The Utility of Insects in Estimation of Post Mortem Interval in Human Dead Bodies

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Abstract

Introduction: In recent decades the use of entomology as a strong tool on human corpses can help in estimation of time of death or post mortem interval in addition to others parameters related with postmortem interval. Forensic entomology is the name given to any aspect of the study of insects and their arthropod counterparts that interacts with legal matters. Since many insects are associated with the human body after death, they are always a potential source of evidence in case of murders or suspicious deaths

Aim: The objective of this study involves the evaluation of postmortem interval from entomological evidences, to study the effect of temperature and humidity on the determination of postmortem interval by using entomological techniques and correlating it with autopsy derived postmortem interval.

Material and methods: The present study was conducted on 100 corpses with the guidance of expert Entomologist at the Mortuary of Gandhi Medical College, Bhopal and all necessary information regarding the scene of crime, methodological data collection, meticulous collection of specimens and routine post mortem examination of corpses were done, to find out the mode and manner of death. Decomposed corpses were categorized in five stages: Stages I Fresh, Stage II - Bloated, Stage III Acute decay stage-IV post decay and stage V – Dry or skeletonized.

Observation and Result: The statistical data collected from this study showed that out of 100 cases 54 cases were of known individual, where 46 cases were of unknown identity of these 82 cases were male and 18 cases were female. Commonest species of insects found on dead bodies were Calliphorids in 78.2% cases followed by Sarcophagids in 12.6% cases, Face (including orbit, nose and ear) was the common site where entomological evidence was found (39 cases) followed by neck. The postmortem interval determined from entomological evidences was correlated with the interval as determined from routine autopsy examination and in 66% cases the two intervals were found to be in the same range.

Conclusion: The present study clearly highlights the importance of forensic entomology in estimating precise postmortem interval which can be used as alternative tool in cases of decomposed bodies with entomological evidences.

Keywords: Forensic Entomology, Insects, Post Mortem Interval

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Introduction

In recent decades the use of entomology as a strong tool on human corpses can help in estimation of time of death or post mortem interval in addition to others parameters related with postmortem interval. Forensic entomology is the name given to any aspect of the study of insects and their arthropod counterparts that interacts with legal matters. Since many insects are associated with the human body after death, they are always a potential source of evidence in case of murders or suspicious deaths, however, the field of forensic entomology remains obscure and in nascent stage in our country, largely because of lack of awareness of the benefits that may generate from its application and hesitation on the part of others to do a proper post-mortem examination in cases infested with maggots.

The insects helpful in forensic entomology include six legged creatures dominating terrestrial and fresh water carrier fauna. They belong to dipterian family including callophonidae; sarcophagidae, muscidae: sepsisdae; Phoridae and coleoaptean family namely Histeridae, cleridae[1,2,3,4,5]. A basic knowledge about the life cycle of the insects and close observation of the findings can be extrapolated to arrive at the duration of collected evidence and thence the same can be extended to the source (corpse) in determining post-mortem interval. The use of forensic entomology is quickly being recognised and accepted as a valid from a forensic identification. Due to poikilothermic (cold-blooded) nature of insects, ovipostion and subsequent stages of Dipterian flies is greatly reduced at lower temperatures thereby lengthening the decomposition process.

The objective of this study involves the evaluation of postmortem interval from entomological evidences, to study the effect of temperature and humidity on the determination of postmortem interval by using entomological techniques and correlating it with autopsy derived postmortem interval. So entomological evidences are well suited to help an investigation to know time since death and where and when the crime occurred. Maggots and corpses go together. For many stages in an insect's life, we can calculate the time since the egg was laid.

Recent evidence in Forensic Entomology have shown that arthropod evidence can provide information about toxicology of deceased victims to uncover crime in circumstances of interest to law and alteration of blood stain evidences at the crime scene[6].Insects life cycle acts as precise clocks which begin within minutes of death. The time of death and other death related events can usually be determined using insect evidence gathered from and around a corpse, if the evidence is properly collected, preserved and analyzed by an appropriately experienced forensic entomologist[7]. Insects can also help in establishing whether the corpse has been moved after death by comparing local fauna around the body and the fauna on the body.

Material and Methods

The present study was conducted on 100 corpses with the guidance of expert Entomologist at the Mortuary of Gandhi Medical College, Bhopal and all necessary information regarding the scene of crime ,methodological data collection ,meticulous collection of specimens and routine post mortem examination of corpses were done ,to find out the mode and manner of death. Decomposed corpses were categorized in five stages: stages - I Fresh, Stage-II - Bloated, Stage III Acute decay stage-IV post decay and stage V –Dry or skeletonized.

