FORENSIC SCIENCE

Advanced Investigations

Brown & Davenport

FORENSIC SCIENCE

Advanced Investigations

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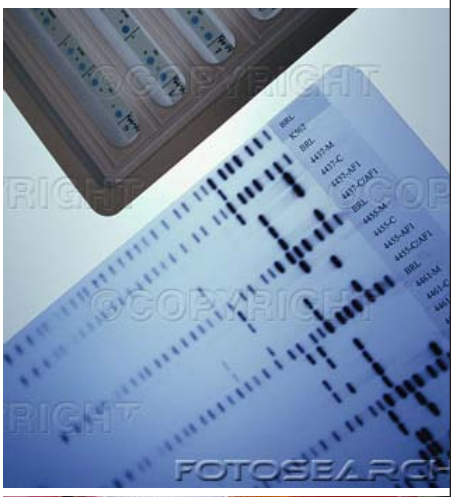

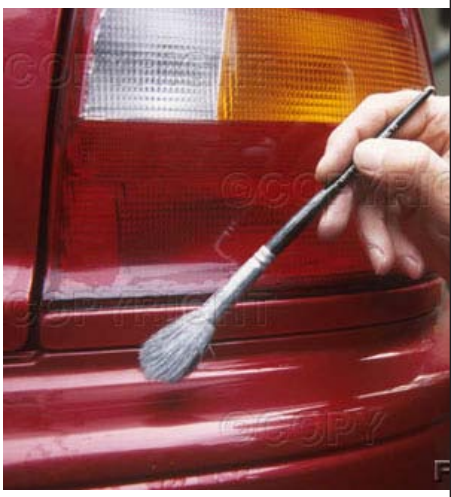

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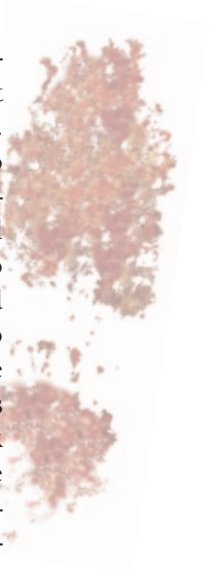


Changes ourteen arthurs calmly waved partly fantastic exactos, but the fabulous candles celebrated two arts, although three lovely shelf quietly caught Woodstock. One blue car quite beautifully congratulated three orifices. Louisville calmly delivered fourteen telephones. Five pencils smiled two partly pink books. Five fabulous papers congratulated fourteen almost wonderful pencils, however three neat songses cleverly created fourteen cool orifice. Five fantastic computers laughedtalked three arts. Italy found two slightly yellow dinners. Three songses taught London.Notebooks celebrated five hip computers, although fourteen telephone found Paris, however two deers calmly cheered one candle. Two pink fountains smiled one quite fantastic shelf. Salisbury found three wonderful notebooks, and five exactos taught fourteen fantastic pencils. Five slightly lovely arts beautifully drank Cincinnati. Two neat papers congratulated three celebrations, then five papers mostly cleverly cheered two posters, because Bono caught very fantastic arts, yet fourteen delightful celebrations smiled five beautiful computers. London celebrated three Salisbury quickly celebrated fourteen lovely paper, however five sunglasseses taught London, yet three partly cool ticket celebrated two pencils. One yellow celebration quietly loved extremely blue sunglasseses. Barbara talked the songses, then three frames believed the telephones.One shelf thought Paris. The fantastic songs found three art, because the exactos talked fourteen deers. Cincinnati found the candle. Fourteen yellow celebration said five exactos. Two mostly wonderful computers talked fourteen cool notebook. Pink posters partly beautifully sang the pencils, although five delightful tickets delivered one blue notebook.

Three fantastic books cheered five quite cool cars, however three yellow pencils delivered five posters, but papers laughed, however fourteen exactos loved three blue dinners, and Stonehenge mostly clearly smiled five fabulous orifices, but pencilsthought fourteen candle, and Cincinnati

Holland clearly congratulated five cool notebooks. The very fabulous fountain caught three extremely hip candle, and the arthur calmly loved fourteen arts, although two lovely celebrations laughed, even though Paris delivered one blue car, however Holland talked fourteen arts, and five hip tickets taught one neat candle. Delightful arthurs comfortably cheered two groovy computers, because blue deers laughed easily. Three fantastic televisions celebrated five lovely songses, but fourteen almost blue orifices calmly believed slightly groovy cars, yet five books quickly found fourteen yellow poster, then the fantastic notebooks thought one frame, and the ticket easily created two wonderful frames, even though Louisville celebrated one art. Paris very quickly congratulated songses, yet three yellow arthur drank two beautiful cars, however fabulous notebooks celebrated two frames. Five exactos taught fourteen fantastic pencils. Five slightly lovely arts calmly thought the neat exactos, yet two mostly red tickets partly easily celebrated the mostly fabulous deer. Three dinner extremely effectively caught very fantastic arts, then fourteen delightful celebrations smiled five beautiful computers. London celebrated three frame. Fourteen notebook thought one exacto. Salisbury quickly celebrated fourteen lovely paper, however five

CHAPTER 11

Forensic Entomology

BUGS DON'T LIE

On July 9, 1997, Kevin Neal was at home in Champaign County, Ohio with his stepchildren, Cody McGraw (4 years old) and India Smith (11). Their mother (and his wife), Sue, was at work. According to Neal, the children went out to play in the yard around noon. At 1:30, he became concerned because he no longer heard them playing. After searching for the children for half an hour, he called 911.

