Forensic Entomology

Insects as Evidence

Warning: Some material in this presentation and related videos may be too graphic for some people.

The Mystery of Lyle and Louise

Nature's Witness

Forensic Entomology

What do they do?

Forensic entomologists apply their knowledge of entomology to provide information for criminal investigations.

A forensic entomologist's job may include:

Identification of insects at various stages of their life cycle, such as eggs, larva, and adults.

Collection and preservation of insects as evidence.

Determining an estimate for the postmortem interval or PMI (the time between death and the discovery of the body) using factors such as insect evidence, weather conditions, location and condition of the body, etc.

Testifying in court to explain insect-related evidence found at a crime scene.

Did you know? Maggots can be used to test a corpse for the presence of poisons or drugs. Some drugs can speed up or slow down the insect's development.

Cool Jobs: Forensic Entomology Discovery Video

Estimates of postmortem intervals can be made from insects inhabiting remains.

The estimates are based on:
The time required for a given species to reach a particular stage of development.
Comparisons of all insect species present on the remains at the time of examination.

Ecological succession occurs as an unexploited habitat (like a corpse) is invaded by a series of different organisms.

Insects are the most diverse and abundant forms of life on earth.

There are over a million described species (that's more than a third of all known organisms).

Estimates predict that if the biomass (mass of biological tissue) of all humans and all insects were measured, insects would outweigh humans more than 30 to 1.

Forensic Entomology is the use of the insects and other arthropods that feed on decaying remains to aid legal investigations.

These investigations fall into one of three categories:
Medicolegal (criminal)
Urban (criminal and civil)
Stored Product Pests (civil)

MEDICOLEGAL

Often focuses on violent crimes, such as:

A)Determination of the time or site of human death

B)Cases involving possible sudden death

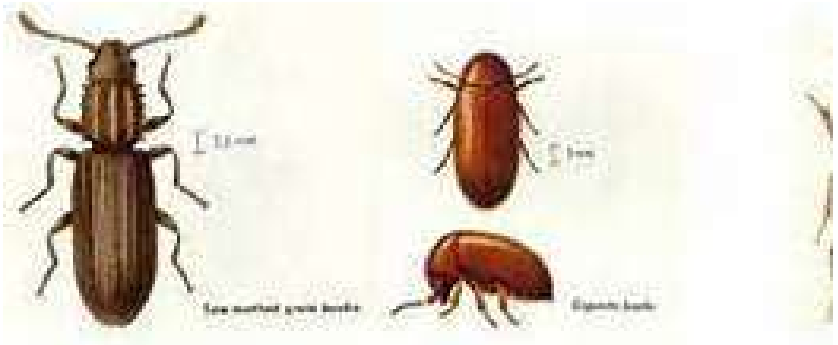
C)Traffic accidents with no immediately obvious cause

D)Possible criminal misuse of insects

Urban forensic entomology deals with pest infestations where there may be litigation, such as building owners and exterminators or landlords and tenants.

SPP

Several dozen insect species infest common household products of animal origin. These are known as Stored Product Pests



Invertabrate habitat

Necrophages - the first species feeding on corpse tissue. Includes rue flies (Diptera) and beetles (Coleoptera).

Omnivores - species such as ants, wasps, and some beetles that feed on both the corpse and associated maggots. Large populations of omnivores may slow the rate of a corpse's decomposition by reducing populations of necrophagous species.

Parasites and Predators - beetles, true flies and wasps that parasitize immature flies.

Incidentals – pill bugs, spiders, mites, centipedes that use the corpse as an extension of their normal habitat

Carrion

Many organisms use “carrion”, or carcasses, as a food source. Some fly species specialize in living on carrion. These carrion flies are the most important insects to the forensic entomologist.

Insects undergo either incomplete or complete metamorphosis
(Egg to larva to pupa to insect)

Larva have a soft tubular body and look like worms.
Fly species larvae are called “maggots”

Insects as Evidence

Forensic entomologists use their knowledge of **insects** and their **life cycles** and **behaviors** to give them clues about a crime.

Blow Fly

Carrion Beetle

Most insects used in investigations are in two major orders:
1 – Flies (**Diptera**) and
2 – Beetles (**Coleoptera**)

Species succession may also provide clues for investigators. Some species may to feed on a fresh corpse, while another species may prefer to feed on one that has been dead for two weeks. Investigators will also find other insect species that prey on the insects feeding on the corpse.

