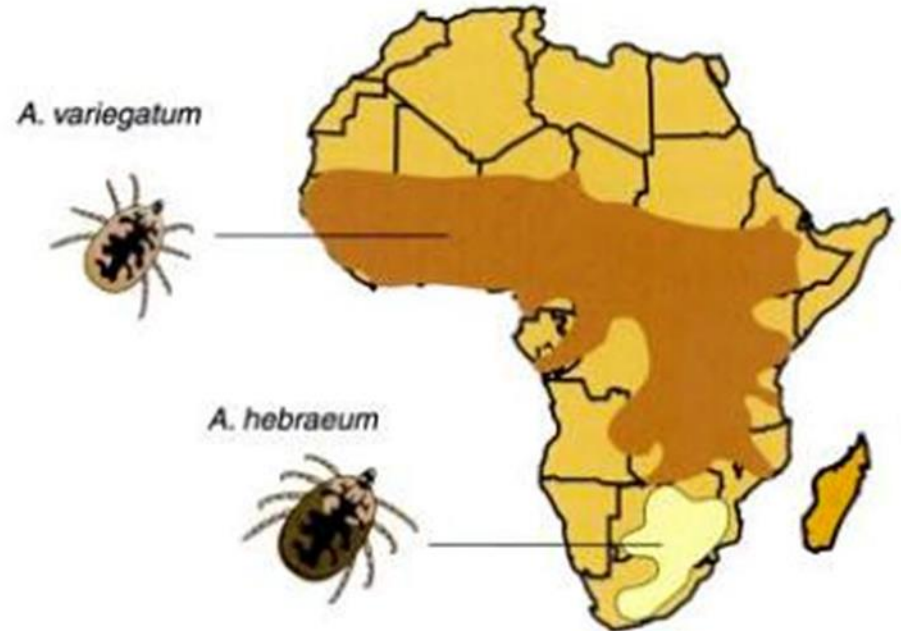


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Ticks – Rickettsioses



Endemic African Countries

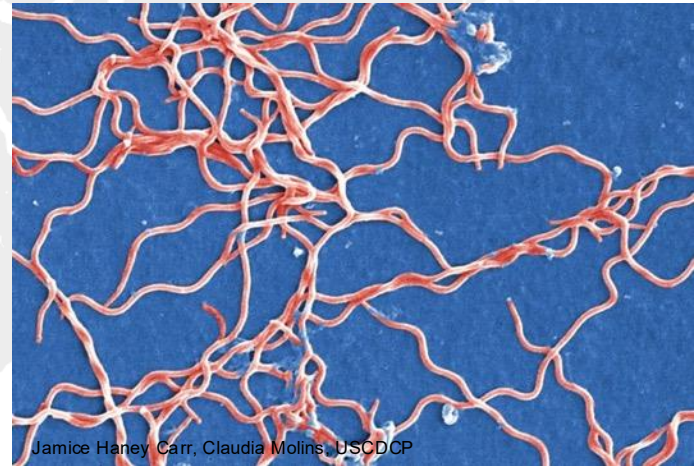


Prevalence of *A. hebraeum* tick

Ticks – *Borrelia*

Lyme Disease

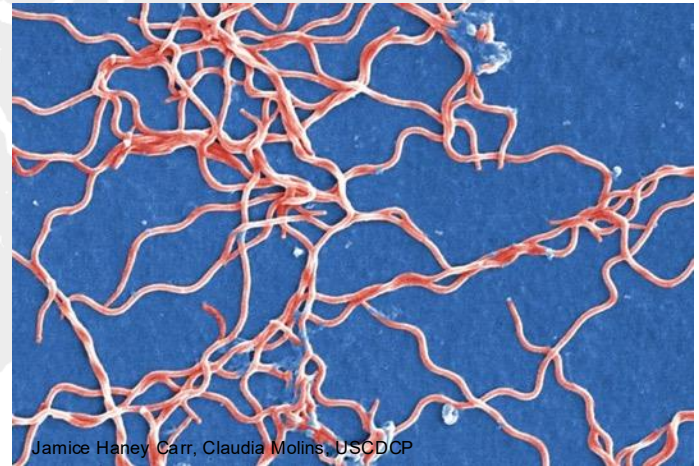
- Transmitted by hard ticks
- Untreated/inadequately treated patients may develop severe and chronic symptoms that affect many parts of the body, including the brain, nerves, eyes, joints, and heart



Jamice Haney Carr, Claudia Molins, USCDCP

Ticks – *Borrelia*

- Most common disease spread by ticks in the Northern Hemisphere
- Has also been reported from African, Asian and South American countries



Jamice Haney Carr, Claudia Molins, USCDCP

Ticks – *Borrelia*

Relapsing Fever

- Transmitted by soft ticks of the genus *Ornithodoros*
- Symptoms include a sudden fever, chills, muscle or joint aches, headaches, and nausea



