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Role of Blow Flies in Decomposition Ecology

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Abstract

An organism's remains begin to break down once it dies. Numerous insects are drawn to this process and may utilize the carrion as a possible food source for themselves and their progeny. The capability of blow flies (Family: Calliphorid) to identify a decompose resource from a great distance makes them among the first insects to find and occupy a dead person. Forensic entomologist utilize the behavior and developmental cycles of early colonist to compute the post- mortem interval (PMI). But in addition to the insects drawn to the decaying food. For the estimation of postmortem intervals (PMI), flies are often used. Usually the age of the larval and pupal specimens serves as the basis for these estimations source, there is also an attraction for other insect predators that feed on these initial colonists. Blow flies are among the main invertebrate consumer, both in their immature and adult phases of decomposing animal organic materials. Post- feeding larval dispersal is the process by which larvae find suitable places for pupation after the food source is depleted or when they migrate and finish developing before the larval substrate disappears completely. The post- mortem interval (PMI) of human cadavers in legal medicine can be estimated with the help of an understanding of post feeding larval dispersal. This is because the larvae that disperse longer, more rapidly, deeper and older dispersing may cause this interval to be underestimated. For a long period, forensic entomology has been developing all around the world. Only a few controlled research on human cadavers at human decomposition facilities have been carried out, with the majority of these being carried out in warm and frequently dry areas, despite the fact that this discipline is employed in criminal investigations all over the world. Due to their ability to aid in determining the time since death, several bug taxa may be extremely important for criminal investigations. When a cadaver is exposed during the day, blow flies are frequently the first insects to establish themselves there. They typically show up minutes to hours later. During the initial stages of colonization, blow fly development can be affected by the arrival of other insects, such as hymenopterans and coleopterans, on a carcass. Flies interact with the remains in order to lay eggs and obtain nutrition during the decomposition process, bringing their bacteria with them. Although the specific core microbiome of each fly is known, it is unknown whether flies connected to human corpses have a distinctive core microbiome. Variations in the fly microbiome could change the type of

microorganisms that the flies carry to the corpse, which could have an impact on how the human decomposer microbiome assembles. Insects are used in forensic entomology to assess the post- mortem interval (PMI), which depends on blow fly colonization. Because it plays an essential role in forensic investigations, the PMI is highly relevant as it provides an estimate of the period between finding and death.

Keywords: Forensic entomology, Postmortem interval, Forensic insects, Cadavers, Ecosystem, Blow flies, Decomposition, Flesh, Insect succession.

Introduction

Forensic entomology is the study of insects that land on rotting carrion and stimulate decomposition. Because of their larvae, blow flies are frequently used as forensic indicators. Blow flies can be attracted to the smell of a decaying carcass for several kilometers. The environment is one of the many factors that cause the carrion to alter. These are most helpful to determine the time of death. They are the ones that appear initially and start decomposing as soon as the body passes away. Their entire life cycle, referred to as complete metamorphosis, consists of the egg, larva, pupa and adult stages. Component such as the state of the environment, area and time with dead bodies, forensic entomology may gather eggs, adult flies and larvae. (Bhimrao and Varade, 2003). Blow flies or Calliphorids, are an essential component of the animal decomposition process in the majority of terrestrial habitats. Since they frequently arrive first and posit on a dead body, the oldest Calliphorid found on the body is frequently used to determine a minimum PMImin, or postmortem interval, is used to resolve death- related cases. Because blow flies are cold blooded and have a species- specific developmental period, it's necessary to correctly identify the species of blow flies and recreate the scene's temperature profiles in order to estimate PMImin. Determination of developmental landmarks such as weight, length and stages of development of the juvenile insect, dependent on the ambient temperature, is typically the method used to age the young insects by entomologists. (Zhang et al, 2019). The study of insects and other arthropods associated with legal investigations is known as forensic entomology. (Goff 1993, Voss et al, 2009). More information obtained from insect succession patterns has shown to be extremely useful in court cases. They can be used in conjunction with other methods to help with the overall reconstruction of the crime scene, the body's accessibility and the identification of any toxicological materials (Wallace 2017) and foreign DNA in the digestive tract. (Carvahlo et al. 2005, Di Luise et al. 2008 and Magni et al. 2018). The biological process through which organic matter breaks down is extremely intricate and involves the body going through various, albeit typically predictable, stages (usually skeletal, dry, progressed, fresh and swollen). (Goff 1993). One of the most crucial decisions for the successful forensic examination of decomposing human

