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THE ROLE OF FORENSIC ENTOMOLOGY IN ESTIMATING THE TIME OF DEATH

PERAN FORENSIK ENTOMOLOGI DALAM MENENTUKAN WAKTU KEMATIAN

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ABSTRAK
Pendahuluan: *Dibutuhkan dedikasi dan ketelitian untuk mengungkap berbagai misteri di balik kasus forensik. Berbagai cara akan diperlukan untuk menjawab pertanyaan terkait kasus tersebut, dan bukti atau keterangan ahli harus dapat dipertanggungjawabkan. Seiring waktu, beberapa bukti, terutama jaringan tubuh manusia, akan mengalami proses degradasi dan akhirnya menghilang. Namun, bagi ahli entomologi forensik, kerusakan dan hilangnya jaringan tubuh dapat membawa bukti baru yang dapat dipertanggungjawabkan secara ilmiah di pengadilan.*
Metode: *Pencarian sistematis beberapa artikel dengan kriteria inklusi dalam bahasa Inggris, berisi informasi forensik dan entomologi, diterbitkan dalam lima tahun terakhir. Kriteria eksklusi adalah duplikasi dan tidak dapat diakses seluruhnya.*
Hasil: *Jaringan tubuh manusia tetap menarik bagi berbagai jenis serangga setelah mati. Berbagai jenis serangga akan tertarik pada tahap yang berbeda dari tahap pembusukan jaringan manusia. Serangga ini mengikuti pola perkembangan.*
Simpulan: *Pengetahuan pertumbuhan dan perkembangan serangga dapat memperkirakan berapa lama tubuh telah mati. Selain itu, identifikasi di atas juga akan menunjukkan kemungkinan jenazah telah dipindahkan dari satu tempat ke tempat lain.*
Kata Kunci: *entomologi forensik, serangga, waktu kematian*

ABSTRACT
Introduction: It takes dedication and thoroughness to uncover the various mysteries behind forensic cases. Various methods will be needed to answer questions related to these cases, and the evidence or expert testimony must be accounted for. Over time, some of the evidence, especially human body tissue, will undergo a process of degradation and eventually disappear. However, for a forensic entomologist, the damage and loss of body tissue can bring new evidence that can be justified scientifically in court.
Method: Systematic searches of some articles with the inclusion criteria were in English, contained information on forensic and entomology, and were published in the past five years. The exclusion criteria were duplicates and could not be accessed entirely.
Results: The human body's tissues remain attractive to the various types of insects after death. Different kinds of insects will be attracted at different stages from the decay stages of human tissue. These insects follow a development pattern.
Conclusion: The insects' growth and development knowledge can estimate how long the body has been dead. In addition, the identification of the above will also indicate whether a corpse has been moved from one area to another.
Key Words: forensic entomology, insect, time of death

INTRODUCTION

Forensic entomology is a branch of forensic science that evaluate insect activity with various techniques to help estimate the time of death and determine whether anybody tissue or corpse had moved from one location to another or the body has been messed up at a specific time, either by the animals or by the

killer who came back to the scene of the criminal case. Entomology deals with the biology and histology of arthropods and other sciences such as chemistry and genetics. With DNA testing in forensic entomology, there is a possibility of identifying the DNA of the body tissue exposed to or eaten by insects. This matter would make it possible to identify a person's body tissue or corpse through insects found at the crime scene.[1]

In recent fifteen years, forensic entomology has been increasingly used to assist the process of investigations conducted by the police. In this regard, Forensic entomology is mainly applied to cases of suspected death that last seventy-two hours or more, as other forensic methods are assessed more accurately in determining the time of death before seventy-two hours or more. However, the insect evidence was more accurate when the death lasted more than three days and can sometimes be the only timing of death clue.[2] In Indonesia, there are still a few articles that discuss forensic entomology. This article aims to review the role of forensic entomology in estimating the time of death.

Systematic searches were carried out in July 2020 on PubMed, Proquest, Science Direct, and Clinical Key. The search term was "Forensic AND Entomology." The inclusion criteria for articles were in English; there was information on forensic and entomology, and the articles were published in the past five years. The exclusion criteria were duplication, and the ones could not be accessed entirely. Publications selected for the title and abstract were extracted using a standard format table and processed using a Microsoft Excel spreadsheet. The data extracted were in the form of author, year of publication, journal, and conclusion. The results are then presented qualitatively.

Of the 268 articles obtained, only five articles met the inclusion and exclusion criteria and passed the exclusion criteria. Figure 1 shows the flow of article selection. A critical review was conducted on four selected articles published by journals in the Q1 and Q2 categories based on the Scimago Journal and Country Rank. Then an analysis was carried out to review the role of forensic entomology in estimating the time of death.