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Ticks – *Borrelia*

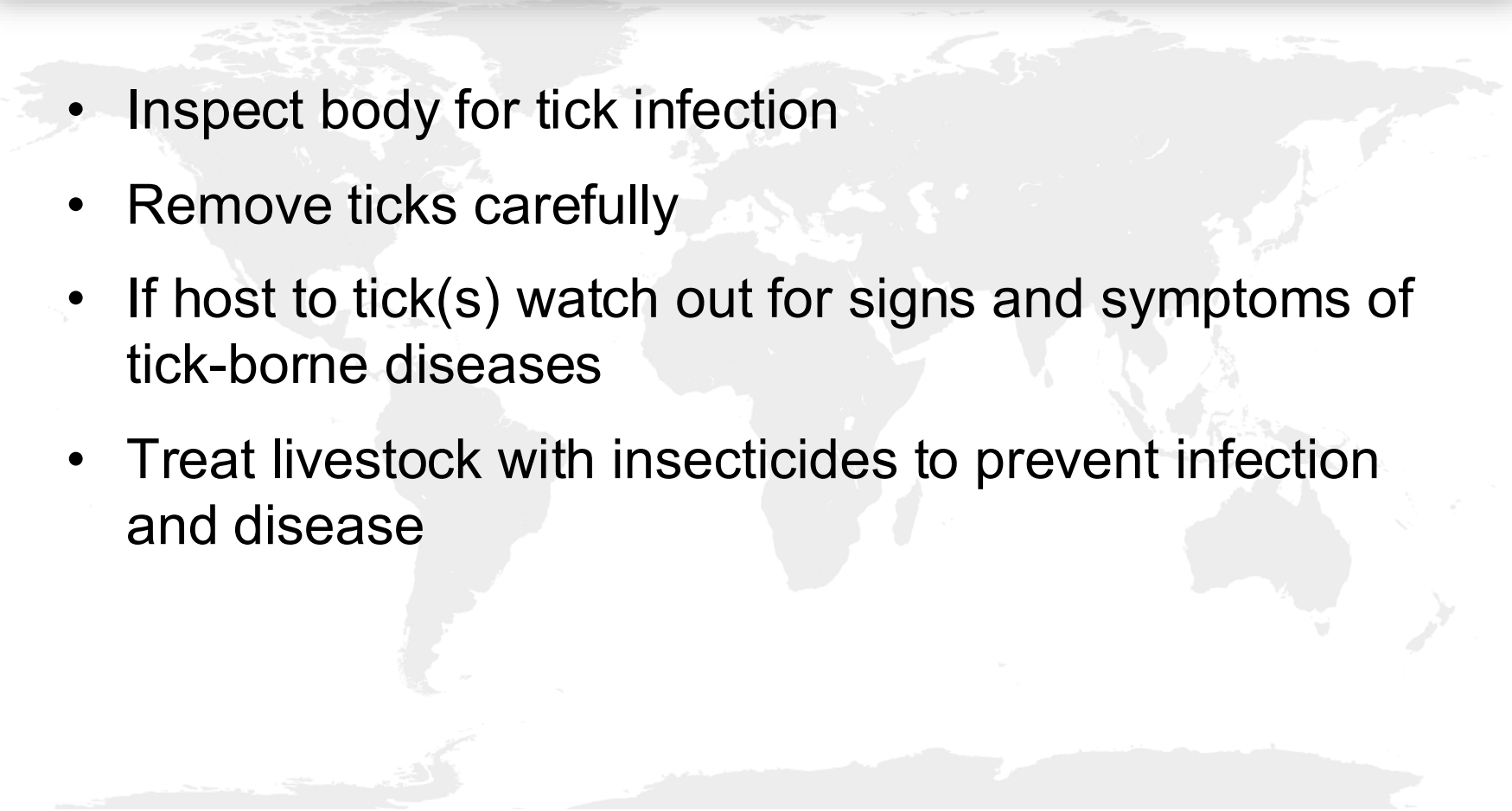
Relapsing Fever

- Primarily reported from countries in Africa, Spain, Saudi Arabia, Asia, and certain areas of Canada and the western United States