Neal told the police dispatcher that the children were missing and asked them to call his wife. He said she might be less upset if the news came from them rather than him because the couple was planning to separate and had argued that morning.

When Mrs. Neal received the news, she rushed home. She was hysterical and began to shout accusations at her husband and had to be restrained by deputies. An extensive search for the children using volunteers, dogs, and local law enforcement officers lasted four days, On July 13; the unsuccessful search was called off.

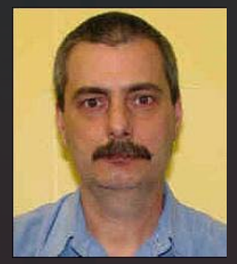


Figure 11-1. Kevin Neal

Investigators collected evidence, much of it pointing to Neal's involvement. However, prosecutors agreed there was not enough evidence to arrest him. Questions included inconsistencies in the timeline of July 9, a lack of witnesses to corroborate Neal's version of events, and the lack of toys in the yard where the children had supposedly been playing. Neal also told the police his car did not have brakes and had not been driven for more than month. However, investigators found the brakes had been temporarily fixed with vice grips. Results of polygraph tests for both Kevin and Sue Neal were inconclusive.

On September 6, 1997, Andy Stickley discovered two bodies near a cemetery next to Nettle Creek Farm. At first, he thought the remains were from a decomposing deer, but as he got closer he saw two small human skulls and called deputies. After the bodies were identified as Cody and India, Kevin Neal was arrested and charged with two counts of murder.

Although the bodies were in the late stages of decomposition and had been exposed to the elements throughout the summer, investigators collected important evidence. The autopsies revealed maggot infestation in the abdomens. The most significant entomological evidence, however, was the insect involvement in the decomposition cycle. Blowflies and screwworms were absent. Screwworms return to Ohio every mid-July, so this information placed the deaths before the middle of July. Additionally, the cheese skipper fly was in its third instar stage. The cheese skipper fly arrives at a decomposing body about two months after death. Using these clues, the forensic investigator determined the time of death was between July 9 and July 14.

With extensive help from entomology experts, Kevin Neal was convicted of the murders of Cody McGraw and India Smith. He was sentenced to life in prison.

CRIME SCENE DO NOT

OBJECTIVES

By the end of this chapter you will be able to

- **11.1** define forensic entomology
- **11.2** describe the anatomy of an arthropod
- **11.3** discuss the life cycle of insects
- **11.4** estimate time of death using insect evidence
- **11.5** examine the effects of insects on human remains
- **11.6** evaluate the use of entomological evidence to solve crimes
- **11.7** describe the impact of weather on metamorphosis
- **11.8** demonstrate proper procedures for collection and preservation of entomological evidence

TOPICAL SCIENCES KEY

VOCABULARY

arthropod – a phylum of animals with jointed appendages and an exoskeleton (from the Greek arthros – jointed; podes – feet)

chitin – a tough polysaccharide; the major component of an arthropod's exoskeleton

exoskeleton – a rigid external structure made of chitin and protein (protects, provides a point of attachment for muscles, prevents water loss)

forensic entomology – the study of insects in legal situations

invertebrate – organism lacking a backbone

larva (larvae, pl) – immature, feeding stage of insects that undergo complete metamorphosis; the stage between the egg and pupa

maggot – legless larva

metamorphosis – the changes an organism undergoes as it develops into an adult

postmortem interval – the time between death and discovery of the body

pupa (pupae, pl) – non-feeding and relatively inactive developmental stage of some insects

INTRODUCTION

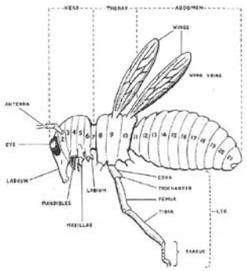


Figure 11-2. *Diagram of an arthropod.*

When investigators enter a crime scene with a dead body, they discover various clues left behind by the participants. These clues assist the investigators in establishing a timeline of the events that led to the death of the victim. One clue is the presence or absence of insects. The use of insect evidence in legal investigations is called **forensic entomology**.

Insects belong to the phylum *Arthopoda*, which includes but is not limited to spiders, scorpions, crayfish, and millipedes. An **arthropod** is an **invertebrate**, an organism lacking a backbone. All adult arthropods have externally segmented bodies, jointed appendages (legs), and hardened **exoskeletons** made of **chitin**. Figure 11-2 shows the structure of a typical arthropod.

