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RESEARCH PAPER

Diversity of lacewing assemblages (Neuropterida: Neuroptera) in different forest habitats and agricultural areas in the East Mediterranean area of Turkey

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Abstract

The objectives of this study were to understand lacewing diversity patterns and the role of environmental factors in determining lacewing diversity in four habitat types: agricultural area (crops and orchards), pine forest (*Pinus nigra* Arnold and, *Pinus brutia* Ten), natural forest (cedar and willow-oak), and mixed forest (beech and oak). Several diversity patterns were evaluated, including evenness and dominance, in the East Mediterranean area of Turkey by analyzing the abundance and species composition of lacewing assemblages using the Simpson and Shannon Diversity Indices. It was questioned whether these communities are structured according to environmental conditions such as altitude, temperature, rainfall, wind and humidity. This question was explored using generalized linear models (GLMs) and principal component analysis (PCA) to detect the effect of ecological parameters on the species composition of the lacewing assemblages. The data suggest that the species abundance, composition, and diversity of lacewings are affected by different forest and agricultural habitat types. Based on the results of the present study, it is recommended that the area of farmland under cultivation is decreased and the area of sustainably managed forest and agricultural land is increased in order to better protect lacewing diversity in the East Mediterranean area of Turkey.

Key words: abundance, diversity, East Mediterranean Area, habitat type, lacewings, species composition

Introduction

Forests are accepted as the most diverse ecosystems on earth (Lindenmayer *et al*. 2006). A large number of communities can be established in different forests depending on biotic factors, such as forest type, and abiotic elements, such as altitude, moisture, temperature, and wind (Duelli *et al*. 2002; Ševčík 2010; Wichard *et al*. 2016; Zelený 2008).

The East Mediterranean area (EMA) of Turkey is a suitable area for agricultural production in terms of soil and climate characteristics (Karacaoğlu & Satar 2017; Candemir & Kızılaslan 2019) and it has 57 widespread agricultural lands including organic farming (Figures 1–12).

Lacewings, especially green ones (Neuroptera: Chrysopidae), are of interest to a large group of entomologists because of their role as predators of pest insects, such as aphids, whiteflies, and scale insects, and their use in biological control (Brooks & Barnard 1990; Delisle *et al*. 2018). Their larvae are generally predators and some families are widely distributed in both natural and semi-natural ecosystems worldwide. Green and brown lacewings have attracted remarkable attention as biological control agents for the potential control of several soft-bodied arthropod pests in field and orchard crops (Deutsch *et al*. 2005; Moussa *et al*. 2018; Soares & Carvalho 2018; Stelzl & Devetak 1999).

The most common lacewing species are found on various deciduous trees and shrubs and occasionally on conifers in forests and forest-steppes. In Switzerland, windthrow and wildfires have been found to enhance biodiversity in various taxa, including most Neuroptera in Swiss forests (Aspöck *et al*. 1980; Duelli *et al*. 2019).

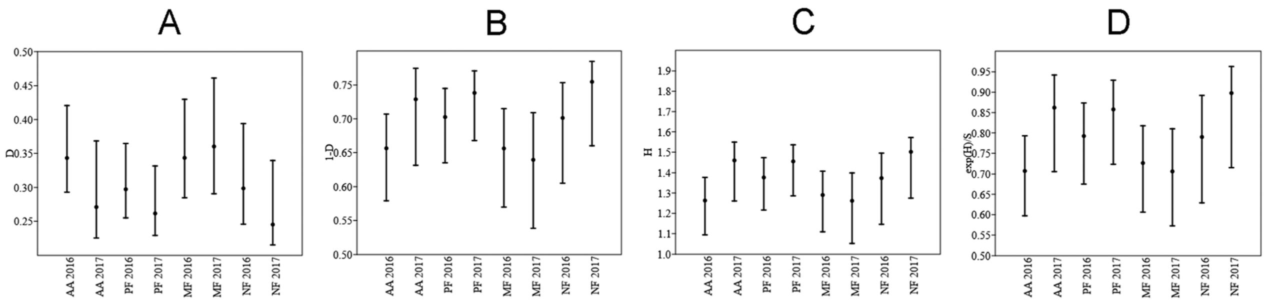

Figure 1 Dominance, Simpson Index, Shannon Index and evenness of lacewing assemblages of Ascalaphinae (Myrmeleontidae) collected in the East Mediterranean area of Turkey.

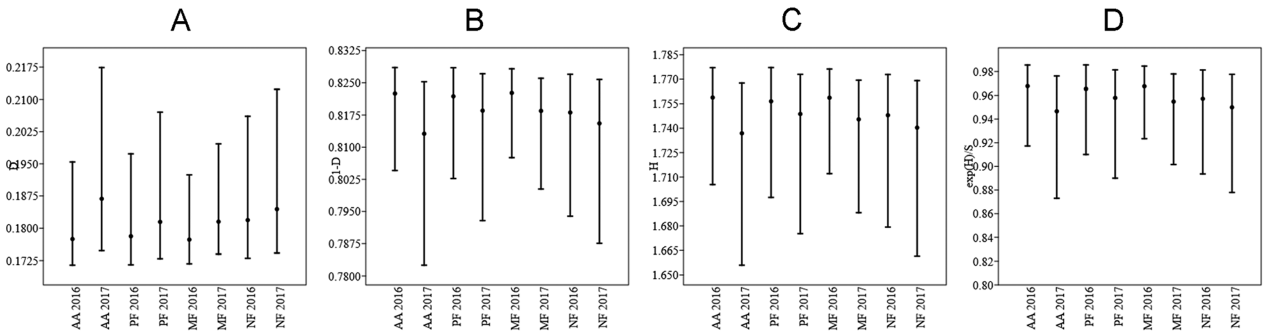

Figure 2 Dominance, Simpson Index, Shannon Index and evenness of lacewing assemblages of Chrysopidae collected in the East Mediterranean area of Turkey.

