

Comparative Analysis of Habitat Preferences of the Diurnal Lepidoptera of Tuz Lake, Turkey

Selma Seven

Department of Biology, Gazi University Science Faculty, 06500 Ankara, Turkey; E-mail: selmaseven@gmail.com

Abstract: The diversity of diurnal Lepidoptera of Şereflikoçhisar District (located on the edge of the Tuz Lake, Turkey) was surveyed. In total 102 species belonging to 12 families were identified from the area. These species were recorded from six types of habitats: halophilous areas, stony and rocky slopes, agricultural lands, forest gaps, steppe areas and plantations. Preferred habitat types were evaluated and compared using Jaccard analysis. The highest species diversity was observed in steppe habitats (with 65 species). The pine plantations and stony and rocky areas had the lowest species diversity. Based on the results for the Jaccard Index, we found the least similarity between stony and rocky areas and halophilous areas. Halophilous lands and agricultural areas had the highest similarity.

Key words: Tuz Lake; diurnal Lepidoptera; habitat; analysis, Jaccard Index

Introduction

The Şereflikoçhisar District is situated to the south of Ankara and north-east of Tuz Lake, Ankara Province, Central Anatolia. The district is placed between Tuz Lake and Hirfanlı Reservoir. The south part of the area is located within the borders of the specially protected area of Tuz Lake, which is also an Important Plant Site (IPS: ADIGÜZEL *et al.* 2005), Important Nature Site (INS: BAŞAK & ERYILMAZ 2006), Important Bird Site (IBS: ERTAN *et al.* 1989), in which the widest halophilous steppes of Turkey are located. The biodiversity of this area is rich: 38 endemic and four endangered plant species, 129 insect and 15 mammal species have been reported (ANONYMOUS 2014).

The Şereflikoçhisar consists of plains with moderate altitude and continental climate. The dominating vegetation type is the steppe, i.e. moorland, due to the insufficient rainfalls in this area.

Studies on the Lepidoptera of the Şereflikoçhisar District around the Tuz Lake, are limited. HESSELBARTH *et al.* (1995) gave 17 butterfly species records from Şereflikoçhisar. SZEKELY (2000) reported 15 butterfly species from Ş. Koçhisar in a contribution to butterflies of Turkey. RONKAY *et al.* (1990),

KARSHOLT & RUTTEN (2005), YAKOVLEV (2008), CAN (2010) and FAZEKAS (2010) have studied moths of Şereflikoçhisar.

In order to prepare an action plan for conservation of the lepidopteran species in Şereflikoçhisar, first we need to list the butterfly species from the region and their habitat preferences. The present study on the diurnal Lepidoptera species from the Şereflikoçhisar area, including some parts of Tuz Lake, where for the first time relationship between habitat and lepidopteran species are examined.

Materials and Methods

Diurnal Lepidoptera species were collected within the borders of Şereflikoçhisar Province at daylight, between March-September 2012-2014. All samples were processed in accordance with methods used for preparation of museum materials and specimens were identified following SKOU (1986), JOSEF & THOMAS (1987, 2001), RONKAY (1990), KOCH (1991), HESSELBARTH *et al.* (1995), RAZOWSKI (2001), TSHIKOLOVETS (2011) and SLAMKA (2013). Some of the plant species in different habitats types were

taken from TUĞ (2006) and GÜLER (2011). Habitats were classified and presented in tables; relationships between habitat and butterfly species were evaluated using Jaccard analysis with Biodiversity Pro2 (Biodiversity Pro 2 1997).

We considered six main types of habitats suitable for lepidopteran species in the studied area:

- *Halophilous areas* (Figs. 1, 2): They are characterised by low vegetation cover. Areas completely covered with salt are very poor of vegetation cover. Higher diversity can be observed in the ruderal areas at the side of the Tuz Lake. The dominant species in halophilous areas belong to Chenopodiaceae, Plumbaginaceae and Poaceae: *Halocnemum strobilaceum*, *Puccinellia convoluta*, *Aerulopus litoralis*, *Petrosimonia brachiata*, *Halimione verrucifera*, *Limonium iconicum*, *Frankenia hirsuta*, *Lepidium caespitosum* and *Salsola stenoptera*.