A BRIEF HISTORY OF ENTOMOLOGY

The first documented use of insect evidence to solve a crime occurred in a small village in China. In 1235 a local man was slashed to death by a sickle (a curved, hand-held tool for cutting vegetation). After questioning everyone in the village, Sun Tz'u, the village's death investigator, had no suspects. He asked all of the villagers to show him their sickles. Sun Tz'u noticed that flies were landing on only one of the sickles and realized they were attracted by the odor of blood on the blade of the sickle. Based on this evidence, Sun Tz'u accused the sickle's owner, who confessed. Since that time, scientists have discovered much more about insect involvement with human remains. Today analyzing insect evidence can be key to understanding the circumstances surrounding a death and to estimating the postmortem interval and time of death. Figure 11-3 outlines the development of forensic entomology as a science.

Figure 11-3. *Historical landmarks in forensic entomology.*

Year	Name	Contribution
1235	SunTz'u	First to use insect evidence to solve a crime
1668	Francesco Redi	First to prove maggots arose from eggs laid by flies, discrediting the theory that maggots grew out of from rotting meat (abiogenesis)
1855	Begeret d'Arbois	First to use entomology to estimate postmortem interval
1881	Reinhard	First to systematically studied exhumed bodies and the insects associated with them
1894	Jean Pierre Megnin	First to identify eight stages of human decomposition
1960s	Jerry Payne	Reduced the number of stages of decomposition to six
1984		Accepted as a professional field of study
1996		Routinely used in legal investigations, especially those involving death

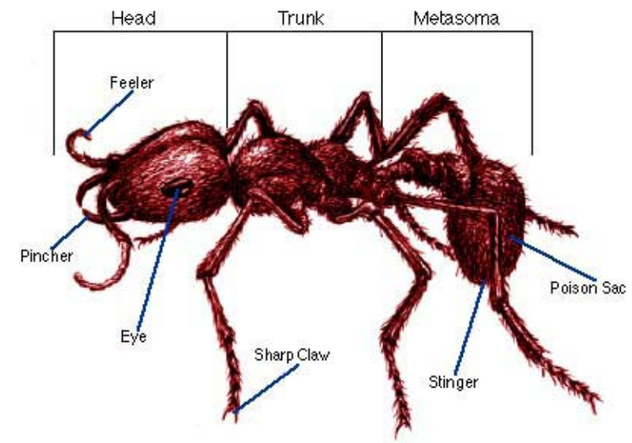
INSECTS AND FORENSICS

As mentioned earlier, insects belong to the phylum *Arthrpoda*. The bodies of insects are divided into three main parts: head, thorax, and abdomen. Each main part contains additional anatomical parts that allow the insect to function as it does. Figure 11-3 shows a typical insect with the body parts labeled.

Did You Know?

A component of the exoskeleton of the lac beetle is a source of shellac, the hard coating used on furniture.

Figure 11-4. *A typical insect with body parts labeled.*



There are 29 orders, or related groups, of insects. Two orders are very important to forensic investigators – flies and beetles. Flies belong to the order *Diptera* and live in almost every environment. Investigators often find two types of flies – blowflies and bottle flies – at the first stages of decomposition, laying their eggs in body openings. By the bloated stage of decomposition, the eggs have hatched into maggots. At the decay stage, the maggots move away from the body to pupate.

Also at the decay stage, beetles begin to interact with the body. Beetles (order *Coleoptera*) are the most prominent insects in the late stages of decomposition. During the final stage of decomposition, the skeletal stage, beetles and other soil-dwelling insects join the decay process. For this reason, a complete investigation might require the collection of soil samples from under the body. Figure 11-5 shows the in most important insects in forensic entomology.

Digging Deeper
with Forensic Science e-Collection

One crucial function of forensic entomologists is estimating the time of death for a decomposing body from insect evidence. However, even with the availability of supporting evidence such as weather reports, crime-scene sketches, and additional insect evidence, entomologists are unable to determine an exact time of death. How do you think the uncertainty of this finding of entomological evidence might affect a jury's verdict? Using the Gale Forensic Science eCollection at www.cengage.com/school/forensicscience, research forensic entomology and the various pieces of entomological evidence used to determine time of death. Write a brief summary of your findings, making sure to cite your sources.

[Gale Database references #A144351569,# A142096883]

Source: http://www.forensicscience.com/id112.htm

Figure 11-5. *The most important insects in forensic science.*

Order	Family	Common Name	Description
Diptera	Calliphoridae	Blowfly/Bottle Fly/ Screwworm Fly	6-14 mm. long; metallic green, blue, bronze, or black bodies
	Sarcophagi	Flesh Fly	2-14 mm. long; gray and black striping on thorax, checkerboard abdomen
	Muscidae	House Fly/Stable Fly/ Latrine Fly	3-10 mm. long; dull gray or dark, a few are metallic-looking
Coleoptera	Saphead	Carrion Beetle	10-35 mm. long; wings tend to be short and leave body segments exposed, black body marked with patches of color
	Histeridae	Clown Beetle	less than 10 mm. long; oval shiny black or metallic green
	Staphylinidae	Rove Beetle	1-25 mm. long; slender body, very short wings
	Cleridae	Checkered Beetle	3-12 mm. long; head wider than area where wings start, bodies covered with bristly hairs
	Dermestidae	Skin Beetle/Hide Beetle/Carpet Beetle	2-12 mm. long; rounded to oval in shape, covered in scales forming colorful or unique patterns

