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Forensic Entomology: Past, Present and Future

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Entomology refers to the study of insects and is derived from the Greek words entomon (insect) + logos (word, reason). One of the oldest fields of forensic science is forensic entomology. It has progressed through time from being used solely to determine the postmortem interval to being used to determine the season of death, geographical location of death, movement or storage of remains after death, and so on. The advancement of entomotoxicology has broadened and strengthened entomology's involvement in forensic science. The use of DNA for species identification has ushered in a new era in the discipline. These are some of the areas where we need to focus our future study efforts.

The Past

In Chinese literature, the first occurrence of forensic entomology may be found. In his book "Hsi yuan chilu," written in the 13th century, Chinese lawyer and death investigator Sung Tzu mentions what may be the first case in which insects led to the murderer. There was a stabbing near a rice field in that case. The investigator ordered all of the labourers to lay down their sickles the next day after the incident. Insects (perhaps blow flies) were drawn to one of the sickles by the presence of invisible bloodstains. As a result, the criminal was captured and confessed to the crime. In the texts of the Middle Ages, there are other instances of insects being found on corpses. Insects play an important role in the decomposition of human bodies, according to documents dating back to the 15th and 16th centuries. They describe a pattern of body disintegration and skeletonisation by insects that has been replicated through modern studies. In 1767, biologist Carl von Linné said that three flies could kill a horse as quickly as a lion. Now that we've seen how entomology had a role in mediaeval times, let's move on to modern times.

Bergeret, a French doctor, is credited with the first contemporary forensic entomology case. In 1855, he discovered the post-mortem interval (PMI) using forensic entomology. A child's body was discovered in a house in that instance. Bergeret was dispatched to locate the PMI. He hypothesised that metamorphosis takes a year and that females lay eggs in the summer so that the larvae would convert into pupae the next spring and hatch in the summer when he was looking for the PMI. He discovered Musca carnaria L. eggs on a corpse that lays eggs before it dries out. He calculated that the body had been placed there for at least a couple of years based on these observations. As a result, even with limited knowledge and resources, entomology may be quite useful in those times. Pierre Mégnin is credited as being the first person to do scientific research in the field of forensic entomology. He worked on the subject for nearly two decades, compiling his results in the book Lafaune des Cadavres, published in 1894. He proposed the hypothesis of eight successional waves of insects on carcasses left out in the open in this book. He also mentioned that insects came in two waves

on buried bodies. He also defined the morphological characteristics of numerous insect classes that were useful in identifying them. His contribution to the popularisation of the subject is unrivalled. People began adjusting Mégnin's conclusions to fit the flora and wildlife prevalent in their areas as word spread that his study entailed a lot of guessing. This process began at the turn of the nineteenth century and has continued ever since. German doctors Klingelhöffer and Maschka, as well as forensic pathologist Stefan von Horoskiewicz from Poland (then Austria), demonstrated the relevance of ants and cockroaches in generating post-mortem artefacts. Ant or cockroach bites that looked like ante-mortem abrasions or bruises have been described by both Horoskiewicz and Maschka. In all of those cases, innocent persons would have been prosecuted if not for the conclusions and testimony of these respected experts. France and Germany were the main hubs for entomological research at the time (the turn of the twentieth century). This can be seen in the following two novels from the time period: Alfred Brehm's Thierleben (Animal Life) and Jean Henri Fabre's Souvenirs entomologiques (Insect Life).

These books focused on carrion beetles and blowflies, and they helped to popularise entomology among the general public. Many scientists worked on the subject during the next few decades, and the database of insect traits grew. Despite the fact that the amount of research in the topic rose, the subject's popularity did not. Only a few scientists researched on insects all over the world. The primary goal of this study was to create a database specific to their geographic area and environmental circumstances. In the mid-1960s, all of that changed. Even Watson and Crick, who discovered DNA in 1953, would not have anticipated its application in forensic sciences, particularly forensic entomology. The use of DNA in the identification of invertebrates ushered in a new era. DNA was soon being used to identify insects found at crime scenes. This method was promoted as being more advanced and scientific than morphological characteristics. We won't go into the relative merits and downsides of using DNA for identification here; instead, we'll simply note that, given the large number of species and diversity seen in invertebrates, using DNA is unquestionably a step in the right direction. Entomotoxicology emerged as a new discipline of forensic entomology in the late 1970s. The presence of poisons in invertebrate decomposers was found in this study, and it was used to determine the cause of death. As a result, forensic entomology was progressing from simply detecting PMI to determining the cause of mortality.