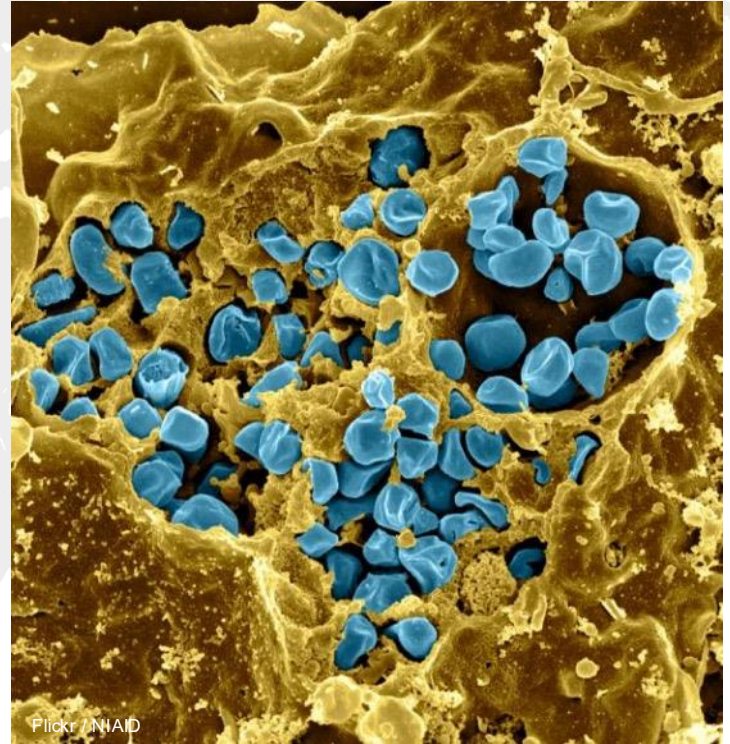
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Tick Control

- 
- Inspect body for tick infection
 - Remove ticks carefully
 - If host to tick(s) watch out for signs and symptoms of tick-borne diseases
 - Treat livestock with insecticides to prevent infection and disease

Ticks – Tularaemia

- Caused by the bacterium *Francisella tularensis*
- Symptoms include fever, skin ulcer, and enlarged lymph nodes
- Most common in the Northern Hemisphere, (North America and parts of Europe and Asia)



Body Lice

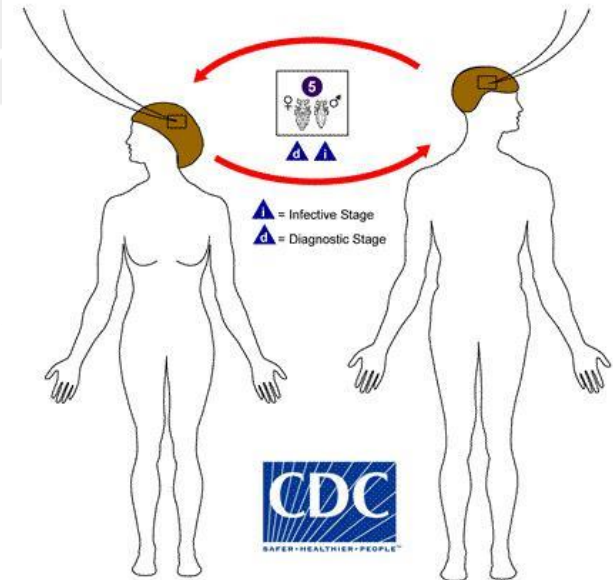
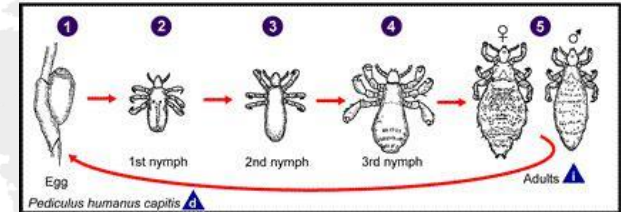
- *Pediculus humanus humanus*
- 2.3–3.6 mm in length
- Live and lay eggs on clothing
- Only move to the skin to feed
- Feeds on blood several times daily and resides close to the skin to maintain its body temperature



Pixnio / James Gathany, Frank Collins, USDCDP

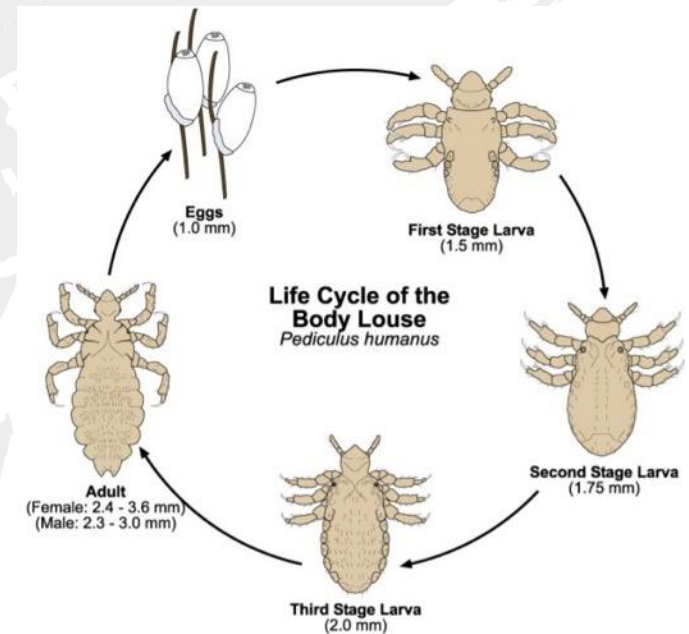
Body Lice

- The life cycle of the body louse has three stages: egg, nymph, and adult
- The only host are humans
- Spread most commonly by close person-to-person contact