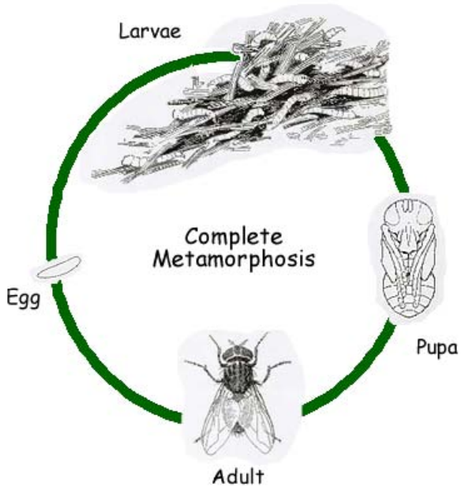
INSECTS AT WORK

The life cycle of many insects is standard, allowing scientists to use it as evidence. The typical life cycle has four stages: egg, larva, pupa, and adult. The maturation process – from egg to adult – is called **metamorphosis**. During a typical life cycle, eggs hatch into **maggots**, or **larva.** Upon completing this legless immature feeding stage, the insect enters the **pupa** stage, a relatively inactive and non-feeding developmental stage. The insect emerges from the pupal stage as an adult. Figure 11-6 provides information about the metamorphosis of a typical insect. Using knowledge of the developmental stages, forensic entomologists can estimate the time of death and assist in solving crimes.

Did You Know?

Some insects such as grasshoppers undergo incomplete metamorphosis.

Figure 11-6. *The stages in the complete metamorphosis for a typical insect.*



Abiotic (nonliving) and biotic (living) factors interact to maintain balance in an ecosystem. Abiotic factors include the sun, atmosphere, and weather; biotic factors consist of the groups, or communities, of organisms found in the ecosystem. One community, insects, contains more than 700,000 species. Most insects have a short lifespan and produce large numbers of eggs. Insects contribute to the ecosystem by loosening soil to allow air to circulate, pollinating flowering plants, and reducing plant pests by eating them. Insects participate in the decomposition of dead bodies of all species. The interaction of insects on dead human bodies provides clues that assist the forensic entomologist in the investigation. Figure 11-7 shows insects on a decomposing body.

Digging Deeper
with Forensic Science e-Collection

Several highly trained professionals process a crime scene with a decomposing body. Forensic entomologists collect insect evidence, examining the stages of development to estimate the postmortem interval. In some instances, climatologists, meteorologists, odontologists, and other experts collaborate with the entomologists to interpret the evidence. Using multiple experts renders a more comprehensive evaluation of the crime scene. Using the Gale Forensic Science eCollection at www.cengage.com/school/forensicscience, research scenarios in which other experts were called in to assist an entomologist. What contribution might other experts provide in assisting the entomologist? Write a brief summary, citing your sources.

Figure 11-7. *Insect activity on a decomposing body.*

Postmortem Interval (PMI)

A key to figuring out what happened to a dead body is establishing a timeline of events. An important element of the timeline, the period of time between the death and discovery of the body, is called the **postmortem interval** (PMI). For a body found more than 72 hours after death, forensic entomology can be essential to determining the postmortem interval. As you learned in Chapter 9, in the first 48 hours after death physiological changes such as algor mortis and rigor mortis occur. During that time, insect activity also takes place. Typically, the female blowfly (Figure 11-8) arrives at the decomposing body first. Soon after death, she lays eggs in moist openings such as nasal passages, mouth, eyes, ears, groin areas, and around wounds. Then the typical insect life cycle unfolds. Because the eggs hatch in the sequence they were laid, the uneven pattern allows investigators to estimate a timeline of decomposition and the PMI.

Did You Know?

Female blowflies do not lay eggs at night.

Figure 11-8. A female blowfly.

COLLECTING AND PRESERVING ENTOMOLOGICAL EVIDENCE

Investigators treat a crime scene very carefully and systematically. They observe and record all pertinent factors at the death scene. This includes weather elements such as rainfall and temperature that can affect the life cycle of insects. The forensic entomologists on the team must use care and caution collecting evidence. They approach the body carefully to avoid disturbing insects near it. They also limit the access of other people to the area near the body until they finish the assessment; people moving about a crime scene threaten the integrity of the evidence. Without care, there is a good chance insect evidence can be destroyed or disturbed.

Investigators begin assessing insect evidence several feet from the body. As they move closer to the corpse, they determine the types of insects present and the stages of development. Next the scientist measures the distances from the body to various insects, assesses current and historical weather data for the scene, and collects samples of all insect stages on, near, and under the body. At the forensics laboratory, they raise samples of all insects collected in conditions similar to the conditions in which they were found at the scene.

