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Determination of the İmportant İnsect Fauna of Forensic Entomology in Kayseri Province

Kayseri İlinin Adli Açıdan Önemli Böcek Faunasının Belirlenmesi

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DETERMINATION OF THE IMPORTANT INSECT FAUNA OF FORENSIC ENTOMOLOGY IN KAYSERI PROVINCE

ABSTRACT:

The aim of this thesis is the determinations of insects' species of forensic importance in Kayserı province. The experimental part of our study was carried out between September 2018 – May 2019; during the periods of winter, spring, autumn seasons in four different regions. In this study, fresh cow liver and chicken muscle were used as the experimental materials. The traps which allow the insects to enter easily but which prevent exit were used to collect insect species. As a result, 21 species were identified at four different study areas. *Calliphora vicina* (Robineau-Desvoidy, 1830) (Diptera: Calliphoridae), *Lucilia sericata* (Meigen, 1826) (Diptera: Calliphoridae), *Chrysomya albiceps* (Wiedemann, 1819) (Diptera: Calliphoridae), Muscina stabulans (Fallen, 1817) (Diptera: Muscidae), *Musca autumnalis* (De Geer,1776) (Diptera: Muscidae), were identified in fall season at all study areas. C. *vicina* was identified in winter season. C. *vicina*, *Thricops sp*. (Rondani, 1856) (Diptera: Muscidae), Fannia canicularis (Linnaeus, 1761) (Diptera: Fanniade), *L. sericata*, *Dermestes frischii* (Kugelann, 1792) (Coleoptera: Dermestidae), were identified in spring season at all study areas. C. *vicina* was seen from September to the end of May at all study areas. L. *sericata* was seen from September to the end of November and April to end of May at all study areas. Therefore, C. *vicina* and *L. sericata* can be used as an indicator species for determining the Posmortem Interval in Kayseri.

Keywords: Forensic Entomology, Insect, Kayseri, Seasonal Variation.

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KAYSERİ İLİNİN ADLI AÇIDAN ÖNEMLİ BÖCEK FAUNASININ BELİRLENMESİ

ÖZ:

Bu çalışmasının amacı; Kayseri ilinde adli açıdan önemli böcek faunasının belirlenmesidir. Çalışmanın deneysel kısmı; Eylül 2018-Mayıs 2019 tarihleri arasında; kış, ilkbahar, sonbahar mevsimleri sürecinde dört farklı bölgede gerçekleştirilmiştir. Çalışmada, taze büyükbaş hayvan ciğeri ve tavuk eti deney materyali olarak kullanılmıştır. Böcek örneklerini toplamak için böceklerin kolayca girmesine izin veren ama çıkışına engel olan tuzak kullanılmıştır. Sonuç olarak 4 çalışma alanında toplam 21 tür tespit edilmiştir. Sonbahar mevsiminde; *Calliphora vicina*, (Robineau-Desvoidy, 1830) (Diptera: Calliphoridae), *Lucilia sericata* (Meigen, 1826) (Diptera: Calliphoridae), *Chrysomya albiceps* (Wiedemann, 1819) (Diptera: Calliphoridae), *Muscina stabulans* (Fallen, 1817) (Diptera: Muscidae) *Musca autumnalis* (De Geer,1776) (Diptera: Muscidae), türleri tüm çalışma alanlarında görülmüştür.

Kış mevsiminde; sadece C. *vicina* türü tüm çalışma alanlarında görülmüştür. İlkbahar mevsiminde; C. *vicina, Thricops sp.* (Rondani, 1856) (Diptera: Muscidae), *Fannia canicularis* (Linnaeus, 1761) (Diptera: Fanniade), *L. sericata, Dermestes frischii* (Kugelann, 1792) (Coleoptera: Dermestidae), tüm çalışma alanlarında görülmüştür. *C. vicina* Eylül ayından Mayıs ayı sonuna kadar tüm çalışma alanlarında görülmüştür. *L. sericata* Eylül ayından Kasım ayı sonuna, Nisan ayından Mayıs ayı sonuna kadar tüm çalışma alanlarında görülmüştür. Bu yüzden *C. vicina* ve *L. sericata* Kayseri'de ölümden sonra geçen zamanın tespitinde kullanılabilir.

Anahtar Kelimeler: Adli Entomoloji, Böcek, Kayseri, Mevsimsel Varyasyon.

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1. INTRODUCTION

Insects are found in many places except deep seas and high mountains (Demirsoy, 2006). They constitute the largest class of Metazoa (multicellular) with approximately two million species and have lived for approximately 350 million years (Triplehorn & Johnson, 2005). They adapt very well to changing environmental conditions and are found in almost all habitats (Triplehorn & Johnson, 2005). They are cold-blooded creatures, unable to regulate their body temperature (Triplehorn & Johnson, 2005; Gennard, 2007) and have a highly developed olfactory organ. they do (Eberhardt & Elliot, 2008). Egg-larval stages-pupae development stages require ambient temperature and there is a linear relationship between the hatching times and growth rates of the larvae and the ambient temperature (Gennard, 2007). The linearity of the relationship between temperature and growth changes as the difference between the ambient temperature and the optimum growth temperature of the insect increases or as the species approaches the lowest and highest growth thresholds (Nabity et al., 2006).

The different and unique environments in which insect species live, the fact that they come to the corpse very soon after death (Carvalho et al., 2000), their feeding from the corpse and their development, diversity, and the variation of their frequency according to environmental factors provide spatial and temporal information (Varatharajan, 2000). Many studies conducted in recent years have shown that time of death determinations based on entomological evidence (insect) are precise and reliable (Gomes & Zuben, 2006). Therefore, entomological findings; These are important data that support other branches of science in illuminating forensic events and are used alone when medical parameters cannot be used (Açıkgöz, 2010).

Knowing the order in which insects arrive on the corpse and their developmental stages, besides answering the questions of when, where and how death occurs,

smuggling, poisoning (Sumodan, 2002), traffic and plane crashes, sexual abuse (Benecke, 1998), inheritance cases in enforcement courts (Kökdener, 2016) helps to illuminate many cases such as elderly and child neglect (Slone et al, 2005).

Insects should be examined in detail from the biological and ecological aspects and their distribution should be determined (Byrd & Castner, 2001). Members of the order Diptera are used to estimate the time of death of cases that have passed shortly after death, while members of the order Coleoptera are used to estimate the time of death of cases that have passed a long time (Smith, 1986).

Table 1. Some insect families and genera important in estimating time of death (Amendt et al., 2004b)

ORDER	IMPORTANT GENUS
[1]COLEOPTERA/BELEGATES	
[2]Cleridae (Colored beetles)	Necrobia
[2]Dermestidae (dry mealybugs)	Attagenus, Dermestes
[2]Histeridae (Beetles)	Hister, Saprinus
[2]Silphidae (corpse beetles)	Necrodes, Nicrophorus, Silpha
[2]Staphylinidae (Short-winged)	Aleochara, Creophilus
[2]Nitidulidae (Beetles)	Nitidula
[1]DIPTERA/FLY	
[2]Calliphoridae (Carrion flies)	Calliphora, Chrysomya, Cochliomyia, Lucilia, Phormia
[2]Fanniidae (Sewer flies)	Fannia
[2]Heleomyzidae (Sun flies)	Heleomyza, Neoleria
[2]Drosophilidae (Fruit flies)	Drosophila
[2]Muscidae (House flies)	Hydrotaea, Musca, Muscina, Ophyra
[2]Phoridae (Humpback flies)	Conicera, Megaselia
[2]Piophilidae (Cheese flies)	Piophila, Stearibia
[2]Sarcophagidae (Meat flies)	Liopygia, Sarcophaga

1.1 Purpose and Importance of Forensıc Entomology

One of the first questions that comes to mind in cases of suspicious death is when the person died, and one of the creatures that can best answer this question is insects (Hall & Hundington, 2010). Measurement of body temperature in the first 72 hours after death, algor mortis (decrease in body temperature), livor mortis (dead bruise) and rigor mortis (dead stiffness) analyzes (Amendt et al, 2004b), measurement of potassium amount in eye fluid by biochemical methods (Knight &

Nokes , 2002), the time of death can be determined by looking at the signs of skin and nail pallor (Bass, 2001). However, in cases where a longer period of time has passed since death, these medical parameters cannot be used properly (Anderson, 2005; Ames & Turner, 2003). Insects are almost the only evidence used to determine the time after death from the initial stage to the advanced stage of decay (Anderson, 2005; Slone et al, 2005). Therefore, it is one of the most sensitive methods used in the calculation of the postmortem time from the first day of death (Madea et al, 2002; Goff, 2001).

