

# Forensic Entomology: The Use of Insects in the Investigation of Homicide and Untimely Death

by Wayne D. Lord, Ph.D. and William C. Rodriguez, III, Ph.D.



## Editor's Note

*Special Agent Lord is currently assigned to the Hartford, Connecticut Resident Agency of the FBI's New Haven Division. A graduate of the Universities of Delaware and New Hampshire, Mr. Lord has earned degrees in biology, entomology and zoology. He formerly served in the United States Air Force at the Walter Reed Army Medical Center in Washington, D.C., and the F. Edward Hebert School of Medicine, Bethesda, Maryland.*

*Dr. Rodriguez currently serves as the forensic anthropologist for the Office of the Medical Examiner, Onondaga County, Syracuse, New York. A graduate of the University of Tennessee, Dr. Rodriguez has earned degrees in biology and anthropology.*

*Dr. Rodriguez also serves as Assistant Professor of Anthropology, Syracuse University and Clinical Professor of Pathology, State University of New York, Medical School.*

## Introduction

**O**n June 4, 1984, the partially clad body of a young female was found alongside a rural highway in the northwestern United States. An autopsy revealed that the victim had died of multiple wounds to the head and neck, inflicted by a heavy sharp object. The victim was subsequently identified as a 14-year-old prostitute who had

reportedly been living in and frequenting the area for several weeks. The young lady had been reported missing by her brother approximately four days prior to discovery of her body.

An investigation conducted by federal, state and local authorities revealed that she had last been seen alive on the morning of May 31, 1984, in the company of a 30-year-old army sergeant, who became the primary suspect. While considerable circumstantial evidence supported the evidence that the victim had been murdered by the sergeant, an accurate estimation of the victim's time of death was crucial to establishing a link between the suspect and the victim at the time of her demise.

Several estimates of postmortem interval were offered by medical examiners and investigators. These estimates, however, were based largely on the physical appearance of the body and the extent to which decompositional changes had occurred in various organs, and were not based on any quantitative scientific methodology.

While processing the crime scene, investigators observed and collected numerous fly larvae (maggots), adult flies, and other insects from in and around the victim's wounds. Some of these insects were placed alive in small containers and subsequently reared by forensic entomologists to adulthood. Others were placed immediately into a liquid preservative. Additional specimens were collected during the autopsy and were processed in a similar manner. Numerous photographs depicting the crime scene, the surrounding vegetation and terrain, and the victim's body were taken. These photographs were examined by forensic entomologists and included enlargements illustrating the adult flies and maggots present at the time the body was discovered.

Reports describing the condition of the body when found and detailing autopsy procedures and results were also reviewed. Climatological data, including maximum and minimal temperatures, incidence of rainfall, cloud cover, wind speed and direction, and relative humidity were obtained from a government weather station located a short distance from where the victim was found. These data were utilized as indicators of the environmental conditions to which the victim's body and the inhabiting insects were exposed.

Based on this information and a detailed examination of the insects collected from the victim's remains, forensic entomologists determined that the first insects to colonize the victim's body had arrived on May 31, 1984. The postmortem interval, therefore, as indicated by the insect evidence, was determined to be four days.

As a direct result of the forensic entomological evidence of the time of the victim's death and other circumstantial evidence acquired during the investigation, the 30-year-old army sergeant with whom the victim had been last seen alive was arrested and charged with first degree murder. A short time later, he admitted to having murdered the victim by striking her six to eight times with a small hand-held hatchet sometime around noon on May 31, 1984. Subsequently, he entered a plea of guilty to the murder charge and was sentenced to life in prison without the possibility of parole.

This case vividly illustrates how insect evidence collected from in, on, and around the body of a victim of untimely death, when properly collected, preserved and analyzed by an experienced and appropriately trained forensic entomologist, can provide an accurate estimate of the victim's time of death, as well as other forensically valuable information concerning the circumstances surrounding the victim's demise.

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Within the United States and around the world insect scientists (entomologists) are being called upon with increasing frequency to apply their knowledge and expertise to criminal and civil proceedings and to become recognized members of forensic laboratories and medical/legal investigation teams. This need has given rise to an entomological sub-speciality termed “forensic entomology.”