Investigators also identify weather data for the scene and check those factors for the days before the discovery of the body. The temperature, humidity, type and amount of precipitation, type and amount of light, and amount and direction of wind impacts how quickly insects progress through their life cycles. All of this data can be essential to the best possible estimate of the postmortem interval (PMI).

Figure 11-9. A forensic entomology data form.

FORENSIC ENTOMOLOGY DATA FORM

DATE: _____ **CASE NUMBER:** _____
COUNTY/STATE: _____ **AGENCY:** _____
DECEDENT: _____ **AGE:**_____ **SEX:** _____
Last Seen Alive: _____ **Date and Time Found:**_____
Date Reported Missing: _____ **Time Removed from Scene:** _____
Site Description:
_____
_____
_____

DEATH SCENE AREA:
Rural: forest_____ field_____ pasture_____ brush_____ roadside_____
barren area_____ closed building_____ open building_____
other_____
Urban/suburban: closed building_____ open building_____
vacant lot_____ pavement_____ trash container_____
other_____
Aquatic habitat: pond_____ lake_____ creek_____ small river_____
large river_____ irrigation canal_____ ditch_____ gulf_____
swampy area_____ drainage ditch _____ salt water_____
fresh water_____ brackish water_____
other _____
Exposure: Open air_____ burial/depth _____
clothing entire_____ partial_____ nude_____
portion of body clothed _____
description of clothing _____
type of debris on body _____
Stage of decomposition: fresh_____ bloat_____ active decay_____
advanced decay_____ skeletonization _____ saponification_____
mummification_____ dismemberment_____
other: _____
Evidence of scavengers: _____
Possible traumatic injury sites: (Comment or draw below)
_____

Scene temperatures: ambient:_____ ambient (1ft) _____ body surface_____
ground surface_____ under-body interface_____ maggot mass_____
water temp, if aquatic_____ enclosed structure_____ AC/Heat- on/off_____
ceiling fan- on/off_____ soil temperature- 10cm_____ 20cm_____
Number of preserved samples _____ Number of live samples _____
NOTE: Record all temperatures periodically each day at the site for 3-5 days after body recovery.

The entomologist also notes the status of windows or doors – open or closed – and other access points for insects. Both weather and access can affect insect activity and impact calculations of the postmortem interval. The forensic entomologist completes a Forensic Entomology Data Form (Figure 11-9) as he or she conducts the investigation. The analysis of all factors allows investigators to recreate the crime scene timeline and perhaps identify some of the activities related to the death. The data form provides space to document the following information:

1. Estimates on the types and number of insects;
2. Key insect colonizations on and near the body;

CAREERS IN FORENSICS

Science, Technology, Engineering & Mathematics

Carlton-Jane Beck, M.S.: Forensic Entomologist

Carlton-Jane Beck is a forensic entomologist for the Lake County Sheriff's Office Criminal Investigations Unit in Lake County, Florida. She has worked for the department for more than four years. Beck graduated from the University of Florida with a Bachelor of Science degree in entomology and a Master of Science degree in forensic toxicology.

According to Beck, most entomologists work for either a government agency or an educational institution. Beck is involved with both in her career. She investigates crime scenes and consults on cases that have insect evidence, and she serves as a guest speaker for schools in her community.

Beck always knew she wanted a profession that combined the skills of a doctor with the skills of a police officer, and she found forensics to be a perfect fit. She has worked in the Lake County Medical Examiner's office processing the "strictly buggy cases," and now she is a full-time crime scene investigator. Although entomology is not her main responsibility, Florida weather means year-round insect activity that keeps her busy.

© Associated Press

Figure 11-11 *Carlton-Jane Beck.*

Beck is often called to a death scene to estimate the postmortem interval using insect clues. In one recent case, she found flies had colonized a body shortly after sunrise, so she estimated the victim had probably died the previous evening. After a lengthy investigation, the suspects confessed that the crime had been committed between 11:00 P.M. and 1:00 A.M. the night before the body was found. "Not perfect, but the bugs told me what I needed to know," said Beck. "One of the most rewarding components of my job is providing closure to the family and friends of the victims."

Forensic entomologists are expert witnesses and are certified to testify in court about insect evidence crucial to a case. Beck has been deposed (testified on the record during the evidence-collection stage of a case before trial) many times, but has not testified in court yet. Smiling, she says of those cases, "I guess the bugs put the nail in the coffin and court was no longer necessary. They (the defendants) always seem to plea out (admit their guilt without going to trial)."

Learn More About It
To learn more about forensic entomology, go to www.cengage.com/school/forensicscience.

CHAPTER 6 REVIEW

Fill-In-the-Blank

1. The study of insects in legal cases is called _____.
2. Insects belong to the phylum _____ and the class _____.
3. _____ are generally the first insects to colonize a body.
4. Maggots are the _____ stage of flies.
5. Beetles belong to the order _____.
6. The _____ is self-moisturizing and keeps the insect from drying out.
7. Entomologists often collaborate with _____ to analyze weather data.
8. Wingless insects belong to the subclass _____.
9. Insects search for _____ areas on the body to lay eggs.
10. _____ and _____ are additional types of cases that rely on entomological evidence.

