

Biology Behind the Crime Scene

Week 9: Lab #9 Crime Scene Insects: Forensic Entomology

Adapted from numerous resources, including The American Biology Teacher articles, including Miller & Naples 2002 and Carloye 2003

Our lab today will go along with the Crime Scene Creatures movie we watched in class. There are many web resources recommended with this movie as well as other resources from education journals that we will use in lab today. Make sure you read over all of the webpages to which there are links in this handout.

- For information about what an entomologist can do with forensic insects, go to the “Information” frame choice at the side on this website:
<http://www.forensicentomology.com/info.htm>
- Read about the blowfly and beetles life cycle at:
<http://www.forensicentomology.com/appear.htm#bwfl>
- Learn about the succession of corpse fauna [in Australia, at least] here:
<http://australianmuseum.net.au/Corpse-Fauna>

You must also read and you may want to print the collection procedure outlined in “Collection of insects from the body at the scene” section of:

<http://www.forensicentomology.com/procedure.htm>

NOTE that while you will generally follow this procedure, not everything applies to our scene. For example, while you will be noting general weather conditions, you will not be using a thermometer in any way. You also will be placing all insects directly into alcohol without using a separate “kill jar;” you will not be boiling any specimens; and you will not need to prepare anything for shipping. You will also leave the “body” [meat] wherever you find it.

More Background Information

(Most text directly from Carloye 2003, with some text adapted):

“When an animal dies, flies (particularly from the family Calliphoridae and Sarcophagidae) are among the first to find and colonize the carcass, usually arriving within ten minutes of death (Goff, 2000). As the carcass decays, the environmental conditions within it change — it becomes drier, the temperature rises, tissues break down, etc. In fact, the process of decay is one of ecological succession whereby a series of predictable changes occur as the carcass progresses from the “fresh” stage, where the body is intact and decay has barely begun, to the “skeletal” stage, when all that is left is indigestible hair and bone. This process is an example of what is known as “secondary succession” (Purves et al., 2001), whereby the Community begins with the death of an animal and the body represents an isolated, rich source of resources that is colonized by particular groups of insects as the resource itself undergoes changes. The process of colonization and utilization of the body continues until decomposition is essentially complete. Because the progression of insect fauna follows a predictable pattern and the developmental rates of flies are relatively predictable, if enough information is known regarding the temperature of the microclimate in which they are found, investigation of the insect community associated with a corpse is used by forensic scientists to estimate the post-mortem interval. This is called forensic entomology.”

Remember that during their lifecycles, insects go through different development stages (egg, several larval instars, pupation, and adult). Remember also that the insects are ectotherms. “Flies create their pupation chamber out of the exoskeleton of the last maggot stage and thus it is called a puparium rather than a pupa and the process is called pupariation rather than pupation.” Colonization and insect development are predictable due to the process of ecological succession

– thus “this parade of insect colonizers can be used to determine the approximate length of time a person has been dead.

Stages of Decomposition

The process of decay begins at the moment of death. This is the ‘Fresh’ stage and it lasts until the body becomes bloated. At this stage, the body looks relatively normal — much like a sleeping person. Blow flies (*Calliphoridae*) and flesh flies (*Sarcophagidae*) are among the first to find the body and they can arrive within 10 minutes of death (also see Catts & Haskell, 1990). They lay their eggs, from which the maggots hatch quickly, and begin to feed on the tissues (the flesh flies do not lay eggs, but rather deposit newly hatched maggots directly onto the corpse). Predatory wasps and/or beetles may arrive to feed on the maggots (but not the corpse).

The ‘Bloated’ stage begins when the body becomes visibly inflated due to the production of gases from bacteria that begin to putrefy the body. House flies (*Muscidae*) now join the other flies and their maggots form feeding masses that help to liquefy the tissues of the body. At this point there are a lot of maggots feeding on the body and competition increases, as do the number and variety of predators that come to feed on the maggots.