1.2. Calculation of Time of Death Using İnsect Data

Two basic methods are used in postmortem estimations using insects (Ames & Turner, 2003). The first of these methods is to calculate ADD (Accumulated degree days) or ADH (Accumulated degree hours) based on the oldest insect development data found on the corpse, and the other method is to use the insect succession on the corpse.

For each stage (Egg-1.larva-2.larva-3.larva-Pupa-Adult) that the insect egg goes through until the adult individual is formed, the heat requirements required for the ADD (Accumulated degree-days) or developmental stages are measured in hours. ADH (Accumulated degree hour) calculations are made. It is the calculation of the insect's egg laying time retrospectively by using the length value of the longest larva in the corpse and the temperature values at the time the corpse was found (Tüzün & Yüksel, 2007).

The second method, the succession method; It is based on knowing the fresh stage, swelling stage, active decay stage, advanced decay stage, dry residue-skeletonization (Tüzün & Yüksel, 2007) stages, which are the stages of decay of the corpse, and the knowledge of which type of insect came in which stage (Schoenly & Reid, 1987).

Knowing the time of the arrival of the insect on the corpse in a particular region, then when a forensic case is encountered, the postmortem time can be estimated by detecting the fauna on the corpse (Goff & Flynn, 1991). However, the vegetation, habitat and climatic characteristics of the regions are different and these differences have an effect on the species (Anderson, 2001). Therefore, succession data of that region should be known in post-mortem estimations.

Many researchers in their studies in different regions have shown that species belonging to the Diptera order (Calliphoridae, Sarcophagidae, Muscidae, Fanniidae) come in the early stages of decay (Fresh stage and Swelling stage), and that in the last stages of decay (Active decay, Advanced decay, Dry residue-Skeletonization) species belonging to the order Coleoptera. (Staphylinidae, Silphidae, Cleridae, Histeridae, Dermestidae, Scarabaeidae and Nitidulidae) species have been observed to come.

1.3. Succession and Order

Depending on the different decomposition stages of the corpse, different insect species reaching the corpse at each stage is called "insect succession" or "faunal succession". Jerry Payne, a PhD student in North Carolina, pioneered the concept of succession (Goff, 2001). Payne (1965) developed the approach model "The changes made by the organisms on the corpse attract the other organism group to the corpse. Therefore, the time spent by each organism group on the corpse can be determined. Based on this information, the order of arrival of the corpse is determined by determining the activities of the insects in the decomposed corpse". (Goff, 2001).

Different odors are emitted in the corpse as a result of biological, physical and chemical changes, and while these odors are attractive for some species, they are less attractive for others (Varatharajan, 2000). E.g; Sarcophagidae (meat flies) are the first family to come and colonize the corpse, and again the Calliphoridae (carrion flies) family prefer the fresh stage of decay (Erzinçlioglu, 1996). Each insect's environment is different (Açıkgöz et al., 2002), and it has a unique growth rate (Wolff et al., 2001). Humidity, temperature, and the presence of ammonia-rich tissue affect the laying of insects. Female flies lay their eggs in the oral cavity of the corpse, in the eyeball, in the vaginal area if it is sexually abused and an open corpse, in the anus area, in open wounds, moist areas and places that do not see direct sunlight if it has died as a result of injury.

Smith (1986) grouped the insects that come to the corpse into 4 categories according to their feeding preferences and ecological roles (Amendt et al, 2004a; Zehner et al, 2004).

Necrophage Species: They feed on corpses and are the first to colonize (Zehner et al., 2004). It includes orders such as Diptera (Calliphoridae, Sarcophagidae,) and Coleoptera (Staphylinidae, Dermestidae, Histeridae) that are used in post-mortem time determination (Merritt et al., 2000).

Predator / Parasitic Species: They do not feed directly from the corpse. They feed on the larvae and pupae of other insects and arthropods. *Chrysomya sp*.(Robineau-Desvoidy, 1830) (Diptera: Calliphoridae), Histeridae and Staphilinidae fall into this group (Merritt et al., 2000; Wolff et al., 2001).

Omnivorous Species: They feed on both the corpse and the larvae on the corpse, as well as other species. (Merritt et al, 2000) Dermestidae, Tineidae, Hymenoptera fall into this group (Amendt et al, 2004b; Zehner et al, 2004).

Incidental Species: They do not feed on the corpse. They come to the corpse as they seek suitable shelter as an extension of their environment. Includes other

species such as Collembola, Araneae, Diplopoda (Amendt et al, 2004b; Aggarwal, 2005; Merritt et al, 2000).

1.4. The Main Factors Affecting The Succession Order

Factors such as geographical distribution, season, humidity, precipitation, sun and temperature are the most important (Voss et al, 2009; Wolff et al, 2001). Whether the corpse is completely submerged in water or burned, buried or in a closed area are factors affecting insect succession (Archer et al., 2003).

Anderson, 2001, in his study in Hawaii, saw that insect colonization started earlier in the burning corpse, much more flies lay eggs, and in corpses wrapped in blankets, fly colonization was delayed by 2.5 days (Hall, 2001).

1.5. Geographic Distribution

Habitat, soil type, meteorological values and vegetation are different in each geographic region. Therefore, one of the important factors affecting insect succession is the geographical region where the corpse is found, and each geographical region has different species (Anderson, 2010).

Although Calliphoridae (carrion flies) and Sarcophagidae (meat flies) were the first colonists to arrive on the body, differences were found between species. For example, in studies conducted in many regions, the first colonists were *Lucilia cuprina* (Wiedemann, 1830) (Diptera:Calliphoridae), *Chrysomya megacephala* (Fabricius, 1794) (Diptera:Calliphoridae) and *Chrysomya rufifacies* (Macquart, 1842) (Diptera:Calliphoridae) species from the Calliphoridae family, while *Bercaea haemorrhoidalis* (Fallen, 1817), *Parasarcophaga ruficornis*, *Sarcophaga occidua* (Fabricius, 1794) and *Helicoba morionella* species from the Sarcophagidae family were also the first colonist species (Gearly, 1986). In the study in the US state), the first colonist species were *Lucilia coeruleiviridis* (Macquart, 1855) (Diptera:-Calliphoridae) and *Phormia regina* (Meigen, 1826)(Diptera:Calliphoridae) species from the Calliphoridae family (Reed, 1958), In Turkey, the first colonists to come to the corpse are *Calliphora vomitoria* (Linnaeus, 1758) (Diptera:Calliphoridae), *C.vicina, L. sericata* and *C. albiceps* species belonging to the Calliphoridae family (Şabanoğlu & Sert, 2010).

1.6. Seasonal Factors

Seasons are the main factor affecting the flora, species and temperature of the regions. While *C. vicina* and *C. vomitoria* species are more common in winter, *L. sericata* and *C. albiceps*, which are in the same family, are more common in summer (Haskell & Williams, 1990). In studies conducted in Maryland (US state), *C. vicina*, *Calliphora livida* (DG Hall, 1948) (Diptera:Calliphoridae), *Lucilla illustris* (Meigen, 1826) (Diptera:Calliphoridae) were found only in autumn; *L. sericata* was

seen only in summer (Introna et al., 1991). Studies conducted in Finland showed that Sarcophagidae (meat flies) vary according to seasons and regions (Nuorteva, 1959).