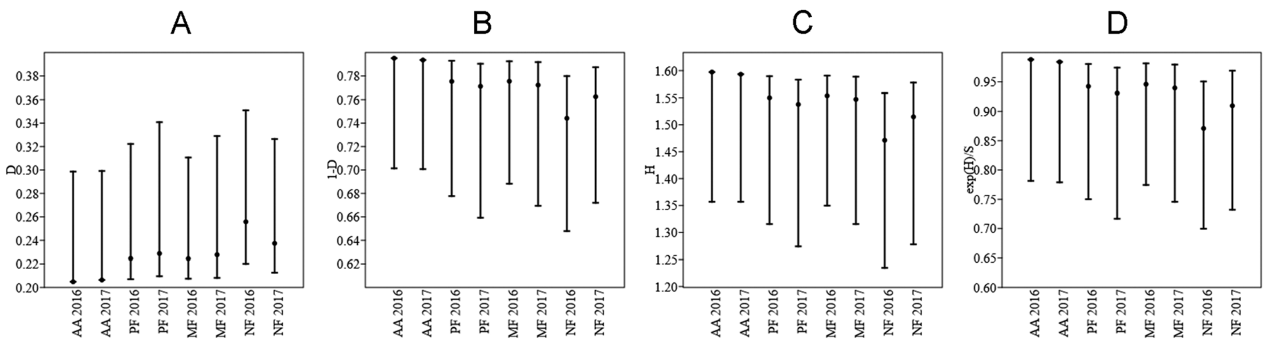

Figure 3 Dominance, Simpson Index, Shannon Index and evenness of lacewing assemblages of Coniopterygidae collected in the East Mediterranean area of Turkey.

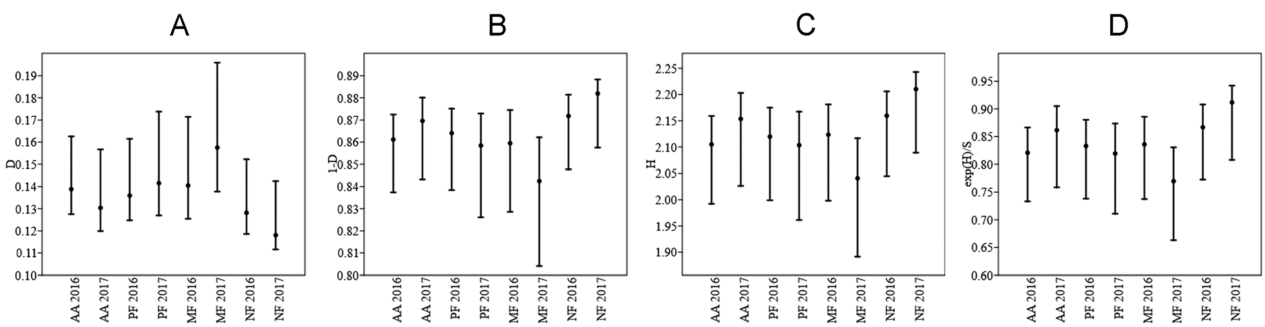

Figure 4 Dominance, Simpson Index, Shannon Index and evenness of lacewing assemblages of Myrmeleontidae (except Ascalaphinae) collected in the East Mediterranean area of Turkey.

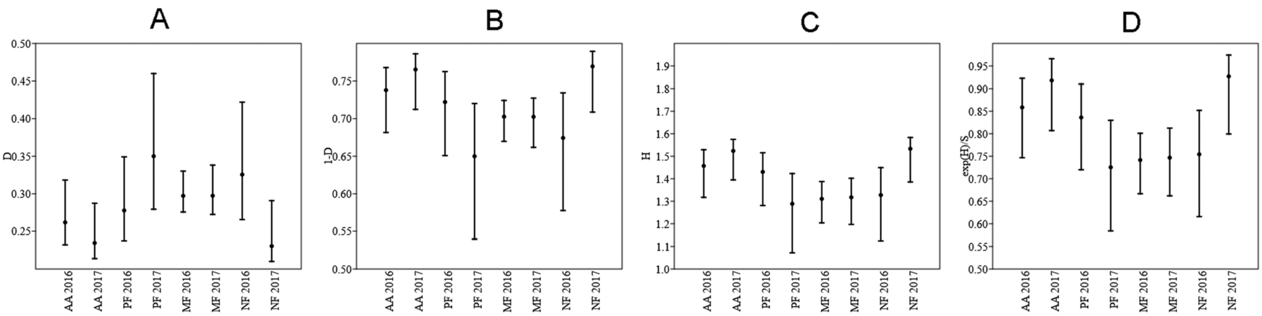

Figure 5 Dominance, Simpson Index, Shannon Index and evenness of lacewing assemblages of Nemopteridae collected in the East Mediterranean area of Turkey.

