J. BIOL. ENVIRON. SCI.,
2019, 13(37), 49-54

Original Research Article

A Forensic Entomological Study in Uludag University Campus, Bursa, Turkey

Ezgi Ecem Erdoğan and Nilüfer Çinkılıç*
Department of Biology, Art and Science Faculty, Bursa Uludag University, 16059, Bursa, TURKEY

Received: 25.03.2019; Accepted: 15.04.2019; Published Online: 25.05.2019

ABSTRACT

In this study, we investigated for the first time the succession of forensic entomofauna attracted to fresh calf meat tissue during the June to September 4 month period in 2018 in Bursa /Turkey. Calf muscular tissue was selected in order to perform a forensic entomological examination in a small wooded area in the Uludağ University Campus of Bursa province. The reason for this choice is that the deterioration in the decomposition stages compared to the internal organs and other tissues, the muscle tissue is less intensive and the exposure to bacterial fungi is less. In addition, we preferred calf muscle tissue due to its structural similarity to a human. During the examination period, we found several forensic insects, *Dermestes undulatus*, *Halyomorpha halys*, *Oniscus asellus*, *Lucilia sericata*, *Calliphora vicina*, *Wohlfahrtia magnifica*, *Hermetia illucens*, *Blatta* sp were attracted to the calf meat both in the underground and in air cages hanging on a tree. *Drosophila* sp. and *Psychodinae* sp. were recorded as an incidental species. This study indicates that in this region of Bursa, Diptera, Hemiptera, and Coleoptera are the most frequent insect orders useful for estimating forensic cases.

Keywords: Insects, Entomofauna, Forensic science, Uludag University campus, Bursa province, Calf meat

INTRODUCTION

In order to clarify the forensic cases, help is obtained from various disciplines. Forensic Biology is one of these main topics. It provides benefits in many issues, from identification to the determination of the time of death. Undoubtedly, the scope of the science of Biology is reflected in the works in the forensic dimension and it is specialized in itself. Forensic Entomology is becoming more and more important as one of these branches.

Forensic Entomology is based on the understanding of criminal events by using insects and arthropod species (Byrd and Castner 2009). It is a branch of science that investigates the ways and methods of arthropod use in unexpected sudden deaths, place of death and time. It is tried to benefit from the development and succession of arthropods, which are able to survive from the Arctic to the oceans and every ecosystem. Species composition and insect succession on a cadaver vary according to the geographical region, climate, seasonal changes and temperatures as shown by various studies that have been conducted on animal carcasses (Richards and Goff 1997, Grassberger and Frank 2004, Özdemir and Sert 2009, Matuszewski et al. 2010, Matuszewski et al. 2013).

In Turkey, the use of classical entomological data in estimating the duration of death time is prevailing and developing as there are many ways of forensic entomological research to be investigated. Recently, publications pertaining to faunal succession, life cycle, and bionomic of forensic flies have been published (Özdemir and Sert 2008; 2009, Bana and Beyarslan 2012).

The purpose of our study is to identify and compare the species of insects involved in the decomposition process of fresh calf meat in the air and underground in forest field at the Uludag University used as a model for forensic entomological study in Bursa/Turkey.

MATERIALS AND METHODS

The first part of our study, the land part, air-suspended and sub-ground is provided by two mechanisms. The second phase was carried out in the laboratory because of the larval stage observation.

In order to determine the forensic entomofauna of the province of Bursa, the forest area within the boundaries of Uludag University Faculty of Arts and Sciences has been selected for the field phase of the study. The study was performed in the coordinates' 40'13 '25 ˚ ˚ N 28' 51' 51 ˚ ˚ E. The city center is 17 km away and

* Corresponding author: aydemirn@uludag.edu.tr

the altitude is 107 m from sea level. The two devices are simultaneously positioned in the selected region (Figure 1). The study was started on 11 June 2018.

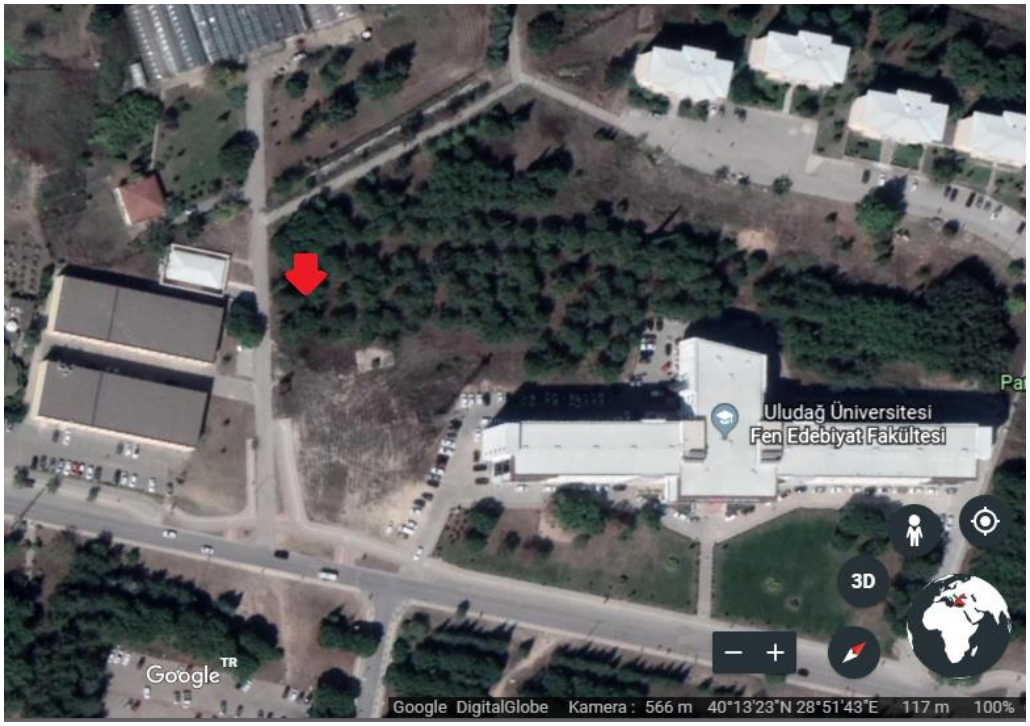

Figure 1. Marked image of the place where the field study is run (Google Earth).

Approximately 400 grams of freshly cut calf muscle tissue (meat) was selected, to be placed inside the devices. The reason for this choice is that the deterioration in the decomposition stages compared to the internal organs and other tissues in the muscle tissue are less intensive and the exposure to bacterial fungi is less. This allows for a clearer understanding of the functions of insects in the event of decomposition. Due to its structural similarity to human, calf muscle tissue was preferred.

In order to be able to diagnose, calf muscles were inspected at 24 h intervals from the aerial and underground devices and individuals collected in different stages of development other than adult were allowed to develop in the controlled mechanisms prepared in the laboratory. Arthropod species present on, inside, and beneath each calf muscle tissue were recorded. Adult flies, beetles, moths, and other insects were killed by diethyl ether. The collected and grown insects were identified according to Lohse (1964), Bousquet (1990), Choate (2003), Hava (2004), Madge (2006), Şabanoğlu (2007) and Özdemir and Sert (2008). The controls of identifications were carried out by Dr. Alper Susurluk.

The laboratory devices consist of meat pieces for the development of larvae and pupae, petri dishes containing wood shavings, measuring device for protecting the temperature and humidity of the laboratory, and cage system which contains insects. Samples of fly larvae were kept alive and reared to the adult stage to confirm species identification and monitor the minimal time of pupariation and eclosion.

Data analyses

In the analyses, we focused on those species of flies and beetles which breed in calf muscle tissue. The abundance of immature Blattidae, Calliphoridae, Drosophilidae, Stratiomyidae was assessed from the number of reared specimens and the number of 3rd instar larvae collected with air and underground devices. The abundance of immature Pentatomidae, Dermestidae and Oniscidae were recorded from the number of 1st instar larvae collected with air and underground devices. As for the immature Sarcophagidae and Psychodidae, their abundance was judged from larvae sampled with any method. We also evaluated all adult flies and beetles sampled from two devices at laboratory conditions.

RESULTS AND DISCUSSION

Climatological data

The evaluation dates, temperature and humidity values of the study field are given in Figures 2, 3 and 4. There were some differences between study sites ambient temperatures and humidity in air, soil and lab mediums. The means and standard deviations of the ambient temperatures and relative humidity in study sites, which were 29.98 ± 2.07°C, 55.27 ± 9.40%; 27.2 ± 10.12°C, 90.9 ± 13.6%; and 24.27 ± 5.77°C, 62.85 ± 5.46% for air, soil, and lab study areas, respectively.

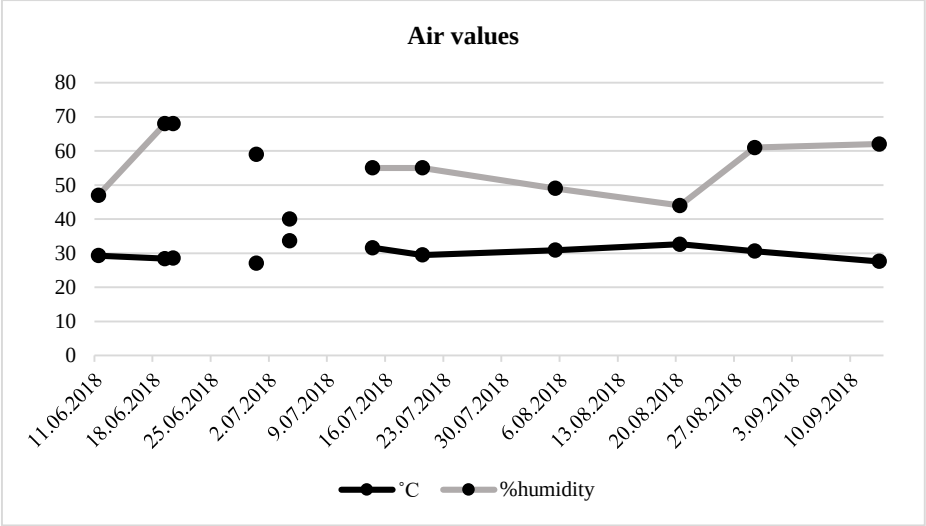

Figure 2. The evaluation dates, and comparison of temperature and relative humidity on air study site.

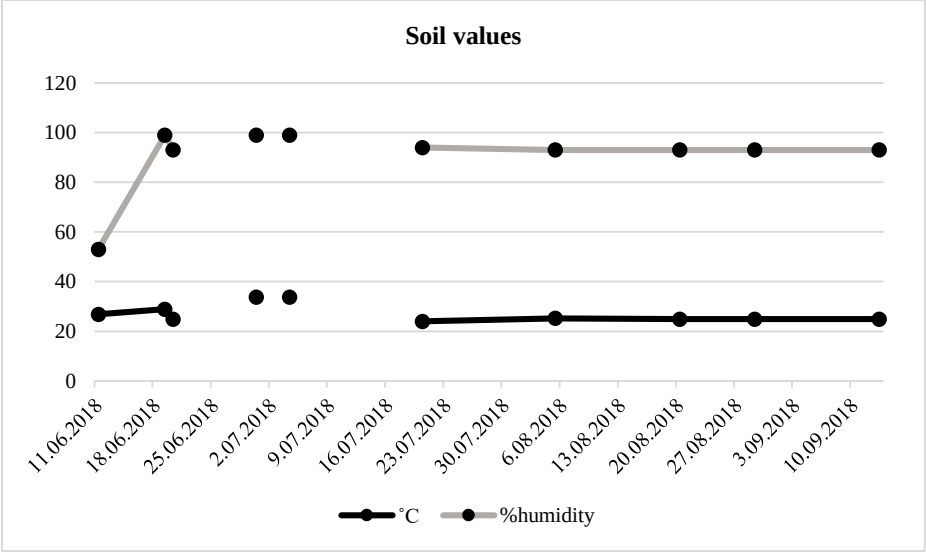

Figure 3. The evaluation dates, and comparison of temperature and relative humidity in the underground device.