1.7. Temperature and humidity/Sunlight

One of the most important meteorological factors affecting succession is temperature, humidity and direct sunlight (Smith, 1986; Haskell & Williams, 1990). The temperature of a corpse exposed to sunlight increases rapidly and the corpse's decomposition accelerates. The rapidly decomposing corpse rapidly loses its biomass (Hall, 2001). Temperature and humidity affect the presence of the insect on the corpse as well as the laying and hatching of the egg (Anderson & Cervenka, 2002).

Shean et al (1993) found that sunlight accelerates decay and insect succession occurs faster (Shean et al., 1993). Turner & Howard (1992), in their study, measured the temperature of the corpse at intervals, found that the amount of larvae and larval movements on the corpse increased the temperature of the corpse, and the temperature of the corpse was 20-26 °C higher than the temperature of the environment and soil (Turner & Howard, 1992).

Table 2. Lower growth threshold temperature values of insect species in forensic sciences (Marchenko, 2001).

Species Name	Lower Growth Threshold Temperature (°C)
Boettcherisca Septenrionalis	7.8
Calliphora Vicina	2.0
Calliphora Vomitoria	3.0
Chrysomya Albiceps	10.2
Muscina Assimilis	7.9
Muscina Stabulans	7.2
Lucilia Sericata	9.0
Phormia Regina	11.4
Piophila Foveolata	6.4
Protophormia Terraenovae	7.8

2. MATERIAL AND METHOD

2.1. Fieldwork

Our study was carried out in 4 regions between September 2018 and May 2019. The first of the study areas is the Republic of Turkey State Railways guest-

house land in the city center. Its coordinates are latitude 38°43'50.48"N longitude 35°28'46.08"E. The second of the study areas is Erkilet roadside land.

Its coordinates are latitude 38°45'35.92"N longitude 35°27'55.64"E. The third of the study areas is the land of the 7th Regional Directorate of Meteorology. Its coordinates are latitude 38°41'21.69"N longitude 35°29'58.08"E. The fourth of the study areas is the roadside cemetery land leading to Erciyes Mountain. Its coordinates are latitude 38°37'41.44"N longitude 35°30'46.77"E.

While selecting the study areas, factors such as the vegetation of the regions, their geographical location and altitude were taken into account. Among the study areas, the Republic of Turkey State Railways (T.C.D.D.) guesthouse land is in the city center and was chosen to determine the difference in insect species between the rural area and the city center. Among the study areas, the Erkilet region was chosen because it is in a transit transition position to the Malatya-Sivas and Ankara-Istanbul inter-city road routes, and the T.C.D.D. It is 20 km from the land of the Meteorology Department, 30 km from the land of the 7th Regional Directorate of Meteorology, and 46 km from the Erciyes cemetery. The land of the 7th Regional Directorate of Meteorology was chosen because it is close to the midpoint of the 2 regional plots (Erciyes cemetery-T.C.D.D. land). Among the study areas, the Erciyes cemetery land is 26 km away from the city center and 46 km away from the Erkilet region, which is the farthest region.

The traps are 1500 ml clear plastic water bottle with 150 g of chicken meat or bovine liver in the inner bottom. In order to allow the insect to enter the traps, the mouth of the bottle was cut off and placed in an upside-down way, nested in the bottom part, and hung on trees at different directions and heights, 75 m away from each other. The study areas were visited systematically every 3 days and the insects coming to the traps placed in 4 regions were collected with the help of forceps and taken into sterile 50 ml falcon tubes, and the temperature-humidity values, land location and date were written. While new traps were left in place of the traps that were taken, the temperature-humidity values of that day, land location, date, and which medium was in the trap were written on the label.

On the other hand, the insect larvae in the traps were taken into glass jars, and bovine livers were placed in them so that they could continue to feed, and the temperature-humidity values, the land from which they were taken, the date were written on the glass jars. In order for the larvae to continue their life cycle, a hole was made in the middle of the lid part of the jars, and a piece of gauze was placed on the upper part and the lid was closed. Larvae that came to the last feeding stage were taken from glass jars to rearing pots. Sawdust was placed inside the rearing pots to enable the larvae taken into the pupa stage to pass into the pupa stage, a hole was made in the middle of the cover part, and a piece of tulle was placed on

the upper part of the cover so that the adult insects that completed the pupa stage could continue their life cycles, and the temperature-humidity values, the land from which they were taken, were written on the rearing pots. Larva-prepupa-pupa-adult developmental stages were monitored and graded every 2 days. Care has been taken that the traps do not harm the environment and are not spoiled by humans and animals. A total of 8 traps, 2 for each region, were left in 4 regions every 3 days. Due to the low insect population in the winter season, field work was carried out once a week. Some of the meteorology data is taken from the address https://weather.com/tr- TR/kayseri/bugun/l/TUKY0286:1: TU from the 7th Regional Directorate of Meteorology. The terrain photos were taken with the PowerShot SX150 14.1 megapixels Canon digital camera.

Located in the city center, T.C.D.D. in the vegetation of his land; *Pinus nigra* (black pine) is present, weeds and shrubs are dominant. In the vegetation of the Erkilet land; There are *Pinus nigra* (J.F.Arnold & Reise Mazriazell Steyerm. 1785) (Pinales:Pinaceae), *Salix alba* (Malpighiales:Salicaceae), *Populus alba* (Malpighiales:Salicaceae), weeds and shrubs are dominant. In the vegetation of the 7th Regional Directorate of Meteorology; There are *P. nigra*, *S. alba*, *P. alba*, *Malus domestica* (Rosales:Rocaceae), *Prunus armeniaca* (Rosales:Rocaceae), Vitis (vineyards), weeds and shrubs are dominant. In the vegetation of the cemetery land of the Erciyes region; there are *P. nigra*, *S. alba*, *P. alba*, weeds and shrubs.

2.1.1. Laboratory Study

Adult insects collected from the traps and insects that have completed their development were brought to the laboratory after they were killed in the killing containers. The samples were examined in Ondokuz Mayıs University Science Faculty Research and Development Laboratory. Leica MZ 12.5 brand stereo microscope was used for the identification of the samples, a special insect stand was used to position the samples under the microscope and the identification of the species was made with the determination keys (Whitworth, 2006; Carvalho & Mello-Patiu, 2008; Me'ndeza et al., 2008; Shazia. et al, 2006; Gregor et al, 2002; Hava, 2004; Almeida & Mise, 2009; Bajerlein, 2009).

3. RESULTS AND DISCUSSION

3.1. Insect Species Seen in the Autumn Season

When we evaluate the four regions in terms of the Autumn season; *C. vicina*, *L. sericata*, *C. albiceps, M. stabulans, M. autumnalis* are the species seen in all fields (Table 3., Table 4., Table 5., Table 6.) Species belonging to the Sarcophagidae family were seen in the other 3 fields except the Erciyes cemetery. The fact that the Erciyes cemetery land is at a high altitude and the temperature values are lower than

other areas may be among the reasons why we did not encounter Sarcophagidae in the Erciyes cemetery. *Sarcophaga sp*. (Meigen, 1826) (Diptera:Sarcophagidae) Erkilet and T.C.D.D. on their land; *Sarcophaga argyrostoma* (Robineau-Descoidy, 1830) (Diptera:Sarcophagidae) T.C.D.D. and 7th Regional Directorate of Meteorology; *Lucilia caesar* (Linnaeus, 1758) (Diptera:Calliphoridae), Erciyes cemetery, T.C.D.D. and 7th Regional Directorate of Meteorology; on the other hand, *C. vomitoria* was seen only in November on the territory of the 7th Regional Directorate of Meteorology. In *C. vomitoria*, it is a species that likes and can live at low temperatures like *C. vicina*. In all fields, only *C. vicina* and *L. sericata* species were seen in October and November. *C. albiceps*, *M. autumnalis*, *M. stabulans* were seen in all fields only in the first week of September.

