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NIGHT-ACTIVE MACROHETEROCERA SPECIES IN TRAPS WITH SYNTHETIC ATTRACTANTS IN THE VELYKA DOBRON'

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We allocated some new types of bait traps using different volatile aromatic compounds in the Velyka Dobron' Game Reserve (Ukraine, Transcarpathian region) where light trap surveys on Macroheterocera were already carried out since 2009. The phenylacetaldehyde-based traps were especially effective for the species of subfamilies Plusiinae and Heliothinae, while the members of some other subfamilies (Hadeninae, Noctuinae) were more attracted by the isoamyl-alcohol-based traps. The highest attractivity was observed in case of the mixture containing isoamyl-alcohol, acetic acid and red wine. The highest number of species was observed in mid-July, but the peak of individual numbers appeared in early August. Majority of species of this assemblage was formed by bivoltine species connected to herbaceous food plants. The dominant species of this late summer period was *Trachea atriplicis* (second brood). It was sharply replaced by the monovoltine *Allophyes oxyacanthae* in September. The bulk of species of this early autumnal period was formed by monovoltine species with woody-shrubby larval food plants. Biogeographical spectrum of the assemblage was dominated by widely distributed Euro-Siberian species combined with significant presence of Mediterranean and Boreo-continental faunal elements. In the ecological spectrum of the assemblage the species connected to forested habitats are well represented but together with the presence of numerous generalist species.

Key words: bait traps, Noctuidae, phenylacetaldehyde, isoamyl-alcohol, Transcarpathia, faunal elements

INTRODUCTION

Different types of light and bait traps are widely used in insect faunistical surveys and in the monitoring of night-active species. The first effective light traps were constructed in the first half of the 20th century (Herczig 1983, Lödl 2000). At the end of 1950s Jermy initiated the establishment of a light trap network for plant protection aims (Jermy 1961). Some years later, the Research Institute of Forestry organised a country-wide network of prognostic light-traps following the standards of the Jermy's light traps. This system proved to be extremely useful for the forecasting of different pest species and supplied an immense amount of faunistical data (e.g. Mészáros 1966, 1967, Rézbányai 1974, Leskó & Szabóky 1997, Leskó *et al.* 1998, 2001, Szentkirályi 2002). The long-term data series have also been recently analysed to survey the effects of the actual climate change (e. g. Szabó *et al.* 2007, Altermatt 2010, Gimesi *et al.* 2012, Végvári *et al.* 2014).

It is well known, however, that all light traps are selectively functioning. Their attractivity mostly depends on the phototaxic activity of insects which is strongly influenced by the physiological disposition of individuals (e.g. reproduction, feeding) and also by several environmental factors (temperature, air pressure, humidity and precipitation, disturbing light sources including moonlight, etc., see Ho & Reddy 1983, McGeachie 1989, Yela & Holyoak 1997, Nowinszky 2003, Jonason *et al*. 2014).

Numerous types of bait traps are also well known and widely used. Different mixtures of honey, fruit extracts and alcoholic drinks (beer, wine) were used from the second half of the 19th century (Kelecsényi 1885, Abafi-Aigner 1907, Mészáros & Vojnits 1972, Petrich 2001). They became, however, in the monitoring schemes overshadowed by the popularity of modern, transportable light sources since the end of the last century (e.g. Leinonen *et al.* 1998, EASAC 2004, Bates *et al.* 2013, Merckx & Slade 2014).

Traps baited with synthetic sex pheromone have widely been used for suppression and control of some pest species of agriculture and forestry. However, these often have captured also numerous non-target species (Weber & Ferro 1991, Hrudová 2003, Myers *et al.* 2009). Additionally, they were also unsuitable to signalise the sex-ratios of the target populations (e.g. Laurent & Frérot 2007, Bereś 2012). Therefore, recently new types of bait traps were developed using different volatile, synthetic compounds. The first experiments were carried out with phenylacetaldehyde which was attractive for females of Noctuidae (Cantelo & Jacobson 1979). They also used bait traps additionally containing the extracts of some moth-visited flowers (e.g. *Araujia*). Some years later the attractivity of the combination of acetic acid and isoamyl-alcohol (3-methyl-1-butanol) was shown in the traps (Landolt 2000, Landolt & Alfaro 2001). They proved to be effective in cases of several cutworm and armyworm pest species as *Xestia c-nigrum, Mamestra configurata* and *Lacanobia subjuncta.* Some years later the grass looper species (*Mocis* spp.) were successfully captured by phenylacetaldehyde-baited traps (Meager & Mislevy 2005). Such traps with synthetic attractants were recently successfully used in Alaska. Here the traps baited with multicomponent floral extracts (phenylacetaldehyde, methylsalicilate, methyl-2-methoxybenzoate, β-myrcene) proved to be the most effective (Landolt *et al.* 2007).