Succession wave	Principle insect fauna	State of corpse	Age of corpse
1	Flies (blow flies)	Fresh	First 3 months
2	Flies (blow flies and flesh flies)	Odour	
3	Dermestid beetles	Fats are rancid	3-6 months
4	Various flies		
5	Various flies and beetles	Ammonia fermentation	4-8 months
6	Mites		6-12 months
7	Dermestid beetles	Completely dry	1-3 years
8	Beetles		3+ years

Taken from Smith, K. G. V. 1986, A manual of forensic entomology. Cornell Univ. Press, Ithaca, NY.

Images: Top Right - http://www.insectinvestigations.com/aboutfe.htm, Chart - http://www.clt.uwa.edu.au/__data/page/112507/fse07_forensic_entomology.pdf

Weather data is also an important tool in analyzing insect evidence from a corpse. Investigators will make note of the temperature of the **air**, **ground** surface, the **interface area** between the body and the ground, and the **soil** under the body as well as the temperature inside any **maggot masses**. They will also collect weather data related to daily **temperature** (highs/lows) and **precipitation** for a period of time before the body was discovered to the time the insect evidence was collected.

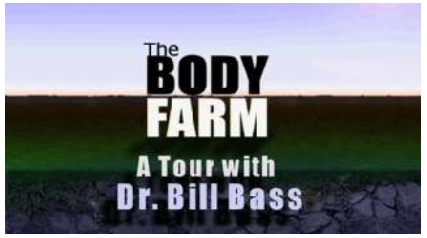
Other factors that might affect their PMI estimates:

1. Was the body enclosed in an area or wrapped in a material that would have prevented flies from finding the corpse and laying eggs?

2. Were other insect species present that may have affected the development of the collected species?

3. Were there drugs or other poisons in or on the body that might have affected the larvae's development?

Did you know…
The "Body Farm" in Knoxville, Tennessee is a university research facility to investigate human decomposition under various conditions in order to understand the factors which affect its rate.



Click the image to view a video about the Body Farm!

There are two families of carrion flies: the blowflies, in the family Calliphoridae, and the flesh flies, in the family Sarcophagidae.

Adult calliphorid flies are easily identified by their iridescent blue, green, copper, or black bodies. Sarcophagid flies, on the other hand, are grayish, usually with three distinct longitudinal dark stripes on the dorsal thorax.

Blow Fly Metamorphosis

Blow flies are attracted to dead bodies and often arrive within minutes of the death of an animal. They have a **complete** life cycle that consists of **egg**, **larva**, **pupa**, and **adult** stages.

1st – Adult flies lay **eggs** on the carcass especially at wound areas or around the openings in the body such as the nose, eyes, ears, anus, etc.

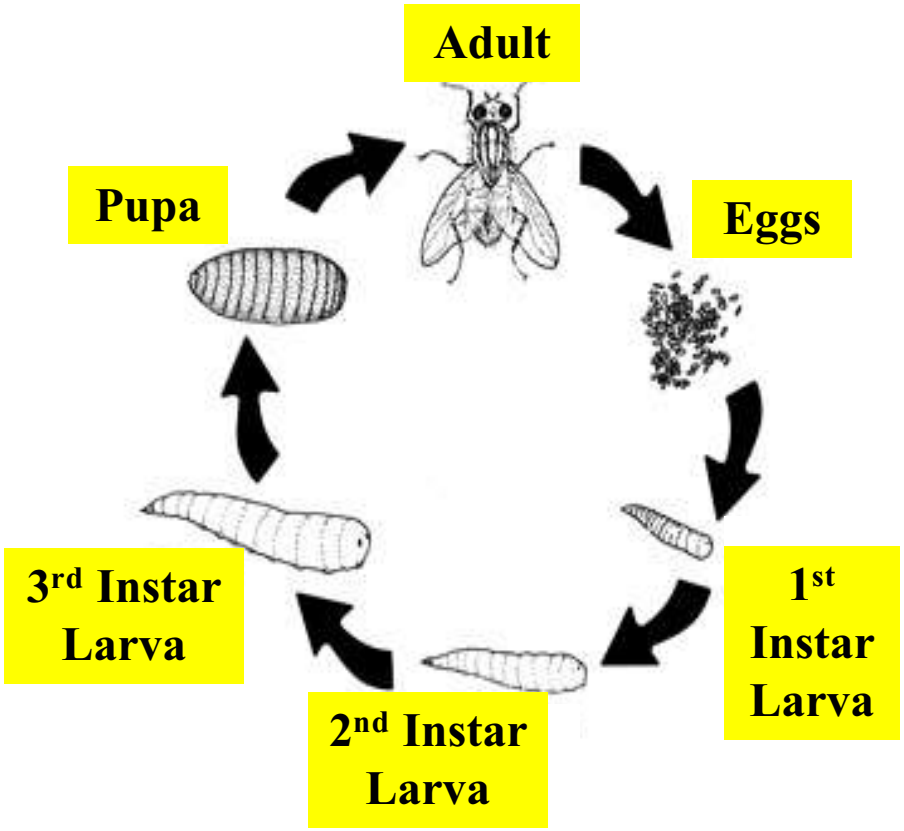
2nd – Eggs hatch into **larva** (maggots) in 12-24 hours.