When the species seen in the autumn season are evaluated in terms of medium; *M. autumnalis* in chicken meat, *L. caesar* in bovine liver in Erciyes cemetery land; In the Erkilet field, *M. autumnalis*, in chicken meat, *Sarcophaga sp*. in bovine liver; T.C.D.D. *M. autumnalis* in chicken meat, *L. caesar*, species belonging to Sarcophagidae family in bovine liver; In the 7th Regional Directorate of Meteorology, *L. caesar, M. autumnalis, C. vomitoria* were observed in chicken meat, but not in cattle liver.

When we look at the numerical distribution of the species seen in the study areas; While 6 species are seen in Erciyes cemetery and Erkilet lands, T.C.D.D. and 8 species were observed in the lands of the 7th Regional Directorate of Meteorology (Table 3., Table 4., Table 5., Table 6.). The % distribution of the species in the autumn season is given in Table 7. The most common species in all fields are *C. vicina* (76.82%) and *L. sericata* (21.27%).

Table 3. Insect species seen in Erciyes cemetery land

Months	Autumn		Food							
			Chicken meat				Bovine liver			
	Order	Family	species	species numbers	percent %	Order	Family	species	species numbers	percent %
September	Diptera	Calliphoridae	Calliphora vicina	214	84.25	Diptera	Calliphoridae	Calliphora vicina	366	91.73
			Lucilia sericata	30	11.81			Lucilia sericata	12	3.01
			Chrysomya albiceps	2	0.79			Chrysomya albiceps	12	3.01
		Muscidae	Musca autumnalis	3	1.18			Lucilia caesar	8	2.01
			Muscina stabulans	5	1.97		Muscidae	Muscina stabulans	1	0.25
			Total number of samples	254	100			Total number of samples	399	100
October		Calliphoridae	Calliphora vicina	143	80.34		Calliphoridae	Calliphora vicina	366	83.75
			Lucilia sericata	35	19.66			Lucilia sericata	71	16.25
			Total number of samples	178	100			Toplam örnek sayısı	437	100
November		Calliphoridae	Calliphora vicina	94	85.45			Calliphora vicina	71	98.61
			Lucilia sericata	16	14.55			Lucilia sericata	1	1.39
			Total number of samples	110	100			Total number of samples	72	100

Table 4. Insect species seen in Erkilet land

Months	Autumn		Food								
			Chicken meat					Bovine liver			
	Order	Family	species	species numbers	percent %	Order	Family	species numbers	species	percent %
September	Diptera	Calliphoridae	Calliphora vicina	68	48.57	Diptera	Calliphoridae	Calliphora vicina	56	56
			Lucilia sericata	33	23.57			Lucilia sericata	10	10
			Chrysomya albiceps	22	15.71			Chrysomya albiceps	1	1
		Muscidae	Musca autumnalis	3	2.14		Muscidae	Muscina stabulans	5	5
			Muscina stabulans	14	10		Sarcophagidae	Sarcophaga sp.	28	28
			Total number of samples	140	100			Total number of samples	100	100
October		Calliphoridae	Calliphora vicina	95	53.37			Calliphora vicina	145	66.51
			Lucilia sericata	83	46.63			Lucilia sericata	73	33.49
			Total number of samples	178	100			Total number of samples	218	100
November			Calliphora vicina	165	88.71		Calliphoridae	Calliphora vicina	152	84.92
			Lucilia sericata	21	11.29			Lucilia sericata	27	15.08
			Total number of samples	186	100			Total number of samples	179	100

Table 5. T.C.D.D. insect species in the field

Months	Autumn		Food							
			Chicken meat				Bovine liver			
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
September	Diptera	Calliphoridae	Calliphora vicina	35	41.18	Diptera	Calliphoridae	Calliphora vicina	36	48.65
			Lucilia sericata	2	2.35			Lucilia sericata	2	2.7
			Chrysomya albiceps	32	37.65			Lucilia caesar	1	1.35
		Muscidae	Musca autumnalis	10	11.76			Chrysomya albiceps	23	31.08
			Muscina stabulans	6	7.06		Muscidae	Muscina stabulans	6	8.11
							Sarcophagidae	Sarcophaga sp.	1	1.35
								Sarcophaga argyrostoma	5	6.76
			Total number of samples	85	100			Total number of samples	74	100
October		Calliphoridae	Calliphora vicina	73	65.77			Calliphora vicina	164	62.36
			Lucilia sericata	38	34.23			Lucilia sericata	99	37.64
			Total number of samples	111	100		Calliphoridae	Total number of samples	263	100
November			Calliphora vicina	130	94.89			Calliphora vicina	154	88
			Lucilia sericata	7	5.11			Lucilia sericata	21	12
			Total number of samples	137	100			Total number of samples	175	100

Table 6. Insect species seen on the land of the 7th Regional Directorate of Meteoroloji

Months	Autumn		Food								
			Chicken meat			Bovine liver					
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
September	Diptera	Calliphoridae	Calliphora vicina	81	43.09	Diptera	Calliphoridae	Calliphora vicina	119	39.02
			Lucilia sericata	75	39.89			Lucilia sericata	142	46.56
			Chrysomya albiceps	13	6.91			Chrysomya albiceps	32	10.19
			Lucilia caesar	5	2.66		Muscidae	Muscina stabulans	10	3.28
		Muscidae	Muscina stabulans	10	5.32		Sarcophagidae	Sarcophaga argyrostoma	2	0.66
			Musca autumnalis	2	1.06					
		Sarcophagidae	Sarcophaga argyrostoma	2	1.06					
			Total number of samples	188	100			Total number of samples	305	100
October		Calliphoridae	Calliphora vicina	125	78.62		Calliphoridae	Calliphora vicina	105	80.77
			Lucilia sericata	34	21.38			Lucilia sericata	25	19.23
			Total number of samples	159	100			Total number of samples	130	100
November			Calliphora vicina	84	94.38			Calliphora vicina	167	88.83
			Lucilia sericata	4	4.49			Lucilia sericata	21	11.17
			Calliphora vomitoria	1	1.12					
			Total number of samples	89	100			Total number of samples	188	100

Table 7. Insect species seen in 4 regions in autumn

Order	Family	Species	species numbers	Percent %
Diptera	Calliphoridae	Calliphora vicina	3178	76,82
		Lucilia sericata	880	21.27
		Chrysomya albiceps	32	0.77
		Lucilia caesar	9	0.22
		Calliphora vomitoria	1	0.02
	Muscidae	Musca autumnalis	8	0.19
		Muscina stabulans	15	0.36
	Sarcophagidae	Sarcophaga argyrostoma	4	0.10
		Sarcophaga sp.	10	0.24
		Total number of samples	4137	100

3.2. Average Temperature/Humidity Values of Autumn Season

In September, the average temperature is 19.2 °C and the humidity is 41.3% on average; In October, the average temperature is 13.2°C and the humidity is 62.8% on average; In November, the average temperature was 6.8°C and the humidity was 69.6% on average (Figure 1.).

