Section 3: Pests and humans

- Arthropods (insects and near relatives) long associated with crop damage, and sickness in humans and animals.
- Direct effects (feeding damage).
- Indirect effects (disease transmission).
- Insects alone are damaging, but vector capacity makes them particularly deadly.

Examples of plant diseases transmitted by insects

Vector	Parasite	Disease	Distribution
Bird-cherry aphid	Virus	Barley-yellow dwarf	Worldwide
Green peach (peach-potato) aphid	Virus	Beet yellows	Worldwide
	Virus	Potato leaf roll	Worldwide
Green rice leafhopper	Virus	Rice Tungro	Asia
Maize leafhopper	Virus	Maize streak	Africa
Beet leafhopper	Virus	Beet curly top	N. America, Mediterranean

An example of an insect-transmitted plant disease

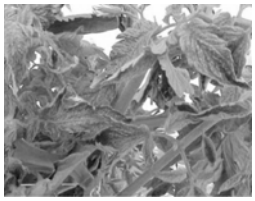
- Aster yellows, a leafhopper-transmitted disease, initially causes red discoloration of the foliage, hairiness of the roots, and eventually affects crop growth and survival.

More diseases

Vector	Parasite	Disease	Distribution
Brown planthopper	Virus	Rice grassy stunt	Africa, Asia
Maize planthopper	Virus	Rice stripe	Asia
Cocoa capsid	Virus	Swollen shoot	Africa
Antestia bug	Fungus	Nematospora taint of coffee	Africa
Bees	Bacterium	Fireblight	N. & S. America, Europe, New Zealand
Bark beetles	Fungus	Dutch elm disease	N. America, Asia, Europe

More insect-transmitted diseases

- The deformed tomato foliage (above) signifying transmission of tomato spotted wilt by thrips is not dramatic injury, but when fruit is harvested (below) it is discolored and uneven in texture, making the fruit unacceptable for sale (photos by Joe Funderburk).



• Mountain pine beetle transmits blue stain fungi. This deadly combination of insect and fungus modifies entire western ecosystems as vast tracts of trees die.

What patterns do you observe?

- Several taxa of pathogens involved
- Several taxa of vectors involved

  (but most having piercing-sucking mouthparts)
- Distribution of pathogens variable
- Some vectors carry more than one disease

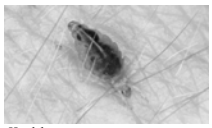
Examples of animal and human diseases transmitted by arthropods

Vector	Parasite	Disease	Distribution
Anopheline mosquitoes	Protozoa	Malaria	Tropics, subtropics
	Filaria	Filariasis	Tropics
Culicine mosquitoes	Arboviruses	Yellow fever	S. America, Africa
Tsetse flies	Protozoa	Trypanosomiasis	Africa
Black flies	Filaria	Onchocerciasis	Africa, S. America
Sand flies	Protozoa	Leishmaniasis	Tropics, subtropics
Triatomine bugs	Protozoa	Chagas disease	C. & S. America

More diseases

Vector	Parasite	Disease	Distribution
Fleas	Bacteria	Plague	Worldwide
Body lice	Rickettsiae	Epidemic typhus	Worldwide
	Spirochetes	Epidemic relapsing fever	Tropics, subtropics
Argasid ticks	Spirochetes	Tick-borne relapsing fever	Tropics, subtropics
Ixodid ticks	Arboviruses	Colorado tick fever	N. America
	Spirochetes	Lyme disease	Worldwide
	Protozoa	Babesiosis	Worldwide

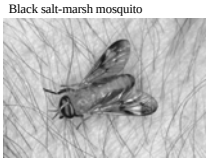
Some medically important insects



Head louse

Black salt-marsh mosquito

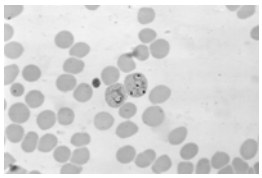
Sand fly



Deer fly

How do plant and animal diseases compare?

