J. Entomol. Res. Soc., 20(2): 91-101, 2018 *ISSN:1302-0250*

An Integrative Approach to Understand the Biogeography, Taxonomy and Ecology of the Macroheteroceran Fauna of the Amanos Mountains in Southern Turkey

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ABSTRACT

In 2014 and 2015, Macroheterocera were collected in three altitudinal transects in the Amanos mountains from 0 m up to 1104 m above sea-level. Altogether, 249 specimens were registered. Tissues from 91 selected specimens (42 Noctuidae/Erebidae, 35 Geometridae, 14 others) were submitted to DNA barcoding, partly for identification purposes, partly to investigate zoogeographical questions about the relationships between Anatolian and Levantine populations.

The sequencing was very successful (97%, only three failures) and revealed to include 81 BINs, 13 of them new for the BOLD database. Three species (*Eublemma* cf. *gratissima*, Erebidae, 3.4% from *E. suppuncta; Dyspessa* cf. *ulula*, Cossidae, 9.1% from *D. ulula*; *Cryphia* cf. *ravula* Noctuidae 4.7% from *C. ravula*) may be new for science and require further taxonomical analysis. All of them differ by more than 3.4% from their nearest neighbours, as currently present on BOLD database. In two other cases (genera *Mythimna* (Noctuidae) and *Zeuzera* (Cossidae), we found smaller genetic divergences (1.3-2.0%) from their European relatives, which require further taxonomic investigation. *Geometra papilionaria* (Linnaeus, 1758) and *Macaria notata* (Linnaeus, 1758) (Geometridae), previously only known from the Black Sea Region in Turkey, now were reported in the Amanos mountains, thus considerably extending the distribution areas southwards. Moreover, *Lomaspilis marginata* (Linnaeus, 1758) (Geometridae), is possibly new for Turkey as the only previous literature record (Koçak and Kemal, 2009) is doubtful as no authentic specimens have been traced. We present several cases where the DNA barcodes helped to clear up zoogeographical patterns.

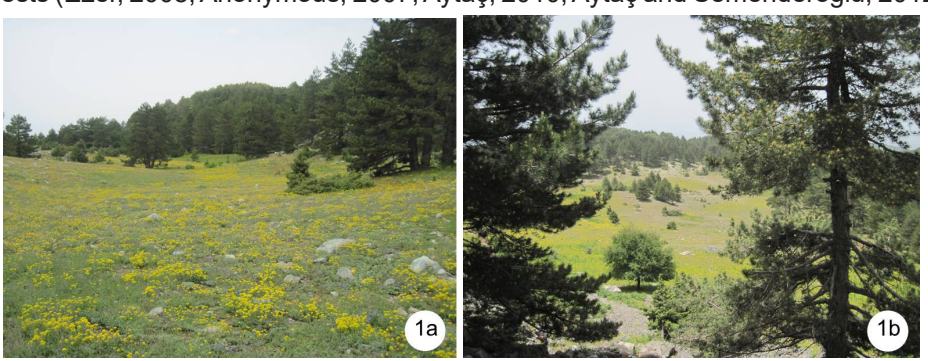
Key words: Geometridae, Lepidoptera, Levant, Amanos, Anatolia.

INTRODUCTION

Turkey, extending from Asia to Europe, is one of the most species-rich countries in the western Palaearctic. Unfortunately, the previous studies on biodiversity of Turkey were just a few. Determination of the insect fauna will help to understand their biology, ecology and also will benefit the improvement of control methods of the pest species. Like many other species, many moth species are facing extinction due to global climate change and human activities. Determination of moth species, their biology and spread areas, therefore, is crucial for Turkey's faunistic studies. Most of the previous studies were conducted by foreign researchers visiting Turkey for short periods of time, and comprised of different lepidopteran species belonging to different

families of Macroheterocera (Lederer, 1865; Mathew, 1881; Wehrli, 1934; Zukowsky, 1941; De Lattin, 1951; Kansu, 1963; Seven, 1991; Hausmann, 1996; Lastuvka and Lastuvka, 2001; Doğanlar, 2003; Özdemir *et al.,* 2005; Can and Mironov, 2006; Koçak and Kemal, 2007; Can, 2008; Okyar and Mironov, 2008; Okyar, 2010; 2012). But, none of these studies specifically targeted the Amanos Mountains' biodiversity, although some of them partly included the area and therefore the moth species of the region.

