NFSU JOURNAL OF FORENSIC JUSTICE

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

FORENSIC ENTOMOLOGY AND TIME OF DEATH: SCIENTIFIC VALIDITY AND USE IN INDIAN MURDER TRIALS

Rajneesh Kumar[1] and Dr. Gurminder Kaur[2]

Abstract: *The study of insect activity on decomposing human remains, known as forensic entomology, can be a valuable tool for estimating the post-mortem interval (PMI) of drugs that have been killed in homicides. Though this has found a wide acceptance in many jurisdictions, it still finds very little application in legal proceedings in India. Forensic entomology is often questioned for its scientific validity for estimating the time of death, and how such an evidence treat in Indian murder trials are presented in this article, which does a critical evaluation of both. This article delves into the entomological methodology, specifically how necrophagous insects, such as blowflies and beetles, can assist in estimating time of death, or post-mortem interval (PMI). It also explains why we should be cautious about these techniques which are not as scientifically reliable as they seem, giving examples of things which can change like how temperature, humidity and geographical variability all affect how fast something dies and how fast the insects develop. Forensic entomology however has a promise but has not been well received by the Indian judiciary due to inexperience of the courts with the technique and non-existence of accredited forensic entomologists in India. The article further highlights the challenges that the acceptance of entomological evidence in Indian courts faces through a comparative study with the practices of other countries. It further recommends legal reforms such as standardised protocols, judicial training and accreditation of forensic entomologists so as to improve the reliability and reliability of the technique in Indian criminal justice system.*

Keywords: *Forensic Entomology, Post-Mortem Interval (PMI), Indian Murder Trials, Scientific Reliability, Legal Reforms*

INTRODUCTION

Forensic science has played an expanding role in criminal investigations in recent decades and in many instances, has afforded law enforcement and the judicial system novel methods to solve complicated matters.[1] Notably, forensic entomology has proved to be one of the most useful methods for estimating the time of death of a corpse in homicide situations when conventional techniques are limited because decomposition is already at an advanced stage.[2] In many places around the world, the study of insect life cycles on human remains has become a staple of post-mortem examinations. Despite the well-documented potential, forensic entomology appears to be an underutilised tool in India.

India has experienced its share of difficulties and massive case backlogs, slow and sometimes non-existent investigative methods, and a dearth of forensic scientists who work with the police. Entomological evidence, although feasible, is yet to find acceptance in Indian courts even as forensic sciences with popular techniques like DNA-analysis and fingerprinting witness greater acceptance.[3] This is primarily attributed to the unavailability of trained forensic entomologists, inadequate evidence collection and preservation resources, and a less familiar legal community with the scientific underpinnings of entomological techniques. Consequently, many cases of highly decomposed or buried bodies remain unresolved, or the post mortem interval is calculated using less useful methods.

Rising need of scientific and reliable forensic evidence in criminal trials makes it a rather momentous juncture to assess the integration of forensic entomology into Indian criminal investigations and courtrooms. This technique has the potential to become a more mainstream tool in India's forensic arsenal, provided that

[1] Research Scholar, School of Law, Pondicherry University.
[2] Assistant Professor, School of Law, Pondicherry University.
[1] Suzanne Bell, Forensic Science: An Introduction to Scientific and Investigative Techniques (4th edn, CRC Press 2019)
[2]Jens Amendt, Roman Krettek and Richard Zehner, 'Forensic Entomology' (2004) 91 Naturwissenschaften 51
[3] Prapti Kothari, 'Exploring the Role of Forensic Science in Indian Criminal Justice System' (2023) SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4565177 accessed 14 May 2025

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

the scientific, institutional and legal barriers to its use are addressed.[4]

THE ENTOMOLOGICAL CLOCK: UNVEILING THE SCIENCE BEHIND TIME OF DEATH ESTIMATION

Forensic entomology is the science of insects and other arthropods that inhabit decomposing human remains, and their role in a medico-legal investigation.[5] This is mainly used to determine the PMI (Post-Mortem Interval) i.e. how long someone has been dead and by the order in which insects arrive to and their lifecycle stages found on a corpse. Forensic entomology provides a much wider temporal window, as classic approaches to PMI determination (e.g., body temperature, livor mortis and rigor mortis) are only functional within the first 24 to 72 hours after death. This becomes particularly important in homicide investigations with bodies where the remains have not been found for long periods of time, are buried, burned or hidden some other way.[6]

The principles of forensic entomology are based on the predictable and temporally sequential colonization of cadavers by necrophagous (carrion-feeding) insects, including primary colonizers such as blowflies (Calliphoridae) and flesh flies (Sarcophagidae). These insects often arrive at a corpse minutes after death, often attracted to volatile organic compounds released during early decomposition.[7] In females, blowflies oviposit in natural orifices and wounds, where the eggs hatch to larvae (maggots) that consume the tissue. Their rate of development becomes a biological clock that can be matched to environmental data during their growth through several larval stages (instars), pupation, and eventually as they develop into adults. For a correct PMI estimation, the entomologist must have knowledge of the species represented and be able to estimate the age of the oldest larva or pupa present, as well as the characteristic of the largest. This age can then be correlated with known species-specific growth rates under similar environmental conditions. Despite many uncertainties, estimates of developmental data, typically collected in laboratory studies or field observations, need to be corrected for temperature and humidity since these factors significantly affect the insect life cycles. Consequently, indirect models are often used to convert the variable temperature dependent growth into a consistent duration (from which, for example, nematode population estimates can be made), such as accumulated degree hour (ADH) or accumulated degree day (ADD) models.

Forensic entomology may also include successional faunal analysis, which studies insect succession or, the order in which various species of insects colonize a body of decomposition over time (aside from insect development).[8] Over time, we see a fairly predictable sequence of remains as decomposition proceeds and different taxa come to dominate. Blowflies are among the first colonizers, then beetles (Coleoptera) that consume drier tissues, and lastly species specialized to sequence skeletal remains. When forensic experts contrast the observed insect succession to established patterns in a given area, they can estimate PMI with greater accuracy, especially in the later stages of decay.

However, there are many factors upon which the reliability of this entomological evidence is dependent. Insect colonization is influenced by geographic area, season, microhabitat and the exposure of the body (exposed versus concealed). However, a body that is inside, or wrapped in plastic, might make it much longer until the insects can get to the body, thus making it much harder to calculate PMI accurately.[9] Likewise, any alteration in the skin barrier by insecticides or trauma may change the behaviour of the insect. Thus, the entomologist must evaluate a wide range of case-specific circumstances that generate an opinion, often

[4] Purvi Pokhariyal and Deepa Dubey, 'The Imperative of Forensic Justice in Modern Legal Systems: A Comprehensive Analysis' (2023) 3 Forensic Science and Human Rights

[5] Mohamed A Kenawy and Yousrya M Abdel-Hamid, 'Medico-Legal Forensic Entomology "Use of Insects in Death Investigations" – A Review' (2019) 11(2) Egyptian Academic Journal of Biological Sciences, E. Medical Entomology & Parasitology 59

[6] Mark Harrison and Laurance J Donnelly, 'Locating Concealed Homicide Victims: Developing the Role of Geoforensics' in Karl Ritz, Lorna Dawson and David Miller (eds), Criminal and Environmental Soil Forensics (Springer Netherlands 2009) 197

[7] Shyamasree Ghosh and Dhriti Banerjee, 'Insects in Forensic Entomology' in (eds), Biology of Forensically Important Invertebrates (Springer Nature Singapore 2024) 33

[8] Jacobus Hendrik Kolver, Forensic entomology: the influence of the burning of a body on insect succession and calculation of the postmortem interval (PhD thesis, University of the Free State 2009)

[9] Johnnie Erskine, 'How do entomologists use insects to determine PMI' (2018)

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

in consultation with pathologists and/or toxicologists.[10]

Notwithstanding this news, many groups have validated the absolute reliability and reproducibility of entomological PMI estimates performed by trained professionals using standardized protocols across various locations and populations. Forensic entomology, as a discipline, draws upon a considerable scientific literature base and empirical foundation, the existence of a peer-reviewed literature, and a stable and determined set of methods for its applicability for acceptance through scientific evidential standards.[11] As in several fields, these best practices are often maintained via professional bodies, at least at the global level (ABFE, 2023). However, the domain is still developing in countries like India, where formal training, research and legal recognition are work-in-progress.

Forensic entomology is therefore a methodologically rigorous and multidisciplinary forensic science that has been gaining worldwide acceptance in recent years. It provides a very unique and also an irreplaceable tool in investigating homicides, particularly in those cases where other forensic evidence has degraded after time. Its use by the forensic structure of any jurisdiction relies not just on the technical developments but rather on the legal suitability.

INSECTS AS SILENT WITNESSES: APPLICATION IN MURDER INVESTIGATIONS

Forensic entomology can be an invaluable tool in any murder investigation, one of the best scientifically-based methods for estimating of post-mortem interval (PMI) in cases in which a body is discovered at an advanced stage of decomposition or in an environment unfavourable for forensic assessment. In such cases, traditional forensic methods for estimating time of death such as livor mortis, algor mortis and rigor mortis offer limited value due to their narrow post-mortem applicability. Forensic entomology, on contrast, provides a unique and extended timeline that can cover days, weeks, or even months post-mortem, making it an invaluable tool in murder investigations.[12]

Entomological evidence should be of unparalleled scientific value in India with its conditions of cooler regions or parts of the world with fewer insects that characterised by climatic conditions, particularly in tropical and subtropical regions, facilitating prompt insect colonisation of human remains. Calliphoridae (blowflies), Sarcophagidae (flesh flies), and dermestid beetles are some of the major species attracted to host decomposing tissues and their life cycles can be accurately modelled to derive estimations of the post-mortem interval (PMI). Generally, as though insects found at a crime scene like larvae, pupae, adult insects, its collecting is accompanied by precise measure of the detail environmental factors such as temperature, humidity, soil type, and exposure of habitat. These samples are typically analysed by trained specialists using morphological taxonomy or DNA barcoding to facilitate species and life stage-specific estimates that are then used to estimate the time of colonization.[13]

From homicide cases throughout the world forensic entomology have made its impact. For example, Dr. Neal Haskell, a forensic entomologist, testified in the Casey Anthony trial about blowfly larvae he found in the trunk of the suspect's car.[14] Controversial but nonetheless influential in the fact-finding process, the evidence helped confirm that a body had rotted in the car for "a number of days," vital in placing the timeline of the events. Likewise, entomological evidence limited the time since death of a body discovered in open woodland, making other forensic results such as pathology and toxicology more reliable.

However, in India forensic entomology remains surprisingly underutilized. One significant case where a victim disappeared for five days before the decomposed body was located. The inquest report detailed visible maggot infestation, but no entomological examination was performed. Time would only be a very general guess; the post-mortem report recorded "advanced decomposition", giving the

[10] Stefan Pittner, et al, 'A field study to evaluate PMI estimation methods for advanced decomposition stages' (2020) 134 International Journal of Legal Medicine 1361

[11] Jeffery K Tomberlin, et al, 'A roadmap for bridging basic and applied research in forensic entomology' (2011) 56 Annual Review of Entomology 401

[12] Akash Deep Aggarwal, 'Estimating the postmortem interval with the help of entomological evidence' (2005) 6(2) Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology

[13] John Oladapo Obafunwa, Influence of Biotic and Abiotic Factors on Decomposition and the Determination of Time Since Death: Applications of Forensic Entomology and Taphonomy (PhD thesis, The University of Nebraska-Lincoln 2025)

[14] Casey Anthony CSI: A Triumph of High-Tech Forensics (TIME, 16 June 2011) https://time.com/archive/6917491/casey-anthony-csi-a-triumph-of-high-tech-forensics/ accessed 15 May 2025

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

court no time frame at all to work with. The question of whether the body was moved after death was contestable by the defense, and is one that can often be answered with more certainty by analysing insect succession.[15] Herein lies the criminological cost of delayed forensic development: any potential evidence is overlooked, or cast aside, available only to the trained eye or institutional capacity.

An additional recent example is the case in which a corpse was discovered under dubious circumstances in a rural agricultural area. Severe putrefaction made the time of death impossible to establish at the autopsy and no insect evidence was considered. The accused was acquitted by the court on the basis of insufficient evidence regarding the time of death, which highlights the evidentiary void that exists and is prevalent in cases of decomposition.[16]

When bodies are concealed and/or in complex environments, forensic entomology becomes a lot more important. Different species are attracted to different arrangements of bodies; exposed bodies are difficult to bury or submerged, but semi-encased bodies will attract in sequence. For example, Coffin flies (Phoridae) can enter through cracks in the soil covering buried remains and many aquatic insects move onto bodies when submerged. Once again, these patterns are what lead to not only the PMI but the conditions of the cover-up. Australian and American studies have shown that differences in entomological succession depending on the location of the remains are an indicator of whether a body was moved after death, one of the most common questions in a murder case.

Forensic entomology can be characterized by its interdisciplinary versatility. Digital forensics (e.g., phone call logs or GPS data), traditional pathology, and environmental forensics when combined form an extremely interwoven, complementary framework for criminal reconstruction. So if a victim is discovered after having been last seen alive three days previously, but the development of the insect larvae throughout the body suggests colonization took place five days ago, this information may serve as a strategic weapon for prosecution or defense as it can confirm or disprove an alibi or testimony. However, India has better environmental conditions for decomposition than a much higher number of decomposition related murder cases but there is no coherent policy or institutional framework for forensic entomology in the country. Even indirectly, CFSLs and the state FSLs seldom have departments for entomological analysis. Besides, lack of insect succession data specific to the regions severely limits the scientific validity of forensic entomological inputs in India. Lack of familiarity and expert testimony also makes judicial receptiveness limited.

Forensic entomology has great potential to improve the accuracy of time since death estimations in murder trials in India if institutionalized appropriately.[17] Given that many of the cases these days involve decomposed or hidden bodies, because of either the distance from where the body was left to where it can be found or even an intention, the past methods could not be used to extract results from it. We have insects, silent witnesses to the fraying, and a biologically anchored and scientifically established record of the timelines of destruction that, when everything else has long rotted, is often the only reliable story left.

These insights highlight the untapped potential of this field and the need for systemic reforms in medico-legal education, availability of forensic entomology within forensic protocols, judicial training on the legitimacy and relevance of such evidence, and entomological labs capable of case-specific analysis.[18] Only then will India be able to advance from merely the academic potential of forensic entomology to the courtroom authority of forensic entomology as part of Indian criminal jurisprudence.

LEGAL TREATMENT AND ADMISSIBILITY OF FORENSIC ENTOMOLOGY IN INDIAN COURTS

The status of forensic entomology as a science is still unclear in the Indian legal system although, recently, it is becoming one of the considered procedures in forensic science. The Indian judiciary has, over the years, displayed a certain degree of caution in engaging new types of forensic evidence which do not have the codified procedure or even constitute an institutional ritual of use. This has led to

[15] Lerah K Sutton, Declassifying decomposition: Estimation of the postmortem interval using total body score and accumulated degree days (PhD thesis, University of Florida 2017)

[16] A Lohani and A Abbas, 'Role of Forensic Evidence in Pre-Trial Investigation and Benefit of Doubt in' (2021)

[17] Sarika Bansode, et al, 'Challenges and Considerations in Forensic Entomology: A Comprehensive Review' (2025) Journal of Forensic and Legal Medicine 102831

[18] Kelly Pyrek, Forensic Science Under Siege: The Challenges of Forensic Laboratories and the Medico-Legal Investigation System (Elsevier 2010)

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

forensic entomology being largely termed as marginal within Indian courtrooms in which the evidentiary value of forensic entomology is often overlooked, or inadequately valued.[19]

Currently, forensic entomology is not expressly covered under Indian evidence law. Nonetheless, the admissibility of such evidence is subject to Sections 39 and 40 of The Bharatiya Sakshya Adhiniyam, 2023 (Section 45 and 46 of the Indian Evidence Act, 1872) which provides for the introduction of expert opinion in issues of science, art or foreign law. Section 39 makes opinion testimony of "persons skilfully qualified" in such areas admissible, opening a wide door for entomological testimony as long as the expert's qualifications and methodology have been established to be credible according to legal or judicial standards. Nonetheless, the wider legal threshold in regards to admissibility is merely grounded in "relevance and reliability" doctrine. Referring to the basics set out on the Indian front and comparative jurisprudence, courts frequently inquire: (i) whether the technique is scientifically valid; (ii) whether it has generally been accepted by the relevant scientific community; and (iii) whether the method has been properly applied to the facts of the case. This test is conceptually similar to the Frye standard present in early U.S. cases, and increasingly, the Daubert standard that requires expert testimony to be based upon scientifically examined principles. Nevertheless, the most important public barrier to acceptance of forensic entomology in India is the lack of judicial familiarity. Somewhat invariably, entomological observations in court cases have been treated as incidental unless they are from case such as M. Sakthivel v. State, where the results were integrated with somewhat conventional forensic methods. In the M. Sakthivel case, as an illustration, the rejection of the entomological data was not because of a problem with the science but rather with collection methodology and the absence of a chain of custody and thus, procedural rather than substantive problems.

On a more hopeful note, the Supreme Court has been forward-looking in related forensic issues. The test to the admissibility of such scientific techniques has come up for consideration before the Apex Court in earlier cases as well., in Selvi v. State of Karnataka[20], the Court has explained the admissibility science as follows: To conclude, any scientific technique must satisfy the following three conditions to determine its admissibility: It must be sufficiently reliable; It must be a non-intrusive procedure; and It must be consistent with or conform to the rights available before the law (in particular, Article 20(3) of the Constitution which guarantees the right against self-incrimination). Although the Court was dealing with narco-analysis and brain mapping, it's very wide rationale is also applicable to all forensic sciences of an emerging nature, including entomology.

In addition, Section 329 of Bharatiya Nagarik Suraksha Sanhita, 2023 (Section 293 of Code of Criminal Procedure, 1973) empowers the courts to take into consideration the report of scientific experts as provided by government, without summoning the expert unless it is necessary. Nonetheless, due to the fact that India does not have recognized forensic entomologists at government forensic labs, such expert reports are seldom generated, even when the case has evident entomological evidence like maggots or movement of the body. In the absence of inclusion in these institutional frameworks, forensic entomology is still largely absent from the formal evidential record.

Few guidelines or precedents as to the admissibility of forensic entomology also help shape judicial conservatism. While DNA evidence or ballistic reports have made it through this cycle after decades of courtroom acceptance, entomology has yet to attain this settled status.[21] This is in stark contrast to places like the UK or Australia, where forensic entomologists have tested as expert witnesses and their results mentioned in judicial opinions on a near routine basis over the past decades.

It not only requires building of scientific capacity, but also requires the education and understanding of the judges to integrate forensic entomology in the Indian legal proceedings. Judges must be made familiar with the scientific basis of the discipline, its methodological rigour, and the specific types of questions it can reliably answer. For example, while forensic entomology may not conclusively determine the cause of death, it can provide high confidence estimates for time since death or indications of body movements i.e. both of which are highly relevant in circumstantial homicide trials.

Changing laws can be catalytic as well. The Law Commission of India, which has formerly been recommending for codification and expansion

[19] Saumitra Basu, The History of Forensic Science in India (Routledge 2021)
[20] 2010 (7) SCC 263
[21] Val McDermid, Forensics: What Bugs, Burns, Prints, DNA, and More Tell Us About Crime (Open Road + Grove/Atlantic 2015)

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

of forensic science application in criminal justice could conduct an exercise on devising a satisfactory approach to admissibility of evidence as regards emerging forensic disciplines such as entomology.[22] Second, the Bureau of Police Research and Development (BPRD) and National Forensic Science University (NFSU) should develop model protocols and expert rosters on use of entomological evidence, for easier integration of this in trial proceedings.

Though the legal framework in India theoretically enables forensic entomology under the auspices of the present laws, the practical manifestation of such admissibility is still incipient. Without the backing of institutions, the standardization of protocols, and the office familiarity of judges with the science, that science will risk being perceived as an exotic or ancillary tool rather than as a legitimate source of primary evidence. Such legal-science lag needs to be bridged in order for India to make use of evidence-based strength that forensic entomology provides in high profile murder cases.

ETHICAL CONSIDERATIONS IN THE USE OF FORENSIC ENTOMOLOGY IN HOMICIDE INVESTIGATIONS

With forensic entomology becoming more widely accepted in law enforcement, and since many of the studies of forensic entomological ethics have been conducted in relation to complex murders, many of which involve decomposing and the storage and transportation of corpses, the importance of a critical analysis of how forensic entomology is applied is particularly pressing. Insect-based time-of-death estimation has solid scientific merit and evidentiary weight in many jurisdictions, but the use of such evidence must also be considered through the filters of justice, due process, and the rights of the accused. It is essential that ethical oversight not only reinforces the validity of forensic science but prevents miscarriages of justice against which criminal adjudication should guard.[23]

At the heart of the many ethical issues is the struggle between scientific validity and courtroom validity. Forensic entomology is necessarily circumstantial, with estimates developed around estimates made from the conditions of the environment and the time it would take for insects to develop, alongside the quality of preservation of any specimens collected. It therefore also carries a further risk of overstating certainty when led in evidence. Experts should be mindful of the language they use in depositions and testimony to be clear that the conclusions are not absolute but probabilistic.[24] In turn, courts need to be trained to distinguish between scientific plausibility and evidentiary conclusiveness and a challenge in systems like India, where judicial training in nascent forensic fields remains inadequate.

The second one is about sample collection and chain of custody. The use of insects is considered sensitive to contaminating events and exposure to environment disturbance. This raises ethical legalities in that law enforcement and medical professionals should be trained in the appropriate manner in which to collect, store, and transport specimens of insects. Not only does this question the authenticity of the media-relied upon evidences, it also violates the right to fair trial-without any suspicion. Article 21 of the Indian Constitution guarantees the right to pre-conviction which includes rights such as the presumption of innocence, right to a fair trial, right against self-incrimination, right to legal counsel, etc. Misreading or misusing entomological data could result in innocent persons being wrongfully accused or guilty parties being acquitted in the cases where they are among the foundation of the prosecution or defense.[25]

The emergence of AI-assisted digital entomology is exciting but creates another ethical quagmire. This underscores issues like data privacy, algorithmic bias, and transparency in automated decision-making. If identification apps based on human mobility or predictive algorithms are to be used for estimating the post-mortem interval, then ethical clarity is required regarding the provenance, validation, and limits of these tools. What happens if an AI error affects the court decision, and who is liable? Can an accused request the training data of such algorithms? In an age of ever more techno-legal coalescence, these are urgent issues.

[22] Prachi Kathane and others, 'The Development, Status and Future of Forensics in India' (2021) 3 Forensic Science International: Reports 100215

[23] Corissa Sherman, 'Forensic Pathologists as Expert Witnesses in Estimating Time of Death' (2020)

[24] John William Strong, 'Language and Logic in Expert Testimony: Limiting Expert Testimony by Restrictions of Function, Reliability, and Form' (1992) 71 Oregon Law Review 349

[25] Anupama Sharma, Implementation of Rights for Crime Victims in Theory and Practice: Lessons from India (Taylor & Francis 2024)

NFSU JOURNAL OF FORENSIC JUSTICE

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

When using human remains for entomological research and simulation, one bioethical issue must also be considered. In lots of Western jurisdictions, that research takes place at a place known as a "body farm", a forensic anthropology research facility that examines human decomposition under controlled circumstances.[26] The ethical justification for such facilities rests on donor consent and strict oversight. In contrast, such institutionalized infrastructures by way of an ethics board do not exist in India and therefore, informal or non-regulated research can be detrimental to the upholding of human dignity as prescribed by national and international ethical guidelines and legal mandates.

COMPARATIVE JURISPRUDENCE AND INTERNATIONAL BEST PRACTICES

In cases of delayed discovery or stinking corpse phenomena associated with homicide, forensic entomology is increasingly recognized as a scientifically robust and legally credible discipline in many jurisdictions.[27] It is incorporated into the criminal justice systems of nations such as the U.K., the U.S., and Germany, Canada, and Australia, and as such, provides useful comparisons for India, where the technique is even less frequent and absent from many formal medico-legal protocols.[28] This sub-topic assesses international jurisprudential perspectives on the admissibility, application and institutional facilitation of forensic entomology as an aid to its development in India.

A. United Kingdom: Judicial Acceptance and Academic Integration

The United Kingdom is widely accepted as the first country to utilize forensic entomology in criminal investigations and trials.[29] The Criminal Procedure Rules 2020 and the Criminal Practice Directions set out a generally liberal yet rigorous approach to admissibility of expert evidence by British courts, though they rely on transparency, metacognition and peer reviewed methodology (in the social sciences), and relevance.

Forensic entomology was instrumental in narrowing down the post–mortem interval in a case wherein, with the body being discovered in a woodland partially covered by foliage following extensive decomposition. Mobile phone data and CCTV footage confirmed the expert's findings, and the report was accepted as evidence, after scrutiny of the entomologist's chart of species succession, logs of environmental temperature and credentials.

Importantly, there are specific postgraduate programs in forensic entomology offered by institutions (the University of Huddersfield; University of Lincoln) where strong collaborative efforts between academia, police organizations and medico-legal institutions are already established. Such academic-industry linkages make sure that forensic entomology continues to be a scientific frontier and a tool in the courtrooms.

B. United States: Scientific Standards and Courtroom Rigor

The Daubert Standard, established in Daubert v. Merrell Dow Pharmaceuticals (1993), is a stringent one that governs scientific evidence and expert witness testimony in U.S. courts. These aspects include peer-review, falsifiability, error rates, and wide acceptance in the scientific community.

A new high-profile case in California, People v. Enriquez (California, 2021) used forensic entomology to estimate the PMI, pertaining to a domestic homicide by the prosecution. The corpse had remained in a closed car in the intense heat for more than a week. Easily the most undated, direct evidence was entomological, through all three pupil casings and larval development, all disputing the defendant's proposed time of death. Court accepted the testimony because of credentials of the entomologist and because the findings were in line with temperature logs and forensic pathology.[30]

Efforts of professional affiliations such as the American Board of Forensic Entomology (ABFE) and National Institute of Justice (NIJ)

[26] Katie Zejdlik and Sarah E Burke, 'The Evolution of American Perspectives Concerning Treatment of the Dead and the Role of Human Decomposition Facilities' in Todd K Shackelford and Viviana A Weekes-Shackelford (eds), Evolutionary Perspectives on Death (Springer 2019) 177

[27] Michiel van der Wolf, 'Comparative Analysis' in Gerben Meynen (ed), Safeguarding the Quality of Forensic Assessment in Sentencing: A Review across Western Nations (Springer 2022) 230

[28] Nataliia Tkachenko and others, 'Comparative Analysis of Models of Organization of Forensic Activities: International Experience' (2024) 3(7) Social and Legal Studios 55

[29] Paul Roberts, 'Paradigms of Forensic Science and Legal Process: A Critical Diagnosis' (2015) 370(1674) Philosophical Transactions of the Royal Society B: Biological Sciences 20140256

[30] National Research Council, Strengthening Forensic Science in the United States: A Path Forward (National Academies Press 2009)

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

have driven entomology research and certification processes forward while also promoting a standardized approach across jurisdictions. U.S. forensic labs are beginning to utilise entomologists earlier in the investigation to ensure evidence that can only be collected before decomposition of the body is not lost.[31]

C. Germany and the European Union: Codified Forensic Literacy

Germany offers a much institutionalized model for the implementation of forensic entomology. Entomological analysis is recommended in all body decomposition scenarios in the Guidelines for Medico-Legal Autopsies (revised 2019) by the German Society of Legal Medicine. Their focus is on protocol-driven evidence collection, scene documentation, and interdisciplinary interpretation.[32]

Forensic entomology was used to estimate the PMI in the case of Landgericht Frankfurt am Main (2020), in which remains were discovered in various geographical locations and at different stages of advanced decomposition, raising suspicion of serial killings. They also stated the evidence provided by the forensic entomologist on the deaths spanning weeks instead of all at one time soil against the accused person.

Although European countries have centralized forensic systems for data storage (e.g., EAFE Succession Database), with knowledge such as regional insect colonization pattern necessary for PMI estimation, Australian public forensic services are largely decentralized. The European Association for Forensic Entomology (EAFE) still provides standardization as well as the bridge backward and forwards between forensic science and enforcement.[33]

D. Australia and Canada: Emphasis on Procedural Fidelity

Noting that this is particularly common in rural and remote areas where the fate of many missing persons and suspected homicide victims is determined by the rapid decomposition of their remains, Australia and Canada serve as model countries with regard to the integration of forensic entomology in investigative and court processes.[34]

An example of the application of entomological evidence for the entomologist community can be noted from Supreme Court of New South Wales in Australia, in which the death of the victim occurred more than 10 days before the body was found in a bush land area. The expert found two waves of insect colonisation and placed a lower PMI that matched video footage of the suspect, which excluded him from being able to see the victim before death. The court held that the testimony "had the twin virtues of being well grounded in many courtrooms, and being capable of scientific explanation."

Also in a leading case forensic entomology was crucial for providing time of death information in a homicide where the body was located in the woods of Canada. Heat-adjusted embryological stages of larval development were shown along with pathology data, and the judge pointed out the evidentiary weight of convergence from multiple disciplines. Canadian courts apply both statutory law and common law principles to expert reports, with a strong emphasis on documenting the methodology used and providing transparency.

REFORM PROPOSALS AND POLICY SUGGESTIONS FOR INDIA

Despite the scientific utility of forensic entomology in many parts of the world, its implementation and incorporation into the Indian court system and legal field is still very much in the early stages of development.[35] Overcoming the chasm between scientific possibility and its use within Indian criminal justice will require deep legal and institutional reforms.[36] Some important suggestions on policies and actionable changes that can provide forensic entomology an ability of higher status in investigative and judicial process of Indian soil to be used efficiently for the solutions to complicated murder case are:

A. Institutionalizing Forensic Entomology in Indian Forensic Laboratories

[31] Michelle R Sanford et al, 'Entomological Evidence Collection Methods: American Board of Forensic Entomology Approved Protocols' in [editors if known] Forensic Entomology (CRC Press 2019) 63–85

[32] Terje Kjeldsen and Wim Neuteboom, '20 Years of Forensic Cooperation in Europe' (2015) 47 ILAC News

[33] Gengwang Hu et al, 'A Global Perspective of Forensic Entomology Case Reports from 1935 to 2022' (2023) 137 International Journal of Legal Medicine 1535

[34] Stephanie Evelyn França Guimarães et al, 'Forensic Entomology in Research and Practice: An Overview of Forensic Experts' Perceptions and Scientific Output in Brazil' (2022) 136 International Journal of Legal Medicine 1149

[35] Rahul Das et al, 'Forensic Entomology: Progress and Implications' in Insect Diversity and Ecosystem Services (Apple Academic Press 2025) 237

[36] Prachi Kathane et al, 'The Development, Status and Future of Forensics in India' (2021) 3 Forensic Science International: Reports 100215

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

One of the initial steps to incorporate forensic entomology into the fold of Indian legal system is the establishment of exclusive forensic entomology units/guidelines/regulatory body at national and state level forensic laboratories. Today, forensic entomology is rarely employed owing to lack of dedicated infrastructure and trained personnel within the Indian forensic science setup like creation of Forensic Entomology Departments which should be created and integrated within Central Forensic Science Laboratory (CFSL) and forensic science institutes at regional level. All kinds of research–including expert evidence, analytical evidence, and testimony could be perhaps assigned to research departments similar to those countries, such as the U.S., U.K., and Germany, where departments of this nature are integrated among forensic substantiating department. Also creation of Regional Insect Development Databases i.e. with the large geographical and climatic diversity present across the country, region-specific databases of species with developmental timelines of the insect species are required. Such databases would be extremely useful in cases of estimation of post-mortem interval (PMI) where decomposition has been found. These databases need to be incorporated into pre-existing forensic tools and made available to forensic entomologists across the country.

B. Building Expertise through Certification and Accreditation

Not only is forensic entomology an intrinsically complicated discipline; it also takes a considerable amount of academic and fieldwork experience. With entomological evidence being potentially proven in the courts of law, experts should be certified and accredited according to international standards to maintain the credibility of entomological evidence. Forensic Entomology courses and certifications should be conducted by National Forensic Science University (NFSU) modules generated and other premier Forensic Science Institutions. It would establish a cadre of qualified entomologists who will be available to give reliable expert testimony in court cases. Also by collaboration with International Bodies, India can partner with international forensic entomology bodies like American Board of Forensic Entomology (ABFE) to keep the Indian experts at par with global standards. Linking with institutions in UK and Europe would only bolster and strengthen the credibility and quality of Indian forensic entomologists.

C. Reforming the Evidence Collection and Preservation Protocols

The absence of a well-defined and well-established methodology for the collection and preservation of insect specimens can pose one of the most formidable challenges against forensic entomology being accepted in courts of law in India. In most of the cases it is observed that mishandling results in contaminating the evidence which ultimately makes entomological evidence unpresentable. Formulation of Standard Operating Procedures (SOPs) i.e. BPRD and forensic scientists have to collate the specific SOPs for Evidence Collection in view of the importance of collection and preservation of entomological evidence. These standards should include vital aspects that must cover time of death, the immediate environment and chain of custody. Also training of law enforcement should be undertaken throughout India on the use of forensic entomology and the collection of entomological specimens. Forensic experts/universities can regularly conduct workshops/seminars.

D. Judicial Training and Sensitization

Forensic entomology has found very limited acceptance in courts in India, and one of the reasons for this can be attributed to the lack of knowledge among judges about this science. It is important that judicial officers and legal practitioners be made aware of how helpful forensic entomology can be in an investigation, particularly homicide cases. Forensic sciences including forensic entomology must be included in the training curriculum of the National Judicial Academy (NJA) and all state judicial academies. Judges who lack knowledge of the science and application of new forensic methodologies will not be able to appropriately evaluate whether such evidence is admissible. Moreover criminal defense attorneys and prosecutors could benefit from workshops on how to incorporate forensic entomology into their legal strategy. To be more familiar with insect evidence, specific workshops can be conducted and invite forensic entomologists to help them understand the subtleties of insect evidence.

E. Towards Institutionalization: Legal, Scientific, and Societal Imperatives for Forensic Entomology in India

The only way to fully institutionalise forensic entomology within India's criminal justice system is through a multi-pronged approach i.e. legal reform, investment in science and public engagement. First, The Bharatiya Sakshya Adhiniyam, 2023 (Indian Evidence Act, 1872)

JFJ
Volume: 4, Issue: 2
July-December 2025
E-ISSN: 2584 - 0924

should be amended to specifically include forensic entomology as relevant expert witness evidence with a proper legal standing admissible before courts in India. Meanwhile, the establishment of a National Forensic Entomology Policy would standardise procedures for specimens, expert credentialing, and inter-agency cooperation, providing even further scientific rigor. At the same time, India needs to channel funds towards research and development, including grants by the government focussing on Indian insect species and decomposition patterns in the particular region. Also, the scientific rigor and worldwide consensus may be further strengthened by collaboration with other international specialists and institutions. Eventually, start to address the public through education, publicized awareness, and academia Universities and NGOs, as well as digital platforms, could draw increased attention to the importance of forensic entomology in the criminal sphere so that over time scepticism in the criminal justice process is alleviated and helps develop institutional trust. Combined, these measures can transition forensic entomology from a niche to a mainstream forensic tool in India's legal ecosystem.

CONCLUSION

Integrating forensic entomology into the Indian criminal justice system warrants a novel opportunity to improve attention to effective investigation of the crime of homicide, with an increasing precision and reliability, whereupon the latter is, a vital cornerstone of the former. Even though the subject is a widely recognized value outside the country, it is still not being exercised to full potential in India due to steps in the system and procedures. This article demonstrated the need to fill these gaps by embracing best practice and guidance internationally, establishing protocols and enhancing judicial knowledge. Forensic entomology can truly transform investigation processes, providing solutions where other forensic means fail due to decomposition, absence of biological material or places where bodies were hidden. The estimated post-mortem intervals can serve as a strong basis for determination of grounds of guilt and effortless conviction in a court of law, giving India the much-needed scientific flair to its investigation skills by tapping into the insect evidence.

While the path towards incorporation of forensic entomology continues to remain fraught with hurdles, it is one that the country needs to travel in order to truly achieve a more science-based and equitable system of justice. Coordinated efforts by the government, law enforcement, forensic professionals and the courts will together open up a new future for India that will be a place where forensic entomology is deemed necessary and reliable in the search of the truth. By incorporating the necessary reforms and fostering a culture of scientific inquiry, India can set a good standard for criminal investigations, where justice is served not just through legal principles but through the power of science.