### Characteristics of Insects

Insects are members of the class Insecta in the invertebrate phylum Arthropoda. As a group, insects are probably the most successful and numerous creatures on earth. Over 900,000 species are known and it is estimated that this represents only 1/5 to 1/10 of the insect species that actually exist. Currently, there are about three times as many known insect species as there are species of all other animals combined. In just the Nearctic region (that part of North

America lying north of Mexico), the insect fauna includes an estimated 125,000 to 150,000 species. In contrast, only about 3,200 species of mammals are known in the entire world.

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Insects are highly adaptable creatures and can be found in nearly every conceivable habitat and situation. Annually, insects destroy millions of dollars worth of agricultural crops. They serve as vectors for the causative agents of many of the worst diseases of man and domestic animals. In addition, they bite, sting and attack man and animals directly, causing irritation, blood loss, and in some cases even death.

Insects, however, are also extremely beneficial, providing such products as bee's wax and honey, silk, shellac, and many of the basic components of cosmetics. For many years insects have been used extensively in the scientific laboratory and have greatly enhanced progress in nearly all aspects of biological and medical research. In certain regions of the world insects are even valued as a protein-rich food source.

Although there is much that can be said both for and against insects as they relate to man, the vast majority of insects are quite neutral, neither bestowing any great benefit nor causing any great harm.

Insects include such well known creatures as flies, mosquitoes, grasshoppers, cockroaches, termites, beetles, butterflies and moths, wasps and bees, fleas and lice. Insect adults can be differentiated from most other animals by several rather distinct traits. Among these are a hardened outer body called an exoskeleton, which is subdivided into a distinct head, thorax and abdomen; three pairs of jointed legs attached to the thorax; a single pair of antennae located on the head; large compound eyes; and one or two pairs of wings.

With few exceptions, adult insects lay eggs. Immature insects emerging from some eggs look very much like their parents, except that they are smaller in size and wingless. These immature insects, called nymphs, periodically cast their skins (moult), as they increase in size. Each stage between moults is termed an instar. Eventually, nymphs pass through a final moult and display all the characteristics of adults. Grasshoppers, cockroaches, and the young of several other groups grow in this gradual fashion.

Most insects, however, pass through three very different stages during their development, namely, egg, larva, and pupa. None of these stages bears any resemblance to any other stage or to the adult. Larva, which hatch from these eggs, are often soft-bodied and resemble caterpillars, maggots, or grubs. As they grow, these larvae also cast their skins (moult) as they increase in size. The number of larval moults varies dramatically from insect group to group. Eventually, however, these larvae surround themselves with a hardened cocoon-like outer skin in which they undergo their final pre-adult development. This stage is called the pupa. Fully formed adult insects eventually emerge from the pupal enclosure. Butterflies, moths, flies, beetles, and numerous other insect groups develop in this manner. Most of the forensically important insect species pass through this latter type of development.

### Insects and Human Decomposition

Apart from the bacteria and fungi, insects are the most important processors of dead animal remains. A wide variety of carcass-frequenting specialists utilize decomposing materials both as a food source and as a place to rear their young. Animal studies have shown that carcasses left uncovered and freely exposed to insects lose up to 90% of their weight within a week during the summer months. In contrast, carcasses covered with mesh to prevent insect access, gradually dry out and mummify over a period of more than 100 days.

Because decomposing animal remains occur relatively infrequently and are widely scattered throughout the environment, insects which specialize in utilizing these resources have evolved highly developed methods of carcass detection (smell) and locomotion (flight). Initially, strong flying insects, particularly flies, are attracted to the odors produced by gases and body fluids oozing from the natural body openings and to blood escaping from wounds. In time, the skin, underlying organs, flesh, and bone become attractive to other groups of scavenging insects. Insects are responsible for the consumption of virtually all parts of the

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carcass except the skeleton. As a carcass decomposes, therefore, it can be viewed as a succession of habitats each attractive to, and supporting, a different group of specialized insects. Although the exact species may differ from country to country, from habitat to habitat, and from season to season, the basic pattern of the succession of insect decomposers is remarkably constant around the world.