- *Steppe areas* (Fig. 3): A large portion of the survey area is steppe. These areas are either as arid (xerophilous) or humid steppe (malacophilous). Some of these are used as agricultural lands as well, while some parts are deteriorated due to the salt industry. Dominant plant species here are *Artemisia santonicum*, *Achillea wilhelmsii*, *Allium pseudoflavum*, *A. scabriflorum*, *Krascheninnikovia ceratoides*, *Reaumuria alternifolia*, *Alyssum blephocarpum*, *Anthemis fumariifolia*, *Verbascum helianthemoides*, *Peganum harmala*, *Astragalus condensatus* and *Senecio vernalis*.

- *Agricultural areas* (Fig. 4): Many areas in the region are more commonly used as dry land farming areas. The northern parts, where the İrfanlı Reservoir is located, are deteriorated. Dominant plant species here are *Anchusa azurea*, *Senecio vernalis*, *Carduus nutans*, *Centaurea solstitialis*, *Xeranthemum annuum* and *Taraxacum scaturiginosum*.



Fig. 1. Halophilous area. Edge of Salt Lake, 20 km north of Şereflikoçhisar, altitude 923 m



Fig. 2. Halophilous area. Şereflikoçhisar, Hamzalı, 910 m



Fig. 3. Steppe dominated by *Artemisia* sp. Şereflikoçhisar, south of Akın village, altitude 960 m



Fig. 4. Şereflidavutlu, 1058 m, oak forest community

- *Rocky and stony areas* (Fig. 5): Poor vegetation areas dominated by rocks and stones are included in this group. Dominant plant species here are *Amygdalus orientalis*, *Astragalus microcephalus*, *Reseda lutea* and *Rhamnus* sp.

- *Forest gaps* (Fig. 6): Particularly between the Karandere – Peçenek Reservoir and Şereflidavutlu.



Fig. 5. Stony area between Şereflikoçhisar-Şereflidavutlu road, altitude 950 m



Fig. 6. Agricultural lands, Şereflikoçhisar, Sadıklı, 1060 m

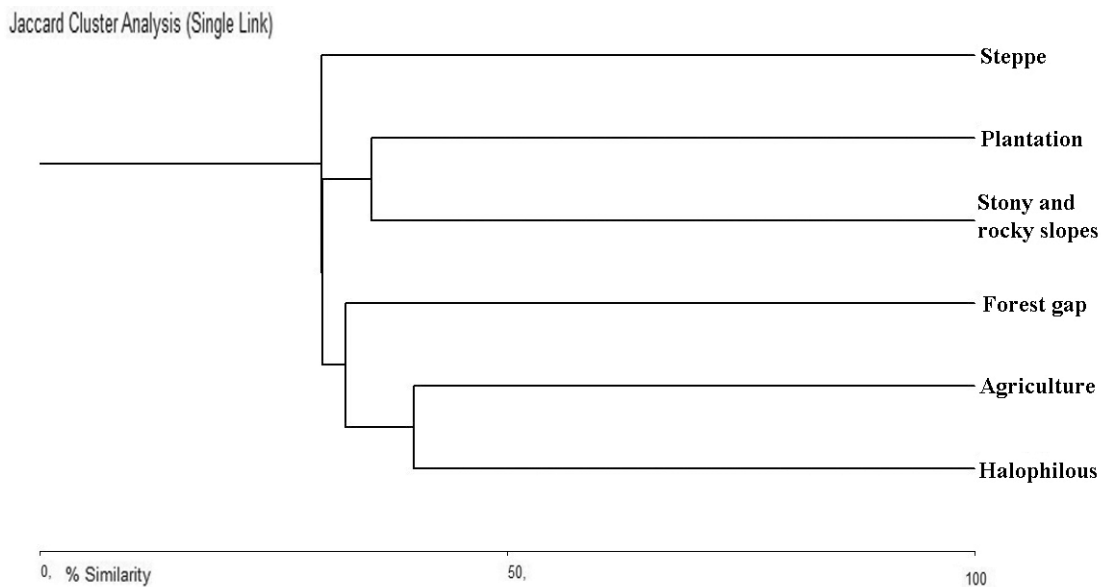


Fig. 7. Habitat types and number of species of diurnal Lepidoptera

Some parts contain damaged oak forest (*Quercus pubescens*, *Juniperus oxycedrus*, etc.) remains.

- *Plantation*: Pine (*Pinus nigra*) plantation areas near the rocky valley are included in this group.

Results and Discussion

In this study, 102 species of 12 families were identified from various habitats (Table 1).