Amanos Mountains, situated in the eastern Mediterranean Region of Turkey, rising sharply from the sea level, has a mountain range extending about 200 km from Kahramanmaraş to Hatay provinces. The range is about 25 km wide, and has topographical, geological and geomorphological features which support a high rate of endemism and a large number of still ongoing speciation events (Aytaç and Semenderoğlu, 2012; Özkoçak, 1993) (Fig. 1). Therefore the Amanos Mountains can be regarded as a 'laboratory of evolution' and thus an ideal model for case studies in research of evolution biology, biogeography and the effects of biotic and abiotic factors on biodiversity (e.g. effects of climatic change). Amanos mountain range (highest peak Mıgır Peak (2240 m)), is one of the least damaged natural ecosystems of Turkey. The range is located in the intersection point of three different phytogeographic vegetation zones namely Euro-Siberian, Iran-Turanian and Mediterranean. There are maquis shrubs and pine forests up to 1000 m elevation and above that forests of larch, cedar and fir trees. Furthermore, Amanos mountain range is the southernmost point of beech forests (Ezer, 2008; Anonymous, 2007; Aytaç, 2010; Aytaç and Semenderoğlu, 2012).



Figs. 1a, 1b. Two habitats in Amanos Mountains.

The biodiversity of the Amanos mountains notably is rich as a consequence of the above mentioned geological and climatical diversity. We therefore believe in a key role of the Amanos mountains for the understanding of biodiversity and speciation events in the Middle East and the Levant. Due to its north/south-position at a right angle to all the other (west/east-positioned) Anatolian mountain chains, each climatic change in the past-until today!-pressed species to extend or shift their distribution areas southwards (as a response to cooling events) or northwards (during warming periods) along the Amanos mountains, like through a "channel" or "gallery". Populations pressed towards the southern end of this chain got often isolated and evolved to separate species, therefore we find endemisms of supposed Anatolian origin on

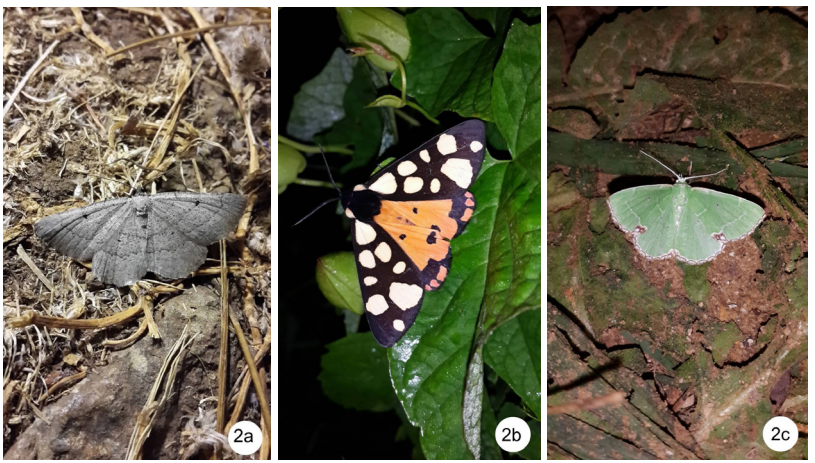
the Al Lawz mountain (e.g. *Scopula* cf. *diffinaria* (Prout 1913), cf. Wiltshire (1990)), Sinai (e.g. *Nebula mantelorum* Hausmann 1997), mountains of central Jordan (e.g. *Thetidia silvia* Hausmann 1991) or northern Israel (e.g. genus *Crocallis* species near *tusciaria*; unpublished). Our hypothesis was supported by preliminary results of own DNA Barcoding pilot projects on geometrid moths of the Middle East: of 210 barcoded geometrid moth species (n=826) in Israel and Jordan, we currently have 107 sister species pairs or conspecific populations in Turkey, which are barcoded in the southern Levant and as well as in Turkey. Sixty two of them (58%!) show remarkable genetic (COI) differentiations of 0.5-4.0% minimum pairwise distance (source: own, unpublished data (in prep.): The geometrid moths of Israel; 350 pp). This fact makes the Macroheterocera of the Levant to an ideal model group to test the hypothesis, that actual climatic change (e.g. warming; desertification) is pressing species distribution areals towards the north and vertically towards higher altitudes. We should expect the arrival of southern species and southern populations at the Amanos mountains (during their northwards-directed extentions or shifts of distribution areas), such as vertical shifts towards the summits of the Amanos mountain chain. We hypothesized that these processes and scenarios are often directly correlated with shifts of host-plant distributions. Since little is known on host-plant relationships of western Asian moths, a certain emphasis is given in our project on synecological investigations on Macroheterocera (host-plants; habitats).