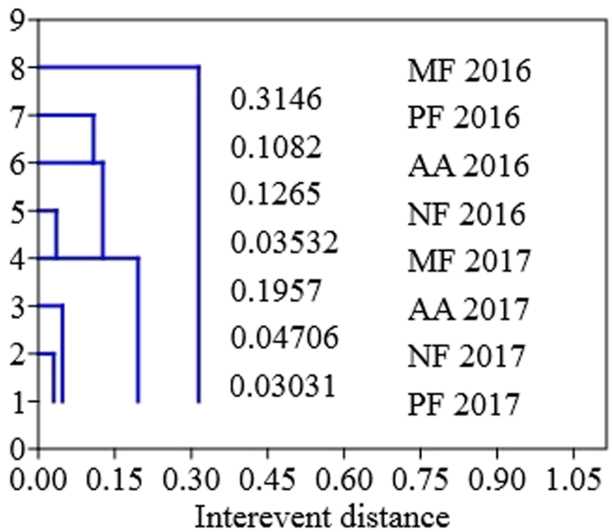

Figure 6 Dendrogram based on cluster analysis using the Bray–Curtis percentage similarity of the lacewings in the four different habitat types.

Neuroptera is a predominantly terrestrial insect order with about 6000 described species in 15 families (Oswald 2019). Lacewing communities are excellent models to research the effect of environmental heterogeneity on species diversity and habitat composition (Stelzl & Devetak 1999). Many lacewing species have been used intensively as several biological control agents in orchards and gardens. Despite its importance, the ecological and seasonal composition of the lacewing in forests and agricultural sites in the EMA of Turkey remain mostly unknown (Zelený 2008).

Many species belonging to Chrysopidae and Ascalaphinae (Myrmeleontidae) depend on external thermal conditions, such as wind speed and temperature, to maintain viable populations, and these variables are the best predictors of species richness and abundances of lacewings (Chen *et al.* 2017; Stelzl & Devetak 1999). Climate characteristics are also important for the Hemerobiidae, *Sympherobius pygmaeus* (Rambur 1842). It can complete its development in the winter of the Mediterranean Region since the lowest mean

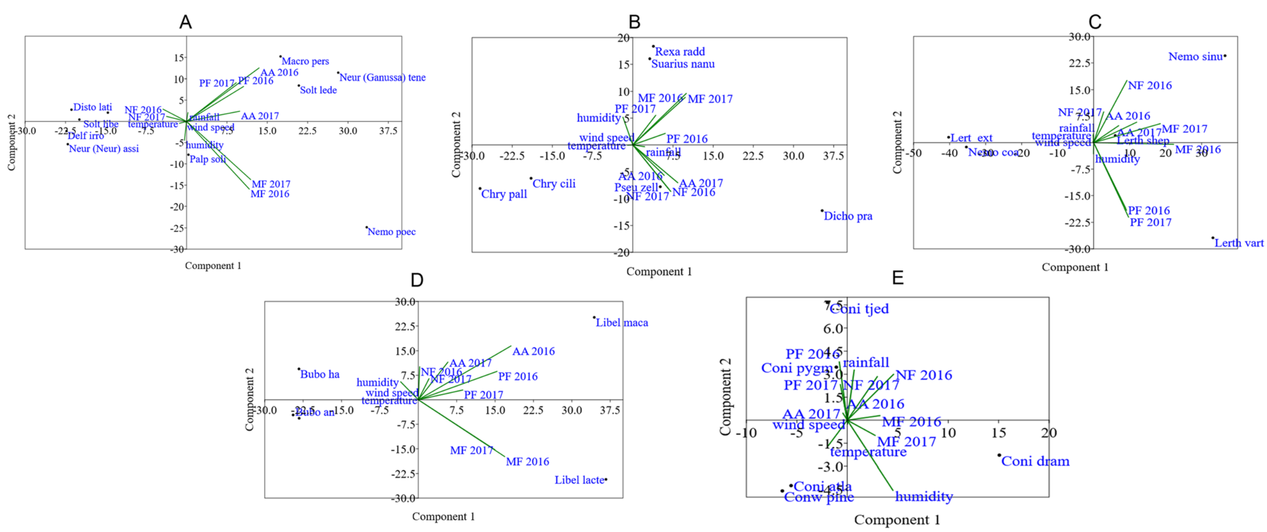

Figure 7 Principal component analysis of all Families.

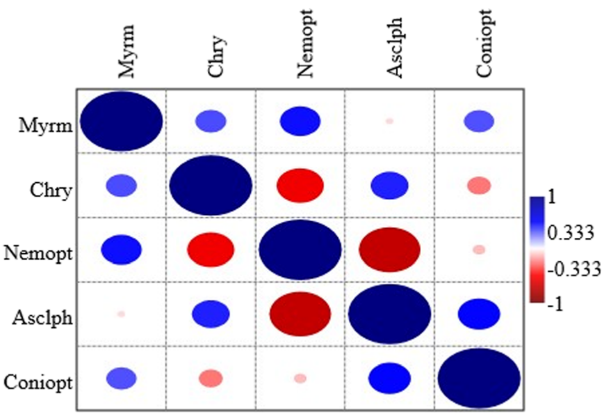

Figure 8 The Spearsman's rank correlation between measured environmental variables and lacewing families of the East Mediterranean area of Turkey. Asclph, Ascalaphinae (Myrmeleontidae); Chry, Chrysopidae; Coniopt, Coniopterygidae; Myrm, Myrmeleontidae except Ascalaphinae; Nemopt, Nemopteridae.