- Sometimes the same pathogen type is involved
- Different insect taxa vectoring animal and plant diseases
- Similar mouthparts



Blood cells infected with the malaria pathogen Plasmodium vivax

Some particularly important groups of insects

- Locusts and grasshoppers
- Aphids
- Armyworms and cutworms
- Mosquitoes
- Tsetse flies
- [rat] fleas
- [body] lice

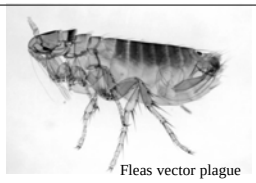
Do you know which of these groups are disease vectors?

The vectors of disease are italicized;
* indicates plant disease,
** human disease

- Locusts and grasshoppers
- *Aphids**
- Armyworms and cutworms
- *Mosquitoes***
- *Tsetse flies***
- *[rat] fleas***
- *[body] lice***

Pea aphid, a vector of plant diseases

Effects of insects on humans



Fleas vector plague

- Many interesting stories
- Insect-transmitted diseases often kill more people during wartime than die during fighting
- Your text cites Mormon cricket as an example of insect impact
- Attributes arrival of predators (sea gulls) to divine intervention
- Actual scenario slightly different, but quite interesting

Mormon Cricket, *Anabrus simplex*

Adult male Mormon cricket. These insects are flightless, but form bands of marching insects that remain together for life.

Band of crickets dispersing across roadway.

The Mormon cricket story

- Mormon cricket (actually a katydid) threatened existence of initial settlement at Salt Lake City, Utah
- Mormon crickets were devouring crops essential to settler's survival
- Huge flock of gulls arrived and consumed crickets
- Statue was erected to commemorate this miraculous event.

Mormon cricket: the real story

- The gull event really happened, but there is no need to invoke divine intervention as an explanation.
- Insect-eating gulls are common in the Rocky Mountain west, and are commonly observed flocking to insect populations, and following farmer's tractors as fields are tilled, where they feed on exposed insects.

More on crickets

- To this day, Mormon cricket populations increase periodically, plaguing farmers and ranchers.
- Because the crickets are so abundant, so mobile, and cover such a large areas, they are beyond the ability of individuals to cope effectively.
- Area-wide suppression programs, coordinated by government agencies, are used to combat the threat.
- This is a good example of the value of area-wide management; this subject is treated later in the course.

What makes an insect a pest

- An insect in the wrong place
- Insects being too numerous

Examples: termites in forest versus infesting a building; single honey bee pollinating flowers versus swarm

Formosan termites

What makes an insect a pest, continued:

- Consume food, fiber, or shelter
- Biting or stinging
- Sheer abundance
- Vector plant or animal diseases

Bee stings can result in swelling, which is potentially dangerous if it involves the neck area. People differ in their sensitivity to stings.

Mosquitoes are, for most people, just a nuisance. However, when they are sufficiently abundant (see the leg at right) they can literally cause mortality to people or livestock through excessive blood removal (exsanguination). They also are important vectors of disease.

Welcome to summer in the Everglades! (photo, Collier County Mosquito Control)

Examples of insect damage to crops

- Yellow-margined leaf beetles have turned these collard plants into trash.

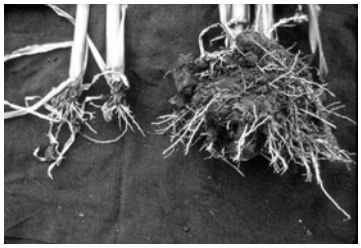
- Russian wheat aphids have invaded the edge of this wheat field and are killing or impairing the growth of young plants.

Another example of crop damage

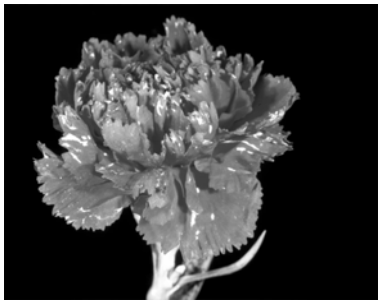
- Here you can see how melon thrips have defoliated bean plants on the edge of this south Florida field. Despite their small size, they can have a great impact.

More damage

Western corn rootworm damage to corn roots (left) versus healthy roots (right). Though not always apparent because it is happening below-ground, the impact can be serious.



Can you identify the cause of the white spots on this carnation?