With this study, the biodiversity of moths of the Amanos Mountains, their vertical and horizontal distribution were investigated by using both morphological and molecular methods.

MATERIALS AND METHODS

Boundaries of the study area of the project were the parts of the Amanos Mountains between Erzin-Üçkoz plateau in north and Mount Musa in the south, within Hatay province borders, and covering almost 2/3 of the mountain range. Field work was conducted in Amanos mountains in 2014 and 2015 between May and June, when the moths are more active, taking the consideration of collecting samples from localities with different altitudes, climatic conditions, vegetation and geographical conditions.

Specimens were collected by a net in the day-light, also methods of shaking the branches and visual checks were used (Fig. 2). Nocturnal light trapping was performed at three altitudinal transects, covering a maximum of habitat diversity (elevation, climate, vegetation and geology) in the Amanos Mountains from the beginning of May to the end of June in 2014 and 2015. Three 15 watt portable light traps were used for each transect. All the localities' elevations and coordinates were recorded by a GPS instrument. Specimens were dissected in the laboratory, with the genitalia embedded on slides (partly in Entellan, partly in Euparal) following standard procedures. All specimens were deposited in the Lepidoptera Collection of the University of Mustafa Kemal, Hatay, Turkey. Confirmation of species identity was assisted by comparing material with identified specimens at the ZSM (Zoologische Staatssammlung München).



Figs. 2a. *Stueningia wolfi.* 2b. *Arctia villica.* 2c. *Proteuchloris neriaria.*

Taxon and tissue sampling for the molecular approach

Our sampling strategy aimed to gain a best possible coverage over the distribution area, the altitudinal range and the habitat preferences of each species. For mtDNA studies, one fresh leg was sampled for a total of 91 specimens belonging to different families of Macroheterocera collected from Amanos Mountains of Turkey.

DNA analysis

DNA extraction was performed following standard protocols, using silica membrane-based DNA extraction kits in robotic systems incubating tissues overnight at 56 °C in lysis buffer, followed by centrifugation and DNA purification (DeWaard *et al.,* 2008). For COI Barcoding PCR amplification and DNA sequencing were performed at the CCDB following standard high-throughput protocols (Ivanova *et al*., 2006; DeWaard *et al.,* 2008), that can be accessed under, Hebert *et al.,* 2003 to recover, with a single primer pair, a 658 bp region near the 5' terminus of the mitochondrial cytochrome *c* oxidase I (COI) gene that included the standard 648 bp barcode region for the animal kingdom (Hebert *et al.,* 2003). All sequences were deposited also in GenBank according to the iBOL data release policy. Complete specimen data including images, voucher deposition, GenBank accession numbers, GPS coordinates, sequence and trace files were accessed in public projects of the Barcode of Life Data System (Ratnasingham and Hebert, 2007).

RESULTS

Altogether, 249 specimens were registered, of which 47 specimens were not considered for further study because of their lower conservation statuses. The sequencing was successful in 88 out of the 91 morphospecies-selected samples (97%) which had been submitted to DNA Barcoding. A total of 84 samples were sequenced

to the full length of the DNA barcode (658bp), in four cases the sequence length was slightly shorter (596-642bp). Our barcodes from Amanos mountains revealed to include 81 Barcode Index Numbers (BINs), 13 of them new for the BOLD database, which are a good proxy for species boundaries (Hausmann *et al.* 2013), cf. Table 1. and Fig. 3.

Three species (*Eublemma* cf. *gratissima*, Erebidae, 3.4% from *E. suppuncta; Dyspessa* cf. *ulula*, Cossidae, 9.1% from *D. ulula*; *Cryphia* cf. *ravula* Noctuidae 4.7% from *C. ravula*) may be new for science and require further taxonomical analysis. All of them differ by more than 3.4% from their nearest neighbors, as currently present on BOLD database. In two other cases (genera *Mythimna* (Noctuidae) and *Zeuzera* (Cossidae), we found smaller genetic divergences (1.3-2.0%) from their European relatives, which require further taxonomic investigation. *Geometra papilionaria* (Linnaeus, 1758) and *Macaria notata* (Linnaeus, 1758) (Geometridae), previously only known from the Black Sea Region in Turkey, now were reported in the Amanos mountains, thus considerably extending the distribution areas southwards. Moreover, *Lomaspilis marginata* (Linnaeus, 1758) (Geometridae), is possibly new for Turkey as the only previous literature record (Koçak and Kemal, 2009) is doubtful as no authentic specimens have been traced.