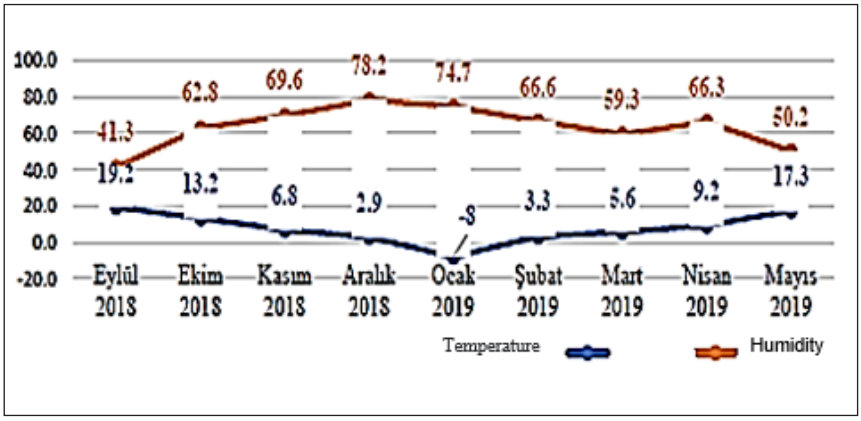

Figure 1. September 2018-May 2019 Average Temperature and Humidity Values

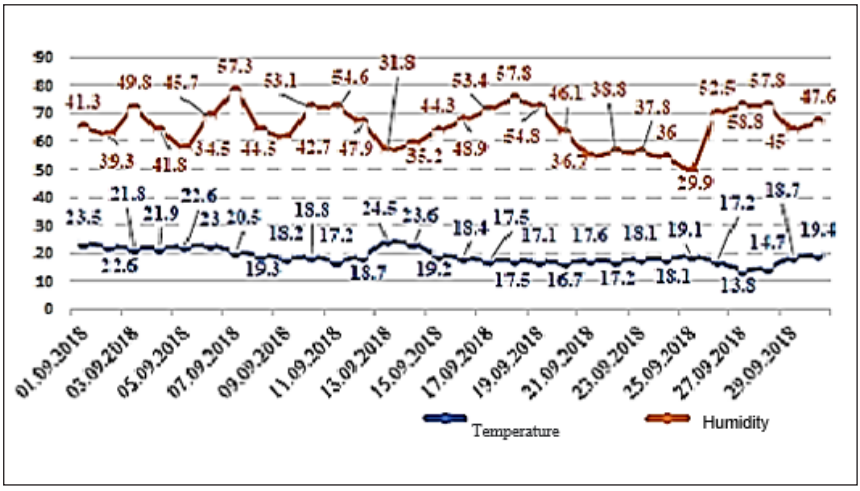

Figure 2. Temperature and Humidity Values of September

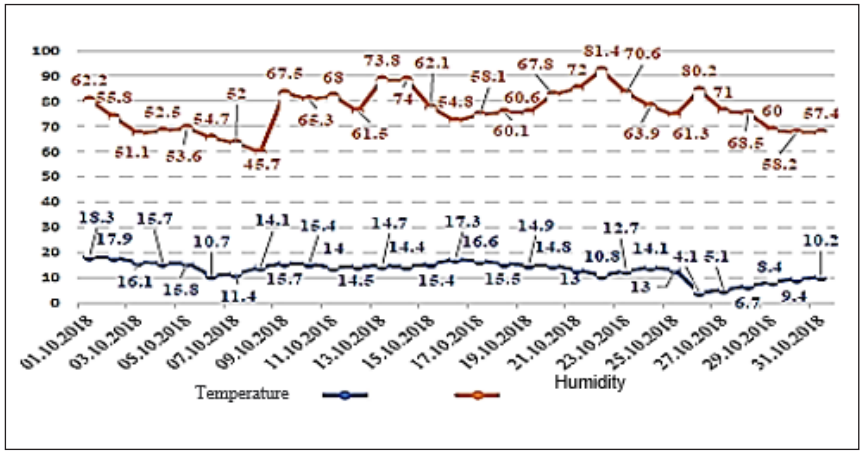

Figure 3. Temperature and Humidity Values of October

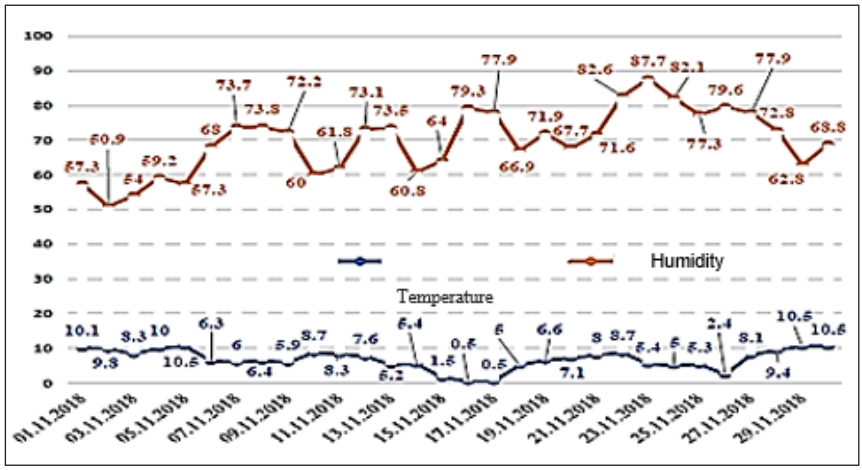

Figure 4. Temperature and Humidity Values of November

3.3. Insect Species in Winter

When we evaluate the four regions in terms of the winter season; only *C. vicina* was seen in all fields. *C. vicina* is a species that can live in different habitats and low temperatures. The highest number in December during the winter season in all terrains; 25 in the Erciyes cemetery; On the Erkilet land 29, T.C.D.D. *C. vicina* has been seen, 40 of which are in the field of the 7th Regional Directorate of Meteorology and 33 in the territory of the 7th Regional Directorate of Meteorology. While the least number of species was seen in the Erciyes cemetery land (chicken meat

15, bovine liver 15, *C. vicina*) among the study areas (Table 8), the highest number of species was T.C.D.D. (26 chicken meat, 28 cattle liver species, *C. vicina*) in the field (Table 9.).

When evaluated in terms of *C. Vicina* medium seen in winter season, 17 in chicken meat and 26 in bovine liver in Erkilet land (Table 10.); On the land of the 7th Regional Directorate of Meteorology, 22 in chicken meat and 25 in bovine liver were observed (Table 11.). The % distribution of the species in the winter season is given in Table 12. The most common species in all fields are *C. vicina* (100%).

Table 8. Insect species seen in the Erciyes cemetery land

Months	Winter		Food								
			Chicken meat			Bovine liver					
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
December	Diptera	Calliphoridae	Calliphora vicina	12	100	Diptera	Calliphoridae	Calliphora vicina	13	100
January			Calliphora vicina	2	100			Calliphora vicina	1	100
February			Calliphora vicina	1	100			Calliphora vicina	1	100
			Total number of samples	15	100			Total number of samples	15	100

Table 9. T.C.D.D. insect species in the field

Months	Winter		Food							
			Chicken meat			Bovine liver				
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
December	Diptera	Calliphoridae	Calliphora vicina	18	100	Diptera	Calliphoridae	Calliphora vicina	22	100
January			Calliphora vicina	6	100			Calliphora vicina	5	100
February			Calliphora vicina	2	100			Calliphora vicina	1	100
			Total number of samples	26	100			Total number of samples	28	100

Table 10. Insect species seen in Erkilet land

Months	Winter		Food							
			Chicken meat			Bovine liver				
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
December	Diptera	Calliphoridae	Calliphora vicina	11	100	Diptera	Calliphoridae	Calliphora vicina	18	100
January			Calliphora vicina	5	100			Calliphora vicina	6	100
February			Calliphora vicina	1	100			Calliphora vicina	2	100
			Total number of samples	17	100			Total number of samples	26	100

Table 11. Insect species seen on the land of the 7th Regional Directorate of Meteorology

Months	Winter		Food							
			Chicken meat					Bovine liver		
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
December	Diptera	Calliphoridae	Calliphora vicina	17	100	Diptera	Calliphoridae	Calliphora vicina	16	100
January			Calliphora vicina	4	100			Calliphora vicina	6	100
February			Calliphora vicina	1	100			Calliphora vicina	3	100
			Total number of samples	22	100			Total number of samples	25	100

Table 12. Insect species seen in 4 regions in winter

Order	Family	species	species numbers	Percent %
Diptera	Calliphoridae	Calliphora vicina	174	100
		Total number of samples	174	100

3.4. Average Temperature/Humidity Values of Winter Season

In December, the average temperature is 2.9°C and the humidity is 78.2% on average; In January, the average temperature is -8°C and the humidity is 74.7% on average; In February, the average temperature was 3.3°C and the humidity was 66.6% on average (Figure 1.).