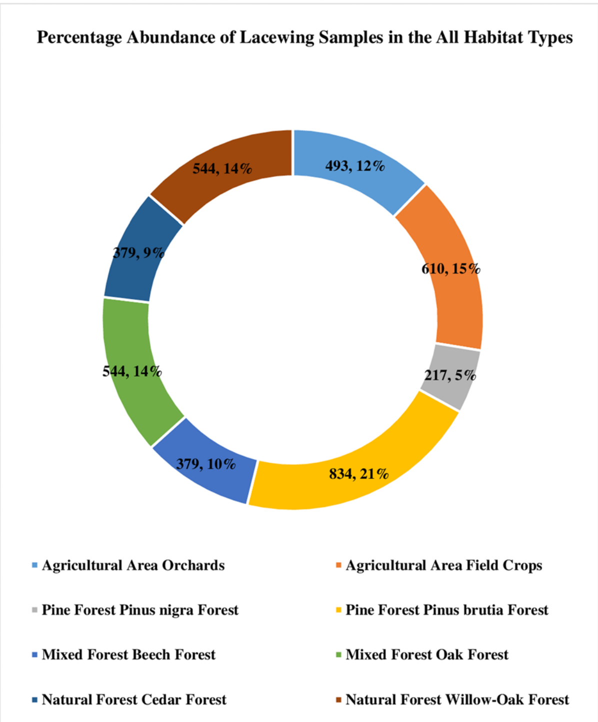

Figure 9 Percentage abundance distribution of the total specimens of the lacewings in the eight different habitat subtypes.

temperatures for December, January and February are 14.3, 12.8 and 15.2°C, respectively (Yayla & Satar 2012). Bioecological studies on lacewing assemblages have been carried out in many locations in Europe. However, there is still much to be learned about these predator insects in order to widely use them in all of the agricultural and forestry areas in Europe. The composition and characteristics of lacewing assemblages are determined by their species of prey, their abundance, microclimate and host plant structure. Therefore, a detailed assessment of biological diversity is necessary to improve our understanding of the composition and density of lacewings.

This study is the first in the EMA of Turkey to reveal ecological patterns of diversity and species composition of lacewings and compare elevational and spatial dimensions of species diversity by using standardized sampling procedures. The study aims to evaluate the response of lacewing assemblages to different ecological parameters in four habitat types in the EMA in Turkey: agricultural area (crops and orchards), pine forest (*Pinus nigra* Arnold and, *Pinus brutia* Ten), natural forest (cedar and willow-oak), and mixed forest (beech and oak).

Materials and methods

To examine the specimen's terminalia and genitalia, the last abdominal segments were cut from the abdomen and treated with a cold 5% potassium hydroxide solution to facilitate examination and dissection. The segments were then rinsed in distilled water and stored in glycerine in a microvial for further examination and preservation.

Study area

The EMA is one of the key biodiversity areas in Turkey. It reaches from the southern tip of the Eastern Black Sea Mountains to the southern end of the Anatolian diagonal with more than 1600 taxa, of which 251 are endemic (Gür 2017). The EMA is also characterized by high habitat heterogeneity and high floristic and faunistic richness. The area has more than 800 species of plants with a high endemism rate (Bozdoğan & Satar 2018; Durmaz & Hüseyinoğlu 2016; Güzelmansur & Lise 2013).

The Eastern Mediterranean mountain ranges, which are called the Anatolian diagonal, provide a route by which floristic elements originating from the north can migrate to the area. These mountains considerably increase the number of plants and animal species in the EMA.

Data collection

The investigations were conducted in the forest habitat and agricultural lands of the EMA of Turkey. Four sampling sites in four different habitats with eight different sub habitats were established. Samples were collected from one agricultural area (AA) with orchards and field crops and three forest habitat types: pine forests (PF), mixed forest (MF) and natural forest (NF). The pine forest included *Pinus nigra* Arnold and *Pinus*

