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Unmasking The Illegal Trade: How Emerging Technologies are Revolutionizing Wildlife Forensics

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Abstract

Forensic science provides a diverse toolkit for investigating wildlife crimes, including DNA analysis, isotopic fingerprinting, morphological assessment, and chemical profiling. These approaches enable species identification, geographic origin determination, supply chain traceability, and the establishment of links to criminal activity. By delving into key concepts such as forensic techniques, challenges, ethical considerations, and future directions, this paper sheds light on the complexities of wildlife crime investigations and emphasizes the importance of interdisciplinary collaboration in conservation enforcement. Challenges in wildlife forensic investigations include sample preservation, inadequate databases for species identification, a lack of defined techniques, and the requirement for specialized knowledge. Overcoming these obstacles necessitates investment in research, technology, and capacity building within law enforcement and conservation organizations. The future of animal forensics depends on technological improvements, interdisciplinary collaboration, and more international cooperation. Portable forensic tools, big data analytics, genetic databases, and artificial intelligence (AI) applications show promise for boosting detection capabilities and prosecution rates. Additionally, creating relationships among scientists, law enforcement agencies, lawmakers, and communities is critical for long-term conservation success.

Keywords: Wildlife, Crime, Forensic, Illegal trade, Endangered species, DNA.

INTRODUCTION

The term 'Wildlife forensic'refers to a research discipline with great promise for providing authentic information about wildlife conservation and Health. The crimes related to wildlife are becoming a matter of concern for public opinion and conservation specialists, which is creating pressure on government and non-governmental organizations. Wildlife forensic is afield that is comprised of many scientific domains which aids law enforcement agenciesin resolving illicit wildlife issues. At first glance, the interdisciplinary field of wildlife forensic can appear to be limited to solving the illegal trade or criminal usage of wild animals, as well as assisting in the reconstruction of crime scenes. However, the scope of applications of this complicated scientific field is far greater, mainly taking into account its effect on wildlife conservation and health.[1]

Illegal wildlife trading refersto "illegal activities that harm the environment and aims to benefit individuals or groups by the exploitation of natural resources and wildlife". IWT includes acquiring, trapping, hunting, selling, transporting,

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processing, and consuming undomesticated flora and fauna, from all sorts of habitats, whether alive or dead, as well as its derivative parts thereof, that are regulated or protected by national and/or international laws.[2,3] Trends like poaching and illegal trade of wildlife are not new nowadays. The overexploitation of wildlife and making this trend being commercialized is affecting the biodiversity of the area leading to the extinction of many species. This not only results in the collapse of an ecosystem but also affects the government revenues threatening the economic desire of developing countries.[2]

OVERVIEW OF ILLEGAL TRADE

In ancient Egypt, cats were regarded sacred and were mummified upon death. Similarly, cows are regarded sacred in Hinduism and should not be mistreated. As human cultures grew, animals were used for utilitarian purposes such as hunting, farming, and transportation. Horses, camels, and elephants were commonly utilized for transportation and carrying goods. Domesticated animals, like cows, sheep, and pigs, were utilized for food and byproducts like wool, milk, and leather.[6]

For a long time, wildlife was eradicated from the wild to gain profit for personal usage. The revengeful killing of animals such as elephants, tigers, lions, etc. has been practised in a long range after they have attacked humans and/or cattle. Many of these behaviours did not break the law. Even when it was illegal in some situations, law enforcement often disregarded or ignored it.[5] The illegal trade of wildlife affects conservation and biosecurity initiatives. The Internet has considerably encouraged wildlife trading, and experts are constantly digging into the Internet to detect unlawful commerce. Yet many attempts to identify unlawful trading on the Internet focus on a single or a few taxa or goods. A comprehensive compilation of unlawfully marketed wildlife taxa and their commercial uses could aid large-scale attempts to locate illegal wildlife over websites.[7]

The illegal trade of wildlife is expanding due to increased demand for fashion items such as fur coats and unusual animal skins, as well as rare pets prized for their scarcity. Traditional medicine frequently drives the trade, with animal parts sought for alleged medicinal benefits. Wild animals are also unlawfully hunted for consumption as a delicacy or for their alleged aphrodisiac properties. Finally, wildlife products are in high demand in the decorative, accessories, and jewellery markets, with items such as ivory and exotic feathers in particular.[3,6] Wildlife crimes are the second most common criminal infraction in the world. This clandestine trade includes poaching, breeding, and transporting. Wildlife crimes, in addition to affecting various species, their habitats and surrounding ecosystems, destroy the economic development of those local communities that rely on them.