The first successful experiments with these compounds in different combinations were started in Hungary some years ago (Tóth *et al.* 2010). They also tested the effects of different synthetic synergistic compounds. According to surveys carried out in agricultural areas, the phenylacetaldehyde-based lures were especially effective for the species of subfamilies Plusiinae and Heliothinae, while the members of some other subfamilies (Hadeninae, Noctuinae) were more attracted by the isoamyl-alcohol-based lures (Nagy *et al.* 2014). Thus, not only the farmland species were captured but also faunal components of different semi-natural and natural habitats were signalised. The high number of captured species allows also the faunistical and community ecological surveys and the comparison with light trap data.

We allocated some different types of bait traps in the Velyka Dobron' Game Reserve (Ukraine, Transcarpathian region) where faunistical surveys on nocturnal Macroheterocera were already carried out since 2009 by light trapping. These surveys were focused on the following aims: (i) to see whether the faunistical results will be completed by new species not registered by light trapping; (ii) to see whether we can observe differences in the attractivity of the two different synthetic lures concerning species composition and individual numbers; (iii) to see whether we can find some differences in the composition of faunal types and habitat preferences of the captured species by different types of traps (light vs. baits or different composition of baits? (iv) to see whether we could draw some conclusions on the phenology of the observed moth species and composition of assemblages despite of the fact that the trapping was carried out in the second half of the vegetation period only?

MATERIAL AND METHODS

Characterisation of the sampling area

The Game Reserve of Velyka Dobron' is located on the marginal area of the former Szernye peatland. Although the ancient flora and vegetation of the peatland was extremely rich and valuable (Simon 1952, Boros 1964), the most important relict habitats and species have became extinct. The area is recently dominated by secondary vegetation with some fragments of the original wetland and forest vegetation. An extended oak-ash-elm hardwood gallery forest represents the most important and most natural habitat type of the Reserve. The canopy coverage is between 70–100% and is formed by *Quercus robur, Fraxinus angustifolia* subsp. *pannonica, Ulmus laevis, Populus canescens*, *Frangula alnus,* etc. The lowland pedunculate oak-hornbeam forest, rich in geophytic species (*Scilla drunensis, Anemone nemorosa, A. ranunculoides, Isopyrum thalictroides*, etc.) and dominated by *Q. robur* and *Carpinus betulus* represents the climax association of the region. Other components of the natural and semi-natural vegetation are the more xerophilous silver lime (*Tilia tomentosa*) – oak forests and forest fringes, the tall forb forest fringes, the mesic and humid forest clearings and willow scrubs. The reserve is surrounded by extended agricultural areas and dissected by drainage channels of the former peatland.

Methods of the trapping

The surveys were carried out in a marginal area of the reserve, in 2014, in the second half of the vegetation period. Near to the edge of the forest CSALOMON® VARL+ funnel traps (MTA ATK Plant Protection Institute, Budapest, Hungary) were placed out baited with synthetic compound previously isolated and identified from fermenting bait liquids (= FERM) (Landolt 2000) or with synthetic floral compounds (= FLORAL), which had previously been isolated and identified from the flower scent of several plants. Traps without baits were also set out for control.

Polypropylene tubes with 4 ml capacity were used as dispensers for the FERM bait (Tóth *et al.* 2015). The synthetic compounds were administered on the dental rolls inside the tubes. The upper, larger opening of the tube was closed. The bait mixture could evaporate across the smaller opening with 4 mm diameter, which was opened when setting out in the field. The attractant contained iso-amyl alcohol, acetic acid and red wine (1:1:1; 3 ml). The wine was prepared (cellary of Dr. G. Vörös) by processing of different grape sorts: Bluefrankish (70%), Merlot (15%), Kadarka (7.5%) and Blauburger (7.5%). Its alcohol content was 13.6–13.8%, the volatile acid (acetic acid) content 0.4–0.6 g/l.