We furthermore found several cases where the DNA barcodes helped to clear up zoogeographical patterns: For instance, *Orygia trigotephras orientalis* (BC ZSM Lep 92813) revealed as a separate taxon from the populations of southern Europe and northern Africa (separate BIN; distance 6.6%), and may better be considered as a separate species. *Pseudoterpna coronillaria* (BC ZSM Lep 92727) was nested within the cluster of subsp. *axillaria* (Lebanon) and subsp. *halperini* (Israel) and not with the barcoded populations from south-western Turkey and Cyprus (including "subsp. *cinerascens*"). *Drymonia querna djezina* (described from the Lebanon) is confirmed as a separate taxon, diverging from the DNA barcodes of European populations (Germany, France, Spain, Italy) by 3.5%.

DISCUSSION

The methods chosen for this pilot study, i.e. collecting along altitudinal transects and analysis applying an integrative approach based on morphological traits as well as on DNA barcodes, has proven to yield very interesting results and to be the right strategy to make successful an extended project on the Lepidoptera of the Amanos mountains in the future.

CONCLUSION

This pilot study had to be based on a comparatively small sample but we could already demonstrate the great potential of biodiversity assessments based on DNA barcoding. For statistical analyses of all the questions presented in the introduction we would need much larger samples which should be taken in the future. It is planned to extend the analytical approach to include also nDNA analyses which will allow to put the results into a phylogenetic context.