Various cross-species are believed in resulting the transmissions of pathogens, including COVID-19.[4] EIDs (emerging infectious disease) pose a severe hazard to wildlife, their ecological systems, and human well-being. Throughout the last decade, EID trends identified in illegal wildlife trade have increased drastically. Cases consisted of 240 pathogens from all groups. Around 60 percent of the infections discovered were zoonotic (a disease that is transmissible between animals and humans), risking the health of the public.[8]

Challenges in Combatting Illegal Trade

The mid-1970s saw a surge in global interest in putting an end to this crime and its negative consequences. The Convention on International Trade in Endangered Species of Fauna and Flora, or CITES for short, is a voluntary global agreement that regulates lawful wildlife trade alongside protecting susceptible and endangered species of flora and fauna.[9]

Combating wildlife trade demands a comprehensive strategy that includes comprehending and changing consumption patterns with sustainable alternatives, involving and supporting local populations dependent on natural resources, maintaining and upholding strong legal structures at national and international levels such as CITES, developing enforcement abilities, funding scientific research for evidence-based policies, and encouraging collaborative efforts.[10]

Fish fillets, blood from an animal trap, a jar of champagne, cut objects of alleged rhinoceros horn or sea turtle shell, or cosmetics containing whale oil or ambergris are all examples of partial or highly modified evidence in wildlife forensics. These evidence kinds provide a variety of scientific issues. The wildlife forensics expert must determine the appropriate way to respond to each inquiry presented by investigators regarding such evidence. The complexity of class characterization demands (i.e., species recognition) is worsened by

the large number of wildlife, fish, and species of plants.[11]

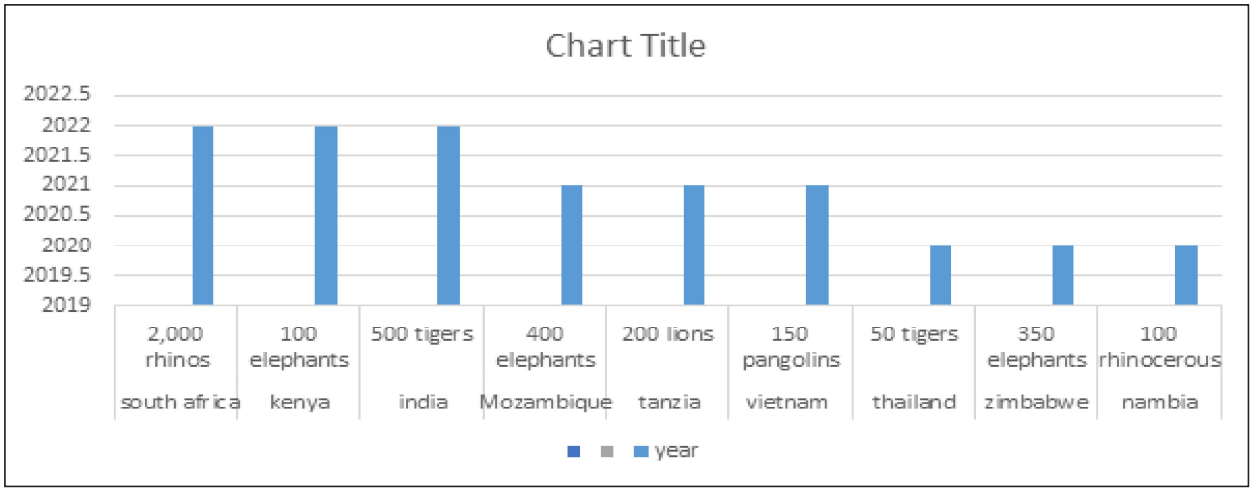
Obstacles in the branch of wildlife forensic genetics involve collecting high-quality DNA samples from a variety of animal species, accurately distinguishing closely related groups or subspecies that exist analyzing population genetics for conservation, analyzing combined or trace DNA specimens efficiently, understanding complicated genetic information for non-geneticist constituents, managing legal and ethical issues concerning genetic data use, building global capacity, To successfully combat wildlife crime and support conservation initiatives, genetic experts, conservationists, law enforcement agencies, policymakers, and international bodies must work together to develop standardized protocols, improve sharing of information, build technical capabilities, and implement strong forensic practices.[2]

Wildlife Crime

Wildlife crime is a broad branch of law enforcement which not only includes animals but also contains plants and their derivatives. It has not only led to the extinction of species but has also led to the devastation of economies, lives, and livelihoods and only the drug and arms transactions surpass these.

The number of animals poached in different countries is given below in the table.

Country	Year	Number of Animals Poached
South Africa	2022	2,000 rhinoceroses
Kenya	2022	100 elephants
India	2022	500 tigers
Mozambique	2021	400 elephants
Tanzania	2021	200 lions
Vietnam	2021	150 pangolins
Thailand	2020	50 tigers
Zimbabwe	2020	350 elephants
Namibia	2020	100 rhinoceroses



Source: World Wildlife Fund (WWF), International Union for Conservation of Nature (IUCN).

In certain parts of the world, terrorists and militia groups receive a significant portion of their funding from this unlawful economy. From killing and snaring animals to electrocuting and poisoning them Poachers will stop at nothing to satisfy the global wildlife trade, which has caused the extinction of numerous animals.[18]

Traditional Forensic Techniques in Wildlife Crime

These methods use forensic science to resolve court cases involving crimes against wildlife. The pieces or confiscated parts are forwarded to forensic labs that work with wildlife related offences or research institutions. These laboratories identify the species using specific techniques involving footprint analysis, serological techniques, molecular biology techniques, morphological analysis and microscopic examination.