Traps with the FLORAL lure were baited with two separate polyethylene bag dispensers (Tóth *et al.* 2002). One of the dispensers contained the mixture (1:1:1, 0.6 ml) of phenylacetaldehyde, eugenol and benzyle acetate (this combination has previously been optimized for *Autographa* spp.; Tóth M. & Szarukán I., unpub.), while the second dispenser contained a mixture (1:1, 0.4 ml) of phenylacetaldehyde and trans-anethol (this combination has previously been optimized for *Helicoverpa armigera;* Tóth M. & Szarukán I., unpubl).

The moths trapped were killed by Vaportape® II insecticide strip developed especially for use in insect traps (10% 2,2 dichlorovinyl dimethyl phosphate). Insecticide does not affect the attractivity of bait and kills insects relatively quickly in the trap. All bait trap types were exposed in four repetitions, i.e. 4×3 traps were placed in the survey area on trees, in 20 m distance from each other, in 1.8–2 m elevations. The traps were used between 20th July and 19th October. They were emptied once in a week and were rotated weekly to mitigate the local effects. The collected material was stored deep-frozen until working up. We identified all individuals until species if possible and calculated the relative frequency of species. The Noctuoidea taxa were identified according to Gyulai *et al*. (2012). The taxonomic list follows the system of Lafontaine & Schmidt (2010) with modifications of Zahiri *et al.* (2012). The subdivision of faunal elements and faunal components follows Varga *et al*. (2004). The data on life cycle (voltinism) and bionomy (herbaceous vs woody food plants) of species was obtained mostly from standard works on European moths (e.g. Noctuidae Europae, Ronkay *et al.* 2001, Hacker *et al.* 2002, Fibiger *et al.* 2009, 2010) but also from the references about light trap surveys on Hungarian night-active macro-moths (e. g. Varga & Uherkovich 1974, Leskó *et al.* 1994, 2001, Nowinszky 2003, Szabó *et al.* 2007, Végvári *et al.* 2014).

Data analysis

In order to characterize the selectivity and attractivity of different baits the total and mean number of sampled species and individuals per traps, number of differencial species and Shannon-Wiener diversity (H) were used. Considering that our data did not meet the assumptions of parametric tests the attractivity of different baits were compared with Kruskall-Wallis nonparametric test. Pairs showing significant differences were compared by Mann-Whitney U-test (Reiczigel *et al.* 2007). Statistical analyses were performed by SPSS 21.0 (Ketskeméty *et al.* 2011).

RESULTS

During the relatively short sampling period we registered 1815 individuals belonging to 107 species of Macro-moths (Table 1): Sphingidae 1; Thyatiridae 3; Geometridae 15; Erebidae 15, Noctuidae 69 species) and 4 species of butterflies, furthermore to 2 families (Hepialidae, Pyralidae) of Microlepidoptera. This species list contains 30 „new" species (Geometridae 2 species), Erebidae 5 species and Noctuidae 23 species) which have earlier not recorded from the survey area (Table 1). Thus, the number of hitherto observed species in the Velyka Dobron' Game Reserve increased from 352 (Szanyi 2015, Supplement) to 383.

The bait traps also attracted a huge mass of other insects. Unfortunately, the numerous individuals of hornets (*Vespa crabro*) and larger beetles (mostly Silphidae and Scarabaeidae) utterly damaged the collected material, mostly in warm summer nights. Thus some few specimens could only identified as

Table 1. List of the species captured by baited traps in the Weliky Dobron Game Reserve in 2014 with their faunal types (FT) and components (FC), total number of sampled individuals (Ns), mean number of sampled individuals per trap (Nt±SE) and number of samples draw into the analysis. Bold: species sampled only in baited traps (S = 30). BorCo = Boreo-continental, EuSib = Euro-Siberian, ExtPal = Extra-Palaearctic, Med = Mediterranean, SCon = Southern-continental, Altherb = altoherbosa, DecFo = deciduous forest, Mesop = Mesophil, Migr = migrant, Gen = generalist, MarFo = marshy forest.