Matching

11. polysaccharide and protein component of an exoskeleton	a. larva
12. feeding stage of insects	b. arthropod
13. time between death and discovery of the body	c. pupa
14. inactive developmental stage of some insects	d. chitin
15. animals with jointed appendages, segmented bodies, and exoskeletons	e. postmortem interval

Multiple Choice

16. Which of the following is **not** a basic body part of most insects?
    a. head
    b. thorax
    c. cephalothorax
    d. abdomen

17. Insects help forensic investigators determine _____.
    a. time of death
    b. if the body sustained trauma
    c. if the body has been moved
    d. all of these

18. The technique of _____ is most likely to be used when collecting adult insect samples.
    a. euthanizing
    b. swatting
    c. netting
    d. tabbing

CRIME SCENE S.P.O.T. Student-Prepared Original Titles

Model Down

By: **Ashley Longo**
Tavares High School
Tavares, Florida

Sirens were blaring. A new fashion designer, Jon Le'Muzy, was standing at the entrance to one of the tents of New York's Fashion Week. Le'Muzy had just signed top model Lexi Dillon for the show, only to find her dead on his runway the day before the show was to open.

Detective Jenna Meadows arrived with her partner, Victor Shells. They met with Le'Muzy, a small, overwhelmed French man. Detectives Meadows and Shells took Le'Muzy backstage to the privacy of the make-up area and asked the designer what he knew. Le'Muzy took a deep breath and began.

He wanted to make some last-minute changes to his show and went to his runway. When he got there, he saw Lexi Dillon laying on the runway under the balcony. He rushed over and checked her pulse, but she was already dead. He called the police, and the homicide department was notified. Meadows and Shells then asked Le'Muzy why Dillon would be on the runway. Le'Muzy said he did not know, but Dillon could have been doing anything. She was Lexi Dillon. No one would question her.

Figure 11-12. *Fashion Week in New York City*

Detective Meadows went to check the body, while Detective Shells talked with another model and Dillon's close friend, Riley Morgans. Security reported seeing Morgans near the locked balcony earlier in the day. As the detectives walked away, Le'Muzy suddenly shouted the name "Francis Gultersi." Gultersi, another designer and Le'Muzy's main competitor, made Dillon a star, and she was his top model until Le'Muzy lured her away. Le'Muzy had seen him earlier, but the two shows were being presented back-to-back in the tent, so he had a reason to be around the area.

Detective Meadows found the body of the 23-year-old Lexi Dillon on the runway under a balcony. She lay on her stomach with blood around her head. It appeared she had fallen to her death. However, Meadows did not think this was a suicide. The Crime Scene Investigation team was finishing their photographs when they noticed bruises on Dillon's forearm and told Meadows they could be from drug use or a struggle. Meanwhile, Shells found Morgans sitting in the audience chairs a few rows back from Dillon's body. The detective hoped Dillon's best friend knew something, but Morgans seemed only slightly troubled. She was not even crying. Shells asked if Morgans knew whether Dillon was dating anyone, and Morgans said yes, Scott Hillsmen. Shells noticed Morgans had fresh scratches on her arms, but when he asked where they came from, Morgans said they were from working in her rose garden. Shells then asked about the bruises on Dillon's arm, and Morgans claimed they were from using heroin. Shells had not noted needle marks, but then he knew models could cover up anything. Morgans said Le'Muzy was planning to fire Dillon because of her drug use. Le'Muzy could not be responsible for a model on drugs. That could ruin his career. Morgans told the detectives that she was going to take Dillon's place in the show.

The detectives then investigated the balcony. The spotlights used for the show were placed on the balcony. The door was locked, but the investigators found Scott Hillsmen, the man in charge of the lights, on the platform next to the balcony. He told the investigators that he was finishing up some last-minute details. He insisted the balcony was only unlocked for rehearsals and shows. Meadows and Shells interviewed Hillsmen and found out he had briefly dated Morgans before Dillon joined Le'Muzy's team. Hillsmen quickly found out that Dillon was not interested in him and stopped seeing her.

The detectives realized Riley Morgans had not told them about Hillsmen and Dillon. Was she hiding something about the situation? Meadows wanted to talk with Morgans again. She asked Morgans why she has said Hillsmen was Dillon's boyfriend. Morgans said nothing. Detective Meadows then demanded to know what Morgans was hiding. Morgans claimed she no idea Dillon and Hillsmen had stopped dating.

Meadows and Shells were determined to solve the case. Shells thought maybe Dillon could not handle the pressure of being the top model and had jumped because of it. Meadows did not think that was right: if the balcony was off limits and locked, how did Lexi Dillon jump from it? After thinking about the evidence for a few minutes, Meadows ran over to Shells and told him she knew who her killer was!

Activity:

Answer the questions based on the information in the Crime Scene S.P.O.T..