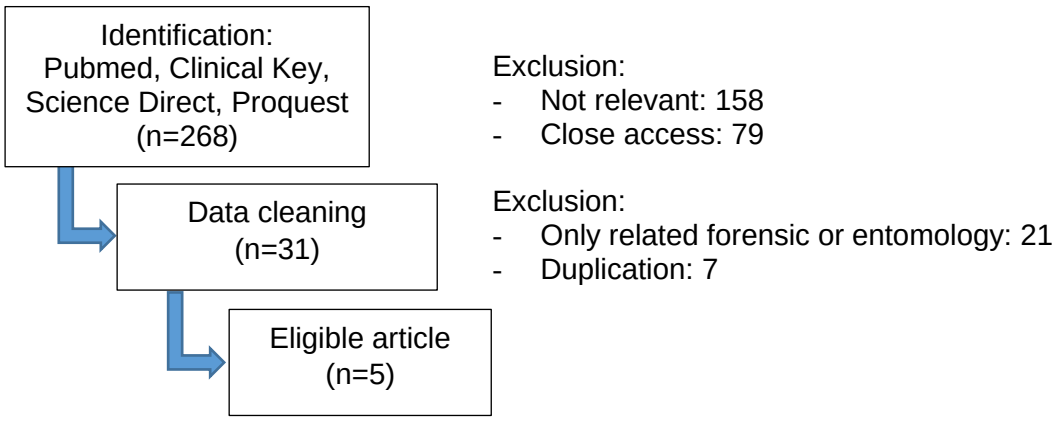

Figure 1. Article Selection Process Schematic

FORENSIC ENTOMOLOGY

Forensic entomology is divided into three aspects, namely urban, stored-product, and medicolegal/medicocriminal. The urban aspect emphasizes the existence of insects living in the environment around humans. The discovery of insects or urban pests that live in humans, both still alive or the dead, can be helpful in legal matters. These insects can attack the body and then inflict damage in the form of wounds that could be mistakenly interpreted as signs of violence that happened before. The stored-product entomology aspect involves the presence of insects or arthropods or insect body parts in food or other products. Examples exist insects or larvae on food, vegetables, or canned food that make consumers demand that the food maker or restaurant sometimes be a fraud committed by someone by inserting insects or parts of its body into pre-purchased food to sue producers food. The case can be solved with the help of forensic entomology.[2]

Medicolegal entomology, better known as entomology medicocriminal, is essential because of its usefulness in solving criminal cases, especially violence. The existence of a type of insect, larvae, or eggs, when and where they came from, or under what circumstances these organisms can appear in the human body are beneficial in estimating time or post mortem interval (post mortem interval) and determining the location where the death occurred because some species were only in a specific place or only active at certain times (particular season or time). Examples of such cases were in Ohio when a man was found guilty of murdering his wife and children in California. He found grasshoppers and insects that appear on night days and are widely available in western America in his car. Another aspect included in medicolegal forensics is entomotoxicology, namely the use of insects for toxicological analysis by testing several substances suspected of causing death in victims because the insect network can assimilate the toxin accumulated on its body tissue before death.[2]

As already explained, medicolegal entomology is a more advanced aspect often used to investigate deaths, first recorded in the century the 13th by Sung Tzu in his book "Washing Away of Wrongs" to write several cases of how a person died and the possible cause of death. In his book, Sung Tzu also describes a murder case that comes to light the killer is the fly. The judge of the village where Sung Tzu lives invited Sung Tzu and all the workers in the village to gather with their sickles to ask him about the body of a man who was found dead near a rice field. The stab wound on the victim's body made the judge suspect a rice worker had killed that person. Not long after the workers arrived in front of the judge, the flies started around a worker's sickle. Microscopic particles of dry blood and skin attached to the scythe attracted the fly, forcing the worker to admit his actions. Sung Tzu's information in his book shows the beginnings of Eastern knowledge about insect behavior and biology. Sung Tzu didn't just consider the case but also described the behavior of flies in decomposing corpses, patterns of flies invading various natural body

orifices, and various attracting insects to wound. In addition, the book also explains how to check the corpse beforehand or after being buried, and his explanation of some of the cases he had experienced became the basis for the development of forensic entomology.[3]

Dr. Bergeret d 'Arbois was the first to apply entomology forensics in determining the post-mortem interval. Since the early 20th century, entomology has increasingly developed with the taxonomic division of insects relating to medicolegal interests. It includes two prominent families, namely Sarcophagidae and Calliphoridae. Concerning the purpose of applying forensic entomology in estimating the time of death, there are two ways to attribute insects to the occurrence of time dead. The first way is based on the fact that the human body or other carcasses support changes in the ecosystem for a while, depending on the geographic conditions. During decomposition, physical, biological, and chemical changes occur. The different stages of the decay phase can attract certain types of insects to appear. Types of Calliphoridae and Muscidae can be found in the area or other bodily fluids within minutes of death. The Piophilidae species do not appear when the body is new but will occur sometime after the fermentation of protein in the body. The second way of estimating the mortality interval is by using the age of the larvae. The age of the larvae can determine the approximate interval of deaths occurring within the first week of death. Certain species are found in the corpse's body and leave the egg, which later will be developed according to its life cycle. The stage in the life cycle of these larvae can be determined by size and spiracles. Furthermore, the development of the stage takes a specific time which is also influenced by the surrounding temperature because insects are cold-blooded creatures whose growth depends on temperature approx.[4]

