An Analysis of the Succession Pattern of Diptera Attracted Throughout Stages of Carrion Decomposition

Devin M. Beach

Dominica 2012

Dr. James Woolley, Dr. Thomas Lacher

Department of Entomology

Texas A&M University, College Station, TX, USA 77843

Abstract

The purpose of this study was to determine the succession of Diptera taxa, the average number of individuals collected, and the relative numbers of male and female Calliphoridae (blow flies) during carrion decomposition. Fresh beef liver was exposed and checked daily over seven days. Ten different taxa of Diptera (flies) were identified, *Chrysomya* being the most numerous. Through the week the abundance of flies present showed a bell-shaped trend of increase and then decrease. The mean number of female Calliphoridae (blow flies) present was greater in comparison to the males. A detailed description of the specific taxa of flies collected and brief observations are explained in further detail.

Key Words: Dominica, diptera, forensic Entomology, carrion, necrophagous

An Analysis of the Succession Pattern of Diptera Attracted Throughout Stages of Carrion Decomposition

Introduction

Forensic entomology is the study of arthropod involvement as it is applied in legal matters (Wallman, 1986). There are three different branches within forensic entomology urban, stored products, and medicocriminal. Medicocriminal entomology is the area that this study will be focusing on because of its relation with violent crimes. Studying the necrophagous diptera lifecycle present on the substrate can help establish an estimated postmortem interval (PMI) (Haglun and Marcella, 1997*)*. PMI can be used by forensic entomologists to estimate a time of death in violent crimes. Necrophagous diptera are flies that feed on and oviposit on carrion such as beef liver, which was used in this experiment (Smith 1986). Another importance of necrophagous diptera is the extensive role of larvae by feeding on the substrate that contributes to nutrient recycling (Byrd and Castner, 2010).

This experiment focused on the successional pattern of fauna arriving on the carrion as it degraded (further explained by Byrd and Castner, 2010). Calliphoridae (blow flies) and Sarcophagidae (flesh flies) are examples of necrophagous species important to forensic entomology. The goal of my study was to document the stages of decomposition in relation to the number of flies, the number of males versus females, and the different species of flies present each day over a seven day period. I also will be expanding on Jonathan Cammack's (2006) "Survey of Necrophilous Diptera of

Dominica" and Charity Owing's (2009) "A Comparative Survey of Calliphorid Attraction to Microbe-Laden and Antibiotic Treated Beef Liver."

Materials and Methods

A study was conducted over seven days on the island of Dominica in the West Indies. Data were collected between the dates of May 28 and June 3, 2012 at the Archbold Tropical Research and Education Center (ATREC). ATREC is located at Springfield, Dominica in St. Paul Parish (15°20'47.7"N 61°22'8.5"W) at an altitude of 360 meters .

One pound of fresh beef liver was placed on a plastic tray and wrapped with chicken wire suspended two inches above the ground. These modifications were made in response to the test trial for beef liver placed directly on the ground, which was covered by ants the next day and no flies were able to colonize it. Chicken wire was also used to keep the large scavengers such as opossum, rats, and crabs, from removing the beef liver.

Each day at 0800 on arrival to the beef liver, the average number of flies were estimated prior to collecting. About thirty percent of the flies present were captured by insect net and placed in a BioQuip® kill jar containing a Kimwipe® saturated with ethyl acetate ($C_4H_8O_2$). A Kestrel® was used to record the temperature, humidity, and wind speed each day and averaged once for each collection period.

Of the flies captured, the number of male and female Calliphoridae were recorded daily. The flies collected were then pinned using Kostal® black enameled pins, labeled, and placed into a Schmidt box. The flies were then identified to family. Identification of species was accomplished by using Whitworth (2006) and Triplehorn and Johnson

(2005).