remains is the precise assessment of the postmortem interval (PMI). (Mann et al. 1990, Micozzi 1991, Rodriguez and Bass 1983, Vass et al. 1994, Voss et al. 2011). According to other scientific fields that work with human remains, the forensic investigations of the PMI usually focuses on shorter time periods, such as Paleontology or Biarchaeology. Identifying the PMI on a time range of hours to days or decades in the case of recently deceased human is typically the responsibility of the forensic anthropologist and pathologist. (Pokines 2014). In general, a corpse that has died will go through a sequence of soft tissue modifications at initial stages to lose its soft tissues and then the hard tissues that are left will disperse during process of breakdown. (Mann et al. 1990, Micozzi 1991, Pokines 2014). The number of technologies that can generate accurate PMI estimations decreases as the time duration between death and discovery and analysis rises because of the factors mentioned above. This is partly because, as the body is continually exposed to the environment for a longer duration of time, there are more factors that can influence the rate of decomposition. (Mcleod 2015). During the early phases of animal disintegration , blow flies are a popular insect, and their larvae are crucial in determining the amount of time from death or the carcass's postmortem interval (PMI). (Nelder et al. 2009). Decomposing matter is often linked to blow flies. Generally, the larvae are found feeding on degrading vertebrate remains, but some species have evolved to eat living tissue, or they can live off of other sources, such as excrement. These insects are closely associated with microorganisms due to their attraction with such septic conditions. These insects have historically been the subject of a great deal of research because of their importance to veterinary medicine. (Tomberlin et al. 2017). Although it is a continual procedure, the disintegration of a carcass can be divided into distinct times, phases or stages, each of which has distinctive features and draws distinct scavenger species lengths that change based on the local fauna and climatic conditions. (Goff 1993, Amendt et al. 2010). Diptera are the most ubiquitous and plentiful insects seen on bodies, which makes them crucial for forensic studies. (Souza and Linhares 1997, Moretti et al. 2008, Rosa et al. 2011, Scaglia 2014, Faria et al. 2018, Ramos Pastrana et al. 2018, Meira et al. 2020, Vairo and Moura 2021, Silva et al. 2023). Blow flies or Calliphorid, are one of the most investigated Diptera families in the field of forensics since they are prolific in decaying carcasses and pioneers in the field utilized as a place of copulation, food supply and substrate as they grow their juvenile stages. (Wolff et al. 2001, Amendt et al. 2010, Oliveira- Costa 2011, Silva et al. 2014, Ramos- Pastrana et al. 2018, Meira et al. 2020, Cruz et al. 2021). Although species of the Calliphoridae family occur throughout the whole process of decomposition, they frequently belong to certain phases. (Byrd and Castner 2001, Perez et al. 2005, Ramos- Pastrana et al. 2018, Meira et al. 2020, Cruz et al. 2021). In order to determine the post –mortem interval (PMI) of human corpses, it is crucial to determine the occurrence of each species by stage,

especially when the corpses are in an advance state of decomposition and conventional techniques are not working. (Catts and Haskell 1991, Byrd and Castner 2001, Oliveria-Costa 2011, Meira et al. 2020, Silva et al. 2023). Necrophagous flies are essential as they can carry diseases that affect humans and livestock, but they are also significant participants in the field of forensic entomology.

Importance of blow flies in cadaver decomposition

In 1991, T.V Goff studied blowfly species' behavior in the context of a human death examination from the Department of Anatomy at the University of Hawaii's Medical School. Glass plate models, suspended 10 and 40cm above the ground to replicate open, sunlight and shady zones, were used for examining fly behavior. A small number of bodies from a morgue that were placed at specific periods were analyzed to look for early and late phases of degradation colonization. In varying humidity and temperature levels, Goff had the ability to identify variations in movement and species transition that might be helpful in identifying the place of origin of a body using bug evidence as well as the date and reason of death.

