North-Western Journal of Zoology
P-ISSN: 1584-9074, E-ISSN: 1843-5629

Vol. 5, No. 1, 2009, pp.104-120
Article No.: 051112

Some aspects of the moth (Lepidoptera, Heterocera) species diversity in Western Black Sea Region of Turkey

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Abstract. The moth species were investigated in the four distinct types of habitat — coniferous, beech, oak forests and shrubs including 57 different sites — of Western Black Sea Region in Turkey between the years of 2001 and 2004. A total of 207 Lepidoptera species belonging to 164 genera and 11 families was determined. Results showed that the index of diversity in the coniferous habitats (H=0.5592) was significantly higher than those of beech (H=0.3561) and oak forests (H=0.4238), but was not significantly different than those of shrubs (H=0.4921). The pooled species numbers of the coniferous habitats were the highest among the four types of habitat (P<0.001). Moreover, the pooled number of species in the Noctuidae and Geometridae families were significantly higher (P<0.001) than those found in the other Lepidoptera families in the study area. The pooled numbers of the species tended to decrease from June to September during the study months.

Key words: Moth, Lepidoptera, Heterocera, diversity, Western Black Sea Region, Turkey.

Introduction

Due to its distinctive zoogeography and habitat diversity, Turkey has been one of the significant survey areas for many naturalists. This is because Anatolia and Trakya regions are located at an important geological crossroads among the three continents in the Palaearctic. It therefore provides highly diverse natural habitats for a wide variety of plant and animal species. Along with the other insects, the Lepidoptera taxa of Turkey have long been the attraction of numerous Lepidopterists for the last two centuries. Very early detailed studies (Zeller 1847, Staudinger 1878, 1881) included several parts of Anatolia from which, 5271 named species can be obtained. Some of the later taxonomical studies have been performed in South-Western (Wehrli 1932, 1934), Eastern (Wagner 1929, 1930, 1931), and Central Anatolia (Zukowsky 1937, 1938, 1941). Recent studies by Turkish researchers have contributed many records from different places around Turkey (Koçak 1977, 1990, Baisch et al. 1998, Doğanlar 2003).

The attempts to compile the Lepidoptera list of Turkey have also involved local reports in the vicinity of Istanbul (Mathew 1881; Graves 1925; Lattin 1944, 1951) in the Trakya Region. Geometrid species and their noxious properties to the plants in Marmara Region have been reported by Mol (1977). The detailed studies of Noctuidae (Okyar & Kornoşor 1994, 1997) and Geometridae

(Okyar & Aktaç 1999) in Trakya Region have included several new recorded species.

The studies dealing with Lepidoptera in the Western Black Sea Region of Turkey are few and have consisted of local taxonomical reports. Hakyemez (1994a, 1994b) has studied the Noctuidae species of Zonguldak province. The Lepidoptera studies with specific Geometrid records in the area have included Bolu and Duzce provinces (Akbulut et al. 2003; Özdemir 2007). Çakan & Okyar (2007) have studied the Noctuidae fauna of the Western Black Sea Region. Recent remarkable contributions regarding the Western Black Sea Region also include several parts of Central Anatolia (Beshkov 1996; 2000, Beshkov & Slivov 2006). In the present paper, the occurrence and diversity of the moth species are given according to the four different types of habitat in the Western Black Sea Region of Turkey for the first time.

Materials and methods

The Western Black Sea Region contains productive and different forests (Kaya & Raynal 2001) on the mountains and hills which are located at various elevations (up to 2500m). Bolu, and Ilgaz are two famous mountains in the area. The mountain ranges are often separated by deep river valleys. The annual precipitation is about 1500-1600mm. The 57 surveyed sampling sites in the study area were categorised into four groups according to the vegetation and the altitude found at each. Therefore, they had particular habitats with distinct microclimatic conditions for the diverse Lepidoptera taxa in the study area. The general habitat properties of the sampling sites in the study area can be addressed as follows (The number of sites and sampling size are given in parentheses respectively):

(a) Humid coniferous forests (27, 79) – These sites are highly humid, relatively cool and are predominantly covered with coniferous tree species such as *Pinus sylvestris*, *P. nigra*, *Picea* spp. and several *Abies* spp. The average altitude is about 1500 m. and reaches up to 2500m. Thus, much of the area is usually covered with snow during the long cold winter.

(b) Sub-humid beech forests (9, 28) – These forests included more humid and cooler sites than the following two sites given below. However, the pine trees of the previous study sites in this area are replaced by several beech species particularly characterised by *Fagus orientalis* which usually show associations with *Rhododendron flavum*. Some slopes in this area also included several other deciduous tree species such as *Quercus spp*., *Castanea sativa*, and *Carpinus betulus*. The average altitude of sampling sites in this area was 900m. The altitude here can extend to 1500m at the habitats highest reaches.