Human corpses, whether they have been produced naturally or as the result of foul play, are processed by these insect decomposers in the same manner as any other piece of animal carcass. Forensic entomology, therefore, is based on the analysis of the insects and other invertebrates which sequentially colonize a corpse as decomposition progresses and on the rates at which the various stages of their offspring develop. Entomological information can be extremely useful in determining manner of death, movement of a cadaver from one site to another, and length of the post mortem interval.

### The Importance of Blow Flies

While a wide variety of insect species are attracted to decomposing remains and play an active roll in the decay process, two groups, the flies (Diptera) and beetles (Coleoptera), are of major importance in most circumstances. Diptera (flies), whose larvae are capable of living in a semi-liquid medium, are the first insects to be attracted to and colonize decomposing remains. Fly larvae (maggots) are responsible for the dramatic consumption of the cadaver's organs and tissues. Only much later, when the corpse has to a large extent dried out, do the species of other insect groups, notably Coleoptera (beetles) move in and continue the process.

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Large, strong flying, highly mobile flies are typically the first insects to be attracted by the faint aromas emanating from a fresh corpse. Blow flies (family: Calliphoridae) frequently arrive within minutes to a few hours after death, and are generally the first individuals to arrive at a crime scene. Blow flies arriving at a corpse either begin to lay eggs immediately, or first feed on the protein-rich fluids emanating from the corpse and then begin oviposition. Initially these flies feed and lay eggs in the natural body openings (ears, eyes, nose, mouth, and if exposed, the anus and genitalia). This is due to the fact that blow fly adults have soft, tongue-like mouth parts which are not capable of piercing human skin. Natural body openings also provide moist, humid cavities which enhance egg hatching and larval survival.

Blow fly eggs are small (2 to 3 mm.), whitish-yellow, and somewhat elongate. They are frequently packed into natural body openings in large numbers and are easily visible to the naked eye. During colder months, however, their numbers may be few and they may be difficult to locate, hidden in more cryptic sites, such as under the eyelids or within the nostrils. Blow fly eggs will typically hatch within one to three days, depending on species and environmental conditions. When blow fly eggs hatch, they produce small, relatively featureless, worm-like creatures called larvae or maggots. Blow fly larvae have a tapered anterior end containing a pair

of mouth hooks which the larvae use in feeding and also for locomotion. Posteriorly the larvae bear a pair of flattened nostrils called spiracles, through which they breathe. These features, along with the larvae size and shape, provide important diagnostic features.

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The larvae grow rapidly, passing through three moults (instars) before becoming fully grown. Large numbers of larvae typically hatch together and move around the corpse as a group. Blow fly larvae are responsible for disseminating bacteria and secreting enzymes which enable them to consume virtually all of the soft tissues contained within the corpse. Blow fly larvae become fully grown within several days to several weeks depending upon species, environmental conditions, and the number of larvae present.

After reaching the third instar, larvae undergo a dramatic behavioral change in which they crawl away from the corpse, burrow down into the soil, and pupate. As previously mentioned, the process of pupation involves the secretion of a hardened outer skin or casing around the body of the larvae. Within this pupal case the larvae undergoes complete physical reorganization and eventually emerges bearing all of the adult fly characteristics. Blow fly pupae are small, football-shaped structures which are reddish to dark brown in color. Pupal cases are extremely resilient and will in some cases remain in the soil beneath the corpse for hundreds of years. Blow fly pupal cases can supply valuable information long after the remains of the body have decomposed. Only through careful examination of the soil either beneath the corpse or at a site where a corpse is reported to have decomposed will this valuable entomological evidence be found.

Blow fly species differ in their abundance from region to region, from habitat to habitat, and from season to season. In the northern United States, for example, the blue blow fly, *Calliphora vicina*, is most abundant during the cooler parts of the year, whereas the bronze blow fly, *Phaenicia sericata*, dominates corpses during the warmest parts of the summer. Similarly, the green blow fly, *Lucilia illustris*, frequents corpses located in the open, brightly lit habitats, whereas the black blow fly, *Phormia regina*, prefers shaded localities.

The careful analysis of the physical characteristics of the various developmental stages of the blow flies inhabiting the corpse, when coupled with the detailed knowledge of their ecology, biology, and the environmental conditions to which they are exposed can provide forensic investigators with meaningful information concerning the time of death, movement of the corpse from one site to another, and manner of death.