In order to arrive at minimum post-mortem interval, mean air temperature (ºC) as derived from daily maxima - minima and mean humidity was recorded during relevant period. The site of finding the body, habitat circumstantial information was noted from inquest papers, requisition form and history as narrated by relatives. The monthly distribution of observed cases was studied to find out the prevalence of seasonal insect activity. Both dead and live insects at all stages of development including eggs, each kind of larvae, pupae and adults found on corpse was separately collected with forceps. Eggs were identified by their sausage shaped appearance; size 0.1- 0.3 laid in bunches at various site of the body. The eggs were hatched to find out the hatching period. P-M interval was calculated in terms of largest (oldest) larvae[8] .Based on variations of larval length a scale relating to their maturation under given climatological condition was drawn which was then utilized to calculate minimize PMI.

The larvae were then transferred to a 70-80% solution of ethanol to prevent their discoloration and shrinkage, which would be the case if they were directly treated with such solution when alive. Fisher's media is the preservative media in which specimen retain their shape and colour indefinitely and is ideal for aqueous procedure required to disclose internal structure of larvae. For fixation Bresle's mountant for permanent specimen preparation was used. Larvae specimen is fully extended state were placed on mm graph and their length was measured using stereoscopic dissecting microscopic with varied magnification range.

Small mass of larvae were reared in mortuary itself while they were placed in dry containers with lids along with a mass of tissue from corpses as rearing media and left undisturbed to be examined from time to time. The species of adult was studied and based on knowledge of life cycle of fly and post mortem interval was calculated successfully using this method inside laboratory; identification of species is possible after adult forms were available[9].

The postmortem interval so arrived was then correlated with the autopsy PMI during PM examination to confirm the convergence of the two tools in determining exact duration of death. Other important information derived from related sources were analyzed to understand para-death events.

Observation and Result

The statistical data collected from this study showed that out of 100 cases 54 cases were of known individual, where 46 cases were of unknown identity .Of these 82 cases were male and 18 cases were female. Clothing was partial in 28 cases, 55 were fully clothed and 17 were naked. Maximum cases (23) were observed in age group of 31- 40 years, followed by 20 cases each in age group of 21-30 and 41-50 respectively.

Table 1: Distribution on the basis of age

Age group (yrs)	No. of corpses
Intrauterine life	01
0-10	03
11-20	12
21-30	20
31-40	23
41-50	20
51-60	07
61-70	08
71-80	06

Considering postmortem changes and decomposition 4 cases showed skeletonisation, 6 cases were fresh, 31 cases showed bloating, 34 cases of acute decay and 34 of post decay.

Considering seasonal variation, 25 cases were reported in September, 11 cases were in June, 10 cases each were in July and November respectively and remaining cases were in other months.

Table 2: Distribution of corpses (month wise) with entomological evidence

Months	No. of corpses
January	01
February	03
March	09
April	05
May	07
June	11
July	10
August	08
September	25
October	09
November	10
December	02

Commonest species of insects found on dead bodies were Calliphorids in 78.2% cases followed by Sarcophagids in 12.6% cases, Muscidae in 3.1% cases and unidentified in 1% case, Dermestid Bettles were found in 1.7% cases and Cleridae in 1.2% cases thus representing secondary wave of faunal succession[10].

Regarding entomological evidence present over the body larvae of all species were found in 90 cases, eggs of all species were found in 12 cases, pupae of different species were found in 12 cases and in 12 corpses adult types of all types of species were found. Other arthropods include ants (26 cases) and beetles (12 cases). Larvae are the predominant forms of evidence from the decomposing corpse.[11,8]

Face (including orbit, nose and ear) was the common site where entomological evidence was found (39 cases) followed by neck (including upper limbs, 14 cases) and genitals were next in the sequence (10 cases). Thus, niches with protected environment provide the nest for the maximal growth and activity of insects. The microclimatic conditions determine the laying of eggs.[12]

The earliest deposition of eggs by the flies was found to be at 14 hours after death in 2 cases. The eggs were found to be deposited earliest in the eyes and nostrils. Also, prolific insect activity was observed when augmented with exposed wounds as was seen in 24 cases of injury where open wounds were found. Natural deaths (10 cases), hanging (8 cases) and drowning (4 cases) were next in the sequence where such activity was found. Open wounds are the common sites attracting insects were eggs are laid.[13]

A numbers of factors affect the life cycle stages of insects including egg hatching period, pupation period, total development period, the most important factors being those of temperature and humidity. The egg hatching period would be delayed with respect to colder environmental condition (temperature). This is depicted in fig. 1, fig. 2 and fig. 3)