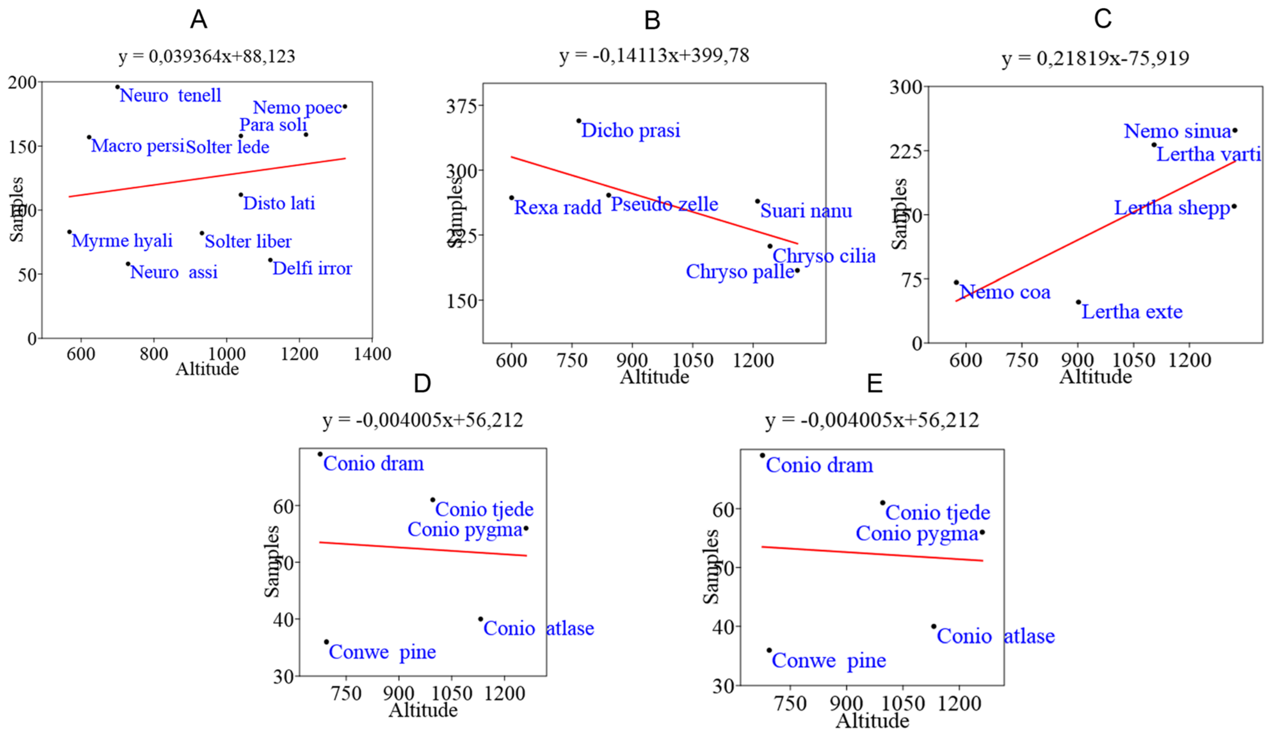

Figure 10 Generalized linear model (GLM) for all the families collected in the East Mediterranean area of Turkey. P = 0.602, slope = 0.034, intercept = 91.9, dispersion phi = 2813.2.

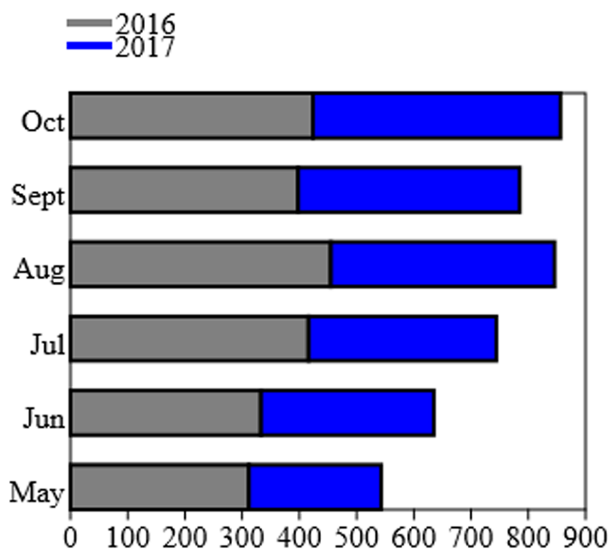

Figure 11 Abundance of lacewings (Neuroptera: Neuropterida) of the East Mediterranean area of Turkey according to the months May–October of 2016–2017.

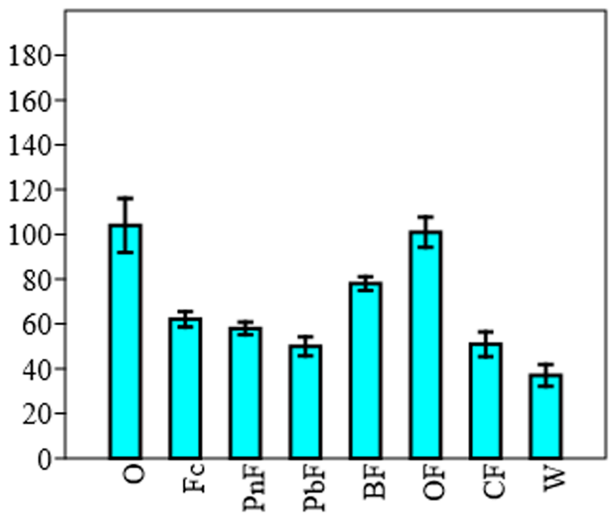

Figure 12 The average number of lacewings specimens collected in the eight different habitat subtypes the East Mediterranean area of Turkey.

brutia Ten. The natural forest included cedar and willow-oak forests and the mixed forest included beech, and oak forests (Table 1).

Mediterranean mountain belt forests consist of cedar and larch in places with altitudes of more than 1000 m. Some areas in the EMA have been designated as national parks because of the cedar forests that occur there.

The EMA is also the southernmost distribution of eastern beech, *Fagus orientalis*. In addition, *Quercus laevis* (*Quercus cerris* var. *cerris* L.) high forest is widespread at altitudes of

Table 1 Climatic and environmental variables in the four studied areas in the East Mediterranean area of Turkey in 2016–2017

Habitat type		Altitude grade (m)	Mean rainfall (mm)	Mean temperature (°C)	Mean wind speed (km/h)	Mean humidity (%)
		2016–2017	2016–2017	2016–2017	2016–2017	2016–2017
Agricultural area	Orchards	500–800	5.7	25.5	2.2	56
	Field crops	400–600	6.4	26.8	2.9	59
Pine forest	*Pinus nigra* forest	1000–1400	12.7	29	4.1	61
	Pinus brutia forest	400–800	6.6	27.4	2.3	54
Mixed forest	Beech forest	1250–1400	7.3	26.2	2.8	70
	Oak forest	800–1000	6.4	28.3	3.3	62
Natural forest	Cedar forest	1100–1400	9.1	25.1	4.1	55
	Willow-Oak forest	900–1350	5.3	27.8	1.8	56

600–900 m and rarely reaches up to 1800 m. In Turkey, because of the ecotones that are present, old-growth forests are very rare and very important ecologically (Aytaç & Semenderoğlu 2012; Güzelmansur & Lise 2013).

The main criterion for choosing the areas studied was the degree of internal and surrounding disturbance of the forest. Studying these areas enabled the examination of a variety of habitats and environmental conditions.

Sampling was carried out along 50 m transects using insect sweep-nets with a diameter 30 cm, and light traps. Surveys were conducted during the main activity period of adult lacewings. Four sampling periods of three hours each were carried out in each transect, randomizing sampling from 6 a.m. to 6 p.m. with four people, totaling 144 h of sampling from May 2016 to the end of October 2017.