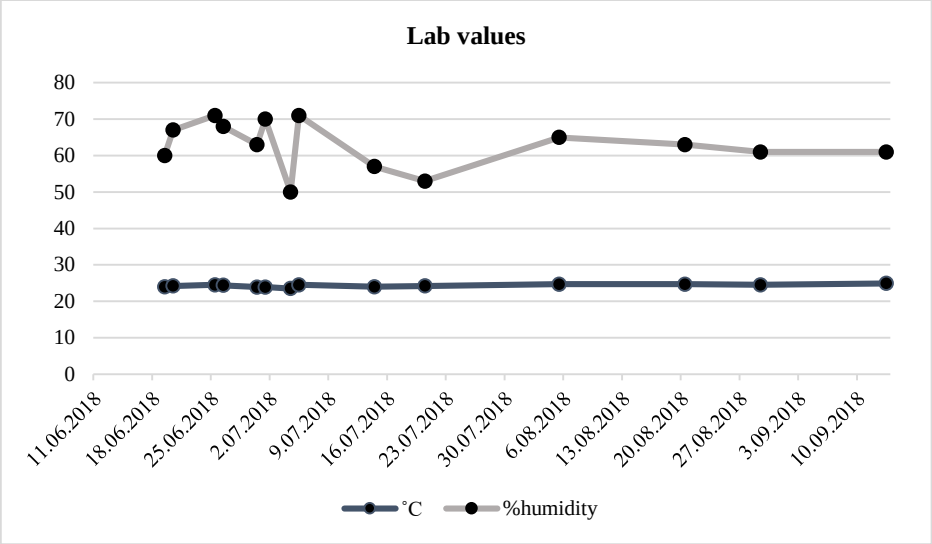

Figure 4. For the laboratory part of the study, dates and comparison of temperature and relative humidity.

When we compared the temperature and humidity in the air and at the underground devices during the four-month period we have found that the temperature and humidity were highly variable in the forest field. Temperature and humidity affect insect activity and rates of oviposition and development (Smith 1986). Therefore, the decomposition rate of meat or carcasses principally depends on climatic conditions such as temperature and humidity (Richards and Goff 1997). High temperatures increase the insect activity and we have also studied during the summer and early autumn season. It was observed that temperature and humidity changes effect on decomposition rate in air and underground devices. Because of the temperature and humidity, the decomposition of calf muscle in the air device was faster than that in the underground device.

According to the ecological categories of Smith (1986), the entomofauna in forensic cases was classified as follows.

1. Necrophagous insects: Calliphoridae (*Lucilia sericata*, *Calliphora vicina*), Sarcophagidae (*Sarcophaga* sp, *Wohlfahrtia magnifica*), Muscidae (*Muscina stabulans*), Silphidae (*Nicrophorus, Silpha*,), Dermestidae (*Dermestes undulatus*).
2. Predators and parasites: Syrphidae (*Eristalis*), Staphylinidae (*Philontus*), Histeridae (*Hister*, *Saprinus*), Vespidae (*Vespa*), Cleridae, Silphidae (*Nicrophorus, Silpha*).
3. Omnivorous: Vespidae (*Vespa*), Formicidae, Dictyoptera (*Blatta* sp.), and some Coleoptera (*Carinetes, Necrobia*).
4. Incidental: Hesperiidae, Coreidae, Nitidulidae (*Epuraea angustula*), Halictidae.

In this study entomofaunal succession on the calf muscle tissue in the air and underground devices is shown in Table 1. The predominant necrophagous arthropods were Diptera followed by Coleoptera. We recorded an incidental species like *Psychodinae* sp. and *Drosophila* sp. in our study. Necrophagous insects were different between air and underground medium. For all air samples, we have observed only necrophagous insects from Diptera class. The arrival time of all species on calf meat from the first day of the study is given in Table 2. On the calf meat, *Lucilia* sp. started laying eggs from the first day and it was followed by blow flies *Calliphora* sp. in air device. *Wohlfahrtia magnifica* namely flesh fly was also seen at the first day from the fresh stage and during the bloating and decaying stages.

Table 1. Air and underground entomofaunal succession of the decomposition process of calf muscle tissue in Uludag University Campus field.

Order and family	Air device samples	Underground device samples	Entomofauna classification
Dictyoptera: Blattidae	-	*Blatt sp.*	3. Omnivorous
Coleoptera: Dermestidae	-	*Dermestes undulatus*	1.Necrophagous insects
Hemiptera: Pentatomidae	-	*Halyomorpha halys*	2. Predators
İsopoda: Oniscidae	-	*Oniscus asellus*	
Diptera: Calliphoridae	*Lucillia sericata*	-	1.Necrophagous insects
	Calliphora vicina	-	
Diptera: Sarcophagidae	*Wohlfahrtia magnifica*	-	
Diptera: Stratiomyidae	*Hermetia illucens*	-	
Diptera: Drosophilidae	*Drosophila sp.*	-	
Diptera: Psychodidae	*Psychodinae sp.*	-	

Table 2. Insect succession on the calf meat during decomposition stages.

Decomposition stages	Fresh stage (0-1 day)	Bloating (2-6 day)	Active decay (7-12 day)	Advanced decay (13-51 day)	Dry stage (52-207 day)
Data Collection Dates	06.11.2018	06.16.2018	06.20.2018 06.30.2018	07.04.2018 07.14.2018 07.20.2018 08.05.2018	08.20.2018 08.29.2018 09.13.2018
Air Device	*Lucilia sericata* *Calliphora vicina* *Wohlfahrtia magnifica* *Drosophila sp.*	*Lucilia sericata* *Calliphora vicina* *Wohlfahrtia magnifica* *Drosophila sp.* *Psychodidae*	*Lucilia sericata* *Calliphora vicina* *Wohlfahrtia magnifica* *Drosophila* sp. *Psychodidae* *Hermetia illucens*	*Lucilia sericata* *Calliphora vicina* *Wohlfahrtia magnifica* *Drosophila* sp. *Hermetia illucens* *Dermestes undulatus*	*Drosophila* *Hermetia illucens* *Dermestes undulatus*
Underground Device	*Drosophila sp.*	*Lucilia sericata* *Calliphora vicina* *Wohlfahrtia magnifica* *Drosophila sp.* *Oniscus asellus*	*Lucilia sericata* *Calliphora vicina* *Wohlfahrtia magnifica* *Drosophila sp.* *Oniscus asellus*	*Oniscus asellus* *Blatt sp.*	*Halyomorpha halys* *Dermestes undulatus* *Blatt sp.*

H. illucens, a fly of forensic interest, was seen in a juvenile form more than adults from the 7th. day of decomposition and we observed more females on the meat surface. Except for *Calliphora* sp., *Lucilia* sp. and *H. illucens* were thermo-tolerant species and lay their eggs when the temperature exceeded 30°C during the July and August. Greenberg and Kunich (2002) reported that *Calliphora vicina* as a low thermo-tolerant species stopping its development above 27°C and in our study we observed adults of this species during June and July in laboratory observations

On the contrary, in soil samples necrophagous, predator and omnivorous insects were recorded. As a necrophagous insects, *Dermestes undulatus* was identified in underground device samples in this study. They were mainly involved in the dry stage of decomposition, with their larvae feeding on the calf meat in the underground device. *D. undulatus* has arrived through the summer, and early autumn months (Özdemir and Sert 2009). The eggs of *Dermestes* and *Blatt* sp. have occurred through the dry stage of decomposition. We observed one predator insect such as *Halyomorpha halys* and an omnivorous insect *Blatt* sp. *Halyomorpha halys* as terrestrial predators regularly feed on fresh and dry stage carcasses (Gu et al. 2014). Also *Blatt* sp. is an omnivorous beetle occurring mainly dry stage of decomposition of carcasses (Dupont et al. 2012).

CONCLUSIONS

The succession of insects on carcasses, corrion, and piece of fresh meat can, in general, be considered to be characterized by the members of two orders, Diptera and Coleoptera. With this study, we compared the forensic entomofauna from the air and underground calf meat decomposition samples during June to September four month period in Bursa province, Turkey and found that the Diptera was the most abundant order in air samples. However, the four forensic insect orders, Coleoptera, Hemiptera, Isopoda and Dictyoptera arriving on calf meat were recorded on the underground samples. This is the first study done in Bursa on the entomofauna of decomposed calf meat used as a model for forensic entomology. Data acquired from the study could be used to help interpret the entomofaunal evidence in forensic cases in Bursa and its surroundings in the future. The entomofauna on cadavers and succession studies are newly developing fields in Turkey and need more attention from scientists.

ACKNOWLEDGEMENTS

We thank you and grateful to Dr. Alper Susurluk for his kindly helps and supports in entomological identification and thesis.

REFERENCES

Byrd , J. H., & Castner, J. L. (2009). *Forensic Entomology: The Utility of Arthropods in Legal Investigations.* United States of America: CRC Press.

Bana, R., & Beyarslan, A. (2012). Research Article Determination of Coleoptera Species of Pig Carcasses and Internal Organs of Bovine in Edirne City of Turkey. *BEU Journal of Science*, 1(2), 122-126, 2012 1(2), 122-126, 2012 122.

Bousquet, Y. (1990). *Beetles associated with stored products in Canada: an identification guide.* Ottawa: Agriculture Canada.

Choate, P. M. (2003). *Introduction To The Identification Of Beetles (Coleoptera). Dichotomous Keys To Some Families Of Florida Coleoptera.*

Dupont, F. Y., Felix, B. C., Daniel, C., & Champlain, D. L. (2012). Biodiversity study of arthropods collected on rat carrion in Yaounde, Cameroon: first study on forensic entomology in Central Africa. *International Journal of Biosciences*, Vol. 2, No. 1, p. 1-8.

Grassberger, M., & Frank , C. (2004). Initial Study of Arthropod Succession on Pig Carrion in a Central European Urban Habitat. *Journal of Medical Entomology*, June 41(3):511-23 .

Greenberg, B., & Kunich , J. (2002). *Entomology and the Law: Flies as Forensic Indicators.* Cambridge University Press.

Gu, X., Haelewaters, D., Krawczynski, R., Vanpoucke, S., Wagner, H. G., & Wiegleb, G. (2014). Carcass ecology – more than just beetles. *Entomologische Berichten*, 74 (1-2): 68-74.

Hava, J. (2004). World Keys to the genera and subgenera of Dermestidae (Coleoptera), with descriptions, nomenclature and distributional records. *Acta Musei Nationalis Pragae, Series B, Natural History*, 60 (3-4): 149-164.

Lohse, G. A. (1964). *Familie: Staphylinidae. In: Freude H., Harde K.W. & Lohse G. A. (Eds.), Die Käfer Mitteleuropas. Band 4, Staphylinidae I (Micropeplinae bis Tachyporinae).* Krefeld: Goecke & Evers Verlag.

Madge, R. B. (2006). *Key to Alberta Silphidae.* From http://www.biology.ualberta.ca/facilities/strickland/silphid.htm

Matuszewski, S., Bajerlein , D., Konwerski, S., & Szpila, K. (2010). Insect succession and carrion decomposition in selected forests of Central Europe. *Forensic Science International* , February 195(1-3):42-51.

Matuszewski, S., Szafałowicz, M., & Jarmusz, M. (2013). Insects colonising carcasses in open and forest habitats of Central Europe: Search for indicators of corpse relocation. *Forensic science International* , September 231(1-3):234-9.

Özdemir, S., & Sert, O. (2008). 1. (Özdemir S., Sert O. 2008. Systematic Studies on Male Genitalia of Coleoptera Species Found on Decomposing Pig (Sus Scrofa L.) Carcasses at Ankara Province: Hacettepe Journal of Biology And Chemistry Hacettepe Journal of Biology & Chemistry, 36 (2), 13. *Journal of Biology And Chemistry Hacettepe Journal of Biology & Chemistry*, 36 (2), 137-161.

Richards , E. N., & Goff , M. L. (1997). Arthropod succession on exposed carrion in three contrasting tropical habitats on Hawaii Island, Hawaii. *Journal of medical entomology*, May;34(3):328-39.

Sert, O., & Özdemir, S. (2009). Determination of Coleoptera fauna on carcasses in Ankara province, Turkey. *Forensic science international*, December 183(1-3):24-32.

Smith, K. G. (1986). *A Manual of Forensic Entomology.* London: Trustees of the British Museum (Nat. History) and Cornell University Press.

Şabanoğlu, B. (2007). Ankara İli'nde (Merkez İlçe) Leş Üzerindeki Calliphoridae (Diptera) Faunasının Belirlenmesi Ve Morfolojilerini Sistematik Yönden İncelenmesi. *Yüksek Lisans Tezi, Hacettepe Üniversitesi, Ankara*.