Species	FT	FC	n	Ns	Agam Nt±SE	NAA Nt±SE
Deilephila porcellus (Linnaeus, 1758)	EuSib	Gen	12	1	0.00±0.00	0.25±0.25
Thyatira batis (Linnaeus, 1758)	EuSib	DecFo	108	89	0.25±0.25	22.00±6.75
Tethea or ([Den. et Schiff.], 1775)	EuSib	DecFo	72	19	0.00±0.00	4.75±2.06
Habrosyne pyrithoides (Hufnagel, 1766)	EuSib	DecFo	84	14	0.00±0.00	3.50±0.29
Idaea aversata (Linnaeus, 1758)	Med	DecFo	36	4	1.00±0.71	0.00±0.00
Idaea biselata (Hufnagel, 1767)	EuSib	MarFo	12	1	0.25±0.25	0.00±0.00
Scopula nemoraria (Hübner, 1799)	BorCo	MarFo	12	1	0.25±0.25	0.00±0.00
Cyclophora puppillaria (Hübner, 1799)	Med	Migr	12	1	0.25±0.25	0.00±0.00
Epirrhoe alternata (Müller, 1764)	EuSib	Gen	12	1	0.25±0.25	0.00±0.00
Euphya unangulata (Haworth, 1809)	BorCo	DecFo	12	2	0.00±0.00	0.50±0.50
Camptogramma bilineata (Linnaeus, 1758)	EuSib	DecFo	48	5	1.25±0.95	0.00±0.00
Spargania luctuata ([Den. et Schiff.], 1775)	BorCo	DecFo	12	1	0.25±0.25	0.00±0.00

Table 1 (continued)