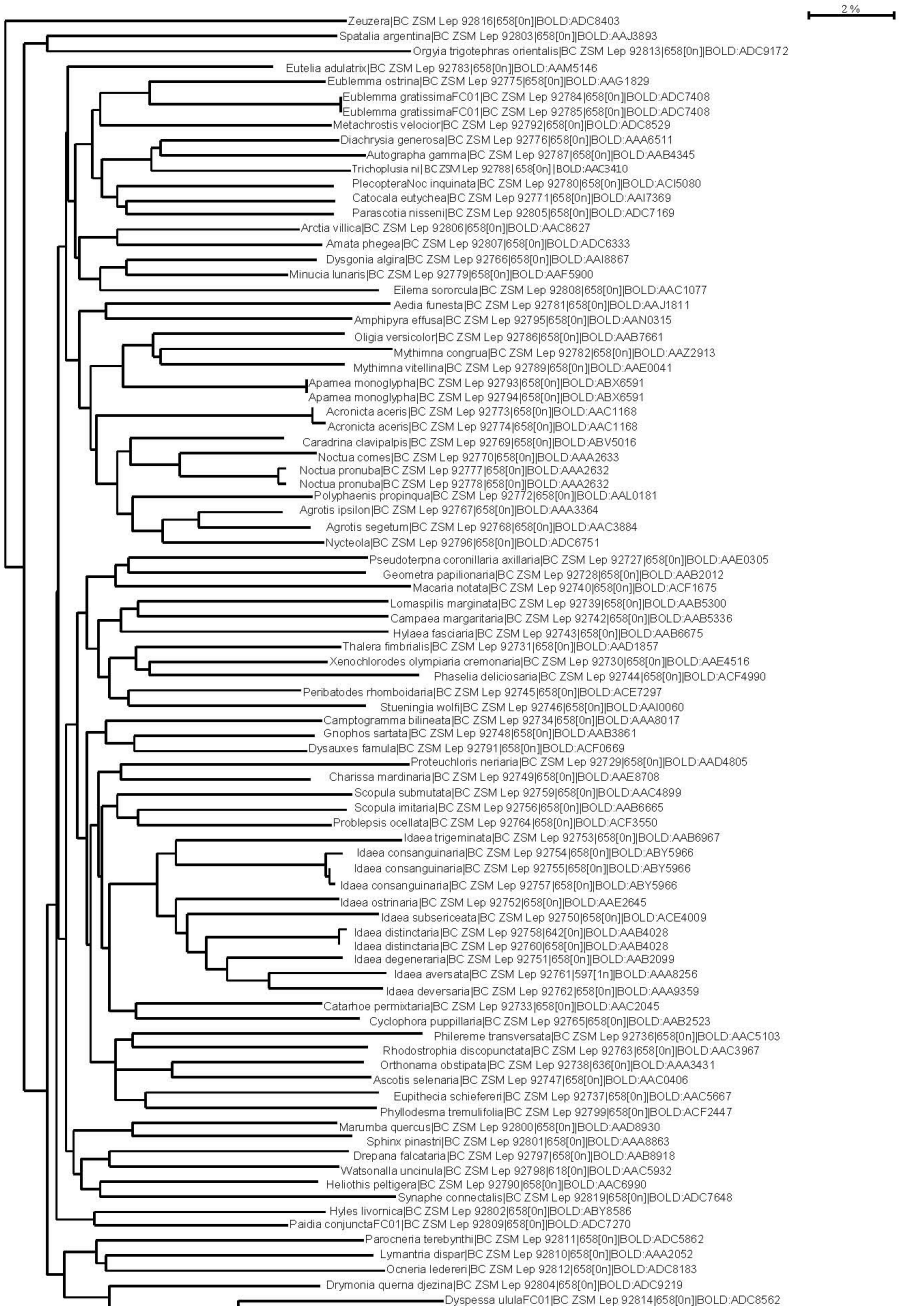


Fig. 3. Neighbour Joining Tree (Kimura 2 Parameter, COI Barcode gene fragment) for the 88 DNA sequences from our pilot study in the Amanos mountains, southern Turkey.

Table 1. Sequencing results (BINs; sequence lengths; species identification) from DNA Barcoding (COI, 5') of 91 Lepidoptera specimens from altitudinal transects in the Amanos mountains, southern Turkey

Sample ID	BIN	COI-5P Seq. Length	Identification	Collection Date	Exact Site	Lat	Lon	Elev
BC ZSM Lep 92727	BOLD:AAE0305	658[0n]	*Pseudoterpna coronillaria axillaria*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92728	BOLD:AAB2012	658[0n]	*Geometra papilionaria*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92729	BOLD:AAD4805	658[0n]	*Proteuchloris neriaria*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92730	BOLD:AAE4516	658[0n]	*Xenochlorodes olympiaria cremonaria*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92731	BOLD:AAD1857	658[0n]	*Thalera fimbrialis*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92732		0	*Phaiogramma etruscaria*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92733	BOLD:AAC2045	658[0n]	*Catarhoe permixtaria*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92734	BOLD:AAA8017	658[0n]	*Camptogramma bilineata*	27.05.2015	Belen-Komurcukuru	36,4103	36,1169	1104
BC ZSM Lep 92735		0	*Mesoleuca albicillata*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92736	BOLD:AAC5103	658[0n]	*Philereme transversata*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92737	BOLD:AAC5667	658[0n]	*Eupithecia schiefereri*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92738	BOLD:AAA3431	636[0n]	*Orthonama obstipata*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92739	BOLD:AAB5300	658[0n]	*Lomaspilis marginata*	02.05 2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92740	BOLD:ACF1675	658[0n]	*Macaria notata*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92741		0	*Cabera pusaria*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92742	BOLD:AAB5336	658[0n]	*Campaea margaritaria*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92743	BOLD:AAB6675	658[0n]	*Hylaea fasciaria*	27.05.2015	Belen-Komurcukuru	36,4103	36,1169	1104
BC ZSM Lep 92744	BOLD:ACF4990	658[0n]	*Phaselia deliciosaria*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92745	BOLD:ACE7297	658[0n]	*Peribatodes rhomboidaria*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92746	BOLD:AAI0060	658[0n]	*Stueningia wolfi*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92747	BOLD:AAC0406	658[0n]	*Ascotis selenaria*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92748	BOLD:AAB3861	658[0n]	*Gnophos sartata*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92749	BOLD:AAE8708	658[0n]	*Charissa mardinaria*	27.05.2015	Belen, Tahtakopru, Benlidere	36,395	36,1581	450
BC ZSM Lep 92750	BOLD:ACE4009	658[0n]	*Idaea subsericeata*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92751	BOLD:AAB2099	658[0n]	*Idaea degeneraria*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92752	BOLD:AAE2645	658[0n]	*Idaea ostrinaria*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92753	BOLD:AAB6967	658[0n]	*Idaea trigeminata*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92754	BOLD:ABY5966	658[0n]	*Idaea consanguinaria*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92755	BOLD:ABY5966	658[0n]	*Idaea consanguinaria*	27.05.2015	Belen	36,3667	36,1797	235

Table 1. Continued.