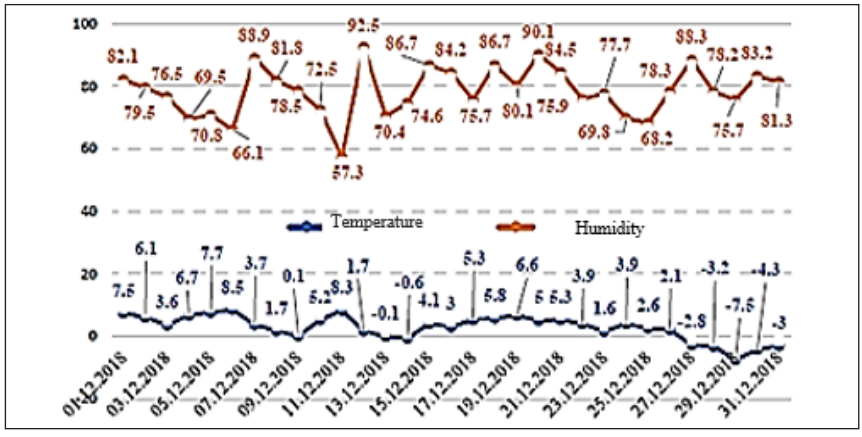

Figure 5. Daily temperature and humidity values of December

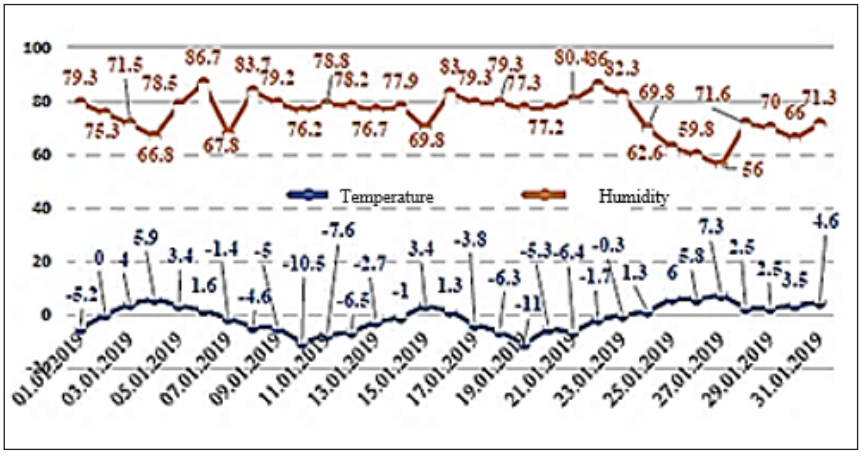

Figure 6. Daily temperature and humidity values of January

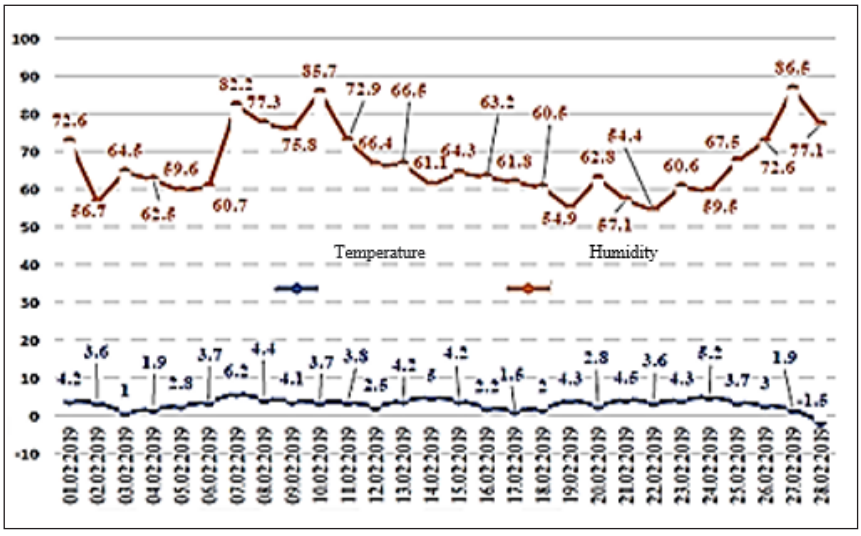

Figure 7. Daily temperature and humidity values of February

3.5. Insect Species Seen in the Spring Season

When we evaluate the four regions in terms of the spring season; *C. vicina*, *Thricops sp*., *F. canicularis*, *L. sericata*, *D. frischii* were seen in all fields (Table 13., Table 14., Table 15., Table 16.). *Musca domestica* (Linnaeus, 1758) (Diptera:Muscaidae), Erciyes cemetery and 7th Regional Directorate of Meteorology (Table 13., Table 16.), *S. argyrostoma* only in Erciyes cemetery land (Table 13.), *Fannia sp*.

Erciyes cemetery and 7th Regional Directorate of Meteorology (Table 13., Table 16.), *M. autumnalis*, and *M. stabulans* were seen only in Erciyes cemetery (Table 13.). *Dermestes undulatus* (Brahm, 1790) (Coleoptera:Dermestidae), *Margarinotus brunneus* (Fabricius, 1775) (Coleoptera:Histeridae) Erciyes cemetery and T.C.D.D. (Table 13., Table 15.), *Saprinus subnitescens* (Bickhardt, 1909) (Coleoptera:Histeridae) Erciyes cemetery, Erkilet and Meteorology 7th Regional Directorate lands (Table 13., Table 14., Table 16.) *Saprinus vermiculatus* (Erichson, 1834) (Coleoptera:Histeridae) Erciyes cemetery and 7th Regional Directorate of Meteorology (Table 13., Table 16.), *Saprinus caerulescens* (Hoffmann, 1803) (Coleoptera:Histeridae) was observed in the Erciyes cemetery and Erkilet lands (Table 13., Table 14.). *Creophilus maxillosus* (Linnaeus, 1758) (Coleoptera:Stafilinidae) was not seen only in the land of the 7th Regional Directorate of Meteorology, but also in all other lands (Table 13., Table 14., Table 15.).

When the species seen in the spring season are evaluated in terms of medium; 14 species in chicken meat, 11 species in bovine liver, 6 species in chicken meat, 7 species in bovine liver in Erciyes cemetery land, T.C.D.D. 7 species in chicken meat, 6 species in bovine liver, 8 species in chicken meat and 6 species in cattle liver in the 7th Regional Directorate of Meteorology. In the Erciyes cemetery, *M. stabulans, M. autumnalis, S. argyrostoma, M. domestica, C. maxillosus* were observed in chicken meat, Saprinus vermiculatus and *D. undulatus* were only observed in cattle liver. In Erkilet land, *C. maxillosus* in chicken meat, *S. caerulescens, S. subnitescens* in bovine liver; T.C.D.D. *M. brunneus* and *C. maxillosus* in chicken meat, *D. undulatus* in bovine liver; *Fannia sp., S. subnitescens* was observed in chicken meat, *S. vermiculatus* was only observed in cattle liver in the 7th Regional Directorate of Meteorology.