Some of the techniques are discussed below.

Morphological Analysis

Depending on the external applicability of the species, morphological or physical traits play a

crucial role in the identification of flora and fauna and in ascertaining the cause and manner of death. Various species present distinct challenges their skin coat colour, eyes, tails, ivory etc. may be different. For example, ivory obtained through the illicit trade of Asian or African elephants is a type of dentine with a special pattern known as Schreger.[12] Whenever an unidentified species or a part of a species is found it is first examined and matched with the reference sample such as taxonomic keys and monograms of the species available. Osteologists and veterinarians are examples of experts who assist in the recognition of these species. The osteologists use distinct appearance or morphology of the skeleton's body components of the species to identify them. Dentition is also another trait which is unique to most species, hence having it greatly boosts the chances of identification (13). However, some species cannot be distinguished using morphological methods.

Footprint Analysis

As per Locards exchange principle, "When two objects come in contact with each other an exchange of physical traces can occur" (14) so when animals walk through a surface, they leave the impressions of their footprints. These footprint impressions help in the identification of animals. Depending on the type of pattern of footprints, the type and age of the species can be determined. Among the primary issues with footprint analysis identification is that it involves invisible impressions on hard surfaces, and occasionally the presence of other animals contaminates these footprint sites.

Microscopic Analysis

A wide range of physical evidence are used in wildlife forensics. However, different evidences are examined in different ways. Microscopy is one such important technique that is used while dealing with the hair evidence. Hair samples are also considered as important evidence in the detection of crimes related to wildlife.

Scanning electron microscopy (SEM) is a useful technique that can be used in studying the surface morphology of hair and has been employed by various researchers. Scale patterns in the wool hairs of Ibex, Cashmere/Pashmina, and Shahtoosh/ Tibetan antelope were studied by Rollins and Phan et al. using SEM. They were able to demonstrate the value of wool fibre scale patterns for species identification.[15]

Analysis of hair sample by SEM

First, hair samples are taken from different animals; to prevent contamination, forceps and gloves should be used. The acquired hair samples are then treated with 100% alcohol at room temperature for one day. After being gathered, the hair samples are stored at 4 degrees Celsius in fresh zip-lock bags for additional examination. To examine the hair samples, it must be cut into 5mm sections, leaving 3mm on the root side. After that, the cut hair samples are put on the carbon sample holder. On the carbon sample holder, the mounted samples are covered using gold using an auto fine coater, and then they are examined under scanning electron microscope. Certain characteristics such as hair shape, hair diameter, surface damage, scale diameter, scale shape etc. can be determined under this technique.[16]

DNA Analysis

DNA analysis can be used in wildlife crimes involving poaching, trading, hunting and consumption of animals. An expanding array of contemporary DNA techniques are available for use in wildlife crime investigation. Among the most successful procedures for handling wildlife crime cases to date is DNA profiling.[17] A few fundamental procedures make up DNA profiling, such as DNA extraction, PCR amplification, DNA sequencing and sequence comparison.

Isotope Study

In some cases, the geographic origin of the specimen is determined by using methods such as inductively coupled plasma mass spectroscopy (ICP-MS) and isotope ratio mass spectroscopy (IRMS).[15] In these methods, a comparison is made between the ratios of different isotopes. This approach becomes crucial when a specific species is protected in one region but not in another, and when wild animals are caught and sold as captive-bred animals. In addition to being a very sensitive elemental analysis method, the ICP-MS methodology can detect metals and non-metals at extremely low concentrations. Additionally, it can identify an element's isotopes in a given sample. The IRMS is a special type of mass spectroscopy in which the proportionate number of isotopes in a sample is ascertained using mass spectrometric techniques.

Toxicological Study

Typically, forensic toxicology entails two distinct processes: first, identifying chemical substances that have been illicitly synthesised from animals, and second intentional or accidental poisoning. The toxic materials are tested using thin layer chromatography (TLC) and high-performance liquid chromatography by forensic experts. To perform the test, the samples are taken from confiscated organs tissues or other derivatives. The killing of bears for their body parts, especially gallbladders, is one of the most well documented wildlife crimes. China has a long history of gathering bile from bear gallbladders, and bile is said to be a powerful therapeutic component of traditional Chinese medicine[13]. This has led to a global black-market trade in bear gall bladders, and the organs' value has significantly increased. While examining these organs the experts first need to identify the type of species and its origin. The bear's bile consists of ursodeoxycholic acid (UDCA), chenodeoxycholic acid (CDCA) and cholic acid (CA) are the active components that are thought to have strong therapeutic effects. The concentration of these ingredients isutilised to identify the type of species as the concentration varies between bears and seasonally.

CONCLUSION

The technologies mentioned are significantly transforming wildlife forensics, enhancing our ability to combat illegal wildlife trade, track endangered species and protect our flora and fauna. The advancement in different methods is enabling more precise identification of species and their origins. These technologies help identify poached animals and their derivatives and track illegal routes and networks.

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