Sample ID	BIN	COI-5P Seq. Length	Identification	Collection Date	Exact Site	Lat	Lon	Elev
BC ZSM Lep 92756	BOLD:AAB6665	658[0n]	*Scopula imitaria*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92757	BOLD:ABY5966	658[0n]	*Idaea consanguinaria*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92758	BOLD:AAB4028	642[0n]	*Idaea distinctaria*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92759	BOLD:AAC4899	658[0n]	*Scopula submutata*	17.05.2015	Samandag	36,0923	35,9747	61
BC ZSM Lep 92760	BOLD:AAB4028	658[0n]	*Idaea distinctaria*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92761	BOLD:AAA8256	596[1n]	*Idaea aversata*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92762	BOLD:AAA9359	658[0n]	*Idaea deversaria*	24.06.2015	Iskenderun	36,6439	36,3219	989
BC ZSM Lep 92763	BOLD:AAC3967	658[0n]	*Rhodostrophia discopunctata*	17.05.2015	Samandag	36,0923	35,9747	61
BC ZSM Lep 92764	BOLD:ACF3550	658[0n]	*Problepsis ocellata*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92765	BOLD:AAB2523	658[0n]	*Cyclophora puppillaria*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92766	BOLD:AAI8867	658[0n]	*Dysgonia algira*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92767	BOLD:AAA3364	658[0n]	*Agrotis ipsilon*	17.05.2015	Samandag, Musa dagi	36,1853	35,9831	519
BC ZSM Lep 92768	BOLD:AAC3884	658[0n]	*Agrotis segetum*	17.05.2015	Samandag, Musa dagi	36,1783	35,9831	724
BC ZSM Lep 92769	BOLD:ABV5016	658[0n]	*Caradrina clavipalpis*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92770	BOLD:AAA2633	658[0n]	*Noctua comes*	27.05.2015	Belen, Tahtakopru, Benlidere	36,395	36,1581	450
BC ZSM Lep 92771	BOLD:AAI7369	658[0n]	*Catocala* eutychea	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92772	BOLD:AAL0181	658[0n]	*Polyphaenis propinqua*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92773	BOLD:AAC1168	658[0n]	*Acronicta aceris*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92774	BOLD:AAC1168	658[0n]	*Acronicta aceris*	17.05.2015	Samandag, Musa dagi	36,1783	35,9831	724
BC ZSM Lep 92775	BOLD:AAG1829	658[0n]	*Eublemma ostrina*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92776	BOLD:AAA6511	658[0n]	*Diachrysia generosa*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92777	BOLD:AAA2632	658[0n]	*Noctua pronuba*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92778	BOLD:AAA2632	658[0n]	*Noctua pronuba*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92779	BOLD:AAF5900	658[0n]	*Minucia lunaris*	17.05.2015	Samandag, Musa dagi	36,1783	35,9831	724
BC ZSM Lep 92780	BOLD:ACI5080	658[0n]	*PlecopteraNoc inquinata*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92781	BOLD:AAJ1811	658[0n]	*Aedia funesta*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92782	BOLD:AAZ2913	658[0n]	*Mythimna congrua*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92783	BOLD:AAM5146	658[0n]	*Eutelia adulatrix*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92784	BOLD:ADC7408	658[0n]	*Eublemma gratissimaFC01*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92785	BOLD:ADC7408	658[0n]	*Eublemma gratissimaFC01*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92786	BOLD:AAB7661	658[0n]	*Oligia versicolor*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232

Table 1. Continued.

