

- XII. Subphylum Uniramia 2009
 - A. Characteristics
 - 1. One pair of antennae
 - 2. Appendages single branched
 - B. Class Insecta
 - 1. Adult characteristics
 - a. Three tagmata: head, thorax, & abdomen
 - b. Four pairs of head appendages
 - (1) Antennae
 - (2) Mandibles
 - (3) 1st & 2nd maxillae
 - c. Three pairs of thoracic (walking) appendages
 - d. Wings
 - 2. Development
 - a. Direct development
 - (1) Produce NYMPHS that resemble adults but are without functional wings
 - (2) Adult form acquired gradually through a succession of molts
 - b. Indirect development
 - (1) Metamorphosis
 - (2) LARVAE bear little resemblance to adults
 - (a) Caterpillar
 - (b) Grub
 - (3) PUPA
 - (a) Inactive
 - (b) Cocoon
 - (4) ADULT
 - (a) Wings
 - (b) Does not molt
 - C. Order Anoplura - sucking lice
 - 1. Ectoparasites of mammals
 - 2. Tests of evolutionary theory
 - a. Lice are usually species specific
 - (1) Different species of mammals have hair shafts with specific diameters
 - (2) The grasping appendages of lice are adapted for hairs of host
 - b. Phylogenetic trees (*i.e.* relatedness) of lice mirror those of their hosts
 - 3. Characteristics
 - a. Wingless
 - b. Mouthparts adapted for sucking
 - (1) Pierce skin
 - (2) Drink blood

4. *Pediculus humanus humanus* (=body) and *P. h. capitis* (= head) lice are varieties of the same species

Picture Slide: Head Louse & Pubic or Crab Louse; <http://edis.ifas.ufl.edu/in261>

- a. Spread by combs and clothing

Picture Slide: Human Body Lice on Clothing; <http://edis.ifas.ufl.edu/in261>

- b. Eggs (= NITS) cemented to clothing and hair

Picture Slide: Nits on human hair shafts; <http://edis.ifas.ufl.edu/in261>

- c. Vectors for 3 important human diseases that are NOT currently reported from United States
 - (1) Epidemic or louse-borne typhus caused by *Rickettsia prowazeki*
 - (2) Trench fever caused by *Rochalimaea quintana* (formerly known as *Rickettsia quintana*)
 - (3) Louse-borne relapsing fever *Borrellia recurrentis*
- d. Humans infected when they scratch bite and rub bacteria in louse feces into wound
- e. Important in wartime when people huddle together and do not bathe

Picture Slide: WWII sign warning soldiers of connection between lice & typhus

Word Slide: “[DDT} acquired a reputation as a cure for insomnia, since those treated were able to sleep without the distraction of the lice, often for the first time in their lives.”

The Fred L. Soper Papers:

<http://profiles.nlm.nih.gov/VV/Views/Exhibit/narrative/typhus.html>

5. *Pthirus pubis* (= crab louse)
 - a. Pubic areas
 - b. Spread by contact
 - c. Not a vector of human disease

D. Order Hemiptera (True bugs)

1. Characteristics
 - a. Wings
 - (1) Structure of forewings gives name to order
 - (a) Bases are thick and leathery
 - (b) Apical ends are membranous and overlap at rest
 - (2) Hindwings membranous
 - b. Piercing-sucking beak
2. Family Cimicidae (= bed bugs)
 - a. Flat, oval and wingless

Picture Slide: Female Bedbug

<http://www.doyourownpestcontrol.com/adultbedbugfemale.jpg>

- b. Feed on blood of mammals
- c. Human pests
 - (1) *Cimex*
 - (2) Not known to be a vector of human diseases
- d. Behavior
 - (1) Nocturnally active
 - (2) Attracted to heat

- (3) Narrow shape allows them to hide in cracks

Word Slide: Excerpts *NY Daily News*

<http://www.nydailynews.com/news/local/story/453996p-382098c.html>

NPR on bedbug outbreak in New York City;