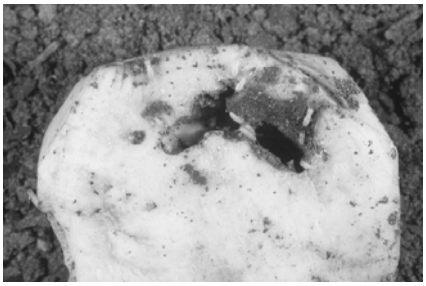


Carnation spotting

- Spots and speckles are caused by piercing-sucking arthropods such as leafhoppers, plant bugs, thrips and mites.
- In this case, the small number of spots caused by thrips earlier in the development of the blossom is considered serious because of the cosmetic high standards for flowers.

Insect feeding can produce a variety of deformities that decrease the value of ornamental plants . Here you see galls produced by spruce gall aphids.

The cause of damage is not always obvious. This ear of corn was originally damaged by birds. Adult corn rootworms and sap beetles will be attracted, and feed, but the real issue is birds.



Insects will never cease to amaze you on how they affect humans. This is a potato being consumed by termites. Generally we think of termites as feeding on wood, but they can be serious pests of crops and living trees. In Florida they affect newly planted trees in citrus groves; in New Orleans they are destroying old street trees.

Vectors of disease

- Disease vectors are a special problem
- Although the importance is related to the number of vectors and proportion capable of vectoring, even a single vector can be damaging

  Examples: certified seed, race horse, someone in your family!

Vectored disease greatly magnifies the importance of the insect and need for control.

Jacksonville, and many other eastern US cities, were repeatedly affected by yellow fever. As late as 1888, nearly 1/3 of the Jacksonville population was killed by this disease.

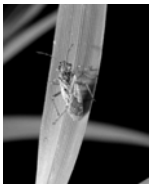
Yellow fever, malaria, and other diseases have killed millions in the past, and in some areas of the world continue to take a high toll of human lives. Without effective vector control, the threat of disease outbreak remains.

Body lice (also called cooties, above) but not head lice (called hobo lice and indistinguishable from body lice) or crab lice (called pubic lice, below) are important vectors of disease. Body lice transmit epidemic typhus, trench fever, and louse-borne relapsing fever. All lice can be a problem, however, as they bite even if they are disease-free.

This palm tree is dying from a disease called lethal yellowing of palm. It is caused by a phytoplasma (mollicute) transmitted by planthoppers, generally Myndus crudus. This is considered by many to be the most serious disease of tropical agriculture.

Not all pests are equivalent in importance

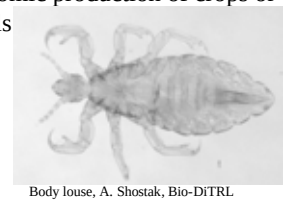
- Major pests and vectors
- Minor pests and vectors
- Occasional pests vectors
- Migrant pests and vectors
- Potential pests and vectors



Note: There may be some overlap in categories, or variation among times and places.

Major pests and vectors

- The real “bad guys” or “key” pests
- Regularly abundant or widespread
- Influences economic production of crops or health of animals
- Management is critical



Body louse, A. Shostak, Bio-DiTRL

Examples of major pests

- *Anopheles gambiae* - malaria
- Locusts and grasshoppers - arid LDCs
- Leafhoppers of rice and corn - viruses
- Bollworms - cotton
- Diamondback moth - crucifers
- Termites - buildings
- Body lice - human disease

Some major pests

- Various species of bollworms affect cotton throughout the world.
- Japanese beetle is a serious pest of turf, ornamental plants and vegetables in the eastern U.S.A.

Minor pests and vectors

- Rarely abundant enough to cause damage
- Not well adapted to exploit host, adapted to the climate, or held in check by natural enemies

Corn leaf aphid, though abundant, rarely causes damage to corn

Examples of minor pests

False chinch bug

- Palestriped flea beetle on bean
- False chinch bug on alfalfa
- Tomato hornworm on eggplant
- Spotted asparagus beetle on asparagus
- Sweetpotato leaf beetle on sweet potato

If you found a paper product, such as this card, with evidence of feeding injury, to what would you attribute the damage?