## Beetles and Their Allies

Following the invasion of the corpse by blow flies, a wide variety of other types of insects also colonize the remains. Carrion beetles, rove beetles, clown beetles, sap beetles, checkered beetles, scarab beetles, and dermestid beetles all become members of the host corpse community feeding and rearing their young on the drier remaining tissues and on the large maggot mass. Additionally, other types of flies including house flies, flesh flies, skipper flies, fruit flies, and coffin flies, also colonize the remaining tissues. The corpse eventually comes to support a complex and diverse community of insects often numbering hundreds of species and thousands of individuals. These insects, while far less numerous than the blow fly larvae which originally colonize the remains, can be seen flying, crawling, and scurrying about the corpse itself and in the soil beneath the remains.

As previously mentioned these insects are attracted to the corpse in an orderly, progressive fashion. The successive nature of the colonization process enables forensic entomologists, when supplied with a representative sample of the insects present, to provide investigators with forensically meaningful information concerning the circumstances surrounding the demise of the individual. Essentially, by knowing the players on the field at the time that the corpse was found, forensic entomologists are able to determine the inning of the game.

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## Collection and Preservation of Specimens

Accurate forensic determinations depend upon the proper collection, preservation, and rearing of entomological specimens. In order to accomplish this, investigators must be able to recognize adult and immature stages of locally abundant, carrion frequenting insects and be familiar with the proper techniques for collecting and preserving these animals. Representative samples of all adult and immature insects should be collected from on, in, and beneath the corpse. Flying insects can be collected with the standard insect or short-handled hand net. It is important to make

collections as soon as possible as specimens of adult flies may leave the area surrounding the corpse when human activity becomes evident. Once collected, adult specimens can be retained indefinitely for analysis. Adult flying insects can be immediately placed in 70% ethanol or isopropyl alcohol diluted 1 to 1 with water. Higher concentrations of isopropyl alcohol may cause specimens to become brittle. Do not use formalin to preserve insects, unless no other preserving fluid is available. Insects preserved in formalin should be transferred to 70% alcohol as soon as possible. A small hand net and preserving fluid can easily be carried as part of standard equipment.

Crawling insects from the surface of and within the corpse should be collected using forceps or the fingers. During sampling, hands should be protected with surgical gloves at all times. Smaller specimens (under 5 mm) can be collected with a small artist's paint brush dipped in a preserving fluid. Crawling insects located on the ground beneath the corpse can most easily be collected by scooping up the top few centimeters of soil and placing it in a plastic bag. The plastic bag containing the soil should be chilled, if possible, until the insects are extracted and preserved to prevent further growth and possible predation or asphyxiation. This is particularly important when large numbers of fly larvae are present.

As previously mentioned, some insects, particularly mature fly larvae and beetles, will burrow into the soil beneath the corpse. A careful examination of the soil beneath the corpse is important, particularly in cases of advanced decay. This analysis is most easily accomplished by removing large samples of soil from beneath the area where the corpse was located. These samples should be placed in plastic bags and refrigerated until they can be processed by a trained entomologist or laboratory technician.

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When skeletal remains are encountered in the field, a close examination of the bones and surrounding soil must be made prior to the skeletal removal. Close examination of bone cavities will usually produce numerous insect remains. The skull should be most closely examined, particularly inside the cranial vault. The skull should be placed on a white sheet or large piece of white paper, and the eye orbits, nasal openings, cranial vault, and auditory meatus probed with a pair of forceps and a penlight. The interior of the skull can then be gently washed inside and outside with water, while being held over a small collection screen or cheese cloth.

Immature and soft-bodied insects, particularly the larvae of blow flies, are critical to an accurate forensic analysis. Representative samples of fly larvae, including the largest individuals present, should be collected and immediately

subdivided into two subsamples. One subsample can be preserved immediately and the other should be saved alive for rearing to adult stages. Sufficient numbers of individuals should be collected to ensure that a representative sample of the insect population is present. Samples of fly larvae to be immediately killed can be preserved by placing them in hot water (170 degrees Fahrenheit) for two to three minutes and then transferring them to 70% ethanol. Various alternative larvae preservatives can be used, depending upon the availability of the chemicals. Specimens for rearing should be placed alive in small ice cream cartons or similar containers 1/4 to 1/2 filled with a coarse inert material such as vermiculite. Moist soil can be used, if other materials are not available. Do not put living specimens to be reared, in sealed plastic bags or sealed vials for longer than 12 hours, since they do poorly in such environments, especially in warm weather. Transport living material by the fastest possible means to a rearing facility. Use of the regular mail service usually is not suitable for transporting material.