(c) Dry oak forests (12, 42) – The several oak species (*Quercus* spp.) are the most prevalent tree in these sites characterising the dry forests in a wide area at middle elevations. The fern (*Pteridium* sp.) associations with the oaks are found in more humid places. Dry forests in certain places also included a mixture of *Carpinus* sp., *Alnus barbata*, *Platanus* spp. *Ulmus* spp. and *Tilia rubra*. In the lower parts *Salix* spp. and *Populus* spp. are found near much of the stream-sides. Although these sites are found at variable middle level elevations, the average altitude is 700m. Thus, the cool climate of the humid forests given above is relaxed in dry forests.

(d) Shrubs (9, 9) – These sites are characterised by pseudomaquis, maquis and bushy vegetation rather than the higher canopy trees as in the other sites. Shrub vegetation occurs sparsely at numerous lower parts of the study area where they usually replace the deforested vegetation. These sites usually included the assemblage of *Coryllus avellana*, *Cornus mas*, *Rubus fruticosus*, *Viburnum* spp., *Ilex aquifolium*, *Arbutus unedo*, and *Daphne* sp. as characteristic shrub plant community. These sites are rather warm and the elevation relatively low being about 250 m at average and rarely reach up to 700m.

The sampling sites were mostly rural, undisturbed and unpolluted, providing a great number of different herbaceous and other favoured plant species for the larvae and the adults of Lepidoptera. The four year sampling of the adult Lepidoptera species was carried out between early June 2001 and late September 2004. Owing to severe cold climatic conditions in the study area and the need to find enough adult specimens, the sampling sessions were conducted between the June and September only.

The adult insects were collected near different plants and trees in the meadows, roadsides, abandoned places and watersides where they occurred more abundantly. A light trap ("Robinson" type) was used at night for collecting the moths. All specimens were analysed in the laboratory, under a binocular stereomicroscope. A total of 1613 specimens belonging to 11 Lepidoptera families were collected from the four different types of habitat (Table 1, Appendix 1). A total of 158 sampling sessions were performed in the 57 different sites during the course of the study. The light traps were kept in the study sites from dusk to dawn during the sampling sessions.

Table 1. Values of Lepidoptera diversity indices (H) and variances (S^2_H) calculated for the four types of habitat, using the Shannon-Wiener diversity index (Data derived from Appendix 1)

Habitat	*H*	S^2_H
Coniferous	0.5592	0.0002135
Beech	0.3561	0.0007035
Oak	0.4238	0.0005986
Shrubs	0.4921	0.0010414

The index of species diversity (H) for the four types of forest was calculated using the Shannon-Wiener formula (Zar 1996):

$$H = -\sum_{i=1}^{s} pi \log pi$$

where pi is the proportion of the i_{th} species and S is the number of species which found in the habitat type concerned. The index of diversity between habitat types was compared pair wise using the t-test proposed by Hutcheson (1970), where the variance (S^2_H) of each H and the degrees of freedom (v) for the preceding t were approximated by using a particular formula (Zar 1996).

The G-test was used where one-way classification of the Lepidoptera species numbers were analysed (Fowler et al. 1998). William's correction factor was applied in the G-test – irrespective of the number of degrees of freedom. Yates' correction was applied where there were only two categories regarding the Lepidoptera species numbers. The pair-wise comparisons included the species numbers between the habitats, the species numbers between the families, and the species numbers between the study months.

Systematic nomenclature was followed; Freina & Witt 1987, Hacker 1990, Hausmann et al. 2007).

Results

A total 207 Lepidoptera species (see Appendix 1) belonging to 164 genera and 11 families (see Appendix) were recorded in the study area. Four families — Noctuidae, Geometridae, Pyralidae and Arctiidae — were found in all four types of habitat. Two families — Sphingidae and Thyatiridae — occurred in only coniferous habitat. Sixty-one species were found in only coniferous forest habitats, whilst five species were found only in deciduous forest habitats. Both mixed forest and shrub habitats had two species of moth that were unique to them. Moreover, 22 species were present in all of the four types of habitat. *Idaea humiliata* and *I. rufaria* were the most abundant (85 and 120 specimens in total respectively) two species, found at the highest frequencies in all types of habitat during the study.

The estimated values (Log_{10} based) for the index of Lepidoptera diversity in the four types of habitat are given in the Table 1. The diversity value of coniferous forests is higher than those in the other three types of habitat. Beech forests have the lowest diversity value. The statistical analyses revealed significant differences between the habitats. According to pair-wise comparisons of indices (Table 2), the diversity of the coniferous forest sites are significantly higher than those of beech and oak forests. The diversity values between the beech forests and shrubs, also between the beech forests and shrubs are also significantly

different. However, the other comparisons do not indicate significant differences.

Table 2. Pairwise comparisons of the Lepidoptera diversity indices between four types of habitat. Three asterisks indicate significance beyond the 0.001 probability level. N.S.; not significant at 0.05 level. (Data derived from Appendix 1)

Habitat	Deciduous	Mixed	Shrubs
Coniferous	(***)	(***)	(N.S.)
Beech		(N.S.)	(***)
Oak			(***)

The data are also appropriate to compare the Lepidoptera species numbers (Fig. 1) distributed in the four types of habitat. The statistical analyses showed that the four types of habitat differ in terms of species numbers (G_{adj}=77.44, d.f.=3, P<0.001). According to pairwise comparisons, the number of species between the beech forests and shrubs, also between the oak forests and shrubs are not significantly different, though other pairwise comparisons reveal statistically significant differences (Table 3). This is because, coniferous forests have the highest species numbers among the four types of habitat and the beech forests have the lowest number of species. The values of the last two types of habitat in Figure 1 are close to each other.