Silverfish, minor pests, inflict this type of damage.

Why worry about minor pests?

- They can become serious, even if for brief period
- Some have gained notoriety by transitioning to major pests

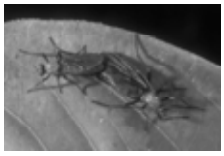
  Examples: twospotted spider mite, diamondback moth, fruittree leafrollers.
- Status change due to weather, use of disruptive insecticides, reduced use of insecticides, change in host susceptibility

Occasional pests and vectors

- Intermediate between major and minor
- Something to watch for because they do cause damage, but not regularly
- Crop producers/health professionals monitor these, but don't plan activities around their occurrence (as with major pests)
- Weather and host abundance are potential causes

Examples of occasional pests

- Mosquitoes - heavy rainfall
- Tent caterpillars - regular population cycles
- Bluebottle flies - cadavers
- Various migrants - in areas of invasion
- Flea beetles - ?
- Lovebug - ?
- Seedcorn maggot- ?

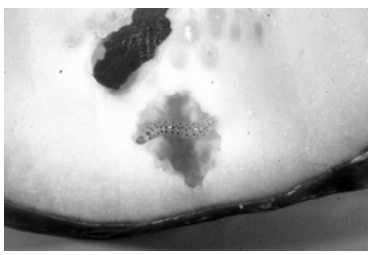


Lovebugs doing what they do best

Lovebugs are best known for becoming plastered on the front of vehicles in the Gulf Coast area of the U.S.A.

More occasional pests

Pickleworm is an occasional pest of cucurbits in the eastern U.S.A. Its occurrence is variable due to its migratory behavior, which is weather dependent.



Migrant pests and vectors

- Long range dispersal is possible for some insects variable success
- Weather usually involved in movement, in addition to flight
- Success varies
- When unexpected or in unusually large numbers, migrants can be very damaging

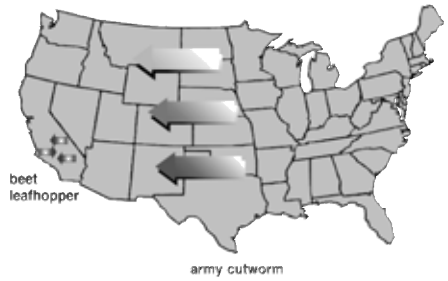
Examples of migrant pests

- Desert locusts in North Africa and Middle East
- Pickleworm and black cutworm north from Gulf Coast
- Greenbug from TX and OK to northern Great Plains
- Potato psyllid from Southwest to Rocky Mountain region

Pickleworms disperse north annually from the Gulf Coast area

More migrants

- Not all pests move northward
- Army cutworms move west to Rocky Mountains, then east to great Plains
- Beet leafhopper moves between California's valleys and foothills



Other forms of dispersal

- Movement of people, produce, and animals foster dispersal of insects because they "hitch-hike"
- Increasing international trade, tourism, and rapid transit increase risk of transport

Examples of ‘hitch-hiking” insects

- Formosan termite from Asia to Southeast USA
- European corn borer from Europe to several areas of USA
- Asian tiger mosquito from Asia to Europe and USA
- Mosquito *Anopheles gambiae* from Africa to Brazil
- Colorado potato beetle from USA to Europe

Questions about “hitch-hikers”

- Can you name 5 additional insects that have been accidentally introduced to the USA in recent years?
- Can you identify the primary route of transport?
- What can be done to reduce the movement of pests?

Potential pests and vectors

- Potential for additional transport remains
- Inspection and fumigation procedures at ports and airports unpopular
- Some products not allowed
- How long barriers will remain effective is uncertain

Medfly: a potential pest

- Although Mediterranean fruit fly occurs widely in some areas (Hawaii, for example) it remains absent from other (e.g., mainland U.S.A.). It is a terrible pest of fruit, and quarantine procedures exist to keep it from establishing in new areas.

Smuggled products that could contain insects

- These items, including fruit, vegetables, herbs and a home-made sausage, are just a few examples of the products that are removed from the luggage of travelers as the enter the U.S.A in Miami despite the prohibition against such importation.