Results

Day	Temperature (°C)	Humidity (%)	Wind Speed (m/s)
1	28.7	67.1	9.1
2	24.9	71.9	9.0
3	25.6	83.2	0.0
4	24.4	82.5	0.4
5	26.4	82.5	0.5
6	24.3	89.0	0.6
7	24.8	79.7	1.0

Table 1-The data recorded at 0800 daily

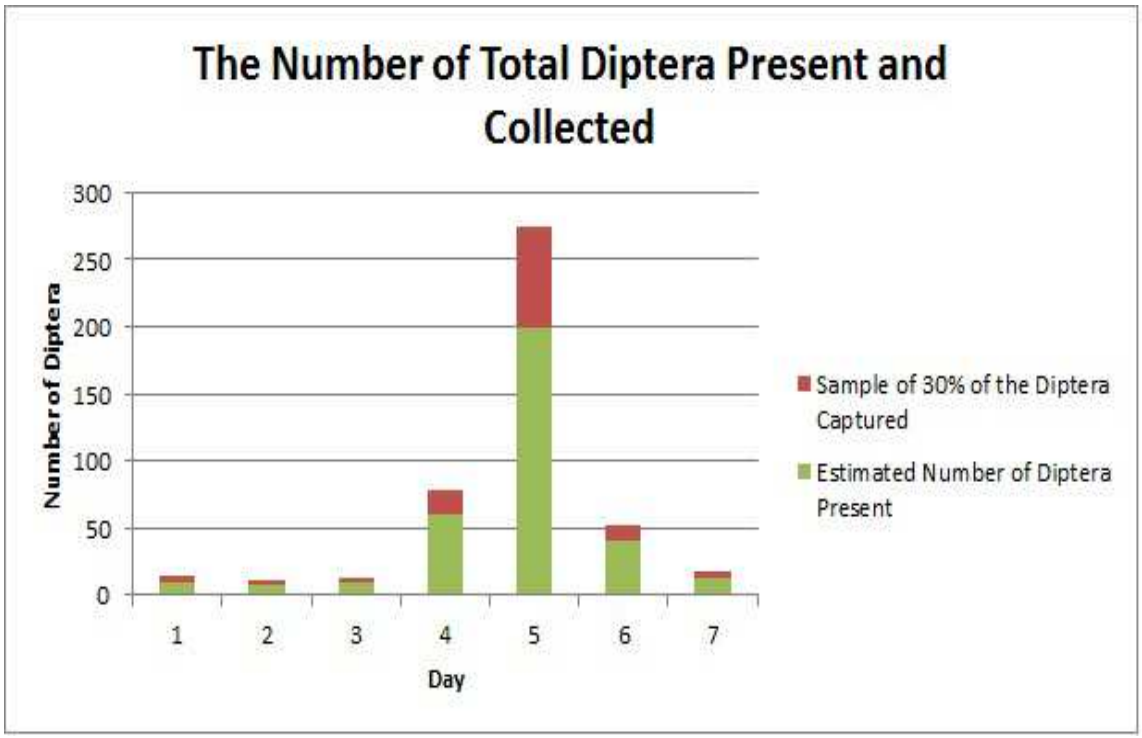

Figure 1-Comparison of diptera captured and estimated to be present each day of the experiment.

