kill cattle, by introducing venom-impregnated cloth into the rectum. Use of an injection to introduce venom would likely be noticed by the victim and should leave some mark. As death is rarely very rapid, there would usually be time for the victim to make known that he/she had been attacked, but this might not always be the case. Introduction of a venomous animal, especially a snake or scorpion, into sleeping quarters, might also result in effective homicide, which, if within the normal distribution of the animal, might go unproven or undetected. Though not discussed elsewhere in this article, it should be noted that a number of toxins, particularly from marine animals, can prove lethal if ingested, so could be introduced via a meal. Indeed, some poisonous fish (fugu fish, which contain tetrodotoxin) are routinely eaten in some countries, a mild degree of poisoning being a desired effect. Plant toxins are also used for suicide in some countries. Another bizarre possibility is the use of "snakebite" to hide some other form of homicidal poisoning, some device being used to mimic fang marks and introduce poison into the victim (e.g., the use, in India, of *Abrus precatorius* poison, injected by paired sui (sharp spikes), mimicking snakebite, used to hide felonious killing of cattle or even humans). Careful examination of the wound and pattern of effects may reveal the true cause in such cases.

See Also

Animal Attacks and Injuries: Fatal and Nonfatal; Predation; **Autopsy, Findings:** Organic Toxins

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VETERINARY ASPECTS OF FORENSIC MEDICINE, WILD ANIMALS

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Introduction

Prior to 1975, the application of forensic science protocols to animal- and wildlife-related evidence was mostly limited to tentative family, genus, and species identifications of blood stains and loose hairs found at human crime scenes. These identifications were usually based upon immunodiffusion tests using relatively nonspecific antisera, and microscopic comparisons utilizing small collections of knowns. The results were frequently more useful in eliminating a suspect (i.e., the blood on the suspect's shirt is not of human origin) than in trying to link suspect, victim, and crime scene.

During this time period, applications of forensic protocols to wildlife law enforcement were generally limited to the identification of blood, meat, and hair from locally hunted species, utilizing the same immunodiffusion and microscopic comparison techniques. The few laboratories that performed this work were uniformly understaffed (one or two scientists), underfunded, and lacking in comprehensive comparison collections.

On July 1, 1975, 80 nations formally agreed to work together to enforce each other's endangered-species laws through the establishment of the Convention on International Trade in Endangered Species Fauna and Flora (CITES) (www.cites.org). This international agreement, although voluntary in scope, encouraged the enforcement of import and export laws related to lists of endangered, threatened, and protected species. In doing so, the agreement also

raised an underlying forensic issue: that illegal trafficking of regulated species would be in the form of parts and products, and that species-specific identifications would be needed to enforce the CITES regulations in courts of law. Thus the need for wildlife forensics on an international scale was born.

In 1986, in response to this need, the US established the National Fish and Wildlife Forensics Laboratory in Ashland, OR (www.lab.fws.gov) (**Figure 1**). The mission of the laboratory is to develop reliable wildlife forensic procedures, and to provide forensic support to wildlife law enforcement officers at state, federal, and international levels. In 1993, at a meeting of the Environmental Crimes Group of Interpol in Lyons, France, the role of the laboratory in assisting CITES and Interpol was documented in the form of signed letters of agreement. The laboratory works with scientists and law enforcement officers from the CITES and Interpol organizations to develop continually and refine reliable methods of identifying wildlife parts and products. They also work to link suspect, victim, and crime scene in suspected criminal cases.

While the science of wildlife forensics is still very much in its infancy, numerous protocols have been established for the identification and comparison of wildlife-related evidence. These protocols are typically divided into the following analytical categories:

1. pathology
2. molecular biology (genetics)
3. morphology
4. criminalistics
5. analytical chemistry.

Pathology

Veterinary pathologists are responsible for determining cause of death of an animal carcass submitted as evidence. This is accomplished through necropsy (autopsy) protocols involving a search for lethal wounds caused by bullets, arrows, spears, and traps. A comprehensive toxicological workup of blood, urine, tissue, and stomach/crop contents to eliminate or confirm a poison or a contaminant as a cause of death; and a professional evaluation of the underlying health of the animal prior to death may also be carried out. In the process of conducting these examinations, the veterinary pathologist will also search for signs of disease vectors that may indicate a natural cause of death.