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Immature flies can be successfully reared on diets of beef liver, or on small pieces of musculature obtained from the corpse. Larvae should be gently transferred with forceps onto the dietary material which has been previously placed atop a 4 to 8 cm. deep container filled with damp, coarse soil or vermiculite. Small glass dishes, 8 to 10 cm. in diameter or beakers are suitable. These cultures should contain 15 to 25 larvae each. Larval activity should be checked daily and a record of larval size and instar recorded. Additional liver can be added to these cultures as needed. Mature larvae will migrate downward into the substrate and pupate. Adult flies will eventually emerge, crawl to the surface and attempt to fly away. Because of this, rearing conditions should be placed inside standard insect-rearing cages or other mesh containers that will prevent adult flies from dispersing.

Whenever possible, fly larvae should be reared in climatic conditions approximating those to which the corpse was exposed. Environmental chambers are useful, if available. Temperature is the most critical factor. Calculations of the average time interval required for each developmental stage (larval instars, pupa and adult emergence), allow accurate determination of corpse colonization, and time of death.

It may be helpful to allow emerged adult flies to feed for 24 hours on a cotton pad or ball soaked with a small amount of Gatorade. This insures that their outer skins will harden, and accurate species identifications can be made. Emerged adult flies can be placed in 70% ethanol or pinned and stored

in insect boxes. Immature beetles need not be reared and should simply be placed in 70% ethanol for identification.

Additional observations concerning any other kinds of animals and plants found in and around the corpse may provide supplemental information about the time, cause, and location of death. Collect samples of any unusual specimens such as ants, fleas, body lice, seaweeds, etc. Likewise, representative samples of specimens encountered at autopsy should be collected for analysis. Any specimens collected during the autopsy can be processed as previously described. Marine and aquatic plants and animals are best preserved in 10% neutral buffered formalin.

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Containers which contain preserved and living specimens should be labeled in the following manner:

1. Date collected
2. Time collected
3. Location of remains (as precise as possible)
4. Area of the body infested
5. Name, address and telephone number of the collector

If the specimens are to be shipped long distances for analysis, package containers and vials of preserved specimens in well-cushioned boxes to avoid breakage and ship by the most convenient means. If shipped by regular mail, wrap each vial individually in a padding material such as cellulocotton and place each vial individually in a box surrounded by styrofoam chips on all sides. This will minimize the possibility of breakage during shipping. Clearly mark the box “Liquid in Glass”. This will generally receive gentler handling by the Post Office.

Containers of soil samples and other living specimens should be kept in relatively cool, well-ventilated, environments. Time is critical if accurate information is to be obtained by living material. Thus these materials must be shipped by the most rapid means.

As with other types of physical evidence, take care to insure a continuous, well documented chain of legally acceptable evidence possession.

### Description of Locality

An accurate, detailed description of the habitat in which the corpse was found is important to forensic entomologists. Whenever possible, written descriptions should be accompanied by a complete set of crime-scene photographs which illustrate the general habitat type, the terrain, the type of vegetation, type of soil, and the extent to which the corpse is exposed to sunlight.

Detailed photographs of the corpse are also necessary, including photographs which illustrate the sex, age, height and weight of the remains, the presence and extent of clothing, the orientation of the corpse when found, the extent

of trauma, the extent and degree of decomposition, and close-up photographs of inhabiting insects.

Because climatic conditions have a profound effect on the development of immature insects, the most accurate data available describing these conditions at the location where the corpse was found is of critical importance. Whenever possible, record maximum and minimum temperature values at the scene as soon as possible after discovery. Obtain climatic data from the nearest National Oceanic and Atmospheric Administration (NOAA), weather station, for the entire estimated post mortem period and for a two to three week interval before the estimated time of death. Additionally, any information available concerning daily rainfall, cloud cover, and wind speed and direction, should be obtained if available.