<http://www.npr.org/templates/story/story.php?storyId=6147499>

3. Family Reduviidae (= assassin bugs)
 - a. Predacious
 - b. Characteristics
 - (1) Elongated head with neck-like appearance
 - (2) Short beak fits into a groove
 - c. Disease vector
 - (1) “Kissing bug” (*Rhodnius*) bites people near the mouth when they sleep
 - (2) Transmits *Trypanosoma cruzi* = Chaga’s disease
 - (3) Both *T. cruzi* and reduviid bugs are present in USA, but potential vectors do not bite humans

Slide: Chaga’s Disease Vector *Rhodnius*, The Kissing Bug; Found in crevices in homes, feeds at night; <http://www.biosci.ohio-state.edu/~parasite/images.html>

E. Order Siphonoptera (= fleas)

1. Adult characteristics
 - a. Wingless
 - b. Body flattened laterally
 - c. Legs modified for jumping
 - d. Ectoparasites of birds and mammals
 - e. Suck blood of host

Picture Slide: Adult flea; <http://edis.ifas.ufl.edu/IG087>

2. Larvae
 - a. Usually do not live on host
 - (1) In nesting material
 - (2) Cat & dog flea larvae in house carpets
 - b. Feed on organic material

Picture Slide: Flea Larva; <http://edis.ifas.ufl.edu/IG087>

3. Important vectors of human diseases
 - a. Plague
 - (1) Bacterial disease normally in rodents (= rats and squirrels)
 - (2) Life cycle
 - (a) Bacteria block digestive tract of flea
 - (b) Flea bites host and regurgitates meal which contains bacilli
 - (c) Infective bacilli enter host
 - (3) Endemic in ground squirrel populations in California
 - b. Typhus
 - (1) Endemic in local squirrel populations
 - (2) Current disease is milder than strains that caused epidemics during WWI and WWII
 - (3) Lice also serve as vectors for typhus

- c. Dog tapeworm (= *Dypylidium caninum*)
 - (1) Flea larvae eat tapeworm eggs
 - (2) Dog (or child) get tapeworm if it eats flea
- d. Humans are at risk when feeding or disposing of rats and squirrels
- 4. Family Tungidae
 - a. Native to Central & South America, but spread throughout tropics
 - b. Females burrow into skin of mammals leaving a small aperture open to outside
 - c. Males mate w/ female after she has formed burrow
 - d. Larvae leave through aperture
 - e. Causes intense itching

Slides: E-mail from PCV E. Horton in Bolivia & photos showing removal of “pique” fleas

F. Order Diptera (Flies)

- 1. Most medically important insect group
- 2. Characteristics
 - a. Only one pair of functional wings (DI = two)
 - b. Second pair of wings
 - (1) HALTERES: Small knobs on thorax
 - (2) Used for balance
- 3. Family Simuliidae = black flies
 - a. Aquatic larvae require well-oxygenated (*i.e.* running) water
 - b. *Simulium damnosum* is the vector for onchocerciasis = river blindness
- 4. Subfamily Phlebotominae (sand flies)
 - a. Larvae require humid, dark conditions with organic debris, well adapted for animal burrows
 - b. Vectors of *Leishmania*
 - c. Species in USA have been shown to be capable of transmitting leishmanial diseases
- 5. Family Culicidae (Mosquitoes)
 - a. Most medically important insect family
 - b. Vectors for numerous ARBOVIRUSES (= Arthropod borne viruses)
 - c. Larvae always aquatic
 - d. *Aedes* vector for many arboviruses
 - (1) Dengue or breakbone fever
 - (2) Yellow fever
 - (3) Eastern equine encephalitis
 - e. *Anopheles*: Malaria vector
 - d. *Culex*
 - (1) “House mosquito”
 - (2) Filarial worm vector
 - (3) St. Louis encephalitis (arbovirus)

Slide Series: Letter by Dr. J.C. Nott, President, Board of Health, City of Mobile, AL appearing in the *Mobile Register*, April 16, 1856 illustrating level of understanding of disease 150 years ago