Prior to the fieldwork, the occurrence of species belonging to lacewing assemblages was mapped in order to locate study sites with sufficiently high abundances. Obtained data included the date, site, color and sex morphology. Temperature measurements were obtained using a digital thermometer (Raytek MiniTemp). Relative humidity was measured using a digital thermohygrometer (Lutron HAT 3004) 1 cm above the ground. For analyzing the suitability of different habitat types for lacewings, the survey sites were chosen to the following habitat types: altitude, mean wind speed, humidity and temperature and rainfall (Table 1).

Specimens were preserved in ethanol and deposited at Kırşehir Ahi Evran University where they were sorted and preserved in 70%–90% ethanol after their identification using standard taxonomic references including identification keys and photographs of genitalia (Abrahám & Mészáros 2002; Hölzel 1965, 1967a, b; Meinander 1972; Mészáros & Abrahám 2002). The taxonomic methods and classification that were used are detailed in Aspöck *et al*. (1980) and Aspöck *et al*. (2001), and the zoogeographical categorization of neuropteran fauna of the Balkan Peninsula proposed by Popov and Letardi (2010) was followed.

Data analysis

To analyze the effect of different habitat types on lacewing assemblages PAST Software 3.20 was used. In the software, habitat type was included as an explanatory variable and the vegetation data as a response variable. Non-metric multidimensional scaling (n-MDS) was conducted and a dendrogram, based on Bray–Curtis dissimilarities, was used, to plot and test differences in assemblage composition of Myrmeleontidae: Ascalaphinae, Chrysopidae, Coniopterygidae, Myrmeleontidae (except Ascalaphinae), and Nemopteridae to test whether geographical distance affected species composition. The subfamily Ascalaphinae (Myrmeleontidae) was analyzed as a separate taxon from the other three subfamilies of Myrmeleontidae, since it was included in Myrmeleontidae recently (Machado *et al*. 2019).

Several diversity patterns were also evaluated, including evenness and dominance, in the EMA of Turkey by analyzing lacewing assemblages considering abundance and species composition using the Simpson and Shannon Diversity Indices, and it was asked whether these communities are structured according to environmental conditions. This was explored using generalized linear models (GLMs) and principal component analysis (PCA) to detect the effect of ecological parameters on the species composition of the lacewing assemblages. Spearman's rank correlation was used to identify the relationship between the parameters of environmental conditions and the lacewing families, and GLMs were used to reveal the relationship between the number of lacewings and altitude of the specimens that belong to five lacewing families.

Results

A total of 4409 individuals belonging to 31 lacewing species were collected (Table 2). Ten species were from Myrmeleontidae, six species were from Chrysopidae and one species was from each of the families Nemopteridae, Ascalaphinae, and Coniopterygidae.

There were significant differences among the abundance of lacewing assemblages in all the habitat types. The Chrysopidae were the most abundant (N = 1540), followed by Myrmeleontidae (N = 1240), Nemopteridae (N = 766), and Ascalaphinae (N = 600). The Shannon index was the lowest in the Nemopteridae, and evenness was highest in Chrysopidae (Fig. 1, Fig. 3).

The dendrogram plot (Fig. 6) shows that MF 2016 and PF 2016 had a high percentage similarity (31.46%) and the second-highest percentage similarity (12.0%) was between AA 2016 and MF 2017. The similarities of MF 2017-NF 2016 and AA 2017-NF 2017 were 0.47% and 3.5% respectively. Other values were below 15% similarity in terms of species composition and distribution pattern.

The PCA ordination diagram of the lacewing family communities at the eight sampling sites is represented in Figures 10a-e. Assessment of the lacewing distribution data

Table 2 Lacewings collected in four different habitats of the East Mediterranean area of Turkey. Agricultural area (AA), pine forest (PF), mixed forest (MF), natural forest (NF)