### Additional Case Histories

In early Spring, the fully-clothed body of a young, white male was found in a sandy, shrub habitat, in the southwestern United States. The victim had died of multiple gun shot wounds to the chest and back inflicted by a small caliber hand gun. While little evidence of decomposition was evidenced externally, a small amount of blood was observed to have oozed from the victim's left nostril and partially coated his left eye.

Crime scene investigators noted and collected a small atypical granular mass from the surface of the victim's left eye. Examination of this substance in the crime laboratory a short time later revealed the material was a small mass of blow fly eggs and that several had hatched.

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The newly hatched blow fly larvae were allowed to grow and were subsequently identified as *Cochliomyia macellaria*, commonly known as the secondary screw worm. Based on the climatic conditions to which the corpse was believed to have been exposed and a knowledge of the developmental biology of this fly, it was determined that the eggs had most likely been laid on the corpse for 24 to 36 hours prior to the time the body was found. Subsequent investigation determined the victim's identity and the fact that he had last been seen alive in the company of a male companion approximately 36 hours prior to the time his body was found. It was later determined that the victim had been murdered by his companion 36 hours prior to his detection.

In this case, blow fly eggs, collected from the remains and analyzed in a timely manner, provided investigators with an accurate estimate of the post mortem interval and allowed them to more narrowly focus their investigative efforts, enhancing their ability to identify the victim and to bring the case to a reasonable solution.

Similarly, in early summer, the body of a young, unidentified, white female was found at the end of a logging road in a rural section of the northeastern United States. Investigators revealed that the unidentified young woman had died from a single gunshot to the right side of the head inflicted by a 12 gauge shotgun. While processing the crime scene, investigators collected representative samples of adult and larval blow flies which had infested the area of the wound.

These samples were immediately preserved and transported to the forensic science laboratory. Subsequent analysis of the samples revealed that both adults and larvae of the black blow fly, *Phormia regina*, were present. It was determined that the blow fly larvae were in the third instar stage.

Climatic information, including maximum and minimum temperature, rainfall, wind speed and direction, cloud cover, and relative humidity were obtained from a nearby weather station. Based on the climatic conditions to which the body was believed to have been exposed and on the age of the larval blow flies collected from the corpse, it was estimated that the flies colonized the remains and began laying their eggs 5 to 6 days prior to the time the body was found.

Based on this information, investigators circulated a request for missing person reports fitting the generalized description of the unidentified woman, and having originated 5 to 6 days prior to the time that she was found, to all state and local police departments in the adjoining areas. Eventually the identity of the victim was determined and investigation focused upon the young girl's boyfriend with whom she had last been seen alive.

Subsequently, as more evidence in the case was developed and an arrest warrant was about to be issued for the young man, investigators were notified that he had committed suicide in a nearby hotel room leaving a suicide note stating that he had murdered his girlfriend five days prior to the time that her body was found.

In this instance, blow fly larvae provided investigators with the only scientifically reliable estimate of the victim's time of death. With this information, investigators were again able to more narrowly focus their investigative efforts, identify the victim, and bring the case to a reasonable conclusion.

Recently, the badly decomposed body of a young, white female was found in a clearing adjacent to a sanitary landfill in the eastern United States. Large numbers of fully mature, third instar, blow fly larvae were present throughout the corpse. The young woman was subsequently identified as a local prostitute who frequented truck stops and diners along a major, nearby highway.

Laboratory analysis of the specimens collected revealed that all were black blow flies, *Phormia regina*. Forensic entomologists immediately recognized that the habitat in

which the body was found was not typical of the environment normally inhabited by black blow flies. Subsequent tests using liver and small animal carcasses revealed that only bronze blow flies, *Phaenicia sericata*, were present at the landfill site where the body was found. Thus, it was concluded that the young woman's remains had not decomposed at the site where found, but rather that the body was moved from a different, more shaded environment where it had been colonized by black blow flies.

In the southeastern United States, police were called to investigate a foul smelling odor which was emanating from a small single family home in a rural section of town. Investigating officers soon discovered the badly decomposed body of a young, black female in a shallow grave in the dirt basement of the dwelling.