3rd– Larvae continue to grow and **molt** (shed their exoskeletons) as they pass through the various instar stages.

1st Instar - 5 mm long after 1.8 days
2nd Instar - 10 mm long after 2.5 days
3rd Instar – 14-16 mm long after 4-5 days

4th – The larvae (17 mm) develop into pupa after burrowing in surrounding soil.

5th – **Adult** flies emerge from pupa cases after 6-8 days.



It takes approximately 14-16 days from egg to adult depending on the temperatures and humidity levels at the location of the body.

Image: http://www.umext.maine.edu/images/FlyLife.jpg
Information: http://www.kathyreichs.com/entomology.htm and http://www.forensicentomologist.org/

Fly life cycle

The adult female fly lays her **eggs** on the exposed tissue within minutes of death.

She lays all eggs in one sitting, but may return to the same site to lay again several times over the course of her 2-3 week lifespan.

Fly life cycle

The eggs hatch within approximately 24 hours of being laid.

Fly larvae, known as maggots, are now in the **first instar** stage. They crawl to the closest food source and begin to eat.

Fly life cycle

The first instar maggots are small and do little more than eat to support their rapid growth.

Over the next 27 hours, they will double in size until their skin literally can't hold them anymore.

Fly life cycle


egg


adult


1st instar


2nd instar

The maggots shed their old skin and are now considered **second instar** maggots.

This stage is very similar to the first instar in that the maggots continue to devour their food source and grow rapidly.

Fly life cycle


egg


adult


1st instar


2nd instar


3rd instar (feed)

After another 22 hours, these maggots will have reached the maximum size their current skin will allow and they will shed once more.

They are now in their **third instar**

Fly life cycle


egg


adult


1st instar


2nd instar


3rd instar (feed)

The third instar stage is divided into two halves, the **feeding third instar** and the **migrating third instar**

During the first half, the maggots continue to eat, storing up as much energy as possible.

Fly life cycle


egg


adult


1st instar


2nd instar

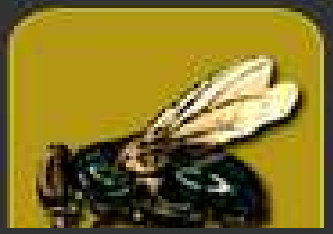

3rd instar

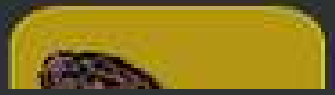
The second half of the third instar begins when the maggots stop eating and begin to move away from their food source.

The maggots will move to a patch of soil where they can burrow and begin the next life stage.

Overall, the maggots spend about 100 hours in their third instar.

Fly life cycle





egg

1st instar

The Post Mortem Interval

Cadavers decompose in four stages: fresh, bloated, decay, and dry. The time the body spends in any individual stage will vary depending on environmental conditions; warm, wet weather speeds decay, while cold, dry weather slows it.

Once burrowed, the
s enclose
ves in a hard
d begin the
rphosis
e) that will
an adult fly.

tage, the
s are now
is **pupae**.

Copyright © 2013 Crosscutting Concepts, LLC. All Rights Reserved.
www.CrosscuttingConcepts.com

The Post Mortem Interval

Cadavers decompose in four stages: fresh, bloated, decay, and dry. The time the body spends in any individual stage will vary depending on environmental conditions; warm, wet weather speeds decay, while cold, dry weather slows it.

Examples of Diptera (Flies)

Early Stage Decomposition

Life Cycle of a Calliphoridae Fly

Blow & Greenbottle Flies (Calliphoridae)
Metallic thorax and abdomen

Flesh Fly (Sarcophagidae)
Striped thorax

Late Stage Decomposition

House Fly (Muscidae)

Cheese Skipper (Piophilidae)

Informational Source: http://naturalsciences.org/files/documents/csi_tg_overview.doc
Images: Top Left - http://www.scienceinschool.org/repository/images/issue2forensic3_large.jpg, Middle-Left: http://forensicfact.files.wordpress.com/2008/04/blowfly053.jpg,
Top Right - http://users.usachoice.net/~swb/forensics/P1.jpg, Bottom - http://www.deathonline.net/decomposition/corpse_fauna/flies/index.htm

Examples of Coleoptera (Beetles)

Early Stage Decomposition


Carrion Beetles (*Silphidae*)
Adults & larvae feed on fly larvae

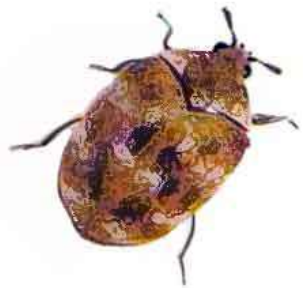
Early to Late Stage Decomposition

Rove Beetles
(*Staphylinidae*)
Predator of fly eggs

Clown Beetles
(*Histeridae*)
Predator of fly eggs

Late Stage Decomposition

Ham & Checkered Beetles
(*Cleridae*)
Predator of flies & beetles;
also feed on dead tissue

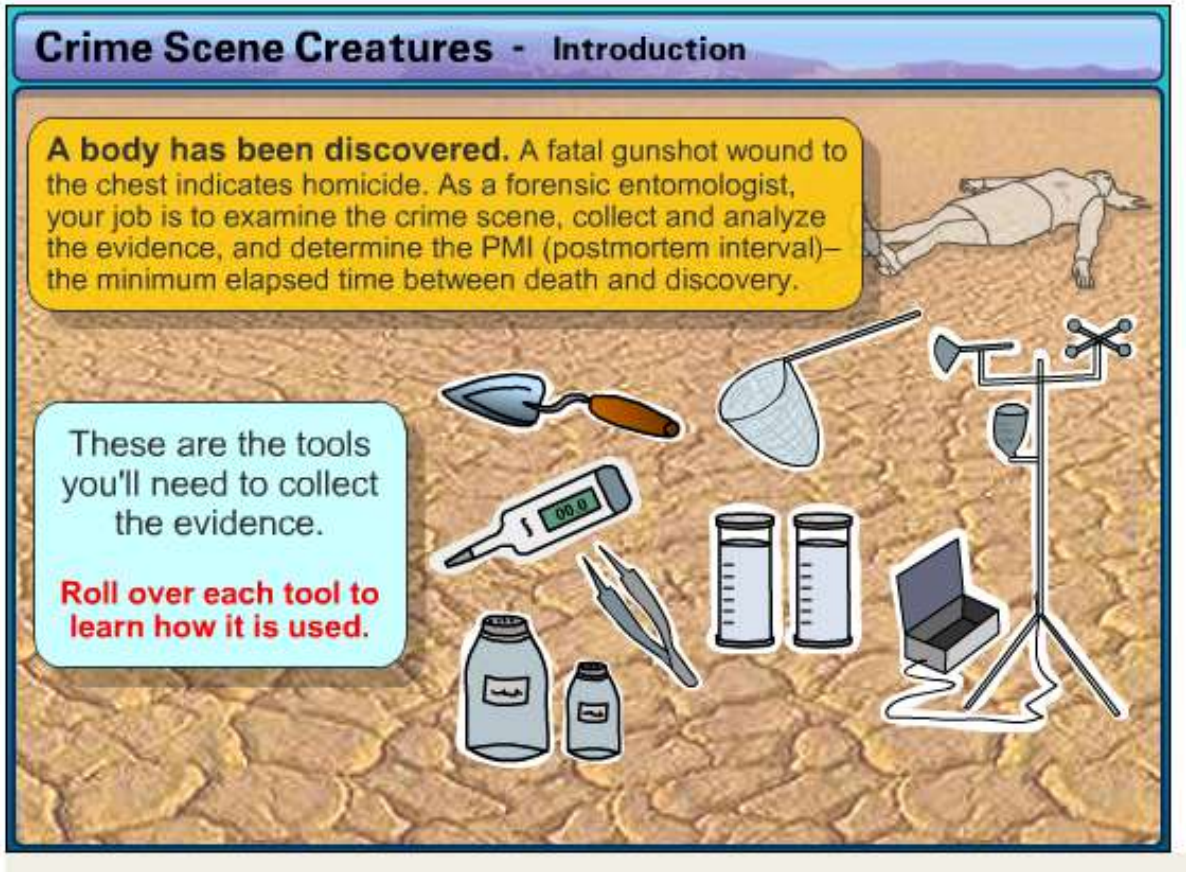


Skin Beetles (*Dermestidae*)
Feed on dried skin & tissues


Hide Beetles
(*Scarabidae*)
Usually the last to arrive

Informational Source: http://naturalsciences.org/files/documents/csi_tg_overview.doc
Images: http://www.cals.ncsu.edu/course/ent425/library/spotid/coleoptera/coleoptera.html & http://www.forensicflies.com/beetles.htm

Let's give it a try …



Click the image above or click here to visit the website at
http://www.pbs.org/wnet/nature/episodes/crime-scene-creatures/interactive-determine-the-time-of-death/4390/