Taxa	Habitats								
	AA 2016	AA 2017	PF 2016	PF 2017	MF 2016	MF 2017	NF 2016	NF 2017	Total
Ascalaphinae (Myrmeleontidae)									
Bubopsis andromache U. Aspöck & H. Aspöck & Hölzel, 1979	4	7	11	9	9	8	4	5	**57**
Bubopsis hamatus (Klug, 1834)	13	10	9	5	5	6	22	10	**80**
Libelloides lacteus (Brullé, 1832)	28	10	29	20	50	44	6	6	**193**
Libelloides macaronius (Scopoli, 1763)	50	27	42	26	23	19	15	14	**216**
Libelloides rhomboideus rhomboideus (Schneider, 1845)	6	8	7	10	10	5	4	4	**54**
Chrysopidae									
Chrysopa pallens (Rambur, 1838)	40	18	20	18	27	22	20	16	**181**
Chrysopidia (*Chrysotropia*) *ciliata* (Wesmael, 1841)	21	20	26	20	34	26	30	27	**204**
Dichochrysa prasinus (Burmeister, 1839)	51	44	37	28	56	50	46	41	**353**
Pseudomallada zelleri (Schneider, 1851)	36	30	41	33	39	34	33	30	**276**
Rexa raddai (Hölzel, 1966)	33	23	42	41	49	44	20	18	**270**
Suarius nanus (McLachlan, 1839)	32	20	26	22	56	51	27	22	**256**
Coniopterygidae									
Coniopteryx (*Coniopteryx*) *pygmaea* Enderlein, 1906	5	6	8	8	8	7	8	7	**57**
Coniopteryx (*Holoconiopteryx*) *drammonti* Rousset, 1964	4	4	4	3	14	12	16	12	**69**
Coniopteryx (*Metaconiopteryx*) *tjederi* Kimmins, 1934	6	5	10	6	8	5	11	10	**61**
Coniopteryx (*Xeroconiopteryx*)*atlasensis* Meinander, 1963	5	6	5	3	6	6	4	4	**39**
Conwentzia pineticola Enderlein, 1905	4	4	5	5	6	5	4	4	**37**
Myrmeleontidae (except Ascalaphinae)									
Delfimeus irroratus (Olivier, 1811)	5	6	7	8	7	5	12	10	**60**
Distoleon laticollis (Navás, 1913)	9	8	17	13	10	10	26	22	**115**
Macronemurus persicus (Navás, 1915)	40	29	20	17	15	13	11	10	**155**
Myrmeleon hyalinus distinguendus Rambur, 1842	12	10	6	5	8	4	22	17	**84**
Neuroleon (*Ganussa*) *tenellus* (Klug, 1834)	37	22	32	30	23	22	17	12	**195**
Neuroleon (*Neuroleon*) *assimilis* (Navás, 1915)	5	6	6	5	11	4	9	10	**56**
Nemoleon poecilopterus (Stein, 1863)	25	27	19	15	44	40	4	6	**180**
Parapalpares solidus Gerstaecker, 1894	18	12	16	10	26	21	33	20	**156**
Solter ledereri Navás, 1912	27	20	31	27	21	17	8	5	**156**
Solter liber Navás, 1912	14	10	5	4	8	6	20	16	**83**
Nemopteridae									
Lertha sheppardi (Kirby, 1904)	17	15	19	14	36	30	17	15	**163**
Lertha vartianae H. Aspöck & U. Aspöck & Hölzel, 1984	29	20	42	40	49	37	10	9	**236**
Lertha extensa (Olivier, 1811)	9	8	6	4	4	5	5	7	**48**
Nemoptera coa (Linnaeus, 1758)	10	12	14	6	6	4	5	14	**71**
Nemoptera sinuata Olivier, 1811	39	28	16	11	50	46	36	22	**248**

alone showed that there were significant differences between the sampling sites. *Parapalpares solidus* Gerstaecker, 1894 was associated with low, rainfall and humidity but *Pseudomallada prasinus* (Burmeister 1839), *Bubopsis hamatus* (Klug 1834), *Bubopsis andromache* U. Aspöck & H. Aspöck & Hölzel, 1979 and *Libelloides rhomboideus rhomboideus* (Schneider 1845) were associated with temperature, more than *Libelloides macaronius*.

The PCA showed a higher variance in the Nemopteridae (78.04%) and Ascalaphinae (71.64%).

The results of the Spearman's rank correlation showed that there is a close correlation between the Ascalaphinae and Nemopteridae (Fig. 8).

The GLM showed that the number of specimens increased with altitude in Myrmeleontidae and Nemopteridae, whereas it declined in Ascalaphinae, Chrysopidae and Coniopterygidae (Figs. 10a-e).

Figure 4 indicates that the Shannon diversity index of Myrmeleontidae was the highest in NF 2017. Data presented in Figure 2 indicated that the Shannon diversity index was higher in 2016 than in 2017 for the Chrysopidae in all the habitat types. The reason for this could be that the ecological parameters may be more favorable for the species belonging to Chrysopidae in 2016.

Pinus brutia forest sites (PbForest, 21%) have suitable communities with high abundance and widespread samples, but the other *P. nigra* forest sites (PnForest, 5%) were observed to have the lowest abundance of lacewing (Fig. 9). The phenology of the lacewings varies in EMA, Turkey. There was a difference in May and July during 2016 and 2017 (Fig. 11).

The average number of lacewings collected specimens in the eight different habitat subtypes of the East Mediterranean area of Turkey is shown in Figure 12.

Discussion

This work emphasizes some subjects surrounding the environmental and climatic changes that are likely to influence lacewings communities and populations. Different habitat conditions are one of the major factors affecting species diversity and abundance in a region (Vidlička & Holuša 2007). This paper indicates the differences in community composition of lacewings among four different areas of study in the EMA. Considering a wider perspective that includes more habitat types provide more information and a better understanding and it could also be a challenge for future studies.

Pine forests, mixed forest and natural forests represent forest habitat types in this study, and the lacewings community structure therein presented a certain degree of similarity, which is similar to other studies (Duelli *et al.* 2002). Natural forests and mixed forest represented a forest habitat type, and the community structure in the Nemopteridae was divergent from that of pine forest habitats. While *Nemoptera sinuata* had a close affiliation with MF and NF, *Libelloides* varied with PF.

The study also shows that ecological parameters directly affect and change biodiversity and community structure in the Ascalaphinae and Nemopteridae, which has also been previously found (Güsten 2002; Kuras & Mazalová 2018; Popov 2002). On the other hand, even though the two species *Coniopteryx atlasensis* Meinander, 1963 and *Coniopteryx drammonti* Rousset 1964 from the family Coniopterygidae belong to the same genus they fall on different axes in the PCA plot (Fig. 7e). We have observed that ecological factors play a crucial role in the life history of lacewings. Our specimens sampling was planned to evaluate whether there is an influence of altitude on species abundance.

Pseudomallada zelleri were more abundant (Neuroptera: Chrysopidae) and diverse than other species (Fig. 7b), presumably because the species may have adapted to the environmental change and further adapted to the different habitat changes (Canard 2005; Duelli *et al*. 2017).

No consistent releationship was found between altitude and the number of specimens. For example, species belonging to Ascalaphinae, Chrysopidae and Coniopterygidae declined in abundance with altitude (Figs. 10 b,d,e). Due to the lack of resources for lacewings in the orchards and oak forests, it is very probable that most of the lacewings found in the willow-oak forests are really local residents. Willow-oak forest was found to have the lowest average number of collected specimens of the eight different habitat subtypes (Fig. 12).