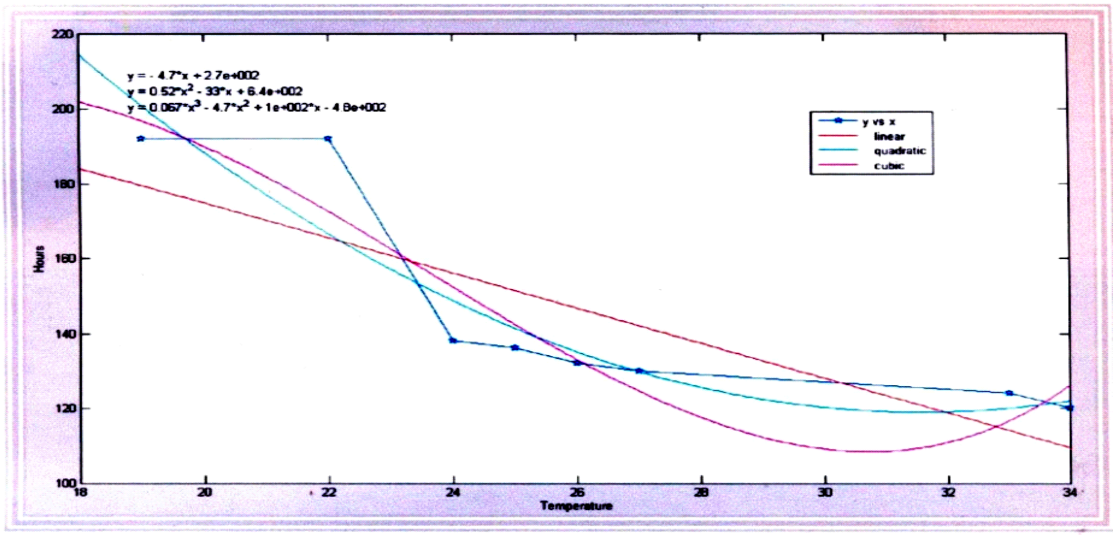

Fig. 1: Showing Relationship of Temperature (Degree Celsius) with Respect To the Duration of Larval Stages in Hours

+ Linear, quadratic, cubic functions have been plotted to reduce the deviation from the mean.

As is clear from fig. 1 and inverse relationship exists between temperature and duration of larval activity, with rise of temperature the duration of larval activity shortens which means an accelerated development activity. Maximum slope of the curve is seen in temperature range 22-27ºC.

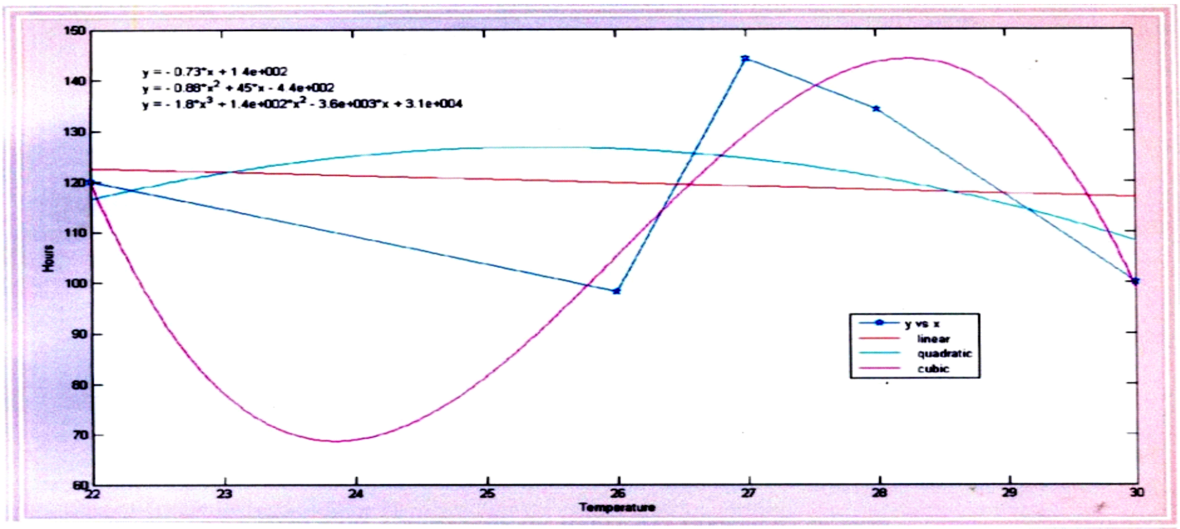

Fig. 2: Showing Relationship of Temperature With Respect To the Average Duration of Pupation Period

+ Linear, quadratic, cubic functions have been plotted to reduce the deviation from the mean.

As is seen the fig. 2 duration of pupation period is also affected by temperature variations. The duration of average pupation period shortens in temperature range 22-26ºC followed by rise in the duration in temperature range 26-28ºC and finally the duration decreases beyond this point.