The decay stage begins when the skin breaks and the gases escape, giving the corpse a deflated look. The maggot masses are large and very active as they continue in their development growing older and larger. This is the stage of decomposition that smells bad. By the end of this stage, most of the maggots have finished development (typically they molt 3 times before pupariation) and they begin to leave the corpse in search of a place to pupariate in the soil. The corpse is now devoid of most of its flesh, with only cartilage, bone, and skin remaining. At this point the post-decay stage begins. This stage is devoid of flies although there are some beetles that continue to feed on the highly desiccated remains (Catts & Haskell, 1990).”

Patterns of Egg-Laying

...when the flies arrive to lay their eggs or larvae, they search out the natural orifices for doing so. This means that eggs/larvae begin their feeding in the head region first (mouth, nostrils, eyes, ears) followed by the anal/genital region. The trunk of the body is invaded much later in the process. This information is useful for determining if foul play was involved in a death. If maggots are found in the chest cavity early in the decomposition process, this is good indication that there was an unnatural orifice present at the time of death. This orifice could be the result of a gunshot or knife wound.”

Effect of Drugs

Drugs present in the body at the time of death can affect the developmental rate of the maggots as they ingest the drug along with the tissue. Cocaine speeds up development (Goff, 2000; Catts & Goff, 1992) while arsenic slows it down (Smith, 1986). This fact can make estimating the time of death difficult due to the presence of large maggots on relatively young corpses and small maggots on relatively old corpses.”

Purpose/Objectives:

- To learn that insects can be used to estimate time of death
- To collect insects from a simulated crime scene
- To observe and try to identify insects that have infested tissues left outside
- To compare the insects found on tissues left outside for different intervals
- To use simulated insects to determine time of death and solve several proposed cases

Materials:

Set-up (by instructor):

chicken pieces
pork chops
string or dental floss wire fly paper
crime scene tape

For collection:

gloves
soft plastic tweezers
insect nets
70-80% isopropyl alcohol in conical tubes

Class resources:

Crime scene insects identification cards
insect field guides
Projected succession website

In Lab:

dissecting microscopes
non-sterile Petri plates water in small containers
isopropyl alcohol
rulers
beaker with strainer

Simulated insects activity (from Carloye 2003)

rulers
Case #1 – Case #4 insect collections
A copy of Table 1 with the 4 different cases on it
A copy of Tables 2 & 3 with information on the
different insect lifecycles, effects of
temperature & habitats of species

Procedures:

WARNING: Much of today's lab will be a little gross and probably VERY smelly. You will be handling insects and possibly bacteria. We will kill all of the insects that will be brought back to the lab; however, there may be insects other than forensic insects on and around the samples in our unpredictable Arizona desert. BE CAREFUL WHERE YOU PUT YOUR HANDS. Also, the isopropyl alcohol is flammable, so do NOT expose it to any open flame (i.e., cigarettes, cigarette lighters, etc.)

Part 1: Insect collection – at the crime scene

Before heading outside, your instructor will show you a brief video called “The Body Farm” <http://video.nationalgeographic.com/video/science/health-human-body-sci/human-body/body-farm-sci/> that shows the importance of forensic entomology and how we can determine various stages of decay.

We will then go outside to the “crime scene” to collect insects from pieces of meat left outside for various periods of time. There are four trees where all of the meat in each tree was hung on the same day but the trees were each hung two days apart. Hopefully the meat is still there! Your group will pick a tree and collect insects from chicken and/or pork. Take all of your collection materials (see list under Materials) – including a pair of gloves to put on while you're collecting the insects - and laboratory notebook and pen with you outside.

1. Note what sample/tree your group used – where it was located and the type of meat – in your notebook. Also note the general weather conditions in your notebook (cloudy or sunny; hot, warm or cold; windy or still; dry or humid; etc.). While you will be noting general weather conditions, you will not be using a thermometer in any way.
2. Note in your notebook what and where insects (maybe as flying insects, larvae, or eggs) were found on your group's tree and meat – draw a labeled sketch as well as making notes. Try not to disturb your sample so that flying insects remain.