Species	FT	FC	n	Ns	Agam Nt±SE	NAA Nt±SE
Cosmorhoe ocellata (Linnaeus, 1758)	EuSib	DecFo	60	7	0.50±0.29	1.25±0.63
Ligdia adustata ([Den. et Schiff.], 1775)	Med	DecFo	12	1	0.25±0.25	0.00±0.00
Epione repandaria (Hufnagel, 1767)	EuSib	DecFo	12	1	0.25±0.25	0.00±0.00
Ectropis crepuscularia ([Den. et Schiff.], 1775)	EuSib	Gen	12	1	0.25±0.25	0.00±0.00
Hypomecis punctinalis (Scopoli, 1763)	EuSib	DecFo	12	2	0.50±0.29	0.00±0.00
Hypomecis roboraria ([Den. et Schiff.], 1775)	EuSib	DecFo	36	9	1.25±0.48	1.00±0.71
Ematurga atomaria (Linnaeus, 1758)	EuSib	Gen	12	1	0.00±0.00	0.25±0.25
Rivula sericealis (Scopoli, 1763)	EuSib	Gen	24	2	0.25±0.25	0.25±0.25
Schrankia costaestrigalis (Stephens, 1834)	BorCo	MarFo	12	1	0.25±0.25	0.00±0.00
Trisateles emortualis ([Den. et Schiff.], 1775)	BorCo	MarFo	12	2	0.00±0.00	0.50±0.50
Hypena proboscidalis (Linnaeus, 1758)	EuSib	Gen	48	11	0.50±0.50	2.25±0.75
Hypena rostralis (Linnaeus, 1758)	EuSib	Gen	24	3	0.00±0.00	0.75±0.75
Scoliopteryx libatrix (Linnaeus, 1758)	EuSib	DecFo	48	11	0.00±0.00	2.75±0.85
Pelosia muscerda (Hufnagel, 1766)	EuSib	MarFo	108	287	7.00±3.70	64.75±6.85
Lithosia quadra (Linnaeus, 1758	EuSib	Lichen	60	8	0.00±0.00	2.00±1.00
Eilema griseola (Hübner, 1803)	BorCo	MarFo	24	5	1.25±0.25	0.00±0.00
Dysgonia algira (Linnaeus, 1767)	ExtPal	Migr	12	2	0.00±0.00	0.50±0.50
Catocala dilecta (Hübner, 1808)	Med	DecFo	12	1	0.00±0.00	0.25±0.25
Catocala electa (Vieweg, 1790)	BorCo	DecFo	24	3	0.00±0.00	0.75±0.25
Catocala elocata (Esper, 1788)	EuSib	DecFo	48	6	0.00±0.00	1.50±0.29
Catocala fraxini (Linnaeus, 1758)	BorCo	DecFo	12	1	0.00±0.00	0.25±0.25
Catocala nupta (Linnaeus, 1758)	EuSib	DecFo	96	17	0.00±0.00	4.25±1.65
Abrostola triplasia (Linnaeus, 1758)	EuSib	Alther	84	17	4.25±1.18	0.00±0.00
Macdunnoughia confusa (Stephens, 1850)	EuSib	Gen	108	52	13.00±2.55	0.00±0.00
Diachrysia chrysitis (Linnaeus, 1758)	EuSib	Alther	36	3	0.75±0.48	0.00±0.00
Diachrysia stenochrysis (Warren, 1913)	EuSib	Alther	60	9	2.25±0.63	0.00±0.00
Autographa gamma (Linnaeus, 1758)	ExtPal	Migr	108	67	16.75±2.87	0.00±0.00
Protodeltote pygarga (Hufnagel, 1766)	EuSib	Gen	36	9	0.25±0.25	2.00±0.71
Craniophora ligustri ([Den. et Schiff.], 1775)	EuSib	Gen	48	53	0.00±0.00	13.25±3.94
Acronicta megacephala ([Den. et Schiff.], 1775)	BorCo	MarFo	24	3	0.00±0.00	0.75±0.75
Acronicta rumicis (Linnaeus, 1758)	EuSib	Gen	48	16	0.00±0.00	4.00±1.58
Omphalophana antirrhinii (Hübner, 1803)	Med	Steppic	12	1	0.25±0.25	0.00±0.00
Amphipyra berbera svenssoni (Fletcher, 1968)	EuSib	DecFo	24	2	0.00±0.00	0.50±0.50
Amphipyra pyramidea (Linnaeus, 1758)	EuSib	Gen	144	49	0.00±0.00	12.25±1.70
Allophyes oxyacanthae (Linnaeus, 1758)	Med	DecFo	60	282	0.75±0.48	69.75±18.14

Table 1 (continued)

