What is Forensic Entomology?

Forensic Entomology is the use of insects and their arthropod relatives that inhabit decomposing remains to aid legal investigations. It is one of the many tools of forensic science. You will see that forensic entomology is not only a useful tool to decide how long human remains have been undetected, but forensic entomology can also be used to find out whether the corpse has been moved after death.
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.
Insects as Evidence

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

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 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.

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

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.
Some Common Forensically Important Insects

- Insects have existed on Earth for about 250 million years. Enormous amount of time has allowed insects to attain a wide diversity in both form and development. Currently, there are about 700,000 described species and it is estimated that there may be more than 10 million species of insects yet to be described.

Blow Flies:

- Larvae commonly recovered from decomposing human remains
- Lack functional legs
- Cream colored, soft-bodied, and “maggot-like”
- Will migrate away from the body and form the pupae stage
- Pupae stage of blow flies are sometimes overlooked--resemble rat droppings
- Most adult blow flies appear metallic green or blue and are easily recognizable.
The blow fly life cycle has six parts: the egg, three larval stages, the pupa, and adult.

At 70 degrees F, each stage in a blow fly's life takes a known amount of time to complete:

- Egg: 23 hours
- First larval stage: 22 hours
- Second larval stage: 27 hours
- Pupa: 130 hours
- Adult: 143 hours
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)
Life cycle of flesh fly

https://www.youtube.com/watch?v=addw97scCqo

Life cycle of cockroach

  https://www.youtube.com/watch?v=lcjAedlIPoU

  https://www.youtube.com/watch?v=GCyiczAcRBY

Body farm documentary 43 min
**Beetles:**
- One of the largest group of animals
- Larvae or “maggots” resembles blowflies
- Have 3 pairs of legs
- Bodies of beetle larvae may range from almost white, robust and hairless, to dark brown, slender and quite hairy

**Cockroaches:**
- Many have strong mandibles that are capable of producing postmortem damage to human skin that resembles abrasions or chemical burns.
- Roaches often consume human hair, and may frequently remove entire hair shafts during their feeding.
- Most commonly encountered by forensic investigators are the American, Australian, and German
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
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.
What information can a forensic entomologist provide at the crime scene?

- Forensic entomologists are commonly called upon to determine the “time since death” in homicide investigations.

- Forensic entomologists estimate the time since death based on the age of the insect present—“Time Since Colonization”

- The complete absence of insects would suggest clues as to the sequence of postmortem events as the body was probably either frozen, sealed in a tightly closed container, or buried very deeply.

Crime Scene procedures and collection of insects

- Notes are taken as to:
  - general habitat
  - location of body:
    - vegetation
    - sun or shade
    - near any open doors or windows
      if recovered in a structure
  - weather conditions
    - hot, humid
    - rainy
    - winter

Entomological Collection Equipment

- nets
- vials
- forceps
- collection containers
- Adults are collected first, then larvae
COLLECTING INSECTS FOR FORENSIC INVESTIGATIONS

EQUIPMENT
1. Hand Net
2. Forceps & Trowel
3. Thermometer
4. Vials, Jars, Plastic Bags

SUPPORTING DATA NEEDED
1. Previous weather for area
2. On site weather data (5-7 days)
3. Photos/video of crime scene
4. Record time of collecting

SOIL/FAUNA SAMPLE
SAMPLE AT LEAST 10cm DEEP
SECURE, VENTILATED TIN
LABEL AS PER SPECIMEN JAR LABEL

HAND NET
USE A STANDARD INSECT NET
OR
MAKE A SMALL HAND NET FROM STIFF WIRE AND CUT-OFF Panty HOSe

COLLECT FLYING INSECTS OVER CORPSE WITH HAND NET
KILL AND PRESERVE ADULT FLIES IN FLUID AS WITH MAGGOTS

MAGGOTS CONCENTRATE IN HEAD OR OPEN WOUNDS FIRST — ALSO AT CORPSE/GROUND INTERFACE

MAGGOTS CRAWL AWAY TO PUPATE. LOOK UNDER OBJECTS 3–10m FROM CORPSE FOR PUPA.

FLY PUPA
FLY PUPA ARE SEED-LIKE, ABOUT 1/2 cm LONG AND RED TO DARK BROWN IN COLOUR
LABEL AS PER SPECIMEN JAR LABEL

MAGGOT
PRESEVE MOST MAGGOTS (a range of sizes and types) IN 70% ETHYL OR ISO-PROPYL ALCOHOL

BEETLES
LOOK FOR INSECT SPECIMENS [PARTICULARLY MAGGOTS] IN FOLDS OF CLOTHES, HERE AND AT AUTOPSY

COLLECT BEETLES FROM ON AND UNDERNEATH CORPSE

SPECIMEN JAR LABEL
LOCATION:
DATE/HR OF COLLECTION:
CASE No.:
SAMPLE No.:
DETAIL:
COLLECTOR:

COLLECT ABOUT 2 DOZEN BIG MAGGOTS AND PUPA. KEEP MAGGOTS AND PUPA SEPARATE.
KEEP HAIRY AND SMOOTH MAGGOTS SEPARATE. PLACE ALL IN A COOLER OR FRIDGE. DO NOT FREEZE.
Have out your entomology notes.

- Entomology test on Wed May 6th!!
- Bring one 3x5 index card!!

- Monday – Entomology lab – be here!