Issues that often complicate a cause-of-death determination in an animal (but should not impact the results of a careful and professional necropsy examination), include:

1. The possibility that the animal may have been struck by additional (nonlethal or crippling) bullets, pellets, or other projectiles days, months, or years prior to the questioned incident.
2. The possibility that an illicit bow-hunter has shot the animal with a firearm first (because of the difficulty in getting close to an alert animal), and then stuck an arrow into the bullet wound.
3. The possibility that the animal was killed or fatally weakened by a modern pesticide or poison designed (as the result of environmental protection laws) to decompose rapidly after a few hours of exposure to air or sunlight.
4. The likelihood that scavengers will have destroyed a considerable amount of useful blood, tissue, or bone evidence if the carcass was not found and collected in a timely manner (**Figure 2**).

In conducting necropsies involving bullet wounds, it is often extremely important that the veterinary pathologist determine the trajectory of the bullet into or through the body. This information may resolve the question of whether the accused hunter was properly defending him/herself against a charging animal, or illegally hunting a protected species (**Figure 3**). The information may also be used by

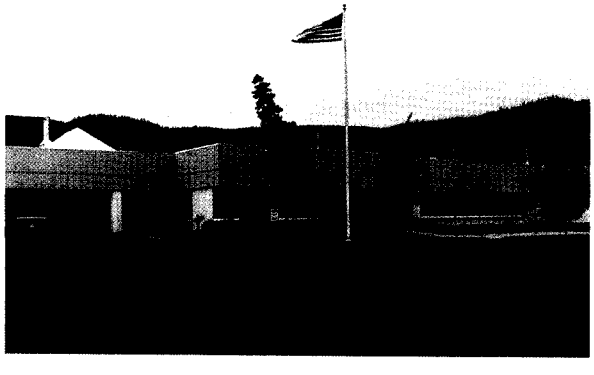

Figure 1 The National Fish & Wildlife Forensics Laboratory in Ashland, OR, USA.

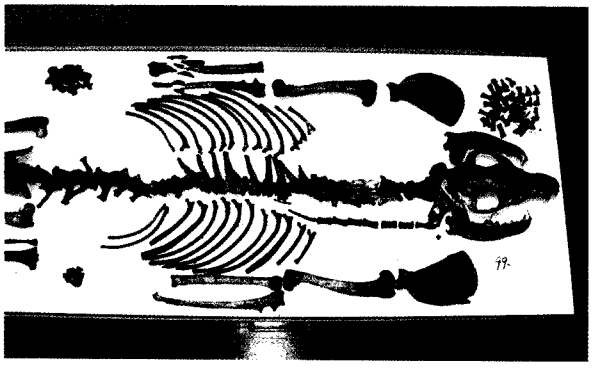

Figure 2 Cause of death can be difficult to determine if the only evidence is the skeleton of the victim – in this case a wolf.

Figure 3 The bullet trajectories related to wounds on a bear can help prove a hunter's claim of self-defense.

investigators, during the interview process, in determining the veracity of suspects and witnesses.

Molecular Biology (Genetics)

Molecular biology involves the study of genetic information encoded in the DNA molecule, and the expression of that coding into proteins and related biological structures. Given the incredible diversity of biological structures present in the known plant and animal kingdoms, molecular biology offers the wildlife forensic scientist an extremely powerful tool to:

1. determine family, genus, and species
2. determine gender
3. individualize blood and tissue samples.

Family/Genus/Species Identification

The forensic process of determining the species origin of an unknown tissue normally begins with a series of screening (immunological) tests designed to narrow the possibilities down to the species comprising a single family (e.g., bears – family Ursidae, or deer – family Cervidae). Once the family source of the specimen is determined, the examiners can go forward with either protein or DNA/polymerase chain reaction (PCR) analysis (along with the necessary and comprehensive databases) to determine the actual genus and species involved.

Gender Identification

A number of nuclear DNA-based gender-determining tests are available for blood and tissue samples from mammalian species. The tests generally use PCR amplification to detect specific sequences of the ZFY and/or SRY genes, both of which are located on the mammalian Y chromosome.

Individualization of Blood and Tissue

Early work on individualizing animal blood and tissue samples involved multilocus DNA probe hybridization techniques. However, new PCR methods for detecting single-locus short tandem repeat (STR) markers have been developed and applied in human forensic casework, demonstrating the technical feasibility of similar applications to animal species. Pending the arrival of new technologies, wildlife research and forensic laboratories focus a considerable amount of effort on the development of STR markers for determining the individual origins of wildlife evidence tissues.

Morphology

Morphology is the study of structure and shape. In wildlife forensic science, morphological examinations of submitted evidence items are normally conducted by eye, and with the use of simple, compound, or scanning electron microscopes. These are often the simplest examinations performed in a wildlife crime lab; but at the same time, they address some of the most complex and difficult identification problems.

As an example, the vast majority of mothers and fathers in this world are perfectly capable of identifying their sons or daughters from 10 000 similar young men or women. But could these people create a written protocol that would enable another individual (i.e., a forensic scientist) to make that same positive identification with the same degree of certainty? The answer is almost certainly "no."

The reasons why such a protocol would be difficult to write lie in the heart of the morphological problem: the lack of standard definitions for individuals, and the fact that no two individuals (even genetic twins) are exactly alike. Two animals (e.g., two whitetail deer that are genetic twins) may start out looking very much alike, but the normal wear and tear that a young whitetail deer experiences literally from the moment of birth creates individual characteristics (a healed cut, a chipped hoof, or broken antler) that quickly separate those twins into distinct individuals.

So the immediate problem for a wildlife forensic scientist is to come up with class characteristics that distinguish and identify family, genus, and species of animals that are separate and distinct from population and individual characteristics. This is not a problem with whole animals, but is very much a problem in the case of wildlife parts and products wherein the commonly occurring species-defining characteristics of the animal source may not be present.

These identification characteristics typically fall within one of the following morphological categories:

1. hair and fur
2. leather and hides
3. bones and skulls (**Figure 4**)

Figure 4 Morphologists Drs Peppes Trail, Bonnie Yates, and Cookie Sims examine bone evidence.

4. teeth, claws, and beaks
5. hooves, horns, and antlers
6. feathers and down
7. other miscellaneous parts.

Criminalistics

Wildlife forensic scientists frequently process evidence from an illegal hunt much in the same way that a police forensic scientist works evidence from a homicide scene. In fact, the events associated with a typical illegal hunt often involve the following categories of criminalistics (or police forensic science) evidence:

1. trace evidence
2. firearms
3. other weapons
4. impression marks
5. latent fingerprints
6. questioned documents.

Trace Evidence

Trace evidence in an animal case can involve a wide range of materials. A classic example is a case in which a mountain lion was held captive for a period of time and then killed in an illegal "canned" hunt. As it turned out, the mountain lion tried to chew his way loose from the synthetic fiber ropes (two types were used by the suspects to secure the lion), and a forensic scientist was able to link the fibers from the lion's stomach back to chewed ropes found at the crime scene.

Firearms

The typical circumstances in which an animal is killed with a firearm vary greatly from those of a homicide case. The most significant differences include:

1. the distance from suspect to victim
2. the choice of firearm
3. the ability of the suspect to "clean up" the scene
4. the tendency of the suspect to take the victim from the scene
5. the tendency of the suspect to reuse the same firearm frequently.

Unlike human crime situations in which the victim is most commonly killed with a pistol at short (contact to 25 m) distances, the typical animal kill involves a high-powered (and large-caliber) rifle or a shotgun at relatively long distances (50–300 m).

Given the nature of the typical hunting area (brush, trees, and ground cover), it is often difficult for an illicit hunter to retrieve expended casings; however, the long shooting distances and the fact that the shot could have come from any 360° vector point makes it extremely difficult for a crime-scene investigator to locate the shooting point, much less the expended casings. However, all of these advantages (to the illicit hunter) tend to be negated by two simple facts:

1. The whole point of the illicit hunting is for the suspect to take the victim (as a trophy or meat) back home. Thus, the bullet is likely to either be in the carcass of the animal, or in the "gut pile" left at the scene (which can be matched to the trophy head or meat with DNA techniques).
2. The typical illicit hunter spends a lot of money on a rifle or shotgun, and is rarely willing to discard this weapon after a single illicit kill. Thus, it is very likely that a succession of illegal kills can be linked to a single poacher by matching the spent bullets or casings to the rifle or shotgun.