Body Lice

- Infestation is found worldwide but is generally limited to persons who live under conditions of crowding and poor hygiene with no access to regular bathing and changes of clean clothes, such as:
 - the homeless,
 - refugees and,
 - survivors of war or natural disasters



Drawing credit: Scott Charlesworth, Purdue University, based in part on Kim, K.C., H.D. Pratt, and C.J. Stojanovich, 1986, The Sucking Lice of North America

Body Lice – Typhus Fever

- Body Lice can transmit typhus fever (Epidemic louse-borne typhus)
- Cause: *Rickettsia prowazekii*
- The body louse becomes infected by feeding on the blood of patients with acute typhus fever
- Infected lice excrete rickettsia onto the skin while feeding on a second host, who becomes infected by rubbing louse faecal matter or crushed lice into the bite wound

Body Lice – Typhus Fever

- Variable but often sudden onset
- Symptoms include: headache, chills, high fever, prostration, coughing and severe muscular pain
- The case–fatality rate is up to 40% in the absence of specific treatment
- The only rickettsial disease that can cause explosive epidemics under the right circumstances

Other Lice – Head Lice

- *Pediculus humanus capitis*
- 2 – 3mm long
- Infest the head and neck
- Attach their eggs to the base of the hair shaft
- Commonly by close person-to-person contact
- Do not spread disease



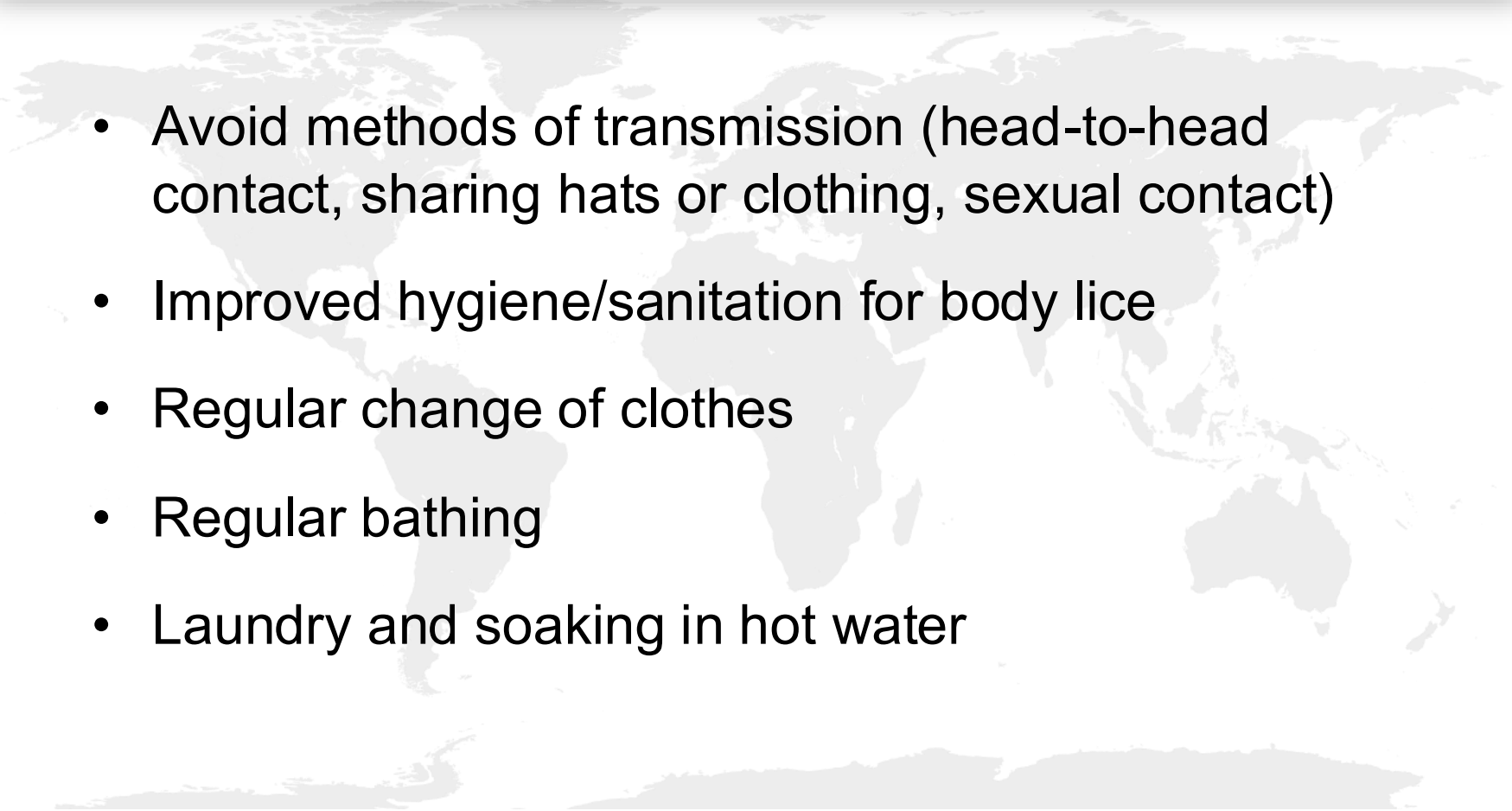
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Other Lice – Pubic Lice (Crab Lice)