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The victim had died of a single gunshot wound to the head, inflicted with a small caliber rifle. Subsequently, a careful examination of the corpse and a detailed excavation of the soil in and around the grave site revealed the presence of numerous larvae of the blue blow fly, *Calliphora vicina*, and larvae and pupae of a relative of the house fly, *Synthesiomia nudesita*.

Specimens collected from the scene were reared in the laboratory to adults. Supplemental information, including climatic data and soil temperatures, were reviewed in an effort to determine the climatic conditions to which the developing flies were exposed. Using information on the developmental biology of both of these species of flies, forensic entomologists were able to estimate that the victim had died and was colonized by flies approximately 28 days prior to the time that she was found.

Once provided with this information, investigators were able to target their investigation in and around the time of the victim's demise. Shortly thereafter a suspect was developed and this individual eventually confessed to having killed the victim 28 days prior to the time the body was located, and having attempted to bury the victim in a shallow grave located in the basement of the house shortly after committing the homicide.

In this case, larvae of multiple species of flies provided investigators with the only scientifically reliable method of estimating time of the victim's death.

Several years ago a young woman was attacked and brutally raped in a suburban Chicago wood lot by a man wearing

a ski mask. Investigators quickly developed a suspect and armed with a search warrant seized a ski mask similar to the one described by the victim from the suspect's apartment. When questioned about the ski mask the suspect informed investigators that the ski mask was indeed his but that it had not been used since the previous winter.

Investigators observed large numbers of cockle burrs and other vegetation attached to the surface of the mask. The mask and its associated vegetation was brought to a forensic entomologist for analysis. Following a careful dissection of the cockle burrs attached to the mask, the entomologist was able to locate several small caterpillars inside the vegetation. The insects were subsequently identified and information concerning their development collected and reviewed.

*“Prosecutors, police, pathologists, and others involved in solving violent crimes should become fully aware of the complex ecology of the decay process, the important role which insects play in decomposition, and necessity of collecting representative specimens and supplemental field data.”*

It was subsequently determined that the caterpillars within the cockle burrs had a one year life cycle, with adults being active in the spring, laying eggs in early summer. Larvae or caterpillars developed within the cockle burr vegetation during mid to late summer, undergoing pupation during the winter, and emerging as adults the following summer. The entomologist was thus able to inform investigators that the mask had been present in the outside environment during mid to early summer of that year, around the time the rape occurred. Armed with this information, investigators confronted the suspect and he subsequently confessed to having committed the rape.

In this case, analysis of vegetation associated with evidence collected from a crime scene enabled investigators to

accurately link the suspect to the crime scene at or about the time of the crime.

Recently, several small children were brought to a local hospital emergency room suffering from widespread diaper rash, malnutrition, and generalized neglect. A physical examination revealed that the anal and genital areas of these children were infested by fly larvae. Samples of the invading fly larvae were collected, preserved, and forwarded to forensic entomologists for examination.

An analysis of the fly larvae infesting the young children revealed that they had been present on the children for a minimum of four to five days. This information was used as an indicator of the minimum amount of time which had passed since the children had their diapers changed, and were properly cleaned and cared for. The entomological information was the only data available which provided quantitative information accurately determining the length of time the children had been without care. The entomological evidence provided crucial information in subsequent hearings concerning the welfare of the children.

## Conclusions

Forensically important insects can be a powerful tool in investigations of homicide, untimely death, and other violent crimes. Accurate forensic determinations are possible, however, only when representative specimens are recognized, properly collected, preserved, and forwarded in a timely manner to qualified forensic entomologists for analysis. Prosecutors, police, pathologists, and others involved in solving violent crimes should become fully aware of the complex ecology of the decay process, the important role which insects play in decomposition, and necessity of collecting representative specimens and supplemental field data. More information about this subject and experts in this field can be obtained from Dr. Wayne D. Lord, Special Agent, Federal Bureau of Investigation, P.O. Box 3659, Central Station, Hartford, Connecticut 06103 or Dr. William C. Rodriguez, III, Forensic Anthropologist, Onondaga County Medical Examiner's Office, Syracuse, New York.

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