Moreover, the data from the six Lepidoptera families (Fig. 2) are also suitable for pairwise comparisons dealing with the species numbers in which the *G*-test reveals sign of significance (G_{adj}=148.23, d.f.=5, P<0.001). As can be seen from Table 4, the number of species between Noctuidae and Geometridae are not significantly different; though these two families have the highest number of species among all Lepidoptera families and are significantly different than them all in the study area. The four families: Pyralidae, Arctiidae, Sphingidae and Notodontidae have very close species numbers and therefore the statistical test results do not extend beyond the 0.05 significance level, in the pairwaise comparisons.

Table 3. Pairwise comparisons of the Lepidoptera species numbers between the four types of habitat in the study area. (Data derived from Fig.1)

Habitat	X^2 (d.f. =1)	*P*
Coniferous v Beech	61.74	< 0.001
Coniferous v Oak	31.45	< 0.001
Coniferous v Shrubs	39.11	< 0.001
Beech v Oak	5.92	< 0.05
Beech v Shrubs	3.08	> 0.05
Oak v Shrubs	0.47	> 0.05

According to the number of species at the four different months (Each months data for each of the four years of study was pooled and analysed) that the study performed is also comparable dealing with the pooled data (Fig. 3). There is a strong tend that the species numbers follows a slope decreasing from June to September (G_{adj}=108.05, d.f.=3, P<0.001). It appears that the numbers of species in June are significantly different than those found in July, August and September, because the highest number of species are found in June. The statistical tests also give indication of significant differences between July and August, also between July and September. However, number of species occurred in August and September months are not significantly different (Table 5).

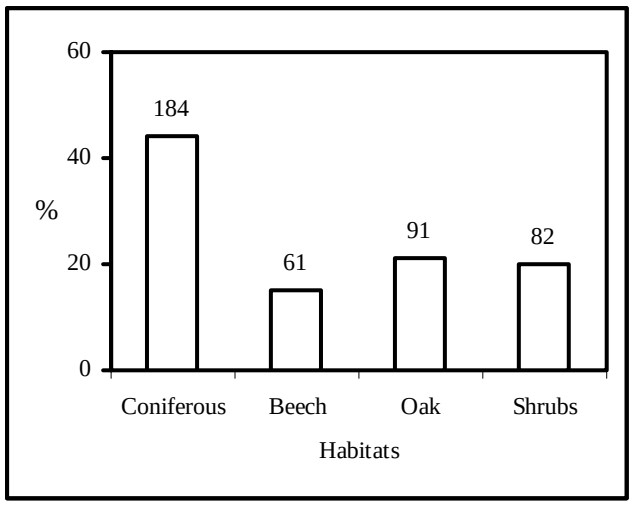

Figure 1. Numbers of the Lepidoptera species recorded in the four types of habitat. The "y" axis shows the percentage. The numbers of the species are given on the top of the bars in the diagram.

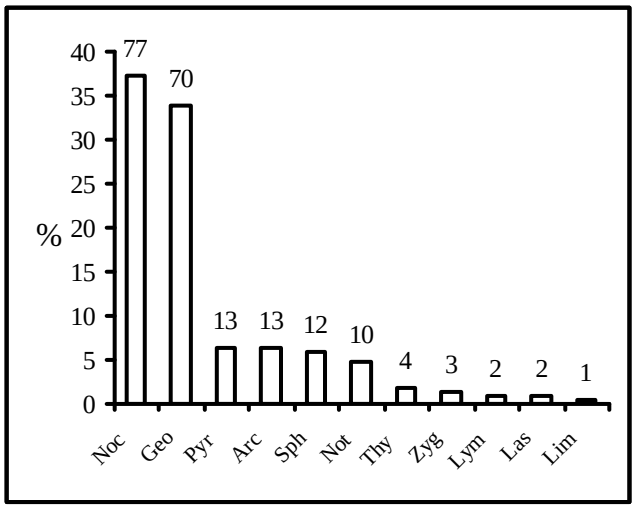

Figure 2. Numbers of the Lepidoptera species by eleven families recorded in the study area. The "y" axis shows the percentage and the numbers of the species are given on the top of the bars in the diagram. The full names of the moth families are given in Appendix.

Table 4. Pairwise comparisons of the Lepidoptera family numbers recorded in the study area. Three asterisks and one asterisks below the chi-square values, indicate significance beyond the 0.001 and 0.05 probability levels respectively. N.S.; not significant at 0.05 level, (d.f. = 1). The five families which did not have appropriate data for the tests were ignored in the calculations. (Data derived from Fig. 2)

Family	Geo	Pyr	Arc	Sph	Not
Noc	0.33 (N.S)	45.52 (***)	45.52 (***)	47.48 (***)	51.60 (***)
Geo		39.15 (***)	39.15 (***)	41.03 (***)	45.01 (***)
Pyr			0.00 (N.S.)	0.04 (N.S.)	0.35 (N.S.)
Arc				0.04 (N.S.)	0.35 (N.S.)
Sph					0.22 (N.S.)