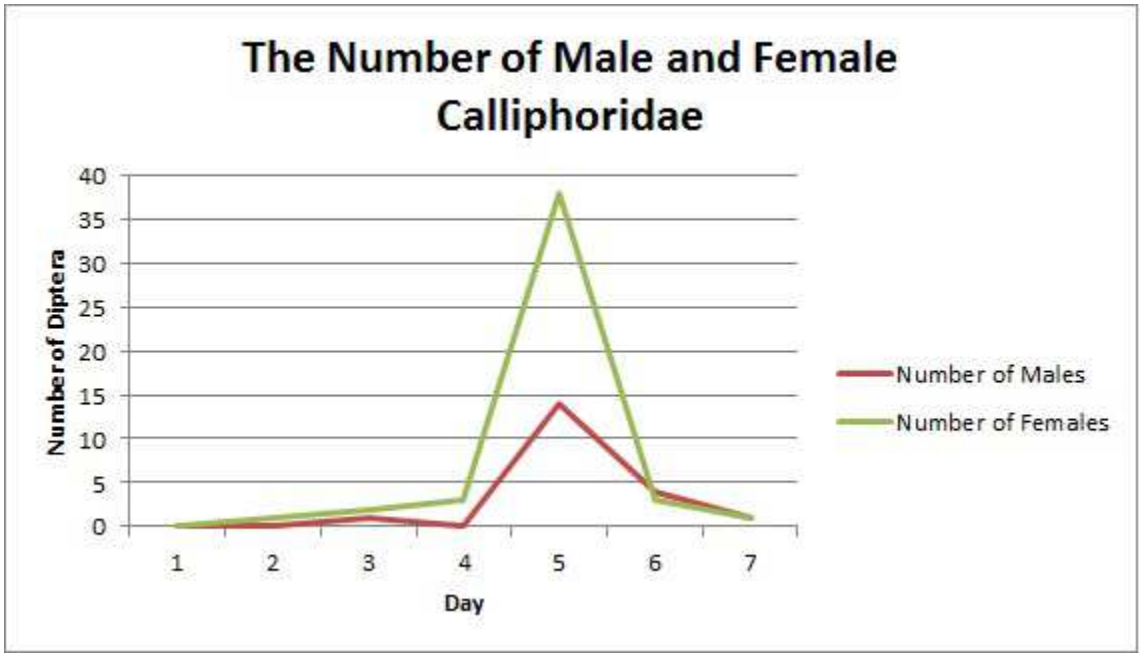

Figure 2-Number of male and female Calliphoridae present each day

Day	1	2	3	4	5	6	7	**Total**
Sarcophagidae	**4**	**1**	0	**2**	**3**	0	0	**10**
Muscidae 2	**1**	**1**	0	**2**	**2**	**1**	**1**	**8**
Lucilia	0	**1**	**2**	**1**	**10**	0	0	**14**
Chrysomya	0	0	**1**	**2**	**42**	**7**	**2**	**54**
Muscidae1	0	0	0	**10**	**8**	**2**	0	**20**
Drosophilidae	0	0	0	**1**	0	0	0	**1**
Sepsidae	0	0	0	**1**	0	0	0	**1**
Cochliomyia	0	0	0	0	**7**	0	0	**7**
Lonchaeidae	0	0	0	0	**3**	**2**	**1**	**6**
Total	**5**	**3**	**3**	**19**	**75**	**12**	**4**	**121**

Table 2-Number of individual taxa collected each day of the experiment in order of appearance (May 28-June 3)

Description of the Families Collected:

The common name for Sarcophagidae is flesh flies. They are easily recognized by their characteristic grayish coloration. They are not metallic and dark stripes are present on their thorax (Triplehorn and Johnson 2005).

The family Muscidae is identified by the anal vein not reaching the wing margin. Muscidae is the family name for house flies. Some may not have setae present on the posterior hind coxae (Triplehorn and Johnson 2005).

The family Calliphoridae includes the gerera *Lucilia*, *Chrysomya,* and *Cochliomyia*. The common name for Calliphoridae is blow flies. They are distinctive for their metallic color and have only two notopleural bristles. They usually have a plumose arista and are rarely gray or brown in coloration (Triplehorn and Johnson 2005).

Drosophilidae are not metallic in coloration and are commonly pomace or vinegar flies. They are identifiable by the developed anal cell wall that is apically closed (Triplehorn and Johnson 2005).

The thoracic spiracle having one or more bristles is characteristic of the Sepsidae. The common name for Sepsidae is black scavenger flies. The head of the scavenger is spherical and is black in coloration. A narrow waist is characteristic in the identification of Sepsidae (Triplehorn and Johnson 2005).

Lonchaeidae are characteristic of having a black coloration and a head hemispherical in shape. The eyes are large in comparison to its head and the third segment of the antenna is elongated (Triplehorn and Johnson 2005).