Other Weapons

Other hunting weapons typically associated with an illicit animal kill include:

1. long bows and arrows
2. crossbows and "bolts"
3. spears
4. spring traps
5. poison discharge devices (**Figure 5**)
6. nets.

Impression Marks

The fact that most illicit hunting situations occur in remote areas or "off road" situations makes it extremely likely that the suspect will leave tire tracks and boot impressions in soil, mud, or snow. And the fact that these tires and boots are typically used in off-road situations makes it all the more likely that the tire or boot treads will possess individualistic wear marks.

Latent Fingerprints

Latent fingerprints are the classical means of linking suspect, victim, and crime scene through physical

Figure 5 A sheep carcass illegally laced with Aldicarb® to kill eagles.

evidence. The following types of latent-bearing evidence are frequently submitted to a crime lab in wildlife cases:

1. firearms
2. expended casings (shotgun and rifle)
3. knives
4. "no trespassing" and "no hunting" signs
5. game tags
6. import/export (CITES) permits.

Questioned Documents

Questioned documents are frequently encountered in wildlife investigations involving the import and/or export of wildlife parts and products. The question most frequently asked by the investigator is whether or not the seized documents (typically import/export permits) are valid. This can be an extremely difficult question to answer when the authorizing seals vary between countries, the names of individuals authorized to approve import/export documents change on a frequent basis, and the shipments must be cleared (the documents examined and approved) at the local port of entry.

Questioned documents typically associated with a wildlife case include:

1. forged or altered hunting licenses
2. forged or altered game tags
3. forged or altered import/export permits.

Analytical Chemistry

Chemical analysis techniques are most often used in a wildlife crime lab to provide toxicological information for a veterinary pathologist conducting a necropsy. As such, a forensic scientist assigned to the chemistry section of a wildlife crime laboratory spends a great deal of time examining blood, urine, tissue, and stomach/crop contents in a search for pesticides and poisons. Analytical chemistry procedures (that utilize chemical biomarkers) are also used to identify the species source of animal products such as bear bile and deer musk; and standard toxicological methods are routinely employed to identify chemical baits and poisons used to trap and kill wildlife.

See Also

Crime-scene Investigation and Examination: Collection and Chain of Evidence

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VICTIM SUPPORT

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Introduction

Responses from clinical, legal, and support professionals can impact significantly in the recovery process for victims of interpersonal crime. Appropriate helping responses can further allay trauma and help set the victim on a path to recovery. Inappropriate responses can do a great deal of further damage and even exacerbate trauma. The need for support for victims of crime has been increasingly recognized around the world, with most western countries now having some form of formalized support for victims. The International Criminal Tribunal – Former Yugoslavia (ICTY) has recognized the need for support for victims and witnesses by establishing a victims and witnesses section. Article 22 in the Statute of the International Tribunal addresses the protection of victims and witnesses, and states:

> ICTY shall provide in its rules of procedure and evidence for the protection of victims and witnesses. Such protection measures shall include, but shall not be limited to, the conduct of in camera proceedings and the protection of the victim's identity.

Under the rules of Evidence and Procedure, Rule 34 was established. This specifically stated that: "There shall be setup under the authority of the Registrar a Victims and Witnesses section consisting of qualified staff to:

1. Recommend protective measures for victims and witnesses in accordance with the Article 22 of the Statute, and
2. Provide counseling and support for them, in particular in cases of rape and sexual assault."

This article discusses the role of professional support workers in relation to victims of personal offenses. For this purpose the term "professional support worker" encompasses anyone who may come into contact with someone who has been a victim of an offense against the person. It can include forensic medical officers, forensic physicians, police, prosecutors, psychologists, counselors, allied health professionals, or services whose primary role is to support victims of crime or specialist support services. Most developed countries now have agencies whose role is to provide support, counseling, information, and advocacy for victims of crime. In addition, there are specialist agencies, which provide support to victims of particular types of crime such as family and friends of homicide victims, child victims or victims of domestic violence or sexual assault. Generally these services are government-funded or through charitable trusts or corporate sponsors; in most cases the services will be provided free of charge. It is important that all professionals involved in responding to victims of crime have a broad understanding of the services available in their area and can refer people to those most appropriate to address their needs. There are a number of websites that can assist in finding the appropriate service; in the UK, for instance, www.home.office.gov.uk provides links to victim support services, and in the USA