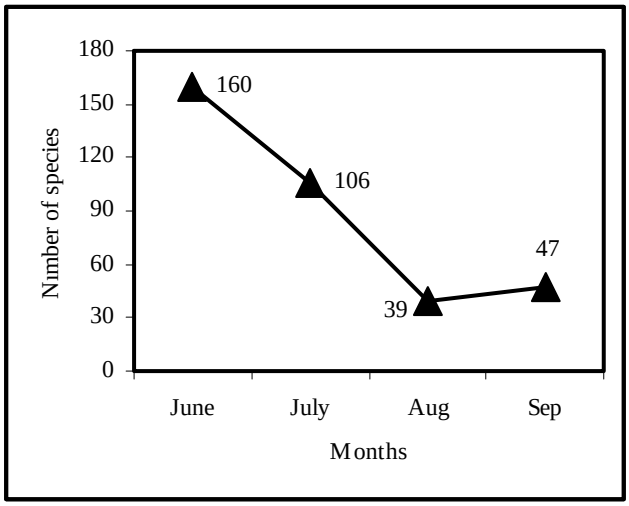

Figure 3. The pooled numbers of the Lepidoptera species at the four months during the four years of study. Numbers of the species are given on the slope of the line crossing the months in the diagram.

Discussion

A total of 207 Lepidoptera species were recorded in the study area, the precise number of the species might be higher than this number, because the present preliminary work was carried out using only night traps in the large area. In this respect,

more detailed studies involving smaller quadrats and day time survey in the future may reveal interesting results. This is the first study dealing with the Lepidoptera diversity in Turkey though, in fact, it seems that the moth fauna is highly diverse in the study area, possibly associating with the rich natural habitats.

Table 5. Pair wise comparisons of the Lepidoptera species numbers recorded in the study area during the four months. Three asterisks below the chi-square values indicate significance beyond the 0.001 probability level. N.S.; not significant at 0.05 level, (d.f. = 1). (Data derived from Fig. 3)

Month	July	Aug	Sep
June	10.88 (***)	73.57 (***)	31.39 (***)
July		30.96 (***)	22.75 (***)
Aug			0.75 (N.S.)

The measures of diversity found in the four types of habitat revealed significant differences. These differences also occurred in terms of the number of species. Since the study sites included a wide variety of habitats with distinct climatic conditions, these results are not surprising. The diversity of the beech forests was lower than the other three groups of the sites surveyed. This may be because these forests are much more densely covered by the mature beech trees. Moreover, the meadow patches which occur in the other three types of habitat are found very rarely in beech forests. Therefore, the number of plant species may be less than the other three types of habitats due to those two reasons. Thus, host plant diversity may be essential for the survival of certain Lepidoptera species and this aspect would repay for future studies and may reveal interesting results.

The coniferous forests had highest value in the index of diversity as well as highest number of species compared to the other three types of habitat. An interpretation of this result could be the coniferous forest habitat provides a wider range of host plants to support a larger diversity of Lepidopterous insects. Therefore, the area effects may also play important role in these results. It appears that the differences including the indices of diversity and the number of species between the habitats do not correlate. Even though the coniferous habitats have significantly higher numbers of species than those of the shrubs, there are no significant differences between these two groups of the habitat regarding the diversity values. It is possible that the sample sizes have substantial effects on the diversity values (Brakefield 1990), because individual numbers in the samples are highly varied. This is possibly due to the abundance and rarity of some species. For example, *Idaea humiliata* and *I. rufaria* were two abundant species occurring at high individual numbers in all types of the habitat. Thus, as it has been implied in similar studies (Wang et al. 2000, Luque et al. 2007), species diversity is a parameter of community structure which involves species as well as their abundance. Since the diversity values between the coniferous habitats and shrubs regards only Lepidoptera in this study, we do not know whether these values also true for other animal species. In conclusion, the plant diversity in those habitats needs to be studied to support these implications.

It appears that the families of Noctuidae (37.2 %) and Geometridae (33 %) have the

highest number of species among the eleven families (29 %) recorded in the study area. All of the 22 species which were found in all four types of habitat belonged to those two families, with most found in Noctuidae. This pattern of distribution in our study also applies to the number of Lepidoptera species dealing with these two families on the whole of Turkey, where about 1200 Noctuidae and about 600 Geometridae species have been known to occur (Koçak & Kemal 2007). The widespread nature of these two families which has also been demonstrated in some other studies (Tayyih et al. 2005, Bocaz et al. 2006, Luque et al. 2007) may be due to their physiological and anatomical properties which enable these moths to have powerful dispersal abilities (Schmidt & Roland 2006). The other hypothesis may be that the area provides common host plants, such as: *Ononis repens*., *Taraxacum* spp., *Rumex* spp., *Genista* spp., *Galium* spp., *Corylus avellana* (Hausmann 2001, 2004, Mironov 2003), which are fairly attractive for these moths particularly for the 22 polyphagous species mentioned above.

Other environmental conditions, such as microclimatic may also fundamentally influence the distribution of the species in the four habitat types. Since the area is vastly mountainous, the spring season usually delays resulting in a relatively lower temperature in these habitats. The green vegetation begins to appear in the late April and therefore the adults of many Lepidoptera species occur most frequently in June as it has been found in the present study. As the temperature drops by the end of the summer, the moths begin to disappear due to the shortage of food and cool temperature. Thus, it is not surprising that the number of species follows a sharp decreasing slope from June to September (Fig. 3). If the study had included the spring months, the slope in Figure 3 would most likely follow a triangle, and the slope would increase from the March to June as the other part of the triangle. However, this prediction will need to be examined in the future studies.

In the present study, some other interesting results are also worth mentioning, these deal with the distribution of particular species. In this respect, *Pasiphila chloerata* is a new record for the Anatolian part of Turkey where we found it in Kastamonu-Küre (one of our study sites). *Phytometra viridaria,* a member of Noctuidae was found for the first time in the Western Black-Sea Region in this study. *Macaria liturata* (Clerck, 1759) and *Parectropis similaria* (Hufnagel, 1767) have been previously reported from Bolu by Özdemir (2007) only. We have collected these two species from two more localities (Zonguldak and Kastamonu) in the Western Black-Sea Region. *Chlorissa cloraria* has been known to occur in Konya in central Anatolia and in Düzce (Özdemir 2007) which is near to our study where we recorded it in Zonguldak. Again, *Lomaspilis bithynica*, has been recorded for the first time in northern and north-western Anatolia by Gelbrecht et al. (2004). We also recorded this species in Bolu, Kastamonu and Zonguldak. Accordingly, along with the previous studies, the distribution of those species mentioned above included new sites with the present study. Moreover, it was interesting that several species (e.g. *Marumba quercus*, *Mimas tiliae*, *Laothoe populi*) often found in other types of habitat occurred in the coniferous habitats. Although their larvae are found only in the tree species as given by their species name, it seems that this limitation does not apply to the adults. Since these

species are also considered good long-distance visitors, they can be found in a variety of habitats.

In the future, more specific long-term studies including different populations in certain Lepidoptera species as well as in the other parts of Turkey may reveal more interesting results dealing with the diversity. These studies along with the molecular population studies may afford good opportunity to study evolution in action and how it shapes the highly diverse Lepidoptera taxa which have adapted to a wide variety of environmental conditions.

Acknowledgements: We are very grateful to the editor, the referees; M. Mironov, and S. Beshkov for patiently reviewing the manuscript. The study was supported by Trakya University Scientific Research Foundation of (TUBAP 486).

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Submitted: 20 March 2008
/ Accepted: 02 January 2009

Published Online: 26 January 2009

Appendix 1. The list of the Lepidoptera species recorded in the four distinct types of habitat in Western Black Sea Region of Turkey. I – Humid Coniferous forests, II – Sub-humid beech forests, III – Dry oak forests, IV - Shrubs. The letters indicate occurrence of the months; a – June, b – July, c – August, d – September.

Families and Species	Habitats			
	I	II	III	IV
Pyralidae				
Thisanotia chrysonuchella (Scopoli, 1763)	a	–	–	–
Evergestis frumentalis (Linnaeus, 1761)	b	–	–	–
Pyrausta aurata (Scopoli, 1763)	acd	–	cd	ac
Loxostege sticticalis (Linnaeus, 1761)	–	–	–	d
Sitochroa palealis ([Denis & Schiffermüller], 1775)	d	d	d	d
Paratalanta pandalis (Hübner, 1825)	abc	–	–	ab
Eurrhypara hortulata (Linnaeus, 1758)	a	–	–	–
Phlyctaenia coronata (Hufnagel, 1767)	a	–	a	–
Ebulea crocealis (Hübner, 1796)	ab	–	ab	b
Pleuroptya ruralis (Scopoli, 1763)	ac	–	ac	–
Synaphe moldavica (Esper, 1794)	a	a	a	–
Pyralis farinalis (Linnaeus, 1758)	a	–	–	–
Oncocera semirubella (Scopoli, 1763)	b	–	–	–
Zygaenidae				
Zygaena transalpina (Esper, 1780)	b	–	–	b
Zygaena loti ([Denis & Schiffermüller], 1775)	b	–	–	–
Zygaena filipendulae (Linnaeus, 1758)	–	ab	ab	b
Limacodidae				
Apoda limocodes (Hufnagel, 1766)	ad	–	–	–
Thyatiridae				
Thyatira batis (Linnaeus, 1758)	a	–	–	–
Habrosyne pyrithoides (Hufnagel, 1766)	abd	–	–	–
Tethea ocularis (Linnaeus, 1767)	ab	–	–	–
Tethea or (Goeze, 1781)	bc	–	–	–
Geometridae				
Aplasta ononaria (Fuessly, 1783)	a	a	a	a
Pseudoterpna pruinata (Hufnagel, 1767)	a	a	–	a
Comibaena bajularia ([Denis & Schiffermüller], 1775)	ab	ab	–	a
Jodis lactearia (Linnaeus, 1758)	a	a	–	–
Hemithea aestivaria (Hübner, 1789)	a	–	a	–
Chlorissa viridata (Linnaeus, 1758)	–	a	a	a
Chlorissa cloraria (Hübner, 1813)	a	–	a	–
Cleta filacearia (Herrich-Schäffer, 1847)	b	–	b	–