Sample ID	BIN	COI-5P Seq. Length	Identification	Collection Date	Exact Site	Lat	Lon	Elev
BC ZSM Lep 92787	BOLD:AAB4345	658[0n]	*Autographa gamma*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92788	BOLD:AAC3410	658[0n]	*Trichoplusia ni*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92789	BOLD:AAE0041	658[0n]	*Mythimna vitellina*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92790	BOLD:AAC6990	658[0n]	*Heliothis peltigera*	27.05.2015	Belen, Tahtakopru, Benlidere	36,395	36,1581	450
BC ZSM Lep 92791	BOLD:ACF0669	658[0n]	*Dysauxes famula*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92792	BOLD:ADC8529	658[0n]	*Metachrostis velocior*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92793	BOLD:ABX6591	658[0n]	*Apamea monoglypha*	27.05.2015	Belen-Komurcukuru	36,4103	36,1169	1104
BC ZSM Lep 92794	BOLD:ABX6591	658[0n]	*Apamea monoglypha*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92795	BOLD:AAN0315	658[0n]	*Amphipyra effusa*	27.05.2015	Belen, Tahtakopru, Benlidere	36,395	36,1581	450
BC ZSM Lep 92796	BOLD:ADC6751	658[0n]	*Nycteola*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92797	BOLD:AAB8918	658[0n]	*Drepana falcataria*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281
BC ZSM Lep 92798	BOLD:AAC5932	618[0n]	*Watsonalla uncinula*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92799	BOLD:ACF2447	658[0n]	*Phyllodesma tremulifolia*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92800	BOLD:AAD8930	658[0n]	*Marumba quercus*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92801	BOLD:AAA8863	658[0n]	*Sphinx pinastri*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92802	BOLD:ABY8586	658[0n]	*Hyles livornica*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92803	BOLD:AAJ3893	658[0n]	*Spatalia argentina*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92804	BOLD:ADC9219	658[0n]	*Drymonia querna djezina*	17.05.2015	Samandag, Musa dagi	36,1783	35,9831	724
BC ZSM Lep 92805	BOLD:ADC7169	658[0n]	*Parascotia nisseni*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92806	BOLD:AAC8627	658[0n]	*Arctia villica*	17.05.2015	Samandag, Musa dagi	36,1853	35,9831	519
BC ZSM Lep 92807	BOLD:ADC6333	658[0n]	*Amata phegea*	27.05.2015	Belen-Komurcukuru	36,4103	36,1169	1104
BC ZSM Lep 92808	BOLD:AAC1077	658[0n]	*Eilema sororcula*	24.06.2015	Iskenderun	36,6511	36,2833	982
BC ZSM Lep 92809	BOLD:ADC7270	658[0n]	*Paidia conjunctaFC01*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92810	BOLD:AAA2052	658[0n]	*Lymantria dispar*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92811	BOLD:ADC5862	658[0n]	*Parocneria terebynthi*	27.05.2015	Belen	36,3667	36,1797	235
BC ZSM Lep 92812	BOLD:ADC8183	658[0n]	*Ocneria ledereri*	17.05.2015	Samandag, Musa dagi	36,1494	35,9983	232
BC ZSM Lep 92813	BOLD:ADC9172	658[0n]	*Orgyia trigotephras orientalis*	27.05.2015	Belen, Tahtakopru, Benlidere	36,395	36,1581	450
BC ZSM Lep 92814	BOLD:ADC8562	658[0n]	*Dyspessa ululaFC01*	27.05.2015	Belen, Tahtakopru, Benlidere	36,395	36,1581	450
BC ZSM Lep 92815	BOLD:ADC7998	658[0n]	*Dyspessa ulula*	27.05.2015	Belen, Tahtakopru, Benlidere	36,395	36,1581	450
BC ZSM Lep 92816	BOLD:ADC8403	658[0n]	*Zeuzera*	13.05.2013	Kirikhan, Kumlu	36,3714	36,5439	79
BC ZSM Lep 92819	BOLD:ADC7648	658[0n]	*Synaphe connectalis*	02.05.2014	Serinyol, Yildirimlar	36,3861	36,1653	281

ACKNOWLEDGEMENTS

We thank Paul D. N. Hebert and his competent team (Biodiversity Institute of Ontario (BIO) and the Canadian Centre for DNA Barcoding (CCDB University of Guelph)) for supporting our genetic analyses. The data management and analysis system BOLD was provided by Sujeevan Ratnasingham. The work was financially supported by Genome Canada (Ontario Genomics Institute) in the framework of the iBOL program, WG 1.9.

REFERENCES

Anonymous, 2007. Türkiye 9 sıcak nokta-Amanos Dağları, *National Geographic,* Şubat.

Aytaç, A. S., 2010, *Amanos Dağlarının orta kesiminin doğal ortam, sosyo-ekonomik faaliyetler, koruma kriterleri ve çevre eğitimi açısından değerlendirilmesi*, Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü, İzmir, Doktora tezi, 327.

Aytaç, A. S., Semenderoğlu, A., 2012. Amanos Dağları'nın orta kesiminin, doğa koruma kriterleri açısından değerlendirilmesi. *Anadolu Doğa Bilimleri Dergisi*, 3(1): 1-16.

BOLD Data Systems, 2017, http://www.boldsystems.org/. (19.04.2017).

Can, F., Mironov, V., 2006, *Perizoma onurcani* sp. n. from Turkey (Geometridae: Larentinae). *Nota Lepidopterologica*, (3, 4): 163-166.

Can, F. C., 2008, The Geometrid Moths (Lepidoptera) from the Middle and Eastern Black Sea Regions of Turkey, *Turkish Journal of Zoology*, 32(3): 351-358.

De Lattin, G., 1951, *Türkische Lepidopteren II*. İstanbul Üniversitesi Fen Fakültesi Mecmuası (Seri B), 16(1): 45-73.

deWaard, J. R., Ivanova N. V., Hajibabei M., Hebert, P. D. 2008, *Assembling DNA barcodes: analytical protocols. In:* Martin C. (Ed.). Methods in molecular biology: environmental genomics methods. *Totowa*, *NJ: Humana Press*, 275-294.