Species	FT	FC	n	Ns	Agam Nt±SE	NAA Nt±SE
Eucarta amethystina (Hübner, 1803)	SCon	MarFo	24	2	0.00±0.00	0.50±0.29
Eucarta virgo (Treitschke, 1825)	SCon	MarFo	48	14	0.00±0.00	3.50±2.53
Helicoverpa armigera (Hübner, 1808)	ExtPal	Migr	36	4	0.75±0.48	0.25±0.25
Cryphia algae (Fabricius, 1775)	EuSib	Lichen	12	1	0.00±0.00	0.25±0.25
Caradrina morpheus (Hufnagel, 1766)	EuSib	Gen	60	9	0.50±0.29	1.75±0.75
Hoplodrina ambigua ([Den. et Schiff., 1775])	Med	Gen	24	3	0.00±0.00	0.75±0.25
Dypterygia scabriuscula (Linnaeus, 1758)	EuSib	DecFo	84	21	0.00±0.00	5.25±1.31
Trachea atriplicis (Linnaeus, 1758)	EuSib	DecFo	120	199	0.00±0.00	49.75±4.71
Mormo maura (Linnaeus, 1758)	EuSib	MarFo	24	3	0.00±0.00	0.75±0.48
Thalpophila matura (Hufnagel, 1766)	EuSib	DecFo	48	5	0.00±0.00	1.25±1.25
Phlogophora meticulosa (Linnaeus, 1758)	EuSib	Gen	60	7	0.00±0.00	1.75±0.85
Euplexia lucipara (Linnaeus, 1758)	EuSib	DecFo	48	11	0.00±0.00	2.75±0.75
Apamea monoglypha (Hufnagel, 1766)	EuSib	Gen	24	4	0.00±0.00	1.00±0.71
Apamea anceps ([Den. et Schiff.], 1775)	EuSib	Mesop	12	1	0.00±0.00	0.25±0.25
Mesapamea secalis (Linnaeus, 1758)	EuSib	Gen	72	35	0.50±0.29	8.25±3.86
Mesapamea secalella Remm, 1983	EuSib	Gen	36	18	0.00±0.00	4.50±1.85
Mesoligia furuncula ([Den. et Schiff.], 1775)	EuSib	DecFo	24	3	0.00±0.00	0.75±0.48
Oligia latruncula ([Den. et Schiff.], 1775)	EuSib	Gen	24	4	0.00±0.00	1.00±1.00
Oligia strigilis (Linnaeus, 1758)	EuSib	Gen	48	8	0.25±0.25	1.75±0.75
Enargia paleacea (Esper, 1788)	BorCo	MarFo	12	1	0.00±0.00	0.25±0.25
Cosmia affinis (Linnaeus, 1767)	EuSib	DecFo	72	7	0.25±0.25	1.50±0.29
Cosmia trapezina (Linnaeus, 1758)	EuSib	DecFo	48	5	0.00±0.00	1.25±0.75
Atethmia centrago (Haworth, 1809)	Med	DecFo	24	5	0.25±0.25	1.00±0.41
Tiliacea aurago (Den. et Schiff., 1775)	Med	DecFo	24	5	0.25±0.25	1.00±0.71
Tiliacea citrago (Linnaeus, 1758)	Med	DecFo	12	1	0.00±0.00	0.25±0.25
Lithophane ornithopus (Hufnagel, 1766)	EuSib	DecFo	36	5	0.00±0.00	1.25±0.48
Lithophane semibrunnea (Haworth, 1809)	Med	DecFo	24	2	0.00±0.00	0.50±0.29
Conistra erythrocephala ([Den. et Schiff.], 1775)	EuSib	DecFo	24	4	0.00±0.00	1.00±0.58
Conistra rubiginosa (Scopoli, 1763)	Med	DecFo	36	5	0.00±0.00	1.25±0.75
Conistra vaccinii (Linnaeus, 1761)	EuSib	DecFo	60	12	0.00±0.00	3.00±1.08
Conistra veronicae (Hübner, 1813)	Med	DecFo	12	1	0.00±0.00	0.25±0.25
Agrochola circellaris (Hufnagel, 1766)	EuSib	DecFo	48	12	0.00±0.00	3.00±0.91
Agrochola helvola (Linnaeus, 1758)	EuSib	DecFo	24	4	0.00±0.00	1.00±0.71
Agrochola lota (Clerck, 1759)	EuSib	DecFo	36	33	0.00±0.00	8.25±2.63
Agrochola macilenta (Hübner, 1803)	Med	DecFo	24	8	0.00±0.00	2.00±1.41

Table 1 (continued)