Appendix 1. (Continueed)

Families and Species	Habitats			
	I	II	III	IV
Idaea rufaria (Hübner, 1799)	ab	ab	ab	ab
Idaea ochrata (Scopoli, 1763)	ac	ab	–	ab
Idaea moniliata ([Denis & Schiffermüller], 1775)	a	a	a	–
Idaea dilutaria (Hübner, 1799)	a	–	a	a
Idaea fuscovenosata (Goeze, 1781)	a	a	a	a
Idaea humiliata (Hufnagel, 1767)	abc	a	ab	a
Idaea politaria (Hübner, 1799)	a	ac	a	a
Idaea dimidiata (Hufnagel, 1767)	a	–	a	a
Idaea trigeminata (Haworth, 1809)	ab	ab	ab	–
Idaea aversata (Linnaeus, 1758)	a	a	a	a
Scopula immorata (Linnaeus, 1758)	ab	–	–	ab
Scopula nigropunctata (Hufnagel, 1767)	ab	ab	ab	–
Scopula rubiginata (Hufnagel, 1767)	ab	a	a	ab
Scopula emutaria (Hübner, 1809)	–	a	–	a
Rhodostrophia vibicaria (Clerck, 1759)	a	a	a	–
Timandra comae Schmidt, 1931	–	–	ac	ac
Cyclophora linearia (Hübner, 1799)	a	a	a	–
Lytria purpuraria (Linnaeus, 1758)	–	ad	–	–
Cataclysme riguata (Hübner, 1813)	a	–	–	–
Scotopteryx mucronata (Scopoli, 1763)	a	–	a	–
Scotopteryx luridata (Hufnagel, 1767)	ac	a	acd	ac
Xanthorhoe ferrugata (Clerck, 1759)	a	–	a	–
Xanthorhoe montanata ([Denis & Schiffermüller], 1775)	ab	–	ab	–
Camptogramma bilineata (Linnaeus, 1758)	ab	ab	ab	a
Cosmorhoe ocellata (Linnaeus, 1758)	a	a	–	a
Dysstroma truncata (Hufnagel, 1767)	cd	–	–	–
Cidaria fulvata (Forster, 1771)	b	b	–	b
Thera obeliscata (Hübner, 1787)	ab	ab	ab	ab
Colostygia pectinaria (Knoch, 1781)	ab	ab	ab	b
Hydria montivagata (Duponchel, 1830)	b	–	–	–
Pasiphila chloerata (Mabille, 1870)	a	–	–	–
Eupithecia tantillaria Boisduval, 1840	a	–	–	a
Eupithecia centaureata ([Denis & Schiffermüller], 1775)	b	b	–	–
Eupithecia orphnata Petersen, 1909	d	–	–	–
Eupithecia denotata (Hübner, 1813)	b	–	b	–
Eupithecia subfuscata (Haworth, 1809)	a	–	–	a

Appendix 1. (Continueed)

Families and Species	Habitats			
	I	II	III	IV
Aplocera plagiata (Linnaeus, 1758)	b	–	–	–
Aplocera uniformata (Scopoli, 1763)	b	–	b	–
Asthena albulata (Hufnagel, 1767)	a	a	a	a
Minoa murinata (Scopoli, 1763)	ab	abc	–	–
Abraxas sylvata (Scopoli, 1763)	–	–	ac	–
Chiasmia aestimaria (Hübner, 1809)	–	–	a	–
Lomaspilis bithynica Wehrli, 1954	a	a	a	a
Heliomata glarearia Brahm, 1791	a	–	–	a
Macaria liturata (Clerck, 1759)	b	–	–	b
Opistograptis luteolata (Linnaeus, 1758)	ab	–	bd	–
Asovia maeoticaria (Alphéraky, 1876)	ab	ab	–	–
Pseudopanthera macularia (Linnaeus, 1758)	ab	–	ab	–
Selenia lunularia (Hübner, 1788)	a	–	–	–
Eilicrinia trinotata Mentzer, 1845	b	–	–	b
Parectropis similaria (Hufnagel, 1767)	–	–	a	–
Biston betularia (Linnaeus, 1758)	a	ab	–	ab
Peribatodes rhomboidaria ([Denis & Schiffermüller], 1775)	ab	b	a	ab
Alcis repandata (Linnaeus, 1758)	bd	b	bd	b
Cleorodes lichenaria (Hufnagel, 1767)	b	–	–	–
Ematurga atomaria Linnaeus, 1758	ab	ab	ab	bd
Fritzwagneria waltheri Wagner, 1919	abc	–	–	ab
Selidosema plumaria ([Denis & Schiffermüller], 1775)	d	d	–	d
Cabera exanthemata (Scopoli, 1763)	ab	a	ab	a
Cabera pusaria (Linnaeus, 1758)	ab	ab	ab	ab
Pungeleria capreolaria ([Denis & Schiffermüller], 1775)	ad	ad	–	a
Hylaea fasciaria (Linnaeus, 1758)	a	–	a	–
Lasiocampidae				
Lasiocampa quercus (Linnaeus, 1758)	bd	bd	–	–
Dendrolimus pini (Linnaeus, 1758)	ab	–	–	–
Sphingidae				
Agrius convolvuli (Linnaeus, 1758)	ad	–	–	–
Sphinx ligustri Linnaeus, 1758	b	–	–	–
Hyloicus pinastri (Linnaeus, 1758)	a	–	–	–
Marumba quercus ([Denis & Schiffermüller], 1775)	ab	–	–	–
Smerinthus ocellatus (Linnaeus, 1758)	a	–	–	–
Mimas tiliae (Linnaeus, 1758)	a	–	–	–

