Green Forensics: The Nexus of Environmental Science and Forensic Innovation

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OPEN ACCESS

Keywords

Green Forensics, Forensic Botany, Environmental Crime, Phytophthora Database, Ecological Justice

How to cite this article:

Niranjan, M. A., Reeja, S., Sivaprakash, M., Balasubramanian, A. and Radhakrishnan, S. 2025. Green Forensics: The Nexus of Environmental Science and Forensic Innovation. *Vigyan Varta* 6(3): 15-17.

ABSTRACT

Green forensics, an emerging interdisciplinary field, integrates environmental science with forensic methodologies to address crimes and issues affecting flora, fauna, and ecosystems. This article explores the potential and methodologies of green forensic science, focusing on botanical evidence, ecological crime investigation, and sustainable forensic practices. Key advancements and challenges in this domain are highlighted, emphasizing the role of forensic botany and databases like the Phytophthora Database in combating environmental crimes. The article concludes by outlining future directions and the importance of green forensic approaches in ensuring ecological justice..

INTRODUCTION

The degradation of natural ecosystems due to anthropogenic activities has necessitated innovative approaches to protect the environment. Green forensics, a novel interdisciplinary domain, has gained prominence for its potential in solving ecological crimes and supporting sustainable practices. By integrating forensic science with environmental studies, green forensics offers tools and methodologies to address crimes

against the environment, wildlife, and plant species. This article delves into the scope and applications of green forensics, with a particular focus on forensic botany, ecological databases, and future pathways for this evolving field.

Role of Forensic Botany in Green Forensics

Forensic botany is a cornerstone of green forensics, employing plant-based evidence in criminal investigations. This discipline encompasses the study of leaves, seeds, pollen, and roots to solve crimes and authenticate herbal drugs. Agrawal *et. al.* (2022) emphasizes the relevance of forensic botany in verifying the authenticity of herbal drugs, demonstrating how botanical analysis can address issues of counterfeit medicines in the market. Similarly, Sharma *et.al.,* (2020) discuss the forensic significance of leaves as botanical evidence, showcasing their utility in linking suspects to crime scenes. Botanical evidence is particularly valuable in environmental crimes such as illegal logging, wildlife poaching, and habitat destruction. Techniques like DNA barcoding and phytochemical analysis enable the identification of plant species and their geographic origins, contributing to ecological justice.

Ecological Crime Investigation and the Phytophthora Database

Green forensics extends beyond individual plant species to boarder ecological investigations. The Phytophthora Database, as discussed by Park *et.al.*, (2008), exemplifies a forensic database aiding in the identification and monitoring of Phytophthora species. These plant pathogens cause widespread ecological and economic damage, and their identification is crucial for mitigating environmental crimes. The database integrates genetic and geographical data, allowing researchers and law enforcement agencies to trace the origins of pathogens and their spread. Such tools are indispensable in addressing crimes that impact agriculture and natural ecosystems, showcasing the potential of green forensics in preserving biodiversity.

Advancements in Forensic Analysis of Botanical Evidence

Advancements in technology have significantly enhanced the capabilities of green forensics. For instance, Sharma and Yadav (2019) highlight the forensic analysis of roots from the abortifacient plant *Plumbago rosea L.*, demonstrating how specific plant parts can provide critical evidence in criminal investigations. Techniques like gas chromatography-mass spectrometry (GC-MS) and high-performance liquid chromatography (HPLC) have revolutionized the identification of phytochemicals, improving the accuracy and reliability of forensic investigations.

Furthermore, the integration of geographic information systems (GIS) and remote sensing in forensic investigations enables the mapping of environmental crimes, offering spatial insights into illegal activities. These advancements underscore the interdisciplinary nature of green forensics and its potential to address complex ecological challenges.

Challenges in Green Forensics

Despite its promise, green forensics faces several challenges. The lack of standardized methodologies and limited databases for plant and environmental evidence hinder its widespread application. Moreover, the interdisciplinary nature of green forensics requires collaboration among botanists, ecologists, forensic scientists, and law enforcement agencies, which can be challenging to achieve. Additionally, the legal admissibility of botanical evidence remains a concern, as courts often demand rigorous validation of forensic methods. Addressing these challenges requires investment in

research, training, and infrastructure to support the growth of green forensics.

Way Forward

The future of green forensics lies in the integration of emerging technologies and international collaboration. Developing comprehensive forensic databases for plants and pathogens, akin to the Phytophthora Database, can significantly enhance the field's capabilities. Additionally, fostering partnerships among academic institutions, government agencies, and non-governmental organizations can drive innovation and standardization in green forensic methodologies. Education and training programs in green forensics are also essential to build a skilled workforce capable of addressing environmental crimes. Promoting public awareness about the significance of green forensics can further support its development and application in preserving ecological integrity.

CONCLUSION

Green forensics represents a crucial step towards achieving ecological justice and combating environmental crimes. By integrating forensic science with environmental studies, this field offers innovative solutions to address pressing ecological challenges. The advancements in forensic botany, databases like the Phytophthora Database, and analytical technologies underscore the potential of green forensics in protecting biodiversity and promoting sustainable practices. Overcoming the challenges in this domain requires collective efforts and investments, paving the way for a greener and more just future.

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