Species	FT	FC	n	Ns	Agam Nt±SE	NAA Nt±SE
Cirrhia gilvago ([Den. et Schiff.], 1775)	EuSib	DecFo	12	1	0.00±0.00	0.25±0.25
Cirrhia icteritia (Hufnagel, 1766)	EuSib	DecFo	108	23	0.25±0.25	5.50±1.50
Cirrhia ocellaris (Borkhausen, 1792)	EuSib	DecFo	12	1	0.00±0.00	0.25±0.25
Griposia aprilina (Linnaeus, 1758)	Med	DecFo	36	10	0.00±0.00	2.50±1.32
Aporophyla lutulenta ([Den. et Schiff.], 1775)	Med	Steppic	48	10	0.00±0.00	2.50±1.04
Mythimna albipuncta ([Den. et Schiff.], 1775)	EuSib	Mesop	96	33	0.2±0.25	8.00±2.12
Mythimna l-album (Linnaeus, 1767)	EuSib	Gen	36	5	0.00±0.00	1.25±0.75
Mythimna turca (Linnaeus, 1761)	BorCo	Mesop	60	23	0.25±0.25	5.50±0.65
Mythimna vitellina (Hübner, 1808)	EuSib	Gen	24	3	0.25±0.25	0.50±0.50
Mythimna pallens (Linnaeus, 1758)	EuSib	Gen	24	2	0.00±0.00	0.50±0.50
Lacanobia oleracea (Linnaeus, 1758)	EuSib	Gen	72	21	0.00±0.00	5.25±2.02
Lacanobia suasa ([Den. et Schiff.], 1775)	EuSib	Gen	12	1	0.00±0.00	0.25±0.25
Axylia putris (Linnaeus, 1761)	Med	Gen	12	1	0.25±0.25	0.00±0.00
Euxoa segnilis (Duponchel, 1837)	Med	Steppic	12	2	0.00±0.00	0.50±0.29
Agrotis exclamationis (Linnaeus, 1758)	EuSib	Gen	84	33	0.25±0.25	8.00±2.27
Agrotis segetum ([Den. et Schiff.], 1775)	EuSib	Gen	108	25	0.00±0.00	6.25±1.11
Xestia castanea (Esper, 1798)	Med	DecFo	12	2	0.00±0.00	0.50±0.50
Xestia c-nigrum (Linnaeus, 1758)	EuSib	Gen	48	11	0.00±0.00	2.75±0.75
Xestia sexstrigata (Haworth, 1809)	EuSib	MarFo	24	3	0.25±0.25	0.50±0.50
Xestia xanthographa ([Den. et Schiff.], 1775)	Med	Mesop	60	14	0.00±0.00	3.50±1.85
Noctua fimbriata (Schreber, 1759)	Med	Gen	36	3	0.00±0.00	0.75±0.48
Noctua janthe (Borkhausen, 1792)	Med	DecFo	72	15	0.25±0.25	3.50±0.96
Noctua janthina ([Den. et Schiff.], 1775)	Med	Gen	24	5	0.00±0.00	1.25±0.95
Noctua orbona (Hufnagel, 1766)	Med	Steppic	12	2	0.00±0.00	0.50±0.29
Noctua pronuba (Linnaeus, 1758)	Med	Gen	60	17	0.00±0.00	4.25±1.44
Number of individuals				1815	236	1576
Number of species				107	42	87

Control traps sampled only three individuals belong to two species: *Hypena proboscidalis* (N = 1); *Allophyes oxyacanthae* (N = 2)

Noctuidae sp. The number of species was relatively high in middle-July which gradually decreased until the end of July. After this period we observed a significant increase of species numbers until the mid and end of August which is followed by a continuous decrease until the end of October (Figs 1–2). This phenomenon matches well with the general species composition of the European temperate nocturnal fauna.

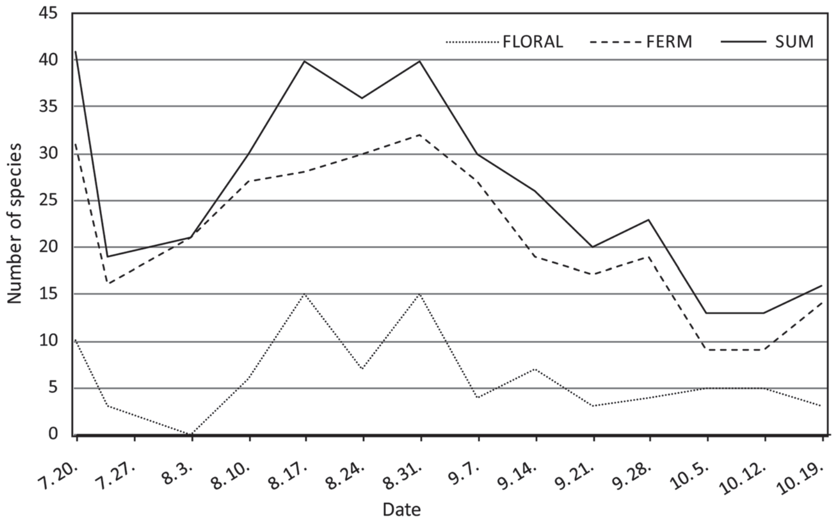

Fig. 1. Temporal changes of species number sampled traps lured with different baits (FLORAL and FERM) and in the whole sample

The distribution of individual numbers shows an essentially similar picture until the autumnal period (Fig. 3). From mid-September we could observe a strong increase of individual numbers, throughout the whