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THE ROLE OF INSECTS IN A CRIME SCENE FORENSIC SCIENCE

Soham Mitesh Vakil*[1]

Abstract: ***Forensic science is a field that operates within the confines of the legal system and has the potential to make a significant contribution to assisting justice in the investigation of crimes and other severe transgressions such as rape, kidnapping, etc. Its objective is to guide individuals conducting these criminal investigations by assisting them in recognizing and retrieving evidence at crime scenes, as well as providing reliable and foolproof information on which they may unequivocally rely in the settlement of criminal and civil issues. Murder, rape, accident-related occurrences, undisclosed individuals, displaced persons, fraud-related instances, and forgeries are all examples of criminal activity which can be investigated through the application of forensic science. However, when one thinks of forensic science, it is often limited to fingerprints, blood, semen, and such, while nature often gets overlooked. The surroundings can be massive indicators of criminal activity and forensic science can be applied to gauge just how. There is a branch of science wherein insects are used for solving crimes, which is called forensic entomology and through this research paper, the author aims to make readers, aware of exactly how INSECTS, can be used as clues, proof, and evidence at a crime scene and in the court of law.***

Keywords: Forensic Entomology, Insects, Blowflies, Maggots, Murder

I. STATEMENT OF PROBLEM

To reiterate, insects play a huge role to help the police investigate a crime scene, however, there is not much known about it to the extent that some people do not even know that it falls under forensic science. Through this research paper, the author aims to make his peers aware of this unique branch of forensic science, Entomology.

II. LITERATURE REVIEW

1. A Review of Forensic Entomology – Sanjay Kumar Meena- Through this research paper, the author aims to provide an overview of the entire work of forensic entomology and lays emphasis on its importance saying that forensic entomology, is constantly trying to solve three important questions in an investigation; when, how, and where the crime happened.
2. Application of Forensic Entomology to estimate of the PMI in homicide investigations by the Rio de Janeiro Police Department in Brazil – J. Oliveira-Costa-This research paper offers three case studies in which the postmortem interval (PMI) was calculated using the accumulated degree-days (ADD) approach. In two cases, PMI estimations based on Chrysomya megacephala (Fabr.) and Cochliomyia macellaria (Wied.) were close to those acquired via other investigative methods. In the third scenario, based on C. megacephala, the PMI estimate was significantly different from the true interval, which is thought to be due to sarcophagous insects' restricted access to the corpse.
3. Use of Diptera in Forensic Entomology to Determine the Elapsed 'Time Since Death' in Bulgaria – Dr. Yanko Kolev- Through this research paper, the author aims to perform three important goals; 1) to research the most important forensic indicator species of flies, 2) to find and collect data on temperature centric development and estimate the times of development of the key species of flies growing at various temperatures during the four seasons for use in determining the postmortem interval, and 3) to develop a simple, direct and easy-to-use field protocol for collecting entomological evidence at crime scenes.
4. Insect Detectives – PK Sumodan- Working in the field of entomology, the author aims to provide an insight into how insects act as detectives and help the police solve crimes in a way that can never be imagined. It includes the role, importance, and examples of forensic entomology
5. Determining Time of Death Using Forensic Entomology – Anubhav Singh, Ananta Joshi, Mahipal Sankhla, Kapil Parihar, Rajeev Kumar & Kunal Shiv- The decomposition of a human body. In forensic entomology, insects are commonly employed to determine PMI. They

* *Symbiosis Law School*, Symbiosis International University, Pune, Maharashtra. The author can be reached at soham1751@gmail.com

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may also be utilized as an alternate approach for drug detection when normal procedures such as urine, blood, or internal organs are no longer available. The pace of growth of insects that feed on corpses may be altered by the temperature within them. These applications include determining the time and place of death, as well as the cause of death.

6. Forensic Entomology: A Review on Use of Insects for Investigation – Manisha Rana- This research paper speaks about how insect evidence is valuable if it is gathered and evaluated properly. Insects may assist you with deciphering what occurred in a criminal case, and they are ubiquitous. On land and in wetlands, insects are the most numerous species. From the early phases of decomposition, insects get attracted to the smell of a rotting corpse and may lay eggs in the crevices. By watching these insects and their development into larvae, entomologists may determine the PMI, any change in the position of the body, and the cause of death.

7. Role of Terrestrial and Aquatic Insects in Forensic Investigation – Pravesh Charan Isai- This article examines certain elements of terrestrial and aquatic insects that are intriguing because they indicate that distinct mechanisms prevail in the two habitats and in Forensic Investigation. The dynamics of terrestrial and aquatic insect species are examined in order to determine how much these two species contribute to the objective of Forensic Investigation.

The fascinating feature of researching terrestrial and aquatic insects in Forensic investigation is "observing the exponential expansion from its early roots in limnology and sport fishery-related inquiry over five decades ago."

In a court of law, terrestrial and aquatic insects, often known as forensic insects, are employed to identify violent crimes such as murder, suicide, rape, and physical abuse.

III. RESEARCH GAP

As evidenced by the various literature reviews above, there are no research papers that have covered everything about forensic entomology, from its history to its practical use to the exact science involved in it, and this is the gap that the author aims to resolve through the current research paper.

IV. HISTORY AND CASE OF FORENSIC ENTOMOLOGY

The earliest known use of forensic entomology was recorded in Sung Tzu's book, 'Washing Away of Wrongs' in 1247 AD. A villager was stabbed in 1235 and died as a result of his wounds. Officials found that his wounds were caused due to the blade of a sickle, which caused them to accuse a fellow peasant laborer. The local magistrate called the populace to the town square, where they were to temporarily surrender their sickles. Within minutes, a swarm of blowflies had gathered around one sickle and none others, attracted by the scent of blood trails invisible to the naked sight. Everyone was aware that the owner of that sickle was the offender, with the latter pleading for compassion when arrested by police.[1]

Other significant experiments include those conducted in Italy by Redi (1668) using the meat of a variety of animal species to show that larvae evolved from flies' eggs, and those conducted by Linnaeus (1775) in constructing a system of categorization. Linnaeus thus established a system of insect identification, including the identification of forensically significant insects such as Calliphora vomitoria (Linnaeus).

Bergeret d'Arbois, a French physician, was the first to employ insect succession to establish the postmortem period of human remains in 1855. Behind the mantelpiece of a couple's Paris house, they discovered the mummified bones of a child. The couple was immediately suspected, despite the fact that they had only recently moved into the house.

The victim's autopsy revealed indications of butterfly larvae and acari on the body, according to Bergeret. He determined that the corpse had been deposited behind the wall years earlier, in 1849, using procedures similar to those used by forensic entomologists today. Bergeret arrived at this period by combining what he knew about insect life cycles and the subsequent colonization of a corpse. His report persuaded authorities to accuse the former residents of the house of murder, and they were later convicted.[2]

After this Reinhard and Hofmann, whom we propose to recognize as co-founders of the field, made observations on insects and other arthropods as forensic markers during major exhumations in Germany and France in the late 1880s. Following the release in France of

[1] Sung Tzu, *Washing Away of Wrong*, 1247.

[2] Mark Benecke, *A Brief Survey of the History of Forensic Entomology* (2008).

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Mégnin's acclaimed book[3] on applied forensic entomology, the notion swiftly traveled to Canada and the United States. At the time, experts realized that the absence of systematic observations of forensically significant insects precluded their use as postmortem interval markers. Over the following decades, general improvements in insect taxonomy and ecology aided in closing this gap.

On 29 September 1935, numerous body parts were retrieved from a Scottish river near Edinburgh. They were eventually recognized as belonging to two ladies. Mrs. Ruxton and Mary Rogerson, the family's 'nanny,' were identified as the dead. The discovery of blowfly larvae in their third larval instar, Calliphora vicina Robineau-Desvoidy, suggested that the eggs had been placed prior to the remains being put in the river. Together with additional evidence, this revelation resulted in the husband, Dr. Ruxton, being convicted of the murders of his wife and Mary Rogerson.[4]

Following World Wars, few forensic entomology cases were published in scholarly journals. Leclecq and Nuorteva were principally responsible for sustaining the technique throughout Central Europe between the 1960s and 1980s, with an emphasis on casework. Since then, fundamental research in the United States, Russia, and Canada has paved the path for entomology to be routinely used in forensic investigations.

A 14-year-old sex worker in the US was found lying in a pool of blood by a highway on 4th June 1984. Her autopsy found that she died as a result of several head and neck injuries sustained while being struck by a sharp instrument. She was last seen alive four days ago with the lead suspect, a 30-year-old army sergeant. Investigators were working tirelessly to pin down a precise time of death in order to apprehend the powerful sergeant. They did so by examining all circumstantial evidence — the body's physical appearance and organ disintegration. However, nothing seemed to help. One officer had gathered several adult maggot flies and larvae from the murder site. He then grew some of the larvae in tiny containers into adult flies. He then hurried to a neighboring meteorological office and acquired apparently unrelated data the murder scene's maximum and lowest temperatures, rainfall, cloud cover, wind speed and direction, and relative humidity. He deduced from this data that the first insects to colonize the body arrived precisely four days ago. That evidence cinched the case and resulted in the sergeant's arrest, who subsequently acknowledged committing the crime by repeatedly hitting the victim with a small hatchet.[5]

Another incident in the case of State v. Kirstin Blaise Lobato[6] showed how insects (or in this instance, the lack thereof) helped in the acquittal of the individual after years of wrongful imprisonment. Duran Bailey's body was found on 8th July 2001 at 10 PM behind a dumpster in Las Vegas with several injuries including amputated genitalia. On inquiry it was found that previously a student, Kirstin Blaise Lobato had tried to cut off a man's penis when he attempted to rape her, and based solely on this, Kirstin was arrested. In spite of a retrial, Kirstin was found guilty and sentenced to prison in 2006. In 2009, Dr. Gail. S Anderson along with Justice Denied attempted to exonerate Kirstin with the help of forensic entomology.

Dr. Anderson said that the only reason why there were no insects on the corpse was that Duran died in the night as that is when insects do not colonize the corpse which would go against the coroner's conclusion that the murder occurred 24 hours before the body was discovered. On 19th December 2017, Dr. Anderson and other three experts testified and gave reasons why the time of death was in fact 8 PM, shortly before the body was discovered and this would make it impossible for Kirstin to be at the scene of the crime because as per alibis, which the prosecution accepted, she was in Panaca. Before the judge could order a retrial, the prosecution dropped the case which in turn absolved Kirstin of murder, seventeen years after she was arrested.

V. SCIENCE AND LAW

Forensic entomology is more of a science than a branch of law but finds numerous applications in the legal field due to its potential in investigating crimes by applying that science. It is the scientific study of the invasion of the succession pattern of arthropods with their developmental stages of various species

[3] La Faune des Cadavres, 1894

[4] The Buck Ruxton *"Jigsaw Murders"* Case, US Nationa Library of Medicine 1935.

[5] Wayne D. Lord and William C. Rodriguez, *Forensic Entomology: The use of insects in the investigation of homicide and untimely death*, 1989.

[6] 2016 Nev. Unpub. LEXIS 978, 385 P.3d 618, 132 Nev. 1001, 2016 WL 6920462 (Nev. November 23, 2016).

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identified on decomposing cadavers[7]. It is most commonly connected with death investigations, although it may also be used to identify narcotics and poisons, locate an occurrence, and determine the existence and timing of wound infliction. An advocate and a judge would not have the requisite knowledge of forensic entomology, which is where an expert in the field comes in. If the court is unable to form an opinion regarding a question of science, an entomologist is called upon to provide his insight and assist the advocate in his arguments and the judge in framing the judgment.[8] Oftentimes, everything the investigator sees around him is what he uses to probe the case, and other factors are disregarded by him as he is not an expert in that field. For example, a police investigator/advocate would not know how to use the movement of insects in his favor as he would not believe that to be a relevant fact. However, an entomologist would, and this would overrule the argument of non-relevance of fact.[9]

VI. INSECTS AND INDICATORS

1. Scene of Crime- Insect species engaged in the decomposition of the body have been documented to differ in different habitats and situations. Species associated with one kind of environment discovered on a body are found to be different from those found when the corpse is relocated after death, revealing species variety. For example, if a murder occurs near a water body, but the corpse is found in the middle of a jungle, it is prudent to assume that the murder scene is in that jungle. However, the corpse will have traces of insects such as mayflies, damselflies, craneflies, etc[10] and a forensic entomologist after examination will conclude that the murder occurred near a water body.

In one case, the presence of larvae helped investigators disregard a particular place they believed to be the scene of the crime. Jonathan Blackwell had been missing since 7th October 2004 after leaving his place of work, Virginia Goodyear Plant. He was confirmed dead, several years later, in December 2006 when investigators found his body buried in the ground. However, his remains were populated with larvae that were a mere seven days old. This indicated that Jonathan had been buried in one grave for a better part of two years and was then dug up and buried in a second grave. When this information came to light, the case was investigated thoroughly again after which a murder warrant was issued for Stacey Webster who subsequently turned himself in.

2. Post Mortem Interval- Forensic entomology also aids in determining the Post Mortem Interval, or how long a human or animal has been dead (PMI). Investigators can estimate this by looking at the process of evolution in bugs. There are insects that are specialized for causing carcasses to begin rotting. Mature blowflies will fly until they get attracted to the smell of a rotting carcass on which they will proceed to deposit their eggs. The developmental process begins after the eggs are deposited. Maggots come out of these eggs and the species of C. megacephala and A. rufifacies are mainly responsible for the bulk of the dead body's breakdown. The larva then grows into a pupa (this is when one can assume the body is 4-5 days old), which ultimately matures into an adult.[11]

If an egg takes an average of 500 hours to grow into a pupa at one temperature, the investigating officer may make an educated guess as to how long the human or animal has been dead and be certain that the period is within a range.[12] In the case of Tikiri Bandage Siripala v. The Hon. Attorney General[13], the doctor merely agreed with the time of death mentioned by the advocate and did not carry out the examination using the acceptable methods, one of which was *insects found on a putrefied body*. In one particular case, R. v. Truscott[14] maggots were critical in proving the innocence of an individual, Steven Truscott 48 years after he was accused of rape and subsequent murder of his friend Lynn Harper when he was 14 years of age. Based on the food in her stomach, her time of death was placed between 7:15 PM and 7:45 PM, and based on evidence Steven could have committed the murder anytime between 7 PM and 8 PM. Solely relying on this, Steven was arrested and sentenced to death by hanging which was changed to life imprisonment. However, several years later forensic entomologists based on the age of maggots on Lynn's body proved that the murder had taken

[7] Verma K, Paul R, *Development Rate and its Implications for Forensic Entomology*, (2016)
[8] Section 45, Indian Evidence Act 1872.
[9] Section 46, Indian Evidence Act 1872.
[10] Tomas Derka, Aquatic Insects, 2019
[11] Dr. Jaising. P. Modi, *Medical Jurisprudence and Toxicology*, Page 437 (1920)
[12] University Teknology MARA (UiTM), *Blowfly Maggots Provide Physical Evidence for Forensic Cases*, 3rd September, 2014
[13] 2015 SCC OnLine SL CA 300.
[14] [2007] OJ No 3221, 2007 ONCA 575, 226 OAC 200, 225 CCC (3d) 321, 50 CR (6th) 1, 75 WCB (2d) 479, 2007 CarswellOnt 5305

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place several hours later thereby overturning Steven's conviction.

3. Crime Indicator

i. Drug-Related Deaths and Crimes- Several times a person who has overdosed/poisoned has been dead for such a long time, that conducting tests on the person to find out the cause of death becomes close to impossible. This is another instance where forensic entomology can be useful. When the maggots feed on the tissues of someone who has taken drugs or been poisoned, they will consume these compounds as well as their metabolites, indicating that the drugs have built up in the body. In a typical drug trafficking case study, authorities determined the country of origin of the substance using insects. When they captured the contraband, cannabis, they discovered the presence of insects, which showed the drug's path and origin.[15]

ii. Kidnapping- When a person is kidnapped and held in a place against his/her will, they are often denied the basic human decencies such that they might be alive, but only just. Victims aren't provided with washrooms and are left in their own fecal matter. A species of insect called Lucilia Sericata, are drawn to ammonia released from urine or fecal contamination. By studying the path of these insects in a general area, investigators can pinpoint the location of this contamination and further the place where the victim is being held.

iii. Weapons- As mentioned previously, Sung Tzu's book was the earliest known case of forensic entomology and speaks about how flies were instantly attracted to a sickle that had traces of blood on it. Blowflies are drawn towards traces of blood that are not latently visible and hence act as natural indicators for the weapon.

iv. Position of wounds- Wounds may be obscured by the decomposition of the corpse making it impossible to form an opinion through the naked eye. However, insects normally lay eggs firstly in wounds and if there aren't any they do so in natural orifices and then go down the body. If the maggots are mainly concentrated away from the natural orifices in the body, a wound is most likely to be present. For example, maggot activity on the palms suggests the wounds on the palm.[16]

v. Identification of Criminal- Haematophagous (bloodsucking) insects make it possible for forensic scientists to harvest DNA from them. This is useful in circumstances where the criminal has left any mark on the body without the use of a weapon. In one case, a man from Chicago was charged with rape. Police discovered a ski mask in his apartment that matched the one he wore during the summer assault, but the suspect claimed he hadn't worn it since the previous winter. Then a forensic entomologist discovered live weevil larvae adhering to the mask inside two cockleburs. He reasoned that since the larvae do not overwinter, they must have been picked up that summer. The rapist was convicted based on this and other evidence.[17]

VII. INSECTS TO BE EXAMINED

Flies and Beetles are two insects that are mainly used in an investigation of a crime. These two broad categories are further divided into more as listed below[18]:

1. Flies-

i. Blowflies: As mentioned previously, these flies are able to smell decaying flesh from over 16km away and hence make for great indicators

ii. Flesh Flies: Flesh flies feed on decomposing bodies, waste, manure, and other decaying materials. Only a few species, however, deposit their eggs in animals' open wounds. Because flesh flies are viviparous, they frequently give birth to decomposing human and animal bodies.

iii. Cheese Flies: These flies are mostly associated with animal products and fungus. Their larvae are particularly prevalent in smoked fish, cured meat, cheese, and rotting animals. The

[15] Alok Sen, Entomology Research Institute at Loyola College, Chennai

[16] Gail S. Anderson, *Forensic Entomology: The Use of Insects in Death Investigations*, https://www.sfu.ca/~ganderso/forensicentomology.html (last visited Mar. 5, 2022).

[17] Erik Stoksad, Crime Fighting Bugs, 2000

[18] William L. Krinsky, Forensic Entomology (2019)

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existence of cheese fly larvae is critical for determining when people die.

2. Beetles-

i. Dermestid Beetles, often known as skin beetles or hide beetles, infest a rotting body only after the soft tissues have been eaten by other creatures. They feed on skin and hair and are one of the most common insects found in human bodies by forensic entomologists.

3. Mites- Macrocheles mites feed on corpses early in the decomposition process, whereas Tyroglyphidae and Oribatidae mites feed on dry skin later in the process.

4. Moth- Moth larvae feed on the hair of mammalian carcasses and are among the last creatures to engage in the decomposition process.

5. Bone beetles- These are also obtained from decomposing bodies. Beetles in this family (Cleridae) feed on decomposing flesh, leaving pristine skeletal remnants.

i. Carrion Beetles: While the larvae of carrion beetles feed on vertebrate corpses, the adults feed on maggots. These gentlemen are quite benefactors of social service since they have a proclivity for digging up and burying little corpses underground.

ii. Hide Beetles: These insects feed on decomposing corpses and dried animal goods including bacon, dog treats, dried fish, and cheese. They often congregate around eating and mating resources.

iii. Rove Beetles: Unlike carrion beetles, rove beetles feed on cadavers or corpses rather than decomposing flesh (carrion). They feed on maggots and other insect larvae found on dead animals.

iv. Scarab Beetles are members of the Scarabaeidae family, which also includes dung beetles. They are often found on or around carrion and carcasses. They eat mushrooms, excrement, and rotting flesh and serve as the animal kingdom's cleaning crew.

v. Sap Beetles: These beetles are often found in close proximity to fermenting or decaying plant juices, such as rotting melons or tree sap. However, certain sap beetles infest corpses as well and are important in forensic entomology.

vi. Clown Beetles: Also referred to as Hister bugs, these beetles are cunning. They often spend the day hiding under the body, emerging at night to feed on maggots or dermestid beetle larvae that thrive on it.

vii. Dung Bugs: These beetles are very beneficial and feed on carrion. At any stage of decomposition, their larvae feed on decomposing fungus, dung, and vertebrate corpses.

VIII. STAGES AND DECOMPOSITION

1. Fresh Decomposition Stage- The fresh decomposition stage is commonly defined as, 'the time period between death and the appearance of the first indications of bloat.'[19] There are not any visible symptoms of physical alteration, despite the fact that inside microorganisms have started digesting organ tissues. The carcass has no odor. Blowflies (Calliphoridae) will arrive and lay their eggs shortly after someone has died. If the insect is in the egg, larvae, or pupa stage, investigators can seek it. This may aid in determining the person's death date. These flies, according to accounts, arrive minutes after death or exposure and lay eggs within 1–3 hours. Adult Sarcophagidae (meat flies) and Muscidae flies are also abundant during this early stage of decomposition. The initial eggs are implanted close to or inside the natural orifices of the head and anus, as well as at the location of perimortem lesions. Depending on the decomposition and development rate of the specific blowfly species, eggs may hatch and immature larvae may begin feeding on tissues and liquids while the body is still thought to be fresh.[20] Mature ants are also be found in the fresh stage of a cadaver. Ants will feed on both the meat of the corpse and the eggs and young larvae of the first arriving flies.

2. Bloat Stage- The first obvious indication of this Stage is a minor abdominal expansion and a few blood bubbles around the nose. In the belly, anaerobic bacteria produce gases that collect and cause stomach bloating. The color of the carcass flesh changes, as does the appearance of

[19] Anderson GS, VanLaerhoven SL, *Initial studies on insect succession on carrion in southwestern British Columbia,* Journal of Forensic Sciences (1996).

[20] Rodriguez WC, Bass WM, *Insect activity and its relationship to decay rates of human cadavers in East Tennessee,* Journal of Forensic Sciences (1983).

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marbling. The stench of putrefaction becomes prominent during the bloat stage. Blowflies, flesh flies, and muscids continue to produce eggs in great numbers during the bloat stage. Insects belonging to the Piophilidae and Fanniidae families enter during the bloat stage. Ants continue to feed on the eggs and larvae of these flies.[21] Further, a species called Coleoptera arrives, including members of the rove beetles (scientific name: Staphylinidae), carrion beetles (scientific name: Silphidae), and Cleridae families. Carrion beetles also appear after the body has progressed to an advanced state of decomposition.[22] During this step, beetle species belonging to the family Histeridae may also be collected, since they are often concealed under remnants.

3. Active Decomposition- This process starts with the corpse being deflated as a result of feeding Dipteran larvae penetrating the skin and releasing internal gases. Due to the liquefaction of tissues, the body takes on a characteristic damp appearance at this stage. The larval feeding activity depletes the skull, anus, and umbilical cord of flesh. A pungent putrefaction odor is released from the cadaver.[23] Feeding larvae of Calliphoridae flies are the dominant insect group during the active disintegration stage of corpses. Larvae are first concentrated in natural orifices that provide the least barrier to feeding. When the larvae lose flesh from the head, they become progressively concentrated in the thoracic and abdominal chambers and orifices.[24] Adult calliphorids and muscids declined in abundance and were not seen mating during this stage. Non-Calliphoridae Dipterans, on the other hand, are obtained from corpses. During the active decomposition stage, the first Sepsidae individuals arrive at the cadaver. Coleoptera variety of insects become the dominant insect around the location where the remains were found. The number of staphylinids along with histerids in particular increases.

4. Advance Decay Stage- During this stage, the majority of the flesh is gone from the corpse, while some flesh may remain in the abdominal cavity. The pungent scents of decomposition begin to diminish. This stage signals the beginning of the third instar calliphorid larvae's mass movement away from the cadaver. At this stage, Piophilidae larvae may also be collected. Only a few adult Calliphoridae are drawn to decaying corpses. Adult Dermestidae (skin beetles) make their way to the cadaver; adult dermestid beetles are rather frequent, but larval stages are uncommon.[25]

5. Dry Decay- Dry remnants are the ultimate stage of decomposition. Payne identified six distinct phases of decay, the last two being distinct dry and remnants. Due to the near-impossibility of distinguishing between these phases, many entomological studies merge them into a single final stage. At this point, very little of the carcass remains, mostly bones, cartilage, and little fragments of dried skin. The remains have little to no odor. Any odor present might be anything from dry skin to moist fur.[26]

Most species have been recorded to appear during the late decay and dry phases. The dry decay stage is marked by the emergence of new species from formerly dominating carrion fauna. At this stage, just a few adult calliphorids are attracted to the carcass, and adult piophilids emerge.[27] Dermestid beetles, which are prevalent in advanced decomposition, depart from the cadaver. Centipedes, millipedes, isopods, snails, and cockroaches are among non-carrion creatures that often infest remains during dry decomposition.

IX. THE SCENE OF FORENSIC ENTOMOLOGY IN INDIA

India faces a complete bankruptcy of knowledge when it comes to forensic entomology such that there exist only two papers of consequence, Kulsherestha & Chandra[28] and Kashyap & Pillay[29] both of which revolve around the similar topic of maggots helping in PMI. 'There are no takers for forensic entomology in India,' is what Dr. Meenakshi Bharti, a scientist at Punjab University Patiala said. She found out the PMI in a murder case in Jabalpore using the age of the maggots. She published a paper too along with Dr. Devinder Singh, outlining

[21] Payne JA, *A summer carrion study of the baby pig sus scrofa Linnaeus* (1965).
[22] Gordon Ramsel, *How Insects Help Solve Crime* (25th April 2020)
[23] Anderson GS, Van Laerhoven SL (1996). "Initial studies on insect succession on carrion in southwestern British Columbia". Journal of Forensic Sciences.
[24] Payne JA, *A summer carrion study of the baby pig sus scrofa Linnaeus*, (1965).
[25] Grassberger M, Frank C, *Initial study of arthropod succession on pig carrion in a central European urban habitat*, Journal of Medical Entomology (May 2004).
[26] Supra note 25.
[27] Grassberger M, Frank C, *Initial study of arthropod succession on pig carrion in a central European urban habitat*, Journal of Medical Entomology, (May 2004).
[28] P. Kulshreshta and H. Chandra, *Time since Death. An Entomological Study of Corpses*, 1987
[29] V.K. Kashyap and V.V Pillay, *Efficacy of Entomological Method in Estimation of PMI*, 1989

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forensic entomology in India or the lack thereof.[30] Devinder Singh, an entomologist at Punjabi University in Patiala, is now working on a Department of Science and Technology-funded study to collect baseline data on carrion insects (those that feed on decomposing flesh) that may be used as evidence throughout the Punjab area.

Another big indication of India's lack of forensic entomology was highlighted in the case of Hem Raj v. State of Haryana wherein the judge said that the investigation officer was not privy to the medical terms used by the counsel of the appellant which included 'presence of maggots,' an issue which would not have arose had a medical expert been present.

One Indian abroad, however, is making strides in the field of forensic entomology as Poulomi Bhadra from King's College London helped the police in investigating a murder case wherein a body was put in a suitcase and dumped. The zip of the suitcase was so compact and yet flies were present on the corpse which caused Poulomi to conclude that the body was left in the open for a long time before being put in the case.

In the case of M Sakthivel v. State[31], a woman was murdered and the accused argument was regarding the time of death, an important aspect as it was the deciding piece of evidence. The court said that this was another situation where the investigators did not call upon the services of a forensic entomologist who would have collected maggots from the corpse and definitely proclaimed the time of death, making the investigation go more efficiently and making the evidence less circumstantial

Another case, Sohail Abdul Rashid Shaikh v. State of Maharashtra[32] highlighted the importance of forensic entomology wherein the deceased, Madan Phatak's body was found on 18th April 2000, but the growth of maggots suggested the murder occurred 4 to 5 days prior.

Further, in the case of Babuddin v. State[33] the judge opined that the medical examiner had failed to preserve the maggots and if he had done so, the time of death of the deceased would have been confirmed.

"The discipline has not yet taken off in India," says PK Sumodan, an entomologist who specializes in mosquitoes. He said that it is not even expected to do so within the next decade as there is a dearth of information on the taxonomy and biology of carrion-feeding insects such as blowflies. As a large nation with astonishingly different environments, generating such data is very difficult. Sumodan believes that, in the absence of the labor and funding required for such in-depth taxonomic investigations, forensic entomology is not a financially viable field of study for researchers in India at the moment.[34]

Therefore, we still have a long way to go before forensic entomology can be used as an obvious choice while investigating cases, but this is more of an indication of India's reliance on general groundwork and lack of knowledge rather than the accuracy of entomology.

X. CONCLUSIONS AND RECOMMENDATIONS

India lacks the technical acumen to carry out forensic entomological practices in criminal matters, and an improvement in that area would be of great consequence in helping to effectively solve crime cases. Being a concept first used in forensic entomology has definitely grown slowly. It wasn't until several centuries later that it actually started being used on a regular basis and yet there exists a massive lack of entomologists. It will still take years for this branch of science to catch up and be used liberally but for this to happen several steps must be undertaken.

Taxonomic studies of bugs belonging to the insect families of Calliphoridae and Sacrophagidae along with a systematic study of insects in their immature stage are both required. Experiments regarding the effect of surrounding temperature, weather, and climate on forensically important larvae are further needed to help determine the place of death. We must keep researching to improve the knowledge base of forensically relevant bugs and work on creating procedures that help in species identification, age estimates, and modeling of maggot mass temperatures are high priorities for improving the accuracy and precision of post-mortem interval calculations.

The presence of entomological evidence may not be clear to a non-specialist while examining a case, but an entomologist who understands insects and their behaviors can make a significant contribution to the reconstruction of events. As a result, a more practical approach would be to require entomologists' participation in investigations at the actual crime scene.

[30] Meenakshi Bharti, Devinder Singh, Tarlok Singh, *Forensic Entomology in the Indian Perspective* (1990).
[31] (2016) 1 LW (Cri) 453.
[32] (2017) 3 AIR Bom R (Cri) 274.
[33] (2009) 112 DRJ 496 (DB).
[34] Subhra Priyadarshani, *Investigators are Increasingly Using Maggots to Solve Crimes*, The Telegraph (9th October, 2006).

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Another requirement is that physicians and police officers get entomological training (how to collect & preserve insects). With the aid of insects, a huge percentage of homicidal cases may be probed considerably more thoroughly. It is hoped that the relevance of this subject of biology would be acknowledged and that scientists will pay attention to it in order for it to be recognized as a full science in India as well.