Ch. 13 Entomology
Taxonomy
Classification of Things in an Orderly Way
Forensic Entomology

Entomology is the study of insects.

*Forensic entomology* involves the use of insects and other arthropods to aid in legal investigations.

There are three areas of application:
- Insect damage to structures
- Infestation of foodstuffs
- Insects that inhabit human remains

The latter category is the subject of this chapter.
Life Cycle of Insects

Metamorphosis

- egg
- larva (maggot)
- pupa
- winged adult

The life cycle of *Musca domestica*

- Eggs, 1.2 mm: 12–24 hrs
- 1st instar, 3 mm: 12 hrs
- 2nd instar, 6 mm: 12 hrs
- 3rd instar, 17 mm: 24 hrs
- Prepupa, 12 mm: 2 days
- Pupa, 9 mm: 3 days
- Adult, 6–8 mm: 12–24 hrs
Time of Death

Insects arrive at a decomposing body in a particular order (*succession*) and then complete their life cycle based on the surrounding temperature. By collecting and studying the types of insects found on a body and their metamorphic stage, a forensic entomologist can estimate the time of death.
Insects of Death

Diptera

First to arrive
Blowflies
Flesh flies

Then
Houseflies

Flies can arrive within minutes. They lay eggs that hatch to maggots. Maggots feed on soft, mushy body parts. More insects arrive to feed on the body and each other.
In rough order of appearance, from within hours to dry decay:

- Rove beetle
- Sexton beetle
- Clown beetle
- Dermestid beetle
- Hide beetle

Some beetles feed on the corpse, some on maggots, some on other beetles.
<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>
Variables Affecting Metamorphosis

Temperature

The higher the temperature (within limits), the faster the growth.

Effects of Temperature on Growth

![Graph showing the relationship between temperature and time to 3rd instar growth.](image)
Habitat

Fly species can vary geographically according to climate, season, and habitat.

For example, the fly pictured on the left prefers shade; the one on the right, sunlit areas.
Other Applications of Forensic Entomology

Damage to structures, clothing, foodstuffs

Location of wounds on a corpse

Linking suspect to scene of crime

Source of contraband

Type of insects can trace vehicle movement

Presence of drugs in corpse
Collection of Evidence

**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

**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**

**MAGGOT**
- Maggots concentrate in head and open wounds first—also at corpse/ground interface
- Preserve most maggots (a range of sizes and types) in 70% ethyl or isopropyl alcohol
- Label as per specimen jar label
- Collect about 2 dozen maggots and pupa. Keep maggots and pupa separate. Keep hairy and smooth maggots separate. Place all in a cooler or fridge. Do not freeze.

**BEETLES**
- Collect beetles from on and underneath corpse
- Look for insect specimens (particularly maggots) in folds of clothes, here and at autopsy

**FLY PUPA**
- Sample at least 10 cm deep
- Fly pupa are seed-like, about 1/2 cm long, and red to dark brown in color
- Maggots crawl away to pupate. Look under objects 3–10 m from corpse for pupa.

**SOIL/FAUNA SAMPLE**
- Secure, ventilated tin
- Label as per specimen jar label

**SPECIMEN JAR LABEL:**
- Location:
- Date/Time of collection:
- Case No.:
- Sample No.:
- Detail:
- Collector:
The Process of Death

*Algor Mortis*: Body cooling rate

\[
\text{Hours since death} = \frac{98.4^\circ \text{F} - \text{internal body temperature}}{1.5}
\]

1. Describes a body’s temperature *loss* after death.
2. When a person is alive, the body maintains *homeostasis* and regulates a *constant* temperature.
3. After death, the body no longer can maintain its heat and it begins to cool down.
4. To record the temperature of a corpse, forensic investigators insert a thermometer into the *liver*.
5. A body cools at a rate of about 1.4 degrees per hour immediately after death, then slows to 0.7 degrees per hour after about 12 hours, until it reaches the *same* temperature as the environment.
Factors that effect Algor Mortis

**Surface area** of the body:
- Larger surface area → speeds up cooling rate.
- Children: increase surface area gives rapid heat loss.

**Body weight**:
- Larger bw: slower cooling
- Smaller bw: faster cooling

**Edema**:
- Slower cooling rate.

**Clothing, posture and**.

**Environmental Temperature**:
- Higher humidity: rapid cooling rate
- Rapid air velocity: rapid cooling rate

**Water**:
- Rapid cooling rate:
  - More rapid in flowing water than still water

**If there is a fulminating infection**, e.g. septicaemia, the body temperature may continue to rise for some hours after death.
• **Livor Mortis**: skin discoloration caused by pooling of blood

• As body decomposition begins, blood *settles* in the lower parts of the victim’s body. Red blood cells break and release *hemoglobin*, which turn *purple* as they spill out of cells. Wherever these *pools* of blood settle, the skin takes on the purple coloring.

The pooling of blood is known as *lividity*.

i. Begin **2 hours** after death.

ii. Between 2-8 hours after death, the color will disappear when the skin is pressed on.

iii. After 8 hours, the discoloration becomes **permanent**.
Livor mortis not only helps approximate time of death, but also indicates the **positioning** of the body during the first 8 hours of death.

a. For example, if all discoloration is on the front of the body, it indicated the person was lying face **down**.

b. Discoloration on many parts of the body can show that a body was **moved** from one location/position to another.
**Rigor Mortis**: rigidity of skeletal muscles

- It is caused by lack of oxygen to cells and **calcium** buildup in the **muscles**, causing stiff muscles and joints.

- Rigor mortis begins in the head about **2 hours** after death, and slowly works down the body and legs.
  - Stiffness peaks at about **12** hours.
  - As the cells **dissolve** during autolysis, the stiffness will slowly disappear.
  - Stiffness completely disappears around **36** hours.

- A dead body that is not stiff has probably been dead less than 2 hours or more than **48** hours.
## Affects of Rigor on a body

<table>
<thead>
<tr>
<th>Temperature of body</th>
<th>Stiffness of body</th>
<th>Time since death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm</td>
<td>Not stiff</td>
<td>Not dead more than 3 hours</td>
</tr>
<tr>
<td>Warm</td>
<td>Stiff</td>
<td>Dead between 3 and 8 hours</td>
</tr>
<tr>
<td>Cold</td>
<td>Stiff</td>
<td>Dead between 8 and 36 hours</td>
</tr>
<tr>
<td>Cold</td>
<td>Not stiff</td>
<td>Dead for more than 36 hours</td>
</tr>
<tr>
<td>Stage</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Initial or fresh decay (autolysis)</td>
<td>The cadaver appears fresh externally but is decomposing internally due to the activities of bacteria present before death (0–4 days).</td>
<td></td>
</tr>
<tr>
<td>Putrefaction or bloating</td>
<td>The cadaver is swollen by gas produced internally, accompanied by the odor of decaying flesh (4–10 days).</td>
<td></td>
</tr>
<tr>
<td>Black putrefaction</td>
<td>Flesh of creamy consistency, with exposed body parts black. Body collapses as gases escape. Fluids drain from body. Odor of decay very strong (10–20 days).</td>
<td></td>
</tr>
<tr>
<td>Butyric fermentation</td>
<td>Cadaver drying out. Some flesh remains at first; cheesy odor from butyric acid (20–50 days).</td>
<td></td>
</tr>
<tr>
<td>Dry decay (diagenesis)</td>
<td>Cadaver almost dry; slow rate of decay. May mummify (50–365 days).</td>
<td></td>
</tr>
</tbody>
</table>
Stages of Decomposition

• Bodies begin to decompose shortly after death and do so in five predictable stages:
  i. **Fresh**
  ii. **Bloat** or Putrefaction
  iii. **Active Decay** or Black Putrefaction
  iv. **Advanced Decay**
  v. **Dry Remains** or Skeletonization
Fresh

1. Begins almost **instantly** after death.

2. Livor, rigor, and algor **mortis** occur.

3. Autolysis, or self-**digestion**, begins as lysosomes break down and release their digestive **enzymes** into the cell.

4. Visible changes caused by decomposition are limited during the fresh stage, although autolysis may cause **blisters** to appear at the surface of the skin.
Bloat Putrefaction

1. This stage of death is mostly due to the activities of microorganisms; first intestinal flora, then saprophytic bacteria and fungi.
2. Characterized by the production of gases which gives rise to the bloated appearance of the decomposing body and strong odor.
3. Skin turns a greenish color as blood decomposes.
4. Skin may break apart and fluids can flow out from the openings.
Active Decay

1. This stage is recognizable by a great loss in mass, due largely to feedings by maggots and other insects. Parts of flesh may be black and corpse gives off an even stronger odor.

2. As gases escape and the body leaks decomposition fluids, the body may collapse.

3. The end of this stage is marked by the dispersal of the maggots from the body.
Advanced Decay

1. The body begins to **dry** and preserve itself; most of the **flesh** is gone.
2. Odor and insect activity **decrease**.
3. Body may form a **wax** layer known as the **adipocere**.

**Dry Remains**

Final stage. Recognizable by a loss of everything on the body but dried up **bone**.
Factors that affect decomposition.

**Age**
- Young decompose faster than elderly.

**Size** of body
- Overweight people decompose faster than average.

**Clothing**
- Naked decompose faster than clothed.

**Health**
- Sick decompose faster than healthy.

**Environmental Conditions**
Bodies decompose fastest in 70-99 °F.2.

Higher temperatures dry out corpses and preserve them; lower temperatures prevent bacterial growth and slow decomposition.

Bodies decompose faster in air, and slower in water or soil.