This study provides new information on lacewing distribution in a little-known region that is considered to be of high biodiversity interest. The data provided herein will be useful for future studies on the ecology, environment and conservation biology of lacewings from this ecologically important area. Additional studies on habitat changes and loss are necessary to estimate their ecological importance.

Conclusion

This study concludes that the population of lacewings is affected by environmental factors and habitat types as results indicate that the highest sample population was observed in *Pinus brutia* forest (21%) followed by field crops (15%) while the lowest population index was observed in *P. nigra* forest (5%). In addition to the study of lacewing assemblage patterns in the EMA, we hope our data will stimulate further research to elucidate the relationship between the lacewing populations and habitat types in this area as well as to initiate appropriate conservation measures to be taken. There is a possibility that lacewings that are specialized to host plant taxa common in forest would achieve higher success and diversity in undisturbed areas (Güzelmansur & Lise 2013; Çelik & Gülersoy 2017). Therefore, the conservation of forest areas is a priority. In addition, more long-term and periodic surveys could provide new records of lacewing species, and additional efforts should be carried out to obtain more new data about the spatiotemporal distribution of lacewings species in the EMA to better understand endemic, rare or endangered species requiring conservation.

Conflict of interest

The author has no conflict of interest.

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Appendix 1

List of lacewings collected in the East Mediterranean area of Turkey over the course of the year 2016–2017.

Taxa	May		June		July		August		September		October	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Ascalaphinae (Myrmeleontidae)												
Bubopsis andromache U. Aspöck & H. Aspöck & Hölzel, 1979	3	3	5	5	5	4	6	5	5	6	4	3
Bubopsis hamatus (Klug, 1834)	9	5	5	6	8	7	5	11	8	6	4	6
Libelloides lacteus (Brullé, 1832)	7	6	10	6	18	6	24	20	26	21	27	22
Libelloides macaronius (Scopoli, 1763)	7	6	12	7	18	6	25	26	26	23	27	33
Libelloides rhomboideus rhomboideus (Schneider, 1845)	4	5	3	6	3	5	6	6	5	5	5	4
Chrysopidae												
Chrysopa pallens (Rambur, 1838)	18	8	16	13	10	5	13	7	30	30	22	9
Chrysopidia (*Chrysotropia*) *ciliata* (Wesmael, 1841)	5	3	9	5	27	10	39	24	22	17	22	21
Dichochrysa prasinus (Burmeister, 1839)	20	5	52	30	50	33	40	20	20	14	29	40
Pseudomallada zelleri (Schneider, 1851)	21	31	24	17	36	26	20	16	16	14	22	33
Rexa raddai (Hölzel, 1966)	8	5	10	28	28	24	27	37	14	39	19	31
Suarius nanus (McLachlan, 1839)	16	14	17	14	14	17	40	22	33	27	12	30
Coniopterygidae												
Coniopteryx (coniopteryx) pygmaea Enderlein, 1906	4	5	3	3	3	5	6	6	6	7	5	4
Coniopteryx (*Holoconiopteryx*) *drammonti* Rousset, 1964	4	5	3	3	3	5	8	6	11	12	5	4
Coniopteryx (*Metaconiopteryx*) *tjederi* Kimmins, 1934	3	3	3	3	3	3	3	5	4	3	3	3
Coniopteryx (*Xeroconiopteryx*)*atlasensis* Meinander, 1963	3	3	3	3	3	3	3	3	4	3	3	3
Conwentzia pineticola Enderlein, 1905	4	6	6	4	6	3	4	6	6	5	8	3
Myrmeleontidae (except Ascalaphinae)												
Delfimeus irroratus (Olivier, 1811)	2	3	5	4	5	4	8	8	7	6	4	4
Distoleon laticollis (Navás, 1913)	7	5	11	10	10	6	16	12	12	10	11	5
Macronemurus persicus (Navás, 1915)	15	12	25	10	14	6	26	17	6	17	2	5
Myrmeleon hyalinus distinguendus Rambur, 1842	14	7	3	2	4	6	8	5	8	6	9	12
Neuroleon (*Ganussa*) *tenellus* (Klug, 1834)	10	9	30	24	17	14	19	22	15	13	12	10
Neuroleon (*Neuroleon*) *assimilis* (Navás, 1914)	6	9	4	4	5	5	5	6	3	4	2	3
Nemoleon poecilopterus (Stein, 1863)	25	14	8	20	28	6	17	17	9	8	9	19
Parapalpares solidus (Gerstaecker, 1894)	8	7	18	11	20	18	16	6	22	20	5	5
Solter ledereri Navás, 1912	30	16	11	12	6	27	6	7	7	15	10	9
Solter liber Navás, 1912	10	8	5	3	12	4	7	6	14	7	2	5
Nemopteridae												
Lertha sheppardi (Kirby, 1904)	11	6	8	12	14	20	14	20	8	19	21	10
Lertha vartianae H. Aspöck &U. Aspöck & Hölzel, 1984	4	3	8	8	29	17	22	27	22	18	66	24
Lertha extensa (Olivier, 1811)	23	7	6	20	8	26	9	7	21	4	44	61
Nemoptera coa (Linnaeus, 1758)	7	4	4	3	4	3	4	3	3	4	5	4
Nemoptera sinuata Olivier, 1811	4	8	6	6	5	4	9	8	5	4	5	7
Total	**312**	**231**	**333**	**302**	**416**	**328**	**455**	**391**	**398**	**387**	**424**	**432**