Methodology

The site chosen for research work is Mullanpur Garibdass which is located in Punjab (India). The purpose of decomposition studies was to examine how blow flies contribute to the controlled decomposition of organic matter in a manner that resembles natural process. A variety of trapping techniques designed to successfully acquire adult flies in a variety of settings were used to collect blow flies. Several parameters were monitored during decomposition experiments to assess the progress and dynamics of the process. These included:

Temperature: Ambient air and substrate temperature were measured regularly using digital thermometers. Temperature fluctuations were recorded to evaluate their influence on blow fly activity and decomposition rates.

Humidity: By the use of hygrometers relative humidity levels were monitored. Humidity data provided insights into microclimatic conditions affecting decomposition processes and blow fly behavior.

Decomposition stages: The decomposition process was visually assessed and categorized into distinct stages based on established protocols such as the Modified Total Body Score system or the stages of decomposition described by Payne. These stages included fresh, bloated, active decay, advanced decay and dry/remains.

Data Collection: Data collection during the decomposition process was conducted at regular intervals, typically ranging from daily to weekly depending on the rate of decomposition. Observations were recorded using standardized data sheets or digital devices to document changes in decomposition stages, temperature, humidity, and blow fly activity.

Result:

This study is conducted between 17 March to 17 April. The maximum temperature during the study was 34℃ and the lowest temperature recorded was 23℃. For relative humidity, the maximum recorded was 62.9% and minimum of 29%. And the maximum pH during the study was 8 and minimum pH was 6. The carcass was of a calf, about age 2.5 to 3 years with length 4 feet and width 1.5 feet. The whole development process of Chrysomium megacephalum from egg to adult can be completed between 23℃ to 34℃. There are five stages of decomposition:

Stage1: Fresh Stage
Stage2: Bloated Stage
Stage3: Active Stage
Stage4: Post Decay Stage
Stage5: Skeletal Stage

(Table1.1): Shows the stages of decomposition with time interval and stages of larva

Stages of decomposition	Time interval	Stages of Larva
Stage1 Fresh Stage	17- 19 March	1st
Stage2 Bloated Stage	20- 24 March	2nd
Stage3 Active Stage	25-30 March	3rd
Stage4 Post Decay Stage	31-6 April	4th
Stage5 Skeletal Stage	7- 17 April	Pupa (blow fly)

(Table 1.2): Shows the temperature, humidity and pH.

Date	Temperature	Humidity	pH
17-03-2024-	30℃	36%	7
18-03-2024	31℃	37%	8
19-03-2024	31℃	39%	6.6
20-03-2024	32℃	36%	7
21-03-2024	27℃	40%	7
22-03-2024	31℃	47%	6
23-03-2024	32℃	38%	7
24-03-2024	29℃	34%	6
25-03-2024	31℃	39%	7

26-03-2024	32℃	35%	7.5
27-03-2024	34℃	36%	7
28-03-2024	35℃	40%	6.5
29-03-2024	35℃	50%	6
30-03-2024	34℃	42%	7
31-03-2024	34℃	44%	6
01-04-2024	31℃	38%	7
02-04-2024	31℃	38%	6.5
03-04-2024	35℃	32%	7
04-04-2024	36℃	40.5%	6
05-04-2024	36℃	33.2%	6.5
06-04-2024	35℃℃	30%	7
07-04-2024	35℃	29%	8
08-04-2024	37℃	28%	6
09-04-2024	37℃	26%	7
10-04-2024	38℃	27%	6.5
11-04-2024	37℃	29%	7
12-04-2024	38℃	27%	7
13-04-2024	34℃	34%	6.5
14-04-2024	30℃	50%	8
15-04-2024	34℃	52%	6
16-04-2024	35℃	44%	7
17-04-2024	32℃	29%	7

Table (1.3): Shows the maximum and minimum environmental factors that affect the decomposition process.