According to the Tuz Lake Special Environmental Protection Zone Management Plan (2014-2018) and for butterflies only seven butterfly species were recorded around Şereflikoçhisar: *Colias croceus*, *Pieris brassicae*, *Pontia edusa*, *Chazara briseis*, *Brenthis daphne* and *Argynnis paphia* (ANONYMOUS 2014). Previous records of *Plebejus argyrognomon* in Şereflikoçhisar is prob-

ably erroneous as this species is distributed only locally in north-eastern Anatolia. SZEKELY (2000) has reported 15 butterfly species from Şereflikoçhisar. In our research, even though the other 14 species were recorded from the area, *Pseudochazara telephassa* was not detected. This record needs to be verified in the future.

The highest species diversity in Şereflikoçhisar was observed for the steppe habitat type (65 species), followed by halophilous areas and forest gap habitats. The lower diversity in halophilous habitat is likely due to both use of a part of these areas as cultivated areas and the negative effect of the adjacent ruderal areas on the species diversity of the diurnal Lepidoptera. The poorest diversity was recorded in pine plantation and in stony and rocky areas (Fig. 7).

Table 1. Species lists and their natural habitat types (A=Halophil, B= Stony and rocky slopes, C=Agriculture, D=Forest grad E=Steppe, F=Plantation)

Family	Taxon	Habitat types						
		A	B	C	D	E	F	
Papilionidae	1. <i>Papilio machaon</i> (L., 1758)	X		X	X	X	X	
	2. <i>Archon apollinus</i> (Herb., 1798)			X				
	3. <i>Zerynthia (Allancastrina) deyrollei</i> (Ob., 1869)			X				
Pieridae	4. <i>Pieris (s.str.) brassicae</i> (L., 1758)	X		X		X		
	5. <i>Pieris (Artogeia) rapae</i> (L., 1758)	X		X		X	X	
	6. <i>Pieris (Artogeia) pseudorapae</i> Ver., [1908]				X		X	
	7. <i>Leptidea duponcheli</i> (St., 1871)			X		X		
	8. <i>Leptidea sinapis</i> (L., 1758)					X		
	9. <i>Anthocharis gruneri</i> H.-Sch., [1851]				X		X	
	10. <i>Euchloe (s.str.) ausonia</i> (Hüb., [1804])	X		X				
	11. <i>Pontia edusa</i> (Fab., 1777)	X	X	X	X	X	X	
	12. <i>Colias (Eriocolias) croceus</i> (Four., 1785)	X	X	X	X	X	X	
	13. <i>Colias (s.str.) alfacariensis</i> Ribbe, 1905		X		X	X		
	14. <i>Zegris eupheme</i> (Esper, 1804)					X		
	15. <i>Gonepteryx (s.str.) rhamnii</i> (L., 1758)					X		
	16. <i>Euchloe penia</i> (Freyer, 1851)					X		
	Nymphalidae	17. <i>Vanessa (Cynthia) cardui</i> (L., 1758)	X	X	X	X	X	X
		18. <i>Aglais urticae</i> (L., 1758)		X				X
		19. <i>Argynnis (Pandoriana) pandora</i> ([D. & Sch.], 1775)		X				
20. <i>Issoria lathonia</i> (L., 1758)		X		X			X	
21. <i>Brenthis daphne</i> (Bergst., 1780)						X		
22. <i>Argynnis (Fabriciana) niobe</i> (L., 1758)						X		