In the spring season, while there were the least number of species in March, the highest number of species was observed in May with the increase in air temperature. Species belonging to the order Coleoptera started to be seen only in April and May, when the air temperature increased in the spring season, and was seen only in May in all fields, *Dermestes frischii* was seen only in the Erciyes cemetery land in April. *C.vicina* seen in the spring season increased in parallel with the air temperature.

When we look at the numerical distribution of the species seen in the study areas; 8 species were seen in Erkilet land, 16 species in Erciyes cemetery land, 8 species in T.C.D.D. and 9 species in 7th Regional Directorate of Meteorology (Table 13., Table 14., Table 15., Table 16.). The % distribution of the species in the spring season is given in Table 17. The most common species in all fields are *C. vicina* (74.51%), *L. sericata* (11.48%) and *F. canicularis* (11.43%).

Table 13. Insect species seen in the Erciyes cemetery land

Months	Spring										
	Food										
	Chicken meat					Bovine liver					
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
March	Diptera	Calliphoridae	Calliphora vicina	163	97.02	Diptera	Calliphoridae	Calliphora vicina	181	90.96
		Fanniidae	Fannia canicularis	5	2.98		Fanniidae	Fannia canicularis	18	9.04
			Total number of samples	168	100			Total number of samples	199	100
April		Calliphoridae	Calliphora	551	89.74		Calliphoridae	Calliphora vicina	847	85.82
			Lucilia sericata	58	9.45			Lucilia sericata	135	13.68
		Fanniidae	Fannia sp.	3	0.49		Fanniidae	Fannia canicularis	2	0.2
			Fannia canicularis	2	0.32	Coleoptera	Dermestidae	Dermestes frischii	3	0.3
			Total number of samples	614	100			Total number of samples	987	100
May		Calliphoridae	Calliphora vicina	665	81.6	Diptera	Calliphoridae	Calliphora vicina	513	73.81
			Lucilia sericata	115	14.11			Lucilia sericata	144	20.72
		Muscidae	Musca domestica	1	0.12		Muscidae	Thricops sp.	3	0.43
			Thricops sp.	1	0.12		Fanniidae	Fannia canicularis	1	0.14
		Fanniidae	Fannia canicularis	1	0.12			Fannia sp.	2	0.29
			Fannia sp.	5	0.61	Coleoptera	Dermestidae	Dermestes frischii	17	2.45
		Muscidae	Muscina stabulans	2	0.25			Dermestes undulatus	2	0.29
			Musca autummalis	3	0.37		Histeridae	Margarinotus brunneus	4	0.58
		Sarcophagidae	Sarcophaga argyrostoma	1	0.12			Saprinus subnitescens	4	0.58
	Coleoptera	Dermestidae	Dermestes frischii	14	1.72			Saprinus caerulescens	3	0.43
		Staphylinidae	Creophilus maxillosus	1	0.12			Saprinus vermiculatus	2	0.29
		Histeridae	Margarinotus brunneus	4	0.49					
			Saprinus subnitescens	1	0.12					
			Saprinus caerulescens	1	0.12					
			Saprinus vermiculatus	1	0.12					
			Total number of samples	815	100			Total number of samples	695	100

Table 14. Insect species seen in Erkilet land

Months	Spring		Food							
			Chicken meat				Bovine liver			
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
Macht	Diptera	Calliphoridae	Calliphora vicina	65	100	Diptera	Calliphoridae	Calliphora vicina	58	98.31
							Fanniidae	Fannia canicularis	1	1,69
			Total number of samples	65	100			Total number of samples	59	100
April		Calliphoridae	Calliphora vicina	170	91.4		Calliphoridae	Calliphora vicina	54	65.06
			Lucilia sericata	13	6.99			Lucilia sericata	19	22.89
		Fanniidae	Fannia canicularis	3	1.62		Fanniidae	Fannia canicularis	10	12.04
			Total number of samples	186	100			Total number of samples	83	100
May		Calliphoridae	Calliphora vicina	126	75.9		Calliphoridae	Calliphora vicina	135	68.88
			Lucilia sericata	32	19.27			Lucilia sericata	13	6.63
		Fanniidae	Fannia canicularis	1	0.6		Fanniidae	Fannia canicularis	39	19.9
		Muscidae	Thricops sp.	2	1.2		Muscidae	Thricops sp.	1	0.51
	Coleoptera	Dermestidae	Dermestes frischii	4	2.41	Coleoptera	Dermestidae	Dermestes frischii	5	2.55
		Staphylinidae	Creophilus maxillosus	1	0.6		Histeridae	Saprinus caerulescens	1	0.51
								Saprinus subnitescens	2	1.02
			Total number of samples	166	100			Total number of samples	196	100

Table 15. T.C.D.D. insect species in the field

Months	Spring		Food							
			Chicken meat				Bovine liver			
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
March	Diptera	Calliphoridae	Calliphora vicina	30	100	Diptera	Calliphoridae	Calliphora vicina	37	100
			Total number of samples	30	100			Total number of samples	37	100
April		Calliphoridae	Calliphora vicina	86	86.87		Calliphoridae	Calliphora vicina	318	77.75
			Lucilia sericata	6	6.06			Lucilia sericata	84	20.54
		Fanniidae	Fannia canicularis	7	7.07		Fanniidae	Fannia canicularis	7	1.71
			Total number of samples	99	100			Total number of samples	409	100
May		Calliphoridae	Calliphora vicina	103	70.55		Calliphoridae	Calliphora vicina	130	52
			Lucilia sericata	12	8.22			Lucilia sericata	78	31.2
		Fanniidae	Fannia canicularis	26	17.81		Fanniidae	Fannia canicularis	32	12.8
		Muscidae	Thricops sp.	1	0.68		Muscidae	Thricops sp.	6	2.4
	Coleoptera	Dermestidae	Dermestes frischii	2	1.37	Coleoptera	Dermestidae	Dermestes frischii	2	0.8
		Staphylinidae	Creophilus maxillosus	1	0.68			Dermestes undulatus	2	0.8
		Histeridae	Margarinotus brunneus	1	0.68					
			Total number of samples	146	100			Total number of samples	250	100

Table 16. Insect species seen on the land of the 7th Regional Directorate of Meteorology

Months	Spring		Food							
			Chicken meat				Bovine liver			
	Order	Family	species	species numbers	Percent %	Order	Family	species	species numbers	Percent %
March	Diptera	Calliphoridae	Calliphora vicina	17	89.47	Diptera	Calliphoridae	Calliphora vicina	48	100
		Fanniidae	Fannia canicularis	2	10.52					
			Total number of samples	19	100			Total number of samples	48	100
April		Calliphoridae	Calliphora vicina	135	88.82		Calliphoridae	Calliphora vicina	216	92.7
			Lucilia sericata	11	7.24			Lucilia sericata	16	6.87
		Fanniidae	Fannia canicularis	3	1.97		Fanniidae	Fannia canicularis	1	0.43
			Fannia sp.	3	1.97					
			Total number of samples	152	100			Total number of samples	233	100
May		Calliphoridae	Calliphora vicina	296	65.77		Calliphoridae	Calliphora vicina	102	69.87
			Lucilia sericata	37	8.22			Lucilia sericata	20	13.7
		Fanniidae	Fannia canicularis	95	21.11		Fanniidae	Fannia canicularis	18	12.33
			Fannia sp.	10	2.22		Dermestidae	Dermestes frischii	5	3.42
		Muscidae	Musca domestica	1	0.2		Histeridae	Saprinus vermiculatus	1	0.68
			Thricops sp.	6	1.33					
	Coleoptera	Dermestidae	Dermestes frischii	4	0.88					
		Histeridae	Saprinus subnitescens	1	0.2					
			Total number of samples	450	100			Total number of samples	146	100