6. Family Muscidae (House flies)
 - a. *Musca domestica*
 - (1) Natural history makes it an efficient vector
 - (a) Parasites adhere to “hairs” that cover body
 - (b) Vomits and excretes when feeding, thus spreading infective stages of parasites
 - (c) Move freely between outdoor & indoor environments
 - (2) Vector for many intestinal diseases (= fecal contamination)
 - (a) *Ascaris*
 - (b) *Entamoeba histolytica* (= amebic dysentery)
 - b. *Glossina*
 - (1) Tsetse fly
 - (2) Vector for sleeping sickness: *Trypanosoma brucei* complex of species
7. Family Calliphoridae (Blow flies)
 - a. MYIASIS common
 - (1) Infection of live host by maggots (= fly larvae)
 - (2) May be OBLIGATORY or FACULTATIVE
 - (3) Produce antibiotic ALLANTOIN
 - (a) Military surgeons knew wounds healed faster if maggots were present
 - (b) Still used in treating deep wounds (such as in bones, *i.e.* osteomyelitis)

Word Slide: Sherman, R.A.. 2003, *Diabetes Care* 26 (2): 446-451

- b. Screwworm
 - (1) Eggs laid in pre-existing wounds
 - (2) Eradicated from USA by release of sterile males (females only mate once)
8. Family Gasterophilidae (Stomach bot flies)
 - a. Horse bot fly lays eggs on legs of host
 - b. Larvae hatch and attach to tongue when host licks itself
 - c. Larvae are swallowed and develop in stomach
 - d. Pupa leave host in feces
9. Family Cuterebridae (Skin bot flies)
 - a. Larvae commonly infect skin of rodents
 - b. Fairly common on local squirrels and occasionally on dogs & cats
 - c. Bots become relatively large (Locally known as “wolves”)
 - d. Usually host unaffected, although castration can occur if swelling cuts off blood circulation to scrotum of male squirrel

Slide Series: Surgical removal of *Cuterebra emasculator* from a local kitten

10. Family Phoridae (Humped backed flies)
 - a. Larval natural history varies considerably

- (1) In decaying animal & vegetable matter
- (2) Commensals in nests of ants and termites
- (3) Parasitoids of ants and termites
- b. A Brazilian phorid has been released by the USDA in the hope that it will control fire ants

Slide Series: Fire ants and phorid flies; Larry Gilbert; Univ. of Texas, Austin;
<http://uts.cc.utexas.edu/~gilbert/research/fireants/faqans.html>

Slide Series: Parasitology & Hollywood: The Emergence of a Parasite in the movie *Alien*

G. Order Hymenoptera (Bees and wasps)

- 1. At least half of the species are parasitoids
 - a. Hyperparasitism (parasitoids of parasitoids) is common & leads to complex trophic interactions

Picture Slide:

<http://arjournals.annualreviews.org/doi/pdf/10.1146/annurev.ento.44.1.291?cookieSet=1>

- b. Some lay eggs in eggs of prey.

Picture Slide: Wasp laying egg in a cockroach egg

http://creatures.ifas.ufl.edu/urban/roaches/A_hagenowii.htm

- c. Many are very small & their ecological importance went unnoticed until the widespread use of insecticides

Picture Slide: Wasp 500 microns in length

- 2. Biological control
 - a. Attack insect herbivores, but many that have been introduced have not been as species specific as originally thought
 - b. Pesticide use can lower density of parasitoids and ironically result in increased densities of later generations of insect pests whose numbers had been controlled by the parasitoids
- 3. Family Ichneumonidae
 - a. All are parasitoids of other insects
 - b. Many with extremely long ovipositors (for deposition of eggs on wood-boring beetle larvae)
 - c. Many very large
 - d. Pupate inside host
- 4. Family Braconidae
 - a. Small and heavy bodied
 - b. Pupate outside host

Slide Series: Braconid wasps infecting, developing within and emerging from aphid hosts

- 5. Polydnviruses (= PNV)
 - a. Utilized by both ichneumonid and braconid wasps
 - b. Unique structure
 - (1) Large segmented genomes
 - (2) 10-25 circles of double stranded DNA
 - c. PNV injected into host during egg deposition (in venom)
 - d. PNV enter host cells and alter host's metabolic activities
 - (1) Hormone production (some species of hosts become giant larvae instead of pupating)

(2) Proteins appear in hemolymph (= blood) that are used by wasp larvae

Slide: Braconid pupae on local caterpillar

Slide: Life cycle of a braconid wasp with transmission and replication of polydnavirus

Slide Series: Cheap Thoughts by Jack O'Brien

Slide Series of Tarantula hawk attacking a tarantula