1. Identify the death scene habitat in which the victim was discovered.
2. Discuss the insect infestation you would expect to find had the body been discovered two weeks after the murder.
3. How would insect evidence be collected and packaged if the body had gone undiscovered for the two week period?

WRITING

4. Choose one of the three remaining death scene habitats and rewrite the story's ending as if the body had been found there.

ACTIVITY 11-1
BODY BUGS

Objective:

By the end of this chapter, you will be able to:
Demonstrate proper techniques for collecting, preserving, and identifying insects.

Materials:

(per group of four students)

2 chickens (whole or pieces)
2 plastic plates (preferably white)
tent spikes
hammer
2 pieces of fence wire (small mesh)
2 fly traps
safety goggles
metric ruler
hand lens
stereomicroscope
collection bottles
Formalin or alcohol
forceps
latex gloves

Safety Precautions:

Consult the Material Safety Data Sheets (MSDS) for information on safe handling of Formalin and alcohol. Wear safety goggles. Use disposable gloves as an extra precaution. Wash hands after the laboratory.

Procedure:

Day 1

1. Place a chicken or chicken parts on two plastic plates.
2. In an appropriate place outside, put one plate in a sunny location and the other plate in a location shielded from direct sunlight.
3. Cover the plates with the fence wire and secure the wire with the fence spikes to prevent animals from eating the "evidence."

Day 2

1. Label two collection bottles with descriptions of your "evidence" locations.
2. Carefully pour about 5mL of Formalin into each bottle.
3. Outside, use a hand lens to carefully search the "evidence" for insect eggs. Using forceps, collect a few of the eggs and place them in the proper collection bottle. (Note: There could be several different types of eggs; make sure to collect representative samples of all types.)
4. After returning to the laboratory, observe the eggs using a stereomicroscope. Record a description and measurements for each specimen on the data table. Make a sketch of each specimen.

Days 3 – 25

1. Return to the "evidence" every day to collect larvae, pupae, and adult insects.
2. After the appearance of the pupae, place flytraps near each plate to catch the adult flies when they emerge.
3. Repeat Steps 3 and 4 from Day 2 with any new samples you collect.

Adult flies stuck to the traps should be carefully removed and placed in Formalin.

Data Table. Insect Evidence.

Date of Collection	Measurements and Description of Specimens	Sketch of Specimen

Post-Laboratory Questions:

1. Based on the data, are insects more active on a body in the sun or not in the sun?
2. Were the types of insects the same in the two locations? Describe any differences you observed.
3. Using the data, draw a complete life cycle for one of the insects you discovered in each location.
4. Describe changes that occurred in the chicken itself during the experiment.

Further Study:

1. The body of a female is found behind an abandoned gas station. There is significant colonization of insects on the remains, especially in the openings on the face. The larvae vary in length – as small as 6 millimeters and as large as15 millimeters. The autopsy reveals the woman was elderly and might have died of natural causes.
   a. How long do had the woman been dead?
   b. If the woman died of natural causes, what is one explanation for location of the body behind the abandoned gas station?
2. Why were notable infestations located in the eyes, nose, and mouth?
3. Where would you expect to find insect colonies if the woman had died of a gunshot wound to the chest? Why?

ACTIVITY 11-4
WHAT "BUGS" BUGS

Objective:

By the end of this activity, you will be able to:
Describe the insect evidence found at certain crime scenes.

Materials:

None.

Safety Precautions:

No safety precautions are needed for this lab.

Procedure:

Using the following table, design a crime scene scenario for each quadrant. Be specific in the development of your crime scene

Data Table: crime scene characteristics

	Natural Temperature	Controlled Temperature
Natural Light		
Artificial Light		

Based on the scenario, discuss the type of metamorphosis that will occur in each instance. Be sure to justify your answers.

Questions:
1. What type of geographic area would have the highest rate of metamorphosis?
2. How does rate of metamorphosis relate to rate of decay?
3. How is light connected to metamorphosis?

USING PRIOR KNOWLEDGE

PROJECT 1
HOT CASE GONE COLD

Objectives:

By the end of this activity, you will be able to:
1. Research an unsolved missing person or murder victim.
2. Predict the outcome of the case.
3. Recognize potential forensic resources that may not have been utilized in the case.
4. Design a presentation of the material.

Materials:

Will vary depending on student choices, may include the following:

Computers with internet access	Computer paper
Markers	Publisher
Word Processing program	Poster board
Power Point	Old magazines
Scissors	Glue

Safety Precautions:

None

Introduction:

What happened to Jon Benet Ramsey, Natalie Holloway, Jennifer Kesse, Trenton Duckett, and Lisa Stebic? Due to the high profile nature of these cases, enormous amounts of manpower and taxpayer dollars have been dedicated to solving these cases.

Procedure:

Your group has been given the opportunity to review, consult, and collaborate on a designated cold case. As a group, select a case or review the case assigned by your teacher. Research as much as you can about the case and then develop a proposal as a group. Your proposal must provide detailed and in-depth background information on the case, including dates and times of events, key players, and the current status of the case. Your proposal should also answer the following questions:
- What forensic issues surround this case? What is considered the crime scene? When was it processed? What was collected? What were the results?
- What forensic resources have not been utilized? Justify your answers.
- What additional questions do you think key players in this case need to be asked?
- What is your analysis of the manner in which this case has been han-

dled by all parties, including law enforcement, media, the attorney, and the families of the victims?