The Present

It progressed from identifying metals to detecting numerous substances and their metabolites in the late 1970s. Beyer *et al* (1980) described a case in which a woman was discovered in the early stages of skeletonisation 14 days after her death. They used Gas Chromatography (GC) and Thin Layer Chromatography (TLC) to examine the larvae of Cochliomyia macellaria (Fabricius) (Calliphoridae); the results confirmed the presence of Phenobarbital. Since then, numerous scientists have discovered the presence of benzodiazepines, barbiturates, tricyclic antidepressants, various opioids, and other substances (the list is endless). Extraction methods have also advanced from GC and TLC to more complex techniques such as RIA, MS, HPLC, and others. All of this suggests that nearly any chemical can now be identified in even minute levels in both adult and larval insects. Although the use of entomotoxicology has grown and opened up new doors, it still has several issues that must be addressed before it can be utilised as an useful forensic tool. We now have no knowledge of the medications that insects collect. We're also oblivious to the concentration levels of the various medicines. Various medications have been seen to impact the rate of insect development. Some medications speed up the rate of growth, while others slow it down. Failure to notice this reality can result in a PMI estimation mistake of up to 18 hours, and in

some cases even more. Let us now turn our attention to the more traditional use of forensic entomology, namely the detection of PMI. The flora and fauna of diverse ecological regions across the world have been seen to change with the passage of time. This also applies to the insect population. As a result, current study is underway to keep track of these shifting trends and update our expertise. Invertebrates, as previously stated, contain the greatest number of species on the planet. We are still far from knowing everything there is to know about all of the species. This is especially true in tropical countries like India. As a result, there is a growing need for new study to find as many species as possible all across the planet. This is one of the most crucial activities taking place around the world. The use of DNA for species identification and categorization is becoming increasingly popular. The benefits of this strategy are self-evident and do not need to be stated again. In cases of child abuse and sexual abuse, one aspect of the application of forensic entomology can be difficult to believe and even harder to establish. The case presented by Benecke and Lessig (2001) demonstrates its usage in child maltreatment. They mentioned a case in which the body of a kid was discovered. The time since death was estimated to be 6-8 days using forensic entomology. However, insects found in the kid's ano-genital area revealed that it had not been cleansed in 14 days before the child died. This case was a watershed moment in the application of entomology to the investigation of child abuse. Post-mortem insect activity, notably maggot masses, mixed with natural decompositional changes has been found in studies to cause clothing modifications similar to those reported in sexual assault cases (Komar and Beattie, 1998). In circumstances where advanced decomposition has set in, this is once again relevant. Forensic entomology is no longer restricted to the detection of PMI. In the field of death investigation, a forensic entomologist has taken on a significant role. He is expected to perform a variety of tasks, including determining the number of days since death, the season of death, the geographical location of death, the movement or storage of remains after death, the time of decapitation and/or dismemberment, the submersion interval, specific sites of injury on the body, postmortem artefacts on the body and the crime scene, the use of drugs, linking a suspect to the crime scene, child neglect, sexual molestation, and the identification of suspects.

The Future

The first and most important step is to identify the correct species. Even now, we do not know all of the bug species. As a result, finishing our list should be our top priority. The method of species identification, such as morphological traits to DNA analysis, can change, but the priority should not. Following on from species identification, the next step is to identify species in distinct environments. For this, study must be conducted in the specific geographic area where the species is discovered. Not only do the species change with the time of day, season, and other factors, but they also alter with the geographical area. As a result, when conducting research on this topic, all of these elements must be considered. I'd like to bring up a handful of unique examples that will help to clarify our perspective. The first is when a body is discovered in an automobile. A car can now be considered a unique ecosystem because the points of entry are minimal, if present at all. As a result, we have no idea what species gain access to this isolated habitat and when they do. Another example is the kind of insects that live in water bodies such as lakes, rivers, and seas. This is critical in circumstances where the remains have been discovered in water. Because the body is frequently degraded beyond identification in most circumstances, determining the time since death becomes extremely difficult. As a result, when all else has failed, the entomologist can assist. The topic of entomotoxicology will be discussed next. Although it has achieved significant progress in recent years, there is still much work to be done. As we indicated in

the last part, this science has not yet progressed to the point where it can be employed in everyday practise. Entomotoxicology can be utilised for identification as well.

This can be accomplished by extracting DNA from the invertebrates of the deceased. Insects absorb human cells when they feed on human remains. These cells can supply the sample required for sampling. Although one may argue that if DNA is present, it will be present in whatever sample of human remains available. But in this situation, we can claim that we came across a case in which the body was completely burnt. We sent a DNA sample to see if there was any DNA in the remains, but it came back negative. On the corpse, maggots were present. Despite the fact that we did not send any maggots for DNA analysis, we believe we may have gotten a positive reaction, especially since the maggots are only present on live tissue. As a result, we believe that this is an area where future research should be focused. It is clear that Dizinno *et al.* (2002) have done some research on this topic. They used mitochondrial DNA to connect the human DNA found in the insect's stomach blood to the human DNA found in the deceased's bone. In this scenario, the DNA of the deceased could be matched. This can be used as evidence that forensic entomology can be utilised to identify the deceased in badly decayed bodies. One thing we must keep in mind is that the future is in the hands of the young. And only if we make the field good enough for them to pursue as a career will the youth get involved. This is our responsibility, as those already on the ground. This is because forensic entomology has not progressed as quickly as it could. As a result, all forensic entomologists around the world should make popularisation of the field a primary priority. More people entering the sector will result in more advancement, which will pave the road for future research. This will start a loop that can only have one outcome: the branch will get more popular. So, this should be one of the most important aspects of future development that we should strive for.

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