3. Wearing gloves carefully collect one of each different kind of insect you find (or different size as in the larva), but noting in your notebook approximately how many of that kind you found. Feel free to collect from the meat, the fly paper, or anything flying around. All of the lab sections use the same trees so make sure there is some left for the last lab section to collect. Generally follow the collection methods you read about from <http://www.forensicentomology.com/procedure.htm> NOTE that while you will generally follow this procedure, not everything applies to our scene. You also kill all insects directly into alcohol without using a separate “kill jar;” you will not be boiling any specimens; and you will not need to prepare anything for shipping. You will also leave the “body” [meat] wherever you find it.

You MUST kill all insects that will be taken into the lab as outlined in the collection procedure.
NO LIVE INSECTS MAY BE TAKEN INTO THE BUILDING.

4. Remove your gloves before returning to the building.

WASH YOUR HANDS when your return from insect collection.

Part 2. Insect identification – back in the lab

You will examine the killed and preserved specimens in open Petri dishes using the dissecting microscopes.

You must draw AT LEAST TWO of your specimens that you examine in your notebook, noting the magnification, the measurements of the specimen, and where the specimen came from (see your notebook). Attempt to identify the insect as closely as possible using the provided insect identification cards and field guides. All insects collected by your group must be at least somewhat identified even if not sketched. NOTE: For clean up, strain your alcohol tubes in the strainer and beaker on the side bench and return the alcohol to the tube as it can be used again. Place the dead insects in the biohazard bag.

Part 3. Time of death – compare your results with other groups

Once each person in your group has made insect drawings and identifications, share this information with other groups. Compare your results and collections to those of other groups. NOTE in your notebook the differences and similarities between the findings of all the groups. Once you have talked to the other groups, attempt to determine the relative “time of death” of your tree versus the other groups [is your crime scene older? newer? the same?]. Note in your notebook which tree you think was hung 1st, 2nd, 3rd, and 4th. Once all groups have compared results and listed an order of “time of death” of the meat in the trees, your instructor will give you the relative time of deaths of the “crime scenes.” NOTE any correlations between time left at the “crime scene” and amount and/or types of insects discovered in the sample.

Part 4. Insect clean-up

Clean up your area so it is back to the way you found it. Dispose of insect samples ONLY as instructed. Wipe down your table with the cleaning solution.

Part 5. Simulated Insect Succession Activity

Obtain the handouts and materials for this activity from your instructor during lab.

****Fully read over the background information in this lab handout as well as any additional background information or procedural information in the simulated insect handouts given in class before performing the investigation. Be sure to make use of the information provided in these readings when interpreting your cases and estimating the time of death.**

NOTE: There are 4 cases. For maximum efficiency, each person in the group should do all the measurement for 1 case, and then share these measurements with all group members when the group works on the case. Once measurements are completed, group members should proceed together all the way through the analysis of each case before proceeding to the next one, starting with Case #1.

1. Open the baggie for your assigned case, measure [and record!] each and every “insect” present in millimeters (mm), noting the color of each. **YOU MUST RECORD EACH MEASUREMENT SEPARATELY FOR EACH “INSECT,”** however, you may want to put the measurements of those of the same color next to each other in a table in your notebook.
2. Once all group members have finished their measurements, the group should read the Police Report and Weather Report for Murder Investigation #1 in Table #1.
3. Whoever has the Case #1 measurements should share these measurements with the other group members as you use Table #2 to determine which species were present in what stages. NOTE this information in your notebook. Re-measure any specimens if necessary.
4. Using your observations in Step 3, the information from the Introduction, the Case’s Police Report & Weather Report in Table 1, and the insect habitats, as well as developmental delays/accelerations from Table #3, answer the questions for Murder Case #1 **IN YOUR NOTEBOOK**. This includes estimating how long the person has been dead (no more than a 2 day range): this is **NOT** an average; you are looking at the developmental stages of each species, and then trying to coordinate these developmental stages between the different species to estimate number of days. Remember to place all simulated insects back in that case’s bag.
5. Repeat these Steps 2-4 for Cases #2 - #4.

Part 6. Simulated insect clean-up and notebook signing

Clean up your area so it is back to the way you found it. Make sure **ALL** of the simulated insects have been placed back in their correct “case” bag. Once you are done with the laboratory exercise, have made all necessary drawings, and have drawn a conclusion about today’s exercise, make sure to get your notebook signed by your instructor before leaving the lab.