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Establishment of PMI through Succession or Presence of Beetle in Forensic Investigation

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Abstract:

Nowadays with access to various fast-moving vehicles as well as increasing tendency of people living alone whenever a crime involving death of a person occurs the bodies are found lying in remote areas after many days when the crime occurred in that case Post Mortem Interval is the most source for clue to get leads on the time line of crime. PMI i.e. Post-Mortem Interval also known as Time Since Death is most important enigma, which has always successfully bedazzled an investigator or a forensic pathologist to determine the correct sequence in which the crime took place. The dead body does not always follow a strict rule towards the different stages of decomposition in regards to the time interval. The temperature, mode of death, food ingested, BMI i.e. Body Mass Index and other environmental factors also influence, the stages observed at different times and often in such scenario forensic entomology is referenced but sometimes, it is not possible to find blow flies or maggots after certain time period. In present study, the main focus is on establishing the post mortem interval through succession of hister sp. and other ground beetles in not only at different stages of decomposition also in different habitats and environmental factors on carcasses found on surfaces but also from exhume bodies.

Keywords: *Beetles, Histeridae, Post-mortem interval, Body mass Index, Succession, Exhume bodies, Exhumation.*

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Introduction

Entomology is also known as ancient science which is the scientific study of insects and their relation to the humans, environment and the organisms, there has been a rapid growth observed in the development of this field during 19th and 20th Centuries. This field of insect's study has also branched out in legal investigation crowned with the term Forensic Entomology. The most apparent use of forensic entomology is establishment of the time period since death, it is also useful in neglect cases. When investigation crime scenes or lawsuits involving mutually both the humans and wildlife, the succession of the carrion insects is an indispensable property or feature that can be referred to establish the time since death. Due to the inherent amphibious nature of some insects, they can also be used in the examination of a scene of crime both on land and in water. The mainstream of the cases where entomological approach has been sought for are those involving unlawful activities which take place on land can be exposed instantaneously with a devoted mind. Gaudry observed that 70% of corpses throughout the France were found outside and of these 60% were fewer than 1 month old by referencing to the life cycle of various insect species found on the carcasses **(Gaudry et al, 29-30).**

Characteristics of Beetle

Beetles such as clown beetles which prey on the dipteran larvae have been established to be the next in line entomological clue in a corpse, which are in a progressive decomposition process and this versatility of the presence of different species of beetle on the corpses has gotten the approval of various scientific communities for the appraisal of minimum Post Mortem Intervals as emphasized. Interpretation of beetles at different stages of life is the very essence by which a forensic entomologist is qualified to say that, the beetles found on corpses explain a story. The family of beetle Carabidae are given due consideration as the foremost pillagers because of their part in food chain, changing aspects and pest control **(Andrade *et al.*, 457-463)**.

Beetles are contributing to be correlate with the next stages of decomposition methods, which is very extensive in terms of dry bones of the body. They are commonly created on corpse when it is further decomposed and their inspection has permit scientists to determine the death time of deceased, PMI (Post mortem interval). The diversification of beetles establishes on a body variation ancient history of time and can accordingly be responsible for the evidence of ecological sequence. The range of the beetles in size

under 1 mm to over 15 cm in length. In beetles the largest species is tropical species.

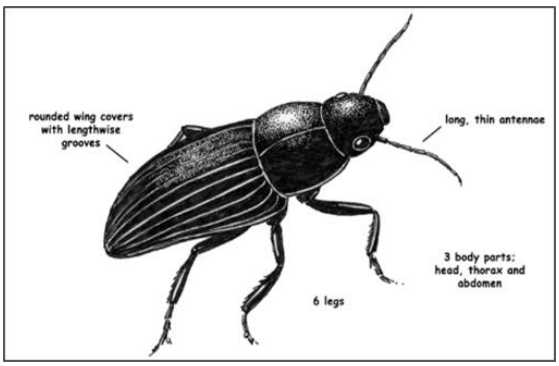

Figure: Parts of Common Black Ground Beetle

Beetles can display highly complex behavior when mating. Smell is considering to play an essential part in the area of a mate, rivalry can act a part in the mating custom of some species such as burying beetles where clash between males and female's bitterness until only one of any is left, this insure reproduction by the vigorous and adequate. Several beetles are sectional and will passionately contend their minor patch of location from disturb males. Majority of the beetles are plant eaters, but some of predators and scavengers and a limited parasite **(www.encyclopedia.com).**

Classification of Beetle

There are several types of beetles which are as following: -

1. **Carpet Beetle –** The *Dermestidae* family collectively accommodates a large variety of

beetles known as carpet beetles, it can feed on both animal element like dry skin and hair object. These beetles are found on saved woolen clothes and also feeding on reserved food in your home. It is of three types.

a. **Black Carpet Beetle –** The first basic type of carpet beetles can establish completely without any use for animal matter in the diet. These beetles are generally found in reserved woolen clothes, wooden carpet and furniture along with stored corn in the kitchen. It is an elongated in shape and black or dark brown in color. The length of the carpet beetle is 5mm.

b. **Varied Carpet Beetle –** The body shape of varied carpet beetle is nearly identical in visual to that of the common carpet beetles in initial stages of life but adult varied carpet beetle is almost round in shape from the aerial view with a shiny black carapace with a length of about 3mm.

c. **Common Carpet Beetle –** The morphological features are quite similar to that of Varied Carpet Beetle however there is a unique bright brick red stripe down the center of upper surface along the inner margins of wing covers.

2. **Larder Beetle -** It is very easy to tell apart a larder beetle form all other carpet beetles, with an oval or elongated black coloured body shape of 7- 9 mm in length and an olive brown band through the middle of carapace. It also sports six black spots within this brown band, with a life span of upto a year they mature during the winter into adult.

3. **Ground Beetle -** Ground beetle has been vested with the scientific name Carabidae as the name implies, are insects living on the soil surface. Which is even more so true for the adult and larvae of the species belonging to Canadian Lands with remarkable ability to run very fast, hence the German name Laufkäfer. Although these beetles. **(fliphtml5.com).**

4. **Carrion Beetle (Histeridae) –** Useful in determination of time since death Histeridae or carrion beetles also known as clown beetles. The Elytra and forewings are shortened and rectangular which is world apart from the well-developed elytra and forewings in other beetle species, they have distinctive characteristic in the form of elbowed antennae, which form a club at the end. They have open circulatory system and spiracles situated on the abdomen. The shape of these beetles is dependent on the habitat they live in for example - Flat Hister beetle are found under the bark while Cylindrical Hister Beetle are not. He stated that, most of the evolving studies of carrion correlated insects have been absorbed on flies, but beetle enlargement has been mostly neglected **(Guo *et al.* (2012).**

Life Cycle of Beetle

Beetles, comparable other insects, undergo a complete method of metamorphosis in which it bear four stages of development.

1. Eggs - It commonly takes from 4 – 19 days for the eggs to entrance.
2. Larvae – 3 days after hatching some species pass through 3 – 5 stages and some species can have up to 30 stages. Generally, the larval anatomy is of campodeiform type.
3. Pupa – It can take 9 months and generally happens in winter period.
4. Adult Beetle – It will amateur eggs for the initiation of another generation **(www.britannica.com)**.

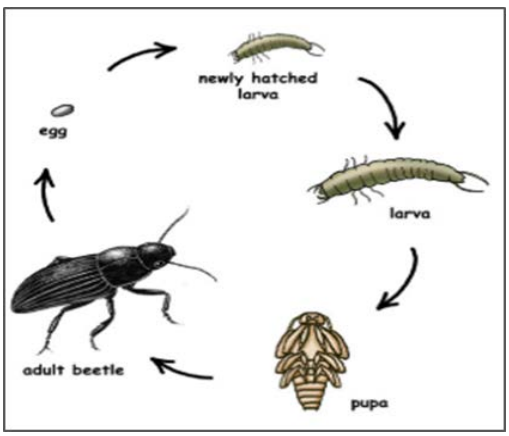

Figure: Life Cycle of Ground Beetle

Role of Forensic Entomology in Medico legal

Medico-legal entomology approach with the usage of insects or other arthropods correlate with a corpse at a scene of crime in a legal inspection to hand over data not available by applying the orderly process of classic pathology. Forensic or medico-criminal entomology is a most important arena of forensic sciences that mainly deals with purpose of mode of death, time and place and from submission of the study of insects and further arthropods to legal issues such as sexual molestation, murder, suicide, abuse and child-neglect, chemical intoxication, contraband trafficking etc. (Singh and Sharma, 26-33). The utmost acknowledged characteristic of forensic entomology is undoubtedly the medico legal aspect, which is establish the time of death, known as post mortem interval (PMI), or further exactly, how long a carrion has been visible in the atmosphere **(Sharma and Singh, 838-845).**

Review of Literature

Andrade *et al.* (2018) discussed about the variation in life expectancy of Abaris basistriata Chaudoir (Coleoptera: Carabidae) from the hatching of eggs to death of an adult i.e. one life cycle, while being reared on three substrates namely Fine vermiculite, soil and paper napkins. They observed that the survival rate of first and second instar larvae was same for all three substrates, while third instar onwards survival rate is higher in soil as compared to other two substrates mentioned above. The species exhibited pre-oviposition and a higher oviposition and post oviposition period in soil. The soil habitat also influences the fertility and fecundity, the beetles exhibited higher levels of fertility and fecundity, when reared on soil. They suggested the above information to be immensely useful for biological control.

Mashaly (2017) observed the decay pattern of the rabbit carcasses and try to establish PMI through beetle succession in urban, agricultural and desert region of Riyadh. He found that the decomposition period was longest i.e. 12 days in agricultural region or habitat and 6 days each in urban and desert habitat. His study divided in three parts i.e. dry stage, decay stage and bloat stage and tried to establish a relation between these three stages and the succession of beetles. He over his studies determined that the bloat stage was completed by day 3 in agricultural habitat and one day shorter in desert and urban habitats than agricultural habitat. The duration of decay stage varied between habitats. This stage lasted 7 days in agricultural stage and 3 days in desert urban habitats.

Bala and Singh (2015) discussed about the beetles establish on corpses tell a story. Beetles are be probably related with the well along stages of decomposition methods, which is very significant in relations of dry bones of the body. They are commonly found on corpse when it is further decomposed and their examination has assisted scientists to explain the time of death of corpse, PMI. The group of beetles initiate on a body deviations over time and can thus be responsible for evidence of ecological succession.

Banerjee (2014) studied the distribution of beetle fauna over the period of one year i.e. 2012 of the nine indigenous species namely *Carabidae, Scarabaeidae, Coccinellidae, Hydrophilidae, Borydae, Curculionidae, Lycidae,* and *Derodontidae* at three sites. He marked as Site A, Site B and Site C and observed that the Site C was less populated (diversified) as compare to other two Site's diversity. He concluded that monsoon is most active period of the year i.e. June-July for all the nine species, while in winter due to the presence of harsh conditions the insects choose to go through diapause to avoid such conditions and hence less diversity in winter months. In Site C due to the unique composition of the flora only three families were observed namely *Carabidae, Hydrophilidae* and *Derodontidae.*

Zahid *et al.* (2013) conducted and experiment to study succession of the beetles on a dog species *Canis domesticus* L. as a substitute for human corpses. They divided the different stages of decomposition in their 11 days of study into fresh, bloat, active decay, advanced decay and dry and observed the relation between these stages and composed Coleoptera species such as *Hister sp.*,

Trox sp., Necrobia rufipes and Dermestes maculates. They observed that *Dermestes maculates* was the first to arrive while in later stages, the hister species adult and larvae were the dominant niche. The presence of four species was observed as following

a. *Dermestes maculatus* was observed in active stage i.e. 3-4 days after death only

b. *Hister sp.*, *Necrobia rufipes & Trox sp*. were present in the corpse form 3rd day of death i.e. active stage, advance stage (5-6th day) and Dry stage (7-11th Days).

They suggested that on observing the species present PMI for a corpse can be determined.

Corrêa *et al.* (2012) suggested that the hister species is able to be associated with the PMI of an exhumed body, when there is no other fauna present in or around the body as a seasonal indicator. They collected around 38 specimens of the Histeridae species (O. hospes) from and around the corpses of rabbit exhume after being buried for 2, 4, 6, 8 and 10 weeks each indicating that on studying the stage of life cycle and maturity of the beetles can be referenced for determining the PMI.

Conclusion

From the literature survey it has been concluded that *hister sp.* ground beetle are an integral part of a forensic investigation and helpful in creating a forensic entomological database, which can be referenced to determine the PMI of a corpse according to the literature survey of various research paper published in journals of national and international repute, it is observed that an average, the hister beetles or any other necrophagous beetle species can be observed on a courts from the 3rd day of the death, when the decay is the most active i.e. active decay stage and can be found till the corpse has completely decomposed. The temperature, season and habitat may also influence the succession of beetle but they may not vary more than 1-2 days. These beetles can not only help an investigator determining PMI from a dead body up to 2 weeks in a decomposed state but also from an exhumed body buried at some unknown time upto 10 weeks or more.

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