23. <i>Melitaea (Cinclidia) phoebe</i> (Goeze, 1779)			X					
24. <i>Melitaea (s.str.) cinxia</i> (L., 1758)						X		
25. <i>Melitaea (Cinclidia) ornata</i> Christoph, 1893						X		
26. <i>Melitaea (Didymaeformis) didyma</i> (Es., [1779])						X		
27. <i>Melitaea trivialis</i> ([D.&Sch.], 1775)						X		
28. <i>Proterebia afra</i> (Fabr., 1787)			X	X		X	X	
Satyridae		29. <i>Maniola jurtina</i> (L., 1758)				X	X	
	30. <i>Melanargia (Turcargia) larissa</i> (Geyer, [1828])	X		X		X		
	31. <i>Lasiommata megera</i> (L., 1767)		X		X			
	32. <i>Pseudochazara (s.str.) pelopea</i> (Klug, 1832)		X					
	33. <i>Pseudochazara (Achazara) anthelea</i> (Hüb., [1824])		X			X		
	34. <i>Chazara (s.str.) briseis</i> (L., 1764)	X	X		X			
	35. <i>Chazara (s.str.) bischoffi</i> Herr.-Sch., [1846])		X					
	36. <i>Coenonympha (s.str.) pamphilus</i> (L., 1758)		X	X	X	X		
	37. <i>Hyponephele lycaon</i> (Rott., 1775)	X						
	38. <i>Hyponephele lupina</i> (C., [1836])	X	X	X				
	39. <i>Pseudochazara (s.str.) mnischechii</i> (H.-Sch., [1851])		X					
Lycaenidae	40. <i>Chilades (Freyeria) trochylus</i> (Fr., [1843])		X			X	X	
	41. <i>Polyommatus (Thersitesia) thersites</i> (Cant., [1835])	X	X	X	X	X		
	42. <i>Lycaena (Loweia) tityrus</i> (Pd., 1761)		X		X	X	X	
	43. <i>Satyrium (Nordmannia) abdominalis</i> (Ger., [1850])				X			
	44. <i>Tomares nesimachus</i> (Ob., 1893)					X	X	
	45. <i>Lycaena (s.str.) phlaeas</i> (L., 1761)	X		X	X			
	46. <i>Lycaena (Alciphronia) alciphron</i> (Rott., 1775)					X		
	47. <i>Thersamonia (s.str.) thersamon</i> (Es., [1784])	X			X	X		
	48. <i>Lycaena ochimus</i> (H.-Sch., [1851])				X	X		
	49. <i>Plebejus (Plebejides) modicus</i> Verity, 1935							
	50. <i>Pseudophilotes vicrama</i> (Moore, 1865)				X	X		
	51. <i>Glaucopteryx (s.str.) alexis</i> (P., 1761)	X						
	52. <i>Celastrina argiolus</i> (L., 1758)					X		
	53. <i>Lampides boeticus</i> (L., 1767)	X		X		X	X	
	54. <i>Polyommatus (Albulina) loewii</i> (Zel., 1847)	X				X		
	55. <i>Polyommatus (s.str.) icarus</i> (Rott., 1775)	X	X	X	X			
	56. <i>Polyommatus (Aricia) agestis</i> ([D. & Sch.], 1775)	X		X	X	X	X	
57. <i>Polyommatus (Agrodiaetus) admetus</i> (Esp., [1783])								
58. <i>Polyommatus (Agrodiaetus) demavendi</i> (Pf., 1938)	X							
59. <i>Polyommatus (Agrodiaetus) menalcas</i> (Fr., [1837])				X	X			
60. <i>Polyommatus (Agrodiaetus) hopfferi</i> (Gerh., [1851])				X	X			
61. <i>Polyommatus (Meleageria) daphnis</i> ([D. & Sch.], 1775)	X	X	X	X	X	X		
62. <i>Cupido (s.str.) osiris</i> (Meig., [1829])				X	X			
63. <i>Plebejus (Kretania) carmon</i> (Gr., [1851])					X			
64. <i>Plebejus (s.str.) argus</i> (L., 1758)				X	X			