- *Phthirus pubis*
- 1.1–1.8 mm in length
- Found attached to hair in the pubic area but also eyebrows, eyelashes, beard etc.
- Usually spread through sexual contact
- Do not transmit disease



Lice – Prevention

- 
- Avoid methods of transmission (head-to-head contact, sharing hats or clothing, sexual contact)
 - Improved hygiene/sanitation for body lice
 - Regular change of clothes
 - Regular bathing
 - Laundry and soaking in hot water

Fleas

- Small, laterally flattened, wingless, and highly specialized
- Of great importance as vectors of pathogens in many parts of the world
- About 2,574 species belonging to 16 families and 238 genera have been described
- Only a minority is synanthropic (live in close association with humans)

Fleas

Family	Distribution (region)	Genera	Species	Major host
Ancistropsyllidae	Oriental	1	3	Ungulates
Ceratophyllidae	Cosmopolitan but predominantly Holarctic	44	403	Primarily rodents, occasionally viverrids, mustelids, birds, and a single species on an insectivore (Siberian mole)
Chimaeropsyllidae	Ethiopian	8	26	Rodents, insectivores, elephant shrews
Coptopsyllidae	Palearctic	1	19	Rodents (gerbils and their allies)
Ctenophthalmidae	Primarily Holarctic, some in southern hemisphere	42	548	Rodents, occasionally pikas, insectivores (shrews and moles), marsupials, and a single species on mustelids
Hystrihopsyllidae	Nearctic, Palearctic, Neotropical, Australian	6	36	Rodents, insectivores
Ischnopsyllidae	Cosmopolitan	20	122	Bats
Leptopsyllidae	Palearctic, Nearctic, Oriental, a few species in Australian or Ethiopian regions (Madagascar)	29	230	Rodents, lagomorphs (hares, rabbits, pikas), insectivores, and rarely elephant shrews and foxes
Malacopsyllidae	Neotropical	2	2	Edentales (armadillos)
Pulicidae (includes tungid flea)	Cosmopolitan	27	182	Very broad host range, including carnivores, ungulates, bats, edentales (armadillos), and occasionally birds (<i>Cariama spp.</i>)
Pygiopsyllidae	Ethiopian, Oriental Australian, and one Neotropical genus	37	166	Rodents, marsupials, insectivores, and occasionally monotremes, birds, or tree shrews
Rhopalopsyllidae	Neotropical, southern Nearctic, Oceanic	10	122	Primarily rodents, some on oceanic seabirds
Stephanocircidae	Primarily Neotropical, two Australian species	9	51	Rodents, a few species on marsupials
Vermipsyllidae	Holarctic	3	39	Carnivores and ungulates
Xiphiopsyllidae	Ethiopian	1	8	Rodents

Bitam, I. et al. (2010). Fleas and flea-borne diseases. International Journal of Infectious Diseases, 14: 667–676.

Important synanthropic fleas

Pulex irritans (human flea)

- Nearly cosmopolitan distribution
- Attacks a wide variety of mammals
- Can be a carrier of the *Yersinia pestis*

Ctenocephalides felis felis (cat flea)

- Extremely common on cats and dogs in many temperate and tropical regions
- Can transmit *Bartonella*, murine typhus, and apedermatitis

Important synanthropic fleas

Xenopsylla cheopis (oriental rat flea)

- Found throughout Africa and central and southern Asia
- Primary vector of *Yersinia pestis*
- Can transmit murine typhus and parasitic helminths

Nosopsyllus fasciatus (northern rat flea)

- Common on commensal rats in temperate regions
- Poor vector of plague
- Can transmit *Salmonella enteritidis*, *Francisella tularensis*, and *Trypanosoma lewisi*

Fleas – Bite Symptoms

- Fleas are a nuisance, cause an itching sensation
- Some people suffer allergic reactions to flea saliva resulting in rashes
- Flea bites generally result in the formation of a slightly raised, swollen itching spot with a single puncture point at the center (similar to a mosquito bite). The bites often appear in clusters or lines of two bites, and can remain itchy and inflamed for up to several weeks afterwards.

Flea-borne diseases – Plague

Plague

- Causative pathogen: *Yersinia pestis*
- Circulation has been detected within populations of more than 200 species of wild rodents inhabiting natural plague foci on all continents, except for Europe, Australia, and Antarctica
- Can have several clinical manifestations: bubonic plague, septicemic plague without bubo, pneumonic plague, meningitis, and pharyngitis

Flea-borne diseases – Plague

- “Flu-like” symptoms after an incubation period of 3-7 days
- Typical symptoms are the sudden onset of fever, chills, head and body-aches and weakness, vomiting and nausea
- Can be a very severe disease in people, particularly in its septicaemic and pneumonic forms, with a case-fatality ratio of 30%-100% if left untreated

Flea-borne diseases – Plague

Bubonic plague

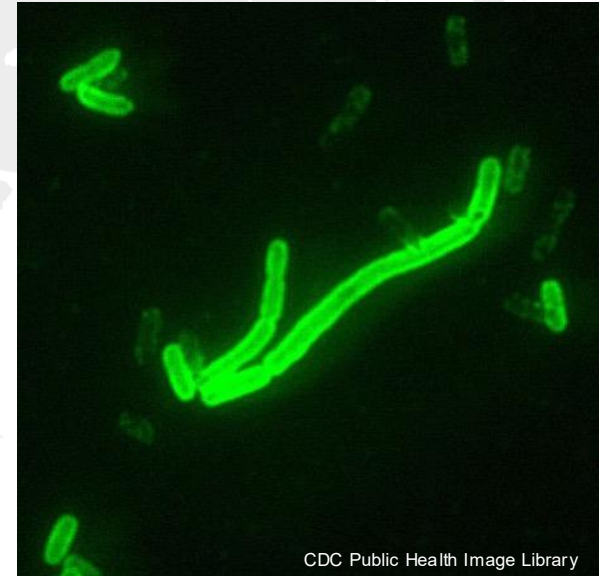
- Infected lymph nodes become inflamed, tense and painful (“bubo”)
- At advanced stages the inflamed lymph nodes can turn into suppurating open sores
- Gangrene of the fingers, toes, lips and nose is another common symptom



Flea-borne diseases – Plague

Septicaemic plague

- Occurs when infection spreads through the bloodstream
- Can lead to bleeding under, bleeding from mouth, nose or rectum, organ failure, gangrene of fingers, toes and nose
- May cause death before any symptoms occur



Flea-borne diseases – Plague

Pneumonic plague

- Most virulent and least common form of plague
- Caused by spread to the lungs from advanced bubonic plague
- A person with secondary pneumonic plague may form aerosolized infective droplets and transmit plague via droplets to other humans
- Untreated pneumonic plague has a case-fatality ratio close to 100%

Flea-borne diseases – Murine typhus

- Caused by *Rickettsia typhi*
- People become infected with murine typhus when infected flea faeces are rubbed into cuts or scrapes in the skin
- Symptoms begin within two weeks after contact
- Symptoms may include: Fever and chills, body aches and muscle pain, nausea, vomiting, stomach pain, rash

Flea-borne diseases – Murine typhus

- Most people will recover without treatment
- When left untreated, severe illness can cause damage to one or more organs including the liver, kidneys, heart, lungs, and brain



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Ctenocephalides felis felis (cat flea)

Flea-Borne Diseases - *Bartonella*

- Currently, 23 *Bartonella* species are recognized and associated with mammalian hosts, and 11 species have been implicated in human disease

Flea	<i>Bartonella</i>	Disease in humans	Known geographical distribution region of <i>Bartonella</i> [Ref.]
<i>Ctenocephalides felis</i>	<i>B. henselae</i> , <i>B. clarridgeiae</i> , <i>B. quintana</i> , <i>B. koehlerae</i>	CSD, BA, BAC, END	France 106, Japan, New Zealand, Thailand, UK, USA
<i>Ctenocephalides canis</i>	<i>B. henselae</i>	CSD, BA	Japan
<i>Pulex irritans</i> / <i>Pulex simulans</i>	<i>B. quintana</i> , <i>Bartonella</i> sp	BAC, END	Gabon, Peru 107
<i>Xenopsylla cheopis</i>	<i>B. elizabethae</i> , <i>B. tribocorum</i>	END	Algeria, Egypt 28
<i>Leptopsylla segnis</i>	<i>Bartonella</i> sp, <i>B. elizabethae</i>	END	Algeria, Egypt 28
<i>Nosopsyllus fasciatus</i>	<i>Bartonella</i> sp	Unknown	Thailand
<i>Oropsylla hirsuta</i>	<i>Bartonella</i> sp	Unknown	USA (Colorado)
<i>Archeopsylla erinacei</i>	<i>B. clarridgeiae</i> , <i>B. elizabethae</i>	END	Algeria unpublished data
<i>Pulex</i> sp	<i>B. rochalimae</i>		Peru
<i>Ornithophaga</i> sp	<i>Bartonella</i> sp, <i>B. elizabethae</i>	END	Portugal
<i>Stenoponia tripectinata</i>	<i>Bartonella</i> sp	END	Portugal
<i>Ctenophthalmus nobilis</i>	<i>B. taylorii</i> , <i>B. grahamii</i>	END	England
<i>Ctenophthalmus lushniensis</i>	<i>B. clarridgeiae</i>	END	China

CSD, cat scratch diseases; BA, bacillary angiomatosis; BAC, bacteremia; END, endocarditis.

Bitam, I. et al. (2010). Fleas and flea-borne diseases. International Journal of Infectious Diseases, 14: 667–676.

Flea-Borne Diseases - Bartonella

Cat scratch disease (*Bartonella henselae*)

- Cats can harbour *Bartonella*-infected fleas. The *Bartonella* bacteria can be transmitted from a cat to a person during a scratch
- Presents as swollen lymph nodes near the site of the bite or scratch or on the neck
- Systemic symptoms include fever, malaise, fatigue, headache, anorexia, and weight loss
- Most cases are benign and self-limiting, but lymphadenopathy may persist for several months

Flea Control

- Insecticide – environment treated with a fogger or spray insecticide containing an insect growth regulator, such as pyriproxyfen or methoprene to kill eggs and pupae
- Fleas tend to breed exponentially in piles of shoes
- Dried pennyroyal has been suggested as a natural flea control but is not recommended in homes with pets due to its high toxicity to mammals

Flea Control

Messages to community:

- Maintain good personal hygiene and clean living conditions
- Look out for signs and symptoms –rash, allergic reaction to bites – as well as for flea- borne diseases
- Treat living spaces with insecticides to eliminate flea infestations
- Treat livestock occasionally as well

Fly Larvae - Myiasis

- Myiasis is defined as the infestation of live vertebrates (humans and/or animals) with dipterous (belonging or pertaining to the order Diptera) larvae
- In mammals (including humans), dipterous larvae can feed on the host's living or dead tissue, liquid body substance, or ingested food and can cause a broad range of infestations, depending on the body location

Fly Larvae - Myiasis

- Some flies attach their eggs to mosquitoes and wait for mosquitoes to bite people. Their larvae then enter these bites.
- Some flies' larvae burrow into skin. They can enter skin through people's bare feet when they walk through soil containing fly eggs or attach themselves to people's clothes and then burrow into their skin
- Some flies deposit their larvae on or near a wound or sore, depositing eggs in sloughing-off dead tissue

Fly Larvae - Myiasis

Family, species, and parameter

Muscidae

Muscina sp.

Distribution	Worldwide
Classification	Facultative myiasis
Hosts	Decaying organic matter
Human myiasis	For <i>Muscina stabulans</i> , intestinal and urogenital myiasis for <i>Muscina</i> sp., cutaneous myiasis

Musca domestica (house fly)

Distribution	Worldwide
Classification	Facultative myiasis
Hosts	Decaying organic matter
Human myiasis	Reported to cause intestinal wound, and cavitory myiasis; related to allergic diseases

Fanniidae

Fannia sp. (lesser house fly)

Distribution	Holarctic and temperate neotropical regions
Classification	Facultative myiasis
Hosts	Decaying organic matter
Human myiasis	For <i>Fannia scalaris</i> , genitourinary myiasis for <i>Fannia canicularis</i> , nasopharyngeal myiasis, intestinal myiasis, and rectal myiasis

- The order Diptera is a large order of insects that are commonly known as true flies.
- Flies are ubiquitous and abundant, with approximately 150,000 species in 10,000 genera and 150 families

Fly Larvae - Myiasis



Wiki Commons / CSIRO

Myiasis – Prevention

- To prevent myiasis in humans, there is a need for general improvement of sanitation, personal hygiene, and fly control
- Clothes should be washed thoroughly, preferably in hot water, dried away from flies, and ironed thoroughly. The heat of the iron kills the eggs of myiasis-causing flies

Myiasis – Prevention

Messages to community:

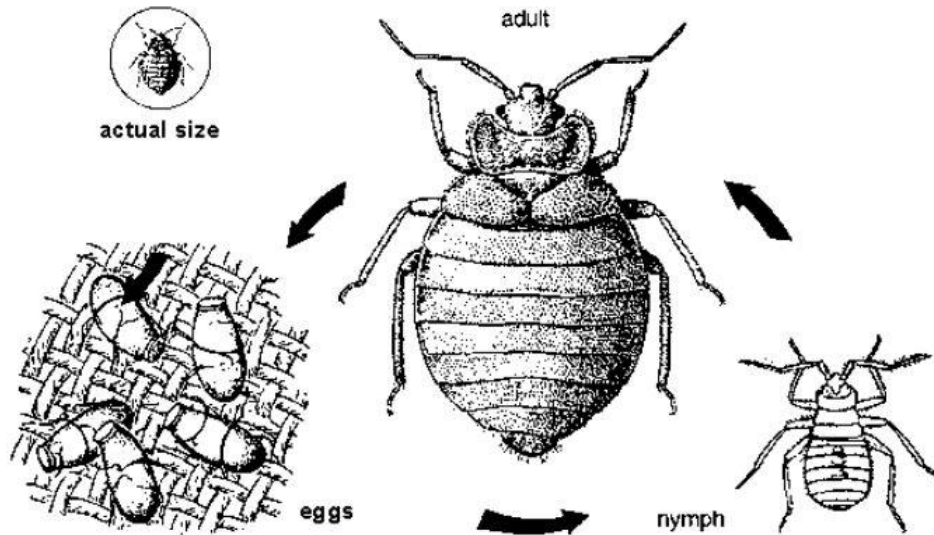
- Clean clothes well, dry and iron
- Do not leave open wounds uncovered and unattended
- Check for signs and symptoms and seek removal of myiasis
- Use fly traps inside homes, if available

Bedbugs

- Two species of bedbug feed on humans: the common bedbug (*Cimex lectularius*), which occurs in most parts of the world, and the tropical bedbug (*Cimex hemipterus*), which occurs mainly in tropical countries



Bedbugs



WHO (1997). Vector Control - Methods for Use by Individuals and Communities.

- The eggs are white and about 1 mm long
- The nymphs look like adults but are smaller.
- Complete development from egg to adult takes from six weeks to several months

Bedbugs

- Both male and female bedbugs feed on the blood of sleeping persons at night
- In the absence of humans they feed on mice, rats, chickens and other animals
- Feeding takes about 10-15 minutes for adults, less for nymphs, and is repeated about every three days
- By day they hide in dark, dry places in beds, mattresses, cracks in walls and floors, and furniture

Bedbugs

- Bedbugs have been suspected of transmitting infectious agents
- Over 40 microorganisms have been considered strong candidates
- In contrast to that for mosquitoes or ticks, the literature evidence level for disease transmission by bedbugs is very heterogeneous and sometimes incomplete

Bedbugs – Prevention

- Eradication of bed bugs frequently requires a combination of pesticide and non-pesticide approaches
- Pesticides historically effective include: pyrethroids, dichlorvos and malathion
- LLINs can control bedbugs
- Resistance to pesticides has increased significantly

Bedbugs – Prevention

- The carbamate insecticide propoxur is highly toxic to bed bugs, but when used indoors may potentially be toxic to children after chronic exposure
- Mechanical approaches such as vacuuming up the insects and heat treating or wrapping mattresses have been recommended
- Cleaning trails of faeces, keeping better hygienic practices

Bedbugs – Prevention

Messages to community:

- Regular inspection of living spaces for bedbugs and faeces
- Watch for signs and symptoms- allergy, rashes
- Clean living and sleeping areas well
- Use insecticides to eliminate infestations

Mites – Scabies

- Parasitic infestation caused by the mite *Sarcoptes scabiei* var *hominis*
- In resource-poor tropical settings, the burden of scabies infestation imposes a major cost on health-care systems



Mites – Scabies

- Scabies mites burrow into the top layer of the skin where the adult female lays eggs



Wiki Commons / Michael Geary

Mites – Scabies

- After 4–6 weeks, the patient develops an allergic reaction to the presence of mite proteins and faeces, causing an intense itch
- Scratching can lead to inoculation of the skin with bacteria (particularly *Staphylococcus aureus* and *Streptococcus pyogenes*), leading to the development of skin sores

Mites – Scabies

- The skin sores can be complicated by deeper skin infection such as abscesses, as well as serious invasive disease and sepsis in infants
- Evidence of renal damage can be found in up to 10% of children with infected scabies in resource-poor settings
- This can persist for years following infection contributing to permanent kidney damage

Mites – Scabies

- A clinical variant is “crusted scabies”
- Occurs particularly in some immuno-suppressed patients, including those with HIV/AIDS, and is characterized by hyperinfestation with millions of mites, producing widespread scale and crust



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