Doğanlar, F., 2003, *Doğu Akdeniz Bölgesinde Geometridae (Lepidoptera) Familyası Üzerinde Faunastik ve Sistematik Araştırmalar*. Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Doktora Tezi, 275.

Ezer, T., 2008, *Güney Amanos Dağları (Musa dağı) Biryofit Florası ve Epifitik Biryofit Vejetasyonunun Araştırılması*. Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Doktora Tezi, 321.

Hausmann, A., 1996, Systematic list of the geometrid moths of the Levant and neigbouring countries. *Nota Lepidopterologica*, 19(1, 2): 91-106.

Hausmann, A., Godfray, H. C. J., Huemer, P., Mutanen, M., Rougerie, R., van Nieukerken, E.J., Ratnasingham, S., Hebert, P.D.N., 2013, Genetic patterns in European geometrid moths revealed by the Barcode Index Number (BIN) system. *Plos One,* 8(12):1-10.

Hebert, P. D. N., Cywinska, A., Ball, S. L., de Ward, J. R., 2003, Biological identifications through DNA barcodes. *Proceedings of the Royal Society London B: Biological Sciences*, 270(1512): 313-321.

Ivanova, N. V., Dewaard, J. R., Hebert, P. D. N. 2006. An inexpensive, automation-friendly protocol for recovering high-quality DNA. *Molecular Ecology Notes***,** 6(4): 998-1002.

Kansu, İ. A., 1963, Türkiye Lepidoptera faunası için ilkel liste: V. *Bitki Koruma Bülteni,* 3(3): 208-223.

Koçak, A. Ö., Kemal, M. 2007, Revised and annotated checklist of the Lepidoptera of Turkey. *Priamus, Serial Publication of the Centre for Entomological Studies Ankara,* 8: 26-42.

Koçak, A, Ö., Kemal, M., 2009, Revised checklist of the Lepidoptera of Turkey, *Priamus, Serial Publication of the Centre for Entomological Studies Ankara,* 17-11: 253.

Laštuvka, Z., Laštuvka, A., 2001, *The Sesiidae of Europe,* Apollo Books, Stenstrup, Denmark, 245.

Lederer, J., 1865, Excursion Lépidopterologique en Anatolie. *Annual Society of Entomology Belgique*, 9: 49-81.

Mathew, G.F., 1881, List of Lepidoptera observed in the neighbourhood of Gallipoli Turkey, in 1878. *Entomologist's Monthly Magazine*, 18: 10-13, 29-32, 92-100.

Okyar Z., Mironov V., 2008, Checklist of the Geometridae of European Turkey with new records (Lepidoptera). *Zootaxa,* 1789(1): 1-56.

Okyar, Z., 2010, A study on Geometridae moths (Lepidoptera) of the Eastern Black Sea Region (Ayder Plateau-Kaçkar Mountain-Turkey), with three new records. *Journal of the Kansas Entomological Society*, 83(3): 193-200.

Okyar, Z., 2012, Heteroceran (Lepidoptera) Fauna of Western Black Sea Region. *Trakya University Journal of Natural Sciences,* 13(1): 1-14.

Özdemir, M., Özdemir Y., Seven S., Bozkurt V., 2005, Orta Anadolu Bölgesinde kültür bitkilerinde zararlı Tortricidae (Lepidoptera) faunası üzerine araştırmalar. *Bitki Koruma Bülteni*, 45(1-4): 17-44.

Özkoçak, O. M., 1993, Hatay Horst ve Graben Yapısının Amanaos Dağları Altın Yatak Zuhurları. *Joeoloji* Mühend*isliği*, 42: 52-59.

Ratnasingham, S., Hebert, P. D. N. 2007, BOLD: The Barcode of Life Data System Molecular Ecology Notes. 7 (3): 355/364.

Seven, S., 1991, Trakya Lepidoptera faunası üzerine bibliyografik araştırmalar. *Priamus*, 6 (1/2): 1-95.

Wehrli, E., 1934, Lepidopteren-Fauna von Marasch in Türkisch Nordsyrien. *Mitteilungen der Münchner Entomologischen Gesellschaft,* 24: 1-57.

Wiltshire, E. P., 1990, *An illustrated, annotated catalogue of the Macro-Heterocera of Saudi Arabia*. *In:* Büttiker, W., Krupp, F. (Eds.). Fauna of Saudi Arabia,11: 91-250.

Zukowsky, B., 1941, Sivas and Akşehir in 1937. *Entomologische* Zeitschift, *Frankfurt,* 54: 266-272.

Received: April 21, 2017 *Accepted: November 21, 2017*