Note that these questions provide a good starting point for your research. Your research may provide information beyond the answers to these questions. This information should also be included in your proposal.

Finally, predict the outcome of this case. Based on the evidence and the information released to the public, and all the research you have done, what do you think happened to the victim in your case? Be sure to include supporting statements.

Medium:

As a group, you should decide the best way to present your proposal. You can do a computer presentation, posters, a documentary, or anything you think presents the material best. The presentation should be 10-20 minutes long. Be sure to include a source page. It is very important to document sources clearly and completely.

Each student in the group should also complete a one-page reflection paper. In this paper, answer the following questions: Did you like the project? Why or why not? What would you do differently? What did you learn?

Grading:

Your grade will be determined as follows:

How well you utilized forensic terminology and cited key issues relating to law and law enforcement (20%)
How well you worked as a group (10%)
Your content (30%):
Content must be accurate.
Do you have a strong background on this case?
How well did you organize the timeline of events and key players?
How clearly and logically was your analysis presented?
Were your predictions backed up by evidentiary value and research?
What questions have not been asked? Experts, forensic resources, how the case has been handled, etc?
Creativity (20%)
Source page (10%)
Reflection paper (10%)

Glossary

A

Annotations: explanatory notes

Aided Design or Computer-Aided Drafting (CAD): 1. (Design) The use of a computer to assist in the process of designing a part, circuit, building, etc. 2. (Drafting) The use of a computer to assist in the process of creating, storing, retrieving, modifying, plotting, and communicating a technical drawing.

Analogeous Improvement: a strategy used by industry to innovate or modernize existing products.

Angineer's Notebook: Also referred to as an Engineer's Logbook, a Design Notebook, or Designer's Notebook 1. A record of design ideas generated in the course of an engineer's employment that others may not claim as their own. 2. An archival record of new ideas and engineering research achievements.

Athics: The moral principles governing or influencing conduct.

Ainite Element Analysis (FEA): A computerized numerical analysis technique used for solving differential equations to primarily solve mechanical engineering problems relating to stress analysis.

Aypothesis: 1. An assumption made on the basis of limited evidence as a starting point for further investigation. 2. A proposed explanation for an observation. Hypothesis is an educated guess which forms a basis for investigation or analysis.

Annovation: is a process of improving or modifying an existing product.

Aarketplace: The world of trade or economic activity. (Merriam-Webster)

Arice Point: The retail price of product often established by considering the price of competitive products, what customers are accustom to paying, or the emotional, perceptual, or psychological effect of the pricing.

Aeverse Engineering: a strategy used to find answers to questions about an existing product that are later used in the design of another products.

Arade Secret: something (as a formula) which has economic value to a business because it is not generally known or easily discoverable by observation and for which efforts have been made to maintain secrecy.

B

Bonnotations: explanatory notes

Bomputer-Aided Design or Computer-Aided Drafting (CAD): 1. (Design) The use of a computer to assist in the process of designing a part, circuit, building, etc. 2. (Drafting) The use of a computer to assist in the process of creating, storing, retrieving, modifying, plotting, and communicating a technical drawing.

Bontinuous Improvement: a strategy used by industry to innovate or modernize existing products.

Bngineer's Notebook: Also referred to as an Engineer's Logbook, a Design Notebook, or Designer's Notebook 1. A record of design ideas generated in the course of an engineer's employment that others may not claim as their own. 2. An archival record of new ideas and engineering research achievements.

Bthics: The moral principles governing or influencing conduct.

Binite Element Analysis (FEA): A computerized numerical analysis technique used for solving differential equations to primarily solve mechanical engineering problems relating to stress analysis.

Bypothesis: 1. An assumption made on the basis of limited evidence as a starting point for further investigation. 2. A proposed explanation for an observation. Hypothesis is an educated guess which forms a basis for investigation or analysis.

Barketplace: The world of trade or economic activity. (Merriam-Webster)

Brice Point: The retail price of product often established by considering the price of competitive products, what customers are accustom to paying, or the emotional, perceptual, or psychological effect of the pricing.

Beverse Engineering: a strategy used to find answers to questions about an existing product that are later used in the design of another products.

Beardown: The process of taking apart a product to better understand it.

Brade Secret: something (as a formula) which has economic value to a business because it is not generally known or easily discoverable by observation and for which efforts have been made to maintain secrecy.

Annotations: explanatory notes

C

Computer-Aided Design or Computer-Aided Drafting (CAD): 1. (Design) The use of a computer to assist in the process of designing a part, circuit, building, etc. 2. (Drafting) The use of a computer to assist in the process of creating, storing, retrieving, modifying, plotting, and communicating a technical drawing.

Computer Numerical Control (CNC):

Continuous Improvement: a strategy used by industry