Examples from California

- California has worked hard to prevent invasion
- Gypsy moth and Japanese beetle eliminated after entry
- Were not able to prevent some insects such as imported red fire ant, glassywinged sharpshooter, and Africanized bee from establishing.

Not all insects are pests

- Scavengers and decomposers - termites break down wood, flies and beetles consume animal carcasses
- Pollinators - very important for some fruit, vegetable and flower crops, but not grains

Colony of bumblebees for pollination of zinnias

(S. Bauer, ARS)

Without decomposers like flies the landscape would be littered with “roadkill.” Here you see some maggots feeding on a cadaver only a few days after the animal has died.

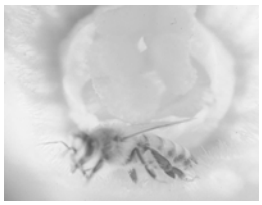
After 2 weeks the cadaver is reduced to skin and bone, with the remaining maggots desperately seeking more food.

More benefits from insects

- Natural enemies - predators, parasitoids, herbivores of pest plants (weeds)
- Insect products - honey and wax from *Apis mellifera*, silk from *Bombyx mori*, shellac from *Laccifer lacca* scales, cochineal dye from *Datylopus coccus* mealybugs, maggot therapy using greenbottle (*Lucilia*) and bluebottle *Calliphora*) flies

Insect-pollinated crops

- Do you know 10 crops that require, or greatly benefit from, insect pollination?
- Can you find sources of information on this subject?



Honey bee inside squash blossom.

Crops that benefit or require pollination by insects

Fruit crops: apple, apricot, blueberry, cherry, peach, pear, plum, mango, papaya, raspberry, some citrus fruits

Vegetables: cucumber, melons, squash, pepper, eggplant

Other crops: almond, coconut, olive, cashew, cacao, coffee

Seed production: most vegetables, oilseed, and some forage crops

Insects as food

- Consumption by humans an oddity in developed countries
- Sometimes and important source of protein and fat, especially in LDCs

  Examples: chironomid (formerly in USA) and chaoborid (in Africa) flies; termites and locusts in Africa; caterpillars and grasshoppers in Mexico; many types in SE Asia

Insects as food, continued

- Insects are important food for wildlife.

  Examples include:

  • Small mammals such as fox, opossum, skunk, raccoon, shrews, bats and many rodents.

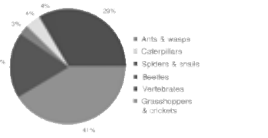
  • Songbirds and other birds, including some that are normally thought of as granivorous (grain feeding), especially when feeding nestlings.

  • Fresh water fish - a critical food source.

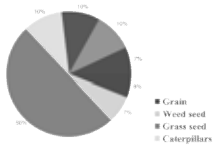
Horned toads depend on insects for food. Are insects important for most reptiles and amphibians?

Dietary habits of birds

- Based on stomach content analysis is is apparent that insects comprise 2/3 of a shrike's diet.



- Chipping sparrows, normally thought of as seed-feeders, also consume many insects, over 1/3 of their diet.



When a hungry fox is looking for a meal, even grasshoppers look good!

Questions:

- Can you distinguish between direct and indirect pests?
- Name some plant and animal diseases transmitted by arthropods?
- Describe what makes an insect a pest?
- Name some beneficial insects and explain why they are important?

Questions from supplementary readings

- Reading 1, History
  - Can you name 5 important insects that transmit diseases to humans?
  - Can you name 5 of the great insect-vectored diseases, and the important effects they had on human history?
- Reading 2, Decomposition
  - What are some roles of insects in trophic processes?
  - What arthropod taxa are important in decomposition of plant remains? Excrement? Corpses?
  - Colonization of corpses occurs in “waves.” What taxa are involved in the waves, and what is the significance of knowing this?

More supplementary reading

- Reading 3, Plant disease
  - Are all plant diseases caused by pathogenic organisms?
  - What are 3 ways that pathogens are transmitted by insects?
  - What plant disease-causing organisms are transmitted by insects?
  - How do bacteria casue plant wiliting?
  - What is a mollicute? What plant tissues initially are invaded/infected?
  - What is sooty mold?