Forensic entomology is used to assist in handling criminal cases to estimate the postmortem interval and the estimated time of death. Postmortem interval is crucial in investigating murder and death cases, not other reasons. The investigation results can help reveal a crime case by getting rid of suspects or attributing someone's death to time intervals certain. If the species identification is not correct, then the estimate of the postmortem interval becomes not right either. In general, below is the explanation of the uses of forensic entomology.[5]

ESTIMATING POSTMORTEM INTERVAL

Several factors influence postmortem changes in the corpse's body, so that the postmortem interval will be difficult. Biological and physical changes, which is a function that still occurs after death, are clues in determining the time of death. But in the case of death that has been over time, the method becomes useless, and the instructions are precisely obtained from the entomological information. Decomposed corpses can affect the behavior and composition of the surrounding species. Many have conducted observations of insects related to the process of corpse decay. One of these processes is the

development of its species eat carrion, for example flies from the family Calliphoridae, Sacrophagidae, and Muscidae, which are insects commonly found on corpses. The estimated age of insects that have eaten the carcass shows a short postmortem interval with scarce exceptions. Adult female flies do not place their young on a live host. Depending on the insect species and conditions of the scene, larval stage development may show a postmortem interval of 1 day to more than one month.[5]

DETERMINING TIME OF DEATH

Analysis of insects can be used to determine time dead. When the body is found after a few weeks or a few months after the death, entomological evidence is often the only method available to determine the exact time of death. Several species are interested in the corpse immediately after death, other types are attracted after active decay, and others are drawn to dry skin and bones. Insects continue to colonize the body until there is no more food.[6]

DETERMINING CORPSE LOCATION

Analysis based on a specific insect inhabiting the area, mainly if there is a corpse, it can almost be concluded that the identified corpse comes from a place which is the region from the habitat of these insects.[6]

ESTIMATING TIME OF DEATH

Estimating the time of death in a forensic case is essential, so it is almost always included in a forensic autopsy conclusion. The moment of death assists the police in confirming a person's alibi, which is on, in turn, will narrow down the list of suspects in police hands. List compilation of sharp and precise suspects will save time, effort, and money in an investigation.[6]

In medical science, it is not possible to estimate the time of death with one method alone. Combining 2 or more methods will give more approximate results more accurate with a smaller bias range. Several methods are commonly used in estimating the time of death is a measure of the decrease in body temperature, interpretation of bruises and stiffness of corpses, interpretation of decomposition processes, measurement of changes in vitreous chemistry, gastric emptying and contents interpretation, and activity interpretation insects namely through forensic entomology.[7]

Forensic entomology evaluates insect activity by various techniques to help estimate the time of death and determine whether the body tissue is or not been moved from one location to another. Entomology is not just about arthropod biology and histology, but nowadays, entomology is in its methods to cultivate other sciences such as chemistry and genetics, including through DNA. This matter allows identifying a person's body tissue or corpse through insects found at the crime scene.[7]

INSECT ACTIVITY

Insects attracted to corpses can be broadly categorized into three groups: necrophage species that feed on body tissue

corpses, groups of predators, and groups of parasites that eat necrophagous insects. A parasite group consists of omnivorous species that feed on body tissue and eat other insects. Of these three groups, the necrophage species group is the most important in helping to estimate the time of death. It depends on the time and species of insects; insects can visit, eat, thrive, and reproduce immediately after death. In line with the decay process, several generations of insects can settle on the bodies of the corpses. Various factors such as the degree of decay, burial, immersion in water, the process of mummification, and geographical conditions can determine the speed at which bodies are damaged, at what rate types of insects, and how many generations of insects can be found.[8]

Flies are the insects most commonly associated with rotting. Flies tend to place their eggs in the orifice of the body or open wounds. This tendency will result in a change in the shape of the wound, or it even shatters the area around the wound. Generally, fly eggs are deposited on the corpse immediately after death during the day. When the corpse is not moved, and only eggs are found on the corpse, it can be assumed that death ranges from 1 – to 2 days. This figure varies slightly depending on temperature, humidity, and fly species. After hatching, the larvae develop to reach the pupa stage. This stage takes 6 - 10 days in tropical conditions. Adult flies emerge from the pupa at 12-18 days. Many variables influence the development of insects; hence an attempt to estimate time death using the method of entomology must be assisted by a medical entomologist.[8]