Table 17. Insect species seen in 4 regions in the spring season

Order	Family	species	species numbers	Percent %
Diptera	Calliphoridae	Calliphora vicina	2933	74.51
		Lucilia sericata	452	11.48
	Fanniidae	Fannia canicularis	450	11.43
		Fannia sp.	15	0.38
	Muscidae	Thricops sp.	20	0.5
		Musca domestica	2	0.05
	Sarcophagidae	Sarcophaga argyrostoma	1	0.02
	Muscidae	Muscina stabulans	2	0.05
		Musca autumnalis	3	0.07
Coleoptera	Dermestidae	Dermestes frischii	34	0.86
		Dermestes undulatus	2	0.05
	Histeridae	Margarinotus brunneus	8	0.2
		Saprinus vermiculatus	4	0.1
		Saprinus caerulescens	4	0.1
		Saprinus subnitescens	5	0.12
	Staphylinidae	Creophilus maxillosus	1	0.02
		Total number of samples	3936	100

3.6. Average Temperature/Humidity Values of Spring Season

In March, the average temperature is 5.6°C and the humidity is 59.3% on average; In April, the average temperature is 9.2°C and the humidity is 66.3% on average; In May, the average temperature was 17.3°C and the humidity was 50.2% on average (Figure 1.).

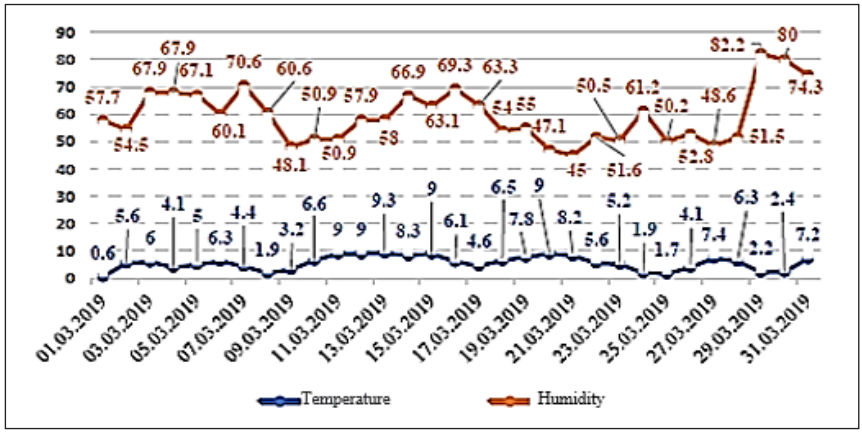

Figure 8. Daily temperature and humidity values of March

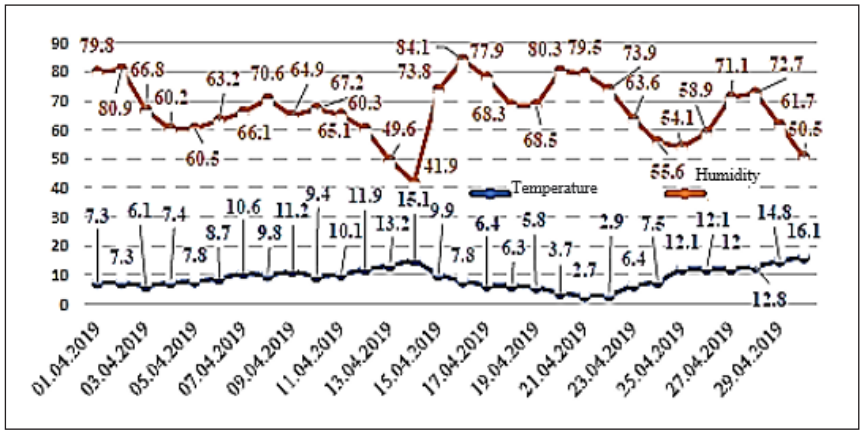

Figure 9. Daily temperature and humidity values of April

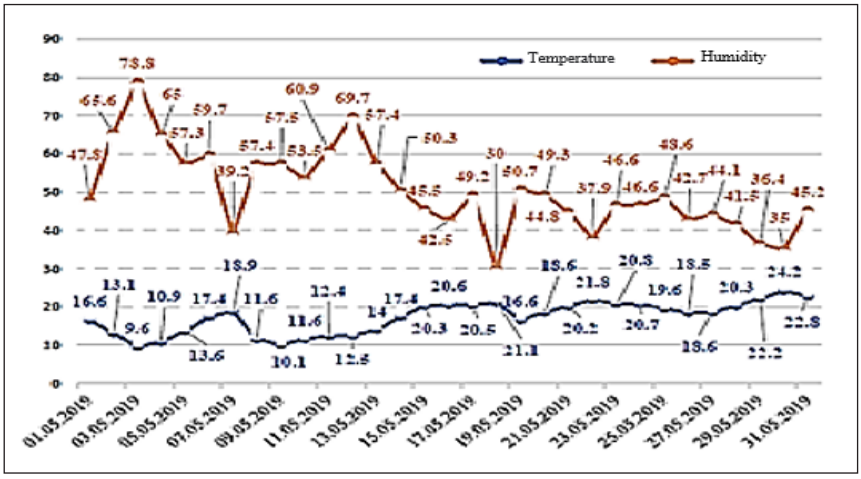

Figure 10. Daily temperature and humidity values of May

When our study is evaluated in terms of incoming species and land; it was observed that the least number of species (Single species, *C. vicina*) was in the winter season (December., January., February), and the highest number of species (16 species) was in the spring. (March., April., May.) (Table 18). The land with the highest number of species is the Erciyes cemetery land. When evaluated in terms of the food used in the traps, although it changes according to the season and the terrain, almost similar numbers of species were caught.

Table 18. Distribution of insect species seen in the study areas by months

Months	Order	Family	species	Order	Family	species
September	Diptera	Calliphoridae	Chrysomya albiceps Calliphora vicina Lucilia sericata Lucilia caesar			
		Sarcophagidae	Sarcophaga sp. Sarcophaga argyrostoma			
		Muscidae	Muscina stabulans Musca autumnalis			
October	Diptera	Calliphoridae	Calliphora vicina Lucilia sericata			
November	Diptera	Calliphoridae	Calliphora vicina Lucilia sericata Calliphora vomitoria			
		Muscidae	Muscina stabulans			
December January February	Diptera	Calliphoridae	Calliphora vicina			

March	Diptera	Calliphoridae	Calliphora vicina			
		Fanniidae	Fannia canicularis			
April	Diptera	Calliphoridae	Calliphora vicina Lucilia sericata			
		Fanniidae	Fannia canicularis Fannia sp.			
	Coleoptera	Dermestidae	Dermestes frischii			
May	Diptera	Calliphoridae	Calliphora vicina Lucilia sericata	Coleoptera	Histeridae	Saprinus vermiculatus Saprinus subnitescens Saprinus caerulescens Margarinotus brunneus
		Fanniidae	Fannia canicularis Fannia sp.			
		Muscidae	Musca autumnalis Muscina stabulans Musca domestica Thricops sp.		Dermestidae	Dermestes frischii Dermestes undulatus
					Staphylinidae	Creophilus maxillosus
		Sarcophagidae	Sarcophaga argyrostoma			

4. CONCLUSION

The fact that *C. vicina* can be seen in all lands from September to the end of May, it can be caught in the traps in a very short time and can live in different geographical areas can be used to determine the time of death in Kayseri in Autumn, Winter and Spring seasons.

L. sericata can be seen in all fields from September to the end of November, from April to the end of May, not seen in December-January-February and March, and can be used to determine the time of death in Kayseri in Autumn and Spring seasons.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethics

This study does not require ethics committee approval

Author Contribution Rates

Design of Study: AD(%100)

Data Acquisition: AD(%100)

Data Analysis: AD(%100)

Writing up: AD(%100)

Submission and Revision: AD(%100)

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