Appendix 1. (Continueed)

Families and Species	Habitats			
	I	II	III	IV
Laothoe populi (Linnaeus, 1758)	b	–	–	–
Hemaris fuciformis (Linnaeus, 1758)	a	–	–	–
Macroglossum stellatarum (Linnaeus, 1758)	a	–	–	–
Proserpinus proserpina (Pallas, 1772)	bcd	–	–	–
Hyles euphorbiae (Linnaus, 1758)	a	–	–	–
Hyles nicaea (De Prunner, 1798)	a	–	–	–
Notodontidae				
Phalera bucephala (Linnaeus, 1758)	ab	–	–	–
Furcula furcula (Fischer von Waldheim, 1820)	a	–	–	–
Stauropus fagi (Linnaeus, 1758)	ad	–	–	–
Notodonta tritophus ([Denis & Schiffermüller], 1775)	b	–	–	–
Drymonia querna ([Denis & Schiffermüller], 1775)	ac	–	–	–
Pheosia tremula (Clerck, 1759)	ab	–	–	–
Pterostoma palpinum (Clerck, 1759)	ac	–	–	ac
Spatalia argentina ([Denis & Schiffermüller], 1775)	ab	–	–	–
Clostera anastomosis (Linnaeus, 1758)	b	–	–	–
Rhegmatophila alpina (Bellier de la Chavignerie, 1881)	abc	–	–	–
Lymantriidae				
Lymantria dispar (Linnaeus, 1758)	–	–	ab	ab
Euproctis chrysorrhoea (Linnaeus, 1758)	bc	–	–	–
Arctiidae				
Atolmis rubricollis (Linnaeus, 1758)	abc	–	–	–
Lithosia quadra (Linnaeus, 1758)	ab	–	–	ab
Eilema complana (Linnaeus, 1758)	b	–	–	–
Eilema sororcula (Hufnagel, 1766)	abd	–	–	–
Spilosoma lubricipedum (Linnaeus, 1758)	ab	–	–	–
Diaphora mendica (Clerck, 1759)	a	–	a	–
Rhyparia purpurata (Linnaeus, 1758)	ac	–	–	ac
Diacrisia sannio (Linnaeus, 1758)	ab	–	–	–
Arctia villica (Linnaeus, 1758)	abcd	–	abc	–
Callimorpha dominula (Linnaeus, 1758)	bd	–	–	–
Tyria jacobaeae (Linnaeus, 1758)	–	–	–	a
Syntomis phegea (Linnaeus, 1758)	ac	–	ac	–
Dysauxes ancilla (Linnaeus, 1758)	bc	–	–	–
Noctuidae				
Euxoa agricola (Boisduval, 1829)	ab	–	a	bc

Appendix 1. (Continueed)

Families and Species	Habitats			
	I	II	III	IV
Agrotis segetum ([Denis & Schiffermüller], 1775)	ac	ac	c	ac
Agrotis clavis (Hufnagel, 1766)	bcd	–	bd	–
Agrotis exclamationis (Linnaeus, 1758)	ab	–	ab	b
Agrotis ipsilon (Hufnagel, 1766)	acd	–	–	ad
Agrotis desertorum wagneri Corti&Draudt, 1933	ab	–	–	ab
Agrotis puta (Hübner, 1803)	a	–	a	–
Dichagyris celsicola (Bellier, 1859)	b	–	b	–
Ochropleura plecta (Linnaeus, 1761)	ab	–	ab	ab
Axylia putris (Linnaeus, 1761)	a	–	–	a
Noctua pronuba (Linnaeus, 1758)	ab	bc	ac	–
Noctua orbona (Hufnagel, 1766)	ab	ab	–	–
Noctua fimbriata (Schreber, 1759)	ab	ab	b	b
Noctua janthina ([Denis & Schiffermüller], 1775)	abc	–	–	abc
Peridroma saucia (Hübner, 1803)	bc	–	bc	–
Xestia c-nigrum (Linnaeus, 1758)	ab	–	b	ab
Anaplectoides prasina ([Denis & Schiffermüller], 1775)	a	–	–	a
Discestra mendax (Staudinger, 1879)	a	–	–	a
Hada plebeja (Hufnagel, 1761)	ab	ab	–	–
Polia nebulosa (Hufnagel, 1766)	abd	b	bd	d
Sideridis reticulata (Goeze, 1781)	abc	–	–	–
Lacanobia contigua ([Denis & Schiffermüller], 1775)	ab	ab	–	ab
Lacanobia w-latinum (Hufnagel, 1766)	ab	ab	ab	–
Lacanobia thalassina (Hufnagel, 1766)	ab	–	–	–
Lacanobia oleracea (Linnaeus, 1758)	a	–	a	a
Melanchra persicariae (Linnaeus, 1761)	a	–	a	–
Hadena magnolii (Boisduval, 1829)	a	–	–	a
Hadena compta ([Denis & Schiffermüller], 1775)	a	–	–	–
Mythimna ferrago (Fabricius, 1787)	a	–	–	–
Mythimna albipuncta ([Denis & Schiffermüller], 1775)	abc	–	abc	–
Mythimna vitellina (Hübner, 1808)	ab	–	–	ab
Mythimna l-album (Linnaeus, 1767)	a	–	–	a
Leucania comma (Linnaeus, 1761)	ab	ab	ab	–
Brachylomia viminalis (Fabricius, 1776)	b	–	–	–
Lamprosticta culta ([Denis & Schiffermüller], 1775)	a	–	a	a
Aporophyla canescens (Duponchel, 1826)	–	–	ac	–
Lithophane socia (Hufnagel, 1766)	b	–	–	–

Appendix 1. (Continueed)

Families and Species	Habitats			
	I	II	III	IV
Dryobotodes eremita (Fabricius, 1775)	b	–	–	–
Mniotype adusta (Esper, 1790)	a	–	–	–
Agrochola lychnitis ([Denis & Schiffermüller], 1775)	b	–	–	–
Acronicta rumicis (Linnaeus, 1758)	acd	cd	–	ac
Cirrhia icteritia (Hufnagel, 1766)	b	–	–	–
Amphipyra pyramidea (Linnaeus, 1758)	bc	–	bc	–
Polyphaenis sericata (Esper, 1787)	abd	ab	abd	–
Thalpophila matura (Hufnagel, 1766)	d	–	d	–
Trachea atriplicis (Linnaeus, 1758)	–	a	a	a
Dicycla oo (Linnaeus, 1758)	–	–	–	a
Cosmia trapezina (Linnaeus, 1758)	abd	–	abd	–
Abromias monoglypha (Hufnagel, 1766)	ab	ab	–	–
Oligia strigilis Hübner, [1821]	abd	–	ab	ad
Caradrina morpheus (Hufnagel, 1766)	ab	–	–	ab
Caradrina clavipalpis (Scopoli, 1763)	ab	–	ab	–
Hoplodrina octogenaria (Goeze, 1781)	a	–	a	–
Charanyca trigrammica (Hufnagel, 1766)	ab	ab	–	–
Charanyca ferruginea (Esper, 1785)	ad	–	–	ad
Helicoverpa armigera (Hübner, 1805)	–	–	ad	ad
Acontia trabealis (Scopoli, 1763)	–	–	acd	acd
Acontia lucida (Hufnagel, 1766)	–	–	bcd	–
Earias clorana (Linnaeus, 1761)	–	ac	–	–
Bena prasiana (Linnaeus, 1758)	a	–	a	–
Panthea coenobita (Esper, 1785)	ab	–	ab	–
Diachrysia chrysitis (Linnaeus, 1758)	c	–	–	–
Macdunnoughia confusa (Stephens, 1850)	a	–	a	–
Abrostola triplasia (Linnaeus, 1758)	a	a	a	–
Autographa gamma (Linnaeus, 1758)	bd	–	bd	–
Autographa pulchrina (Haworth, 1809)	a	–	–	–
Trichoplusia ni (Hübner, [1803])	ab	–	–	–
Chrysodeixis chalcites (Esper, 1789)	ab	–	–	b
Catocala elocata (Esper, 1787)	bd	–	bd	–
Dysgonia algira (Linnaeus, 1767)	–	a	a	–
Euclidia glyphica (Linnaeus, 1758)	–	abcd	–	abcd
Aedia funesta (Esper, 1786)	–	–	a	a
Tyta luctuosa ([Denis & Schiffermüller], 1775)	acd	acd	–	–

Appendix 1. (Continueed)

Families and Species	Habitats			
	I	II	III	IV
Laspeyria flexula ([Denis & Schiffermüller], 1775)	a	–	–	–
Phytometra viridaria (Clerck, 1759)	abd	–	–	–
Trisateles emortualis ([Denis & Schiffermüller], 1775)	–	abcd	abcd	bc
Paracolax tristalis (Fabricius, 1794)	bc	–	–	bc