Environmental factor	Maximum	Minimum
Temperature	38℃	27℃
Relative Humidity	52%	26%
Soil Ph	8	6
Carcass pH	8	6

Table (1.4): Shows the several stages of blow fly with time taken

Stages of blow fly	Time taken (hours)
1st instar larva	23
2nd instar larva	27
3rd instar larva	22
4th instar larva	130

Blow fly	143

Discussion

The forensic value of Chrysomya megacephala has been well- documented in various studies, and this investigation adds to that body of knowledge by providing essential developmental is predominantly influenced by environmental factors, particularly temperature and humidity. Our findings indicate that in warmer and more humid conditions, C. megacephala exhibits faster growth rates. The highest abundance of C. megacephala was observed during the summer months, peaking in April and gradually declined during the rainy season and winter. These seasonal variations underline the need for further research into the seasonal activity of C. megacephala to better understand its forensic implications.

Impact of Climate variables

Climate variables significantly influence blow fly density. Our results demonstrate a clear negative correlation between C. megacephala density and relative humidity, and a positive correlation with temperature. This indicates that C. megacephala thrives in high temperature, low- humidity environments. The highest abundance of C. megacephala was recorded during the summer when temperatures were elevated and relative humidity was low, suggesting that these conditions are optimal for their proliferation. Conversely, lower temperature and higher humidity during the winter and rainy seasons were associated with reduced C. megacephala populations. This data is critical for forensic investigations as it helps predict the presence and activity of C. megacephala based on seasonal and climatic conditions.

Temperature and Blow Fly Biology

Temperature is a crucial environmental variable affecting the biology of blow flies. It directly influences their growth, survival, longevity and population dynamics. Our study reveals that C. megacephala is highly adaptable to temperature variations, with adult activity peaking at higher temperature and decreasing at lower ones. Specifically, C. megacephala was most active at temperature ranging from 23.3℃ to 34℃, with the highest abundance observed at temperatures above 34℃. This adaptability to a wide range of temperature highlights the species resilience and underscores the importance of temperature in forensic entomology.

Life Cycle and Diurnal Activity

Our findings also indicate that C. megacephala develops more slowly at lower temperatures and more quickly at higher temperatures. While blow flies are generally considered diurnal, some research suggests they can be active at night and even lay eggs. In this study, C. megacephala exhibited diurnal activity, with peak activity in the afternoon. However there were seasonal variations in diurnal activity patterns, with more flies caught during the day than at night.

Temperature Effects on Life Cycle

Maintaining a constant temperature shortens life cycles, decreases activity, and increases mortality. Our study also explored how temperature affects the developmental period of the blow fly cycle, establishing a correlation between temperature and the rate of insect development. Higher temperatures and more moisture accelerate growth, while lower temperature extend the life cycle duration. This relationship between temperature and developmental rate is vital for forensic investigations as it affects the accuracy of PMI estimations. Our findings show that relative humidity and temperature significantly impact the number of C. megacephala, further emphasizing the importance of these environmental factors in forensic entomology.

Forensic Implications

Establishing PMI is essential in many forensic investigations involving unexplained deaths. Understanding the biology, behavior and distribution of insects species associated with decomposing remains aids in establishing PMI and/or demonstrating post- mortem movement of the body. Decomposing remains provide a transient, resource- rich environment for various arthropod species, attracting and colonizing other species at different decomposition stages. The timing of insect colonization, development and departure from remains is predictable and orderly under specific conditions and closely related to the rate of carcass decomposition.

Conclusion:

Our study underscores the significance of environmental factors, particularly temperature and humidity, in influencing the abundance and development of Chrysomya megacephala. These factors are crucial for forensic entomologists when estimating PMI. The predictable patterns of insect succession and development on decomposing remains provide valuable data for forensic investigations, helping to establish timelines and understand the circumstances surrounding death. Future research should continue to explore the complex interactions between environmental variables and arthropod development to enhance the accuracy and reliability of forensic entomology practices.

References

1. Bhimrao, J.D. and Varade, G., 2023. Research and Casework in Forensic Entomology Urban Area of Satara, Maharashtra. International Journal of Modern Developments in Engineering and Science, 2(4), pp.69-71.
2. Byrd, J.H. and Castner, J.L., 2001. The utility of arthropods in legal investigations. Forensic Entomology, pp.43-79.
3. Carvalho, C.J.B.D. and Mello-Patiu, C.A.D., 2008. Key to the adults of the most common forensic species of Diptera in South America. Revista Brasileira de Entomologia, 52, pp.390-406.