Discussion

The temperature, humidity, and wind speed were recorded each day before collecting thirty percent of the flies that were present. An average of each recording was calculated to give an estimate for the overall weather during the succession project. The daily averages were 25.6 °C, humidity 79.4%, and wind speed 2.9 m/s. It is important to take into consideration the weather because it has a direct affect on the life cycle of Calliphoridae. It was hot and humid making the life cycle faster than if in a drier and cooler location (Smith 1986).

The succession of the total number of diptera gradually increased to a maximum point on day 5 (June 1) then decreased until the last day (June 3) (Fig 1). According to Smith (1986), Payne (1965) tested the stages of decomposition and acquired the same results. The attraction of species also increased until an advanced state of decay where the number began to then decrease until dry. Several studies can further be done to determine why this pattern occurs.

Each day the number of female and male Calliphoridae were recorded. The number of female Calliphoridae were on average greater than the number of males daily (Fig 2). Number of both male and female Calliphoridae collected followed the same pattern as the total amount of flies present and collected (Fig 1). The female Calliphoridae being present in larger numbers may be due to the fact of females ovipositing on the carrion. The males may not be as abundant due to the lack of laying eggs, but looking for a female to mate or get nutrition. Future research will have to be performed in order to be certain of these conclusions.

Many of the species collected were mentioned in Jonathan Cammack and Charity

Owing's past research projects completed on Dominica. Jonathan Cammack's "A Survey of the Necrophilous Diptera on the Island of Dominica" covers several different species present on various carrion specimens observed across the entire island of Dominica. I expanded on Cammack's project by using only one specific carrion and location, while observing the fauna over a span of time. I also expanded on Charity Owing's "A Comparative Survey of Calliphorid Attraction to Microbe-Laden and Antibiotic Treated Beef Liver" by using unaltered beef liver as well as expanding research only on Calliphoridae to all Diptera taxa present.

Sarcophagidae, Lonchaeidae, and *Chrysomya* showed a single peak abundance (increasing to a specific point and then decreasing). Once Muscidae species 1 and species 2 appeared they began to decrease. *Cochliomya* were only present on June 1st (day five), while Sepsidae and Drosophilidae were not abundant enough to report a trend. Reasons for Drosophilidae being present could be the location near fruiting plants or being blown by the wind.

As more research in regards to forensic entomology is performed, medicocriminal entomology can continue to improve. The results of the total number of flies and the number of male and female blow flies recorded each day can help improve the understanding of diptera and their importance to forensic entomology. Calliphoridae (blow flies) are the main diptera that are studied by forensic entomologists. This succession project can be repeated in the future to determine if different flies, rather than just Calliphoridae, could one day be used in the determination of PMI (postmortem interval).

Acknowledgements

I would like to thank Dr. James Woolley, Dr. Thomas Lacher and Dr. Frances Gelwick for the amount of time each of them put into helping make our projects and overall experience in Dominica perfect. I would also like to thank my parents, Dana and Philip Beach for providing me with the funds to experience this once in a life time opportunity to study abroad. I would like to thank Dr. Tomberlin and Charity Owings for helping me prepare for this trip to Dominica by helping me solidify my research project and provided me with the correct reference materials to do so. I would also like to thank my fiancé Alex Edmunds for being supportive of everything I do in order to one day accomplish all my goals in life.

References

Byrd, Byrd, J H, & Castner, J L. 2010. Forensic entomology: The Utility of Arthropods in Legal Investigations.

Cammack, J.A. 2006. A Survey of the Necrophilous Diptera on the Island of Dominica.

Haglun, W.D. and M.H. Marcella. 1997. Forensic Taphonomy: The Postmortem fate of Human Remains.

Owings, C.G. 2009. A Comparitive Survey of Calliphorid Attraction to Microbe-Laden and Antibiotic Treated Beef Liver.

Smith, K. G. V. 1986. A Manual of Forensic Entomology. Cornell University Press.

Triplehorn, C.A. and N.F. Johnson. 2005. Borror and Delong's Introduction to the Study of Insects. 7th ed. 864 pp.

Whitworth, Terry. 2006. Keys to the Genera and Species of Blow Flies (Diptera: Calliphoridae) of America North of Mexico. 1st ed. 36 pp.