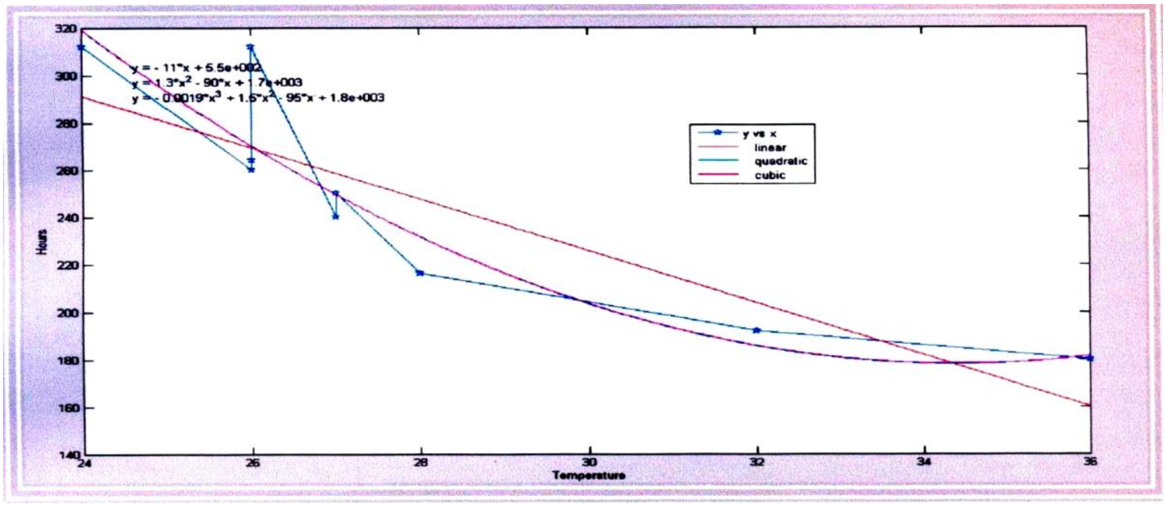

Fig. 3: Showing Relationship of Temperature with Respect to the Total Development Period (Egg to Adult)

+ Linear, quadratic, cubic functions have been plotted to reduce the deviation from the mean.

The pattern seen in total developmental period is depicted in fig. 3. In relatively lower temperature ranges (24-28ºC) alternate crest and trough are seen. However, with further rise of temperature the duration of total developmental activity shortens thereby establishing an inverse relationship in the two parameters.

Temperature and humidity are interdependent factors generally acting reciprocally, factors being inseparable ecologically changes in one variable modifies other and vice-versa. While high humidity may be protective to some species from adverse effect of temperature, it can prove to be fatal more readily than low humidity at lower temperature.[14] Factors of temperature and humidity combined together have important bearing on different phases of life cycle of insects, thus affecting their development and distribution to variable extent at different times of the year. Temperature might operate in winter against the hibernating larvae with adverse humidity may operate against eggs or feeding larvae.[15] Earlier researches reports that during peak winter month few insects will be associated with the corpses, but a number of other species will remain active on corpses throughout the year[7]. Confluent insect activity was observed in the settings of relatively high temperature and supporting average humidity settings with shortening of minimum PMI.

The postmortem interval determined from entomological evidences was correlated with the interval as determined from routine autopsy examination and in 66% cases the two intervals were found to be in the same range. The table below plots the range of time since death in a consolidated form.

Table 3: Post Mortem Interval Estimation from Entomology and others methods

Insect Life Cycle	Approximate Size	PMI From Entomology (Minimum Duration)	PMI from Others Post Mortem Changes
Eggs	02	12 – 36 Hours	1- 2 Days (Bloating, Upper limb & Lower Limb Rigor Mortis)
Larvae 1st	05	1 - 2 Days	½ -- 1 Day (Rigor Mortis all over the body)
Larvae 2nd	10	2 - 3 Days	2 Days (Marbling, Bloating, Skin Peeling)
Larvae 3rd	20	3 - 7 Days	(Teeth and skull suture loose)
Puparium	10	8 - 21 Days	2- 3 Weeks (All viscera liquefied) 1-2 Weeks (Liquefaction present) 1-2 Weeks(Liquefaction Present)
All Stages		20 - 25 Days	3 Weeks – 3 Months (Skeletonisation)

Conclusion

The present study clearly highlights the importance of forensic entomology in estimating precise postmortem interval which can be used as alternative tool in cases of decomposed bodies with entomological evidences. Though these evidences are influenced by a number of environmental factors, even then they can be magical tools in supplementing PMI determined from routine examinations. More than this a number of other important death related events can be answered using this technique and thence more and more use of the techniques should be done in routine autopsy involving insects and derivatives along with making a data base of the same for future references.

Conflict of Interest: None

Source of Support: Nil

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