THE STAGES OF DECAY

There are five stages of decomposition accompanied by different insect activity.[9]

Fresh stage

In the fresh stage, the first insects to arrive are flies. Some researchers regard the entire colonization as blowflies, whereas others view blowflies and flesh flies as distinct types. A more accurate description is through the actual classification wherein blowflies belong to the Calliphoridae family and is known as green bottles, blue bottles, and house flies, while flesh flies were included in the family Sarcophagidae.[9]

The way to tell the difference is that blowflies can be metallic, green, blue, or black, whereas fleshflies tend to be colorless and striped with a red ridge on the back of the abdomen. Blowflies lay eggs in sores or open areas such as the eyes, nose, penis, or vagina. Meanwhile, fleshflies directly deposit live larvae into the body.[9]

The insects that come in this phase are green bottles and blue bottles. These insects come from a few minutes to several hours after death, depending on environmental conditions. Female flies lay eggs in every exposed part of the body. The first egg place can not be immediately visible because the eggs are deposited very deep in the body cavity. Egg the blowfly is about 2 mm long and is white or yellow. Fleshflies can come at the same time or several hours after blowflies. As already mentioned, Flesh flies deposit larvae

live in the body. At this stage, they can become prey for flies adults. Ants can also emerge and eat eggs and grubs.[10]

Several methods are used to estimate the PMI (post-mortem interval) during this stage. The eggs are collected, then brought to the laboratory. The researchers have to create environmental conditions in the laboratory, such as when the body was found. Several researchers recommend beef liver as a good food source for breeding maggots. The eggs hatch and adult flies emerge. Some adult flies were collected and identified. The second cycle may occur; thus, the investigator must note the exact time of each stage and the total length of time required for a complete process.[10]

The fly life cycle consists of five stages. The first is eggs. The two stages are three instars, each producing more big maggots. The fourth is the pre-pupa stage, where the larvae leave their bodies and try to wrap themselves in the area where they are going pupate and become adult flies. The pupa formation stage is the fifth and final stage. Stage three instars are identified through the morphology of the mouth and posterior spiracles. Live maggots found collected and compared to the growth rate. However, this growth rate is influenced by conditions, the environment, and the flies' species.[11]

Bloated stage

This stage is distinguished from the presence of gas production by bacteria breaking down the network. The fly eggs will hatch, and larvae actively contribute to decomposition through increased activity tissue damage that can increase body temperature up to 127 degrees Fahrenheit. The higher the body temperature, the more bacterial activity that occurs.[12]

Decay stage

The skin has broken off at the decay stage, and body fluids are absorbed into the surrounding area. The maggots (larvae) will stop eating and leave the body. Larvae are in their third instar stage during this phase. Depending on their species, maggots will move away from the body en masse. Some will move 20 meters away from the body. The beetle becomes the most common insect by the end of this phase.[13]

Post decay stage

The beetle is mainly found in the body in the post decay stage. Species will vary according to conditions. Some beetles cannot live in wet conditions, while others require humid conditions.[14]

Skeletal stage

At this stage, only soil insects can be found. At this stage, it is essential to take a soil sample from the bottom of the body up a distance of three feet from the body.[15]

CONCLUSION

Determining the approximate time of death in a forensic case is a matter of course, plays a vital role so that it is always included in an autopsy impulse forensics. The estimation of the time of death assists the police in investigating and do confirm someone's alibi, which in turn narrows the suspect list in police hands. Compilation of a list of suspects who will be sharp and precise saves time, effort,

and funds in an investigation. In medical science, estimating the time of death cannot be made by one method alone. Combining two or more methods will give a more accurate estimate with a range of bias the smaller one.

Forensic entomology evaluates insect activity by various techniques to help estimate the time of death and determine whether body tissue or yat has been moved from one location to another. The time of death can be determined by identifying the age of insects and eggs in the corpse to estimate the timing of the corpse's death. The primary assumption is that human corpses still "new" have not been infested with insects and are not yet thriving in the carcass. Thus the age of the insects getting old and the eggs found on corpses can be used as the basis for estimating the minimum postmortem interval. To determine whether a corpse has been removed from the site of its murder can be done by identifying the insects on the corpse and comparing them to similar insects around. By molecular identification, data will be obtained whether the insects found on the corpse came from the area where the corpse was found or did it come from another place because it was on basically. Even insects of the same type can have different genetic variations.

Medical entomology, including forensic entomology, continues to develop rapidly, and medical entomologist services are needed. Entomologist skills are required in investigations, in the judiciary, and in the supervision of the medical field, ensuring the fulfillment of community needs. Although this field has not been as popular as other medical sciences in Indonesia, with the information age and current globalization, trend entomology is expected to be as popular as the discipline of entomology in other parts of the world.

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