4. Catts, E.P. and Goff, M.L., 1992. Forensic entomology in criminal investigations. Annual review of Entomology, 37(1), pp.253-272.
5. Clark, K., Evans, L. and Wall, R., 2006. Growth rates of the blowfly, Lucilia sericata, on different body tissues. Forensic science international, 156(2-3), pp.145-149.
6. Fremdt, H. and Amendt, J., 2014. Species composition of forensically important blow flies (Diptera: Calliphoridae) and flesh flies (Diptera: Sarcophagidae) through space and time. Forensic Science International, 236, pp.1-9.
7. Goff, M.L., 1993. Estimation of postmortem interval using arthropod development and successional patterns. Forensic Science Review, 5, pp.81-81.
8. Magni, P., Zwerver, M. and Dadour, I.R., 2019. Insect succession pattern on decomposing pig carcasses in Tasmania: a summer study.
9. McLeod, E.V.H., 2015. The effect of rainfall on blowfly (Calliphoridae) activity and decomposition on recently deposited animal remains (Doctoral dissertation)
10. Meira, L.M.R., Barbosa, T.M., Jales, J.T., Santos, A.N. and Gama, R.A., 2020. Insects associated to crime scenes in the northeast of Brazil: consolidation of collaboration between entomologists and criminal investigation institutes. Journal of Medical Entomology, 57(4), pp.1012-1020.
11. Michaud, J.P. and Moreau, G., 2009. Predicting the visitation of carcasses by carrion-related insects under different rates of degree-day accumulation. Forensic Science International, 185(1-3), pp.78-83.
12. Moretti, T.D.C., Ribeiro, O.B., Thyssen, P.J. and Solis, D.R., 2008. Insects on decomposing carcasses of small rodents in a secondary forest in Southeastern Brazil. European Journal of Entomology, 105(4), pp.691-696.
13. Nelder, M.P., McCreadie, J.W. and Major, C.S., 2009. Blow flies visiting decaying alligators: is succession synchronous or asynchronous?. Psyche: A Journal of Entomology, 2009(1), p.575362.
14. Silva, J.O.D.A., Carvalho-Filho, F.D.S., Juen, L. and Esposito, M.C., 2023. Ecological succession of blow flies (Diptera: Calliphoridae) in the decomposition of pig carcasses in Cerrado areas of Brazil. Journal of Medical Entomology, 60(6), pp.1297-1304.
15. Tomberlin, J.K., Crippen, T.L., Tarone, A.M., Chaudhury, M.F., Singh, B., Cammack, J.A. and Meisel, R.P., 2017. A review of bacterial interactions with blow flies (Diptera: Calliphoridae) of medical, veterinary, and forensic importance. Annals of the Entomological Society of America, 110(1), pp.19-36.
16. Turner, B. and Wiltshire, P., 1999. Experimental validation of forensic evidence: a study of the decomposition of buried pigs in a heavy clay soil. Forensic Science International, 101(2), pp.113-122.

17. Voss, S.C., Cook, D.F. and Dadour, I.R., 2011. Decomposition and insect succession of clothed and unclothed carcasses in Western Australia. Forensic Science International, 211(1-3), pp.67-75.
18. Weiss, H.B., 1937. The Criminal Prosecution of Insects. Journal of the New York Entomological Society, 45(2), pp.251-258.
19. Yang, S.T. and Shiao, S.F., 2014. Temperature adaptation in C hrysomya megacephala and C hrysomya pinguis, two blow fly species of forensic significance. Entomologia Experimentalis et Applicata, 152(2), pp.100-107.
20. Zhang, Y., Wang, Y., Sun, J., Hu, G., Wang, M., Amendt, J. and Wang, J., 2019. Temperature-dependent development of the blow fly Chrysomya pinguis and its significance in estimating postmortem interval. Royal Society open science, 6(9), p.190003.