Table 1. Continued

Family	Taxon	Habitat types					
		A	B	C	D	E	F
Hesperiidae	65. <i>Thymelicus acteon</i> (Rott., 1775)	X					
	66. <i>Thymelicus lineola</i> (Och., 1808)					X	
	67. <i>Thymelicus sylvestris</i> (Poda, 1761)	X		X		X	
	68. <i>Carcharodus (s.str.) alceae</i> (Es., [1780])		X			X	X
	69. <i>Eogenes alcites</i> (H.-Sch., [1852])	X			X	X	
	70. <i>Carcharodus (Reverdinus) orientalis</i> Reverdin, 1913					X	
	71. <i>Muschampia nomas</i> (Led., 1855)					X	
	72. <i>Spialia (Neospialia) orbifer</i> (Hüb., [1823])		X			X	X
	73. <i>Pyrgus melotis</i> (Dup., [1834])						
	74. <i>Spialia phlomidis</i> (H.-Sch., [1845])				X	X	
75. <i>Erynnis (s.str.) tages</i> (L., 1758)	X			X			
76. <i>Thymelicus hyrax</i> (Led., 1861)	X				X		
Zygaenidae	77. <i>Zygaena (Agrumenia) loti</i> ([D. & Sch.], 1775)					X	
	78. <i>Zygaena (s.str.) filipendulae</i> (L., 1758)	X				X	
	79. <i>Zygaena (Agrumenia) formosa</i> H.-Sch., [1852]	X				X	
Pyralidae	80. <i>Evergestis frumentalis</i> (L., 1761)			X	X	X	
	81. <i>Aporodes floralis</i> (Hüb., [1809])	X				X	
	82. <i>Endotricha flammealis</i> ([D. & Sch.], 1775)					X	
	83. <i>Synphe moldavica</i> (Es., [1789])	X	X		X	X	X
	84. <i>Nomophila noctuella</i> ([D. & Sch.], 1775)	X		X	X	X	
	85. <i>Tretopteryx pertusalis</i> (Geyer, [1832])					X	
Geometridae	86. <i>Chrysocrambus craterellus</i> (Scop., 1763)	X	X			X	
	87. <i>Scotopteryx chenopodiata</i> (L., 1758)					X	
	88. <i>Aspitates ochrearia</i> (Rossi, 1794)					X	
	89. <i>Lythria rotaria</i> (Fab., 1798)	X					
	90. <i>Lythria purpuraria</i> (L., 1758)	X					
	91. <i>Rhodometra sacraria</i> (L., 1767)	X				X	
	92. <i>Rhodostrophia calabra</i> (Petagna, 1786)					X	
Tortricidae	93. <i>Rhodobates laevigatellus</i> (H.-Sch., [1854])					X	
	94. <i>Tortrix viridana</i> (L., 1758)	X			X		
Noctuidae	95. <i>Tyta luctuosa</i> ([D. & Sch.], 1775)					X	
	96. <i>Acontia (Emmelia) trabealis</i> (Scop., 1763)	X			X	X	
	97. <i>Eublemma parva</i> (Hüb., [1808])	X					
	98. <i>Eublemma purpurina</i> ([D. & Sch.], 1775)					X	
	99. <i>Autographa gamma</i> (L., 1758)	X				X	
	100. <i>Calamia staudingeri</i> Warnecke, 1941	X					
Sphingidae	101. <i>Polymixis paravarga</i> (Ronkay, 1990)	X					
	102. <i>Macroglossum stellatarum</i> (L., 1758)					X	
Total		39	23	24	30	65	19

Table 2. Similarity proportions of habitat types in terms of species diversity, calculated using Jaccard Index.

	Halophilous	Stony and rocky slopes	Agriculture	Forest gap	Steppe	Plantation
Halophil	*	16,9811	40	32,6923	28,3951	20,8333
Stony and rocky slopes	*	*	23,6842	26,1905	17,3333	35,4839
Agriculture	*	*	*	28,5714	23,6111	30,303
Forest gap	*	*	*	*	30,137	25,641
Steppe	*	*	*	*	*	21,7391
Plantation	*	*	*	*	*	*

Jaccard Index similarity proportions demonstrated that stony and rocky and halophilous areas have the least similarity. The highest was the similarity proportion for halophilous and agricultural areas (Table 2).

For all the habitats evaluated in the study area, there was a species similarity of 30%. I found that steppe and other habitat types form two distinct clusters. Based on species diversity, the steppe stands out from the other habitat types, being the main habi-

tat structure of the area. Forest gaps, positioned in the other cluster, is another habitat type that may be considered as natural in the area. As it is represented by narrow areas due to deterioration, the number of the recorded species was lower than expected. Agricultural and halophilous areas are the most similar habitat types in terms of butterfly species. This is likely related to the fact that some parts of halophilous areas are used as agricultural lands. Plantation and stony rocky areas, partaking within the steppe

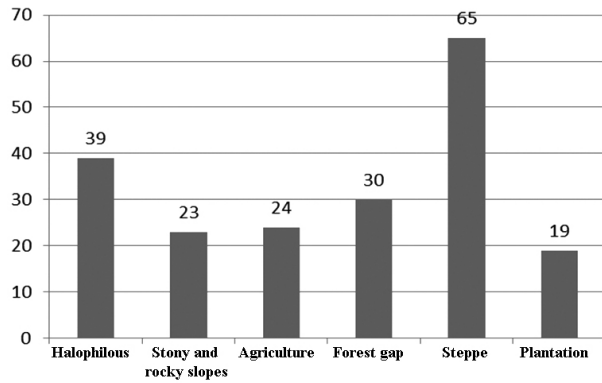


Fig. 8. Similarity diagram of studied habitats according to Jaccard Index (Cluster analysis)

References

- ANONYMOUS 2014. Tuz Gölü Özel Çevre Koruma Bölgesi Yönetim Planı. – *Çevre ve Şehircilik Bakanlığı*, 192 pp.
- ADIGÜZEL N., BYFIELD A., DUMAN H. & VURAL M. 2005. Tuz Gölü stepleri. – In: ÖZHATAY, N., BYFIELD, A. & ATAY, S. (eds.) Important Plant Areas of Turkey. (In Turkish).
- BAŞAK E. & ERYILMAZ Ç. D. 2006. Tuz Gölü. – In: EKEN G., BOZDOĞAN M., İSFENDİYAROĞLU S., KILIÇ D.T. & LISE Y. (eds.): Important Nature Areas of Turkey. (In Turkish).
- BIODIVERSITY PRO v2, 1997. The National History Museum and the Scottish Association for Marine Sciences, Oban, UK. Available online <http://www.sams.ac.uk>
- CAN F. 2010. Evaluation of morphological characters and male genitalia features of emerald moths (Lepidoptera: Geometridae, Geometrinae) from Turkey. – *African Journal of Agricultural Research*, **5** (9): 867-873.
- ERTAN A., KILIÇ A. & KASPAREK M. 1989. Important Birds Areas of Turkey. (In Turkish).
- FAZEKAS I. 2010. Notes on the genus *Agdistis* from Asia Minor, with descriptions of two new species (Lepidoptera, Pterophoridae, Agdistinae). – *Nachrichtenblatt der Bayerischen Entomologen*, **49** (1/2): 2-10.
- GÜLER F. 2011. The Flora of Paşa Mountain (Şereflikoçhisar/Ankara). MSc Thesis, 129 pp. (In Turkish).
- HESELBARTH G., VAN OORSCHOTT H. & WAGENER S. 1995. *Die Tagfalter der Türkei unter Berücksichtigung der angrenzenden Länder* Vol. 1+2, 1354 pp., Vol. 3, 847 pp.
- JOSEF J. DE F. & THOMAS J. W. 1987. Die Bombyces und Sphinges der Westpalaearktis, Band 1. *Noctuoidea – Bombycoidea*.
- JOSEF J. DE F. & THOMAS, J. W. 2001. Die Bombyces und Sphinges der Westpalaearktis, Band 3. *Zygaenidae*.
- KARSHOLT O. & RUTTEN T. 2005. The genus *Bryotropha* Heinemann in the western Palearctic (Lepidoptera: Gelechiidae). – *Tijdschrift voor Entomologie*, 148: 77-207.
- KOCH M. 1991. Wir bestimmen Schmetterlinge. 792 pp. Neumann Verlag. Germany.
- ÖZHATAY N., BYFIELD A. & ATAY S. 2005. 122 Important Plant Areas of Turkey, WWF Türkiye, Istanbul, Turkey. (In Turkish).
- RAZOWSKI J. 2001. Die Tortriciden (Lepidoptera, Tortricidae) Mitteleuropas. Bestimmung – Verbreitung – Flugstandort Lebensweise der Raupen. F. Slamka, Bratislava, 319 pp.
- RONKAY G., FABIAN B., HERCZIG B. T. & SZABÓKY B. 1990. Contributions to the Noctuidae fauna of Turkey (Lepidoptera). – *Annales historico-naturales Musei nationalis hungarici*, **81**: 115-123.
- SKOU P. 1986. The Geometroid Moths of North Europe (Lepidoptera: Drepanidae and Geometridae). Copenhagen, 236 pp.
- SLAMKA F. 2013. Pyraloidea of Europe (Lepidoptera). Vol. 3, Pyraustinae & Spilomelinae, 357 pp.
- SZEKELY L. 2000. Contributions to the Knowledge of the Lepidoptera fauna of Turkey. I. (Hesperiidae & Rhopalocera). Asociația Muzeografilor Naturaliști din România Naturalia, Studii și Cercetări, Tom 4-5. Brașov, Romania.
- TSHIKOLOVETS V. 2011. Butterflies of Europe & the Mediterranean area, 544 pp.
- TUĞ G. N. 2006. Determination of the factors effective on zonation of halophytic vegetation of Salt Lake inner Anatolia, Turkey. PhD Thesis. 203 pp. (in Turkish).
- YAKOVLEV R. V. 2008. New species of Palearctic and Oriental Cossidae (Lepidoptera). IV. New taxa of the genus *Dyspessa* Hübner, [1820] from the Mediterranean–Iranian Region. *Eversmannia*, 15–16; 53–68.

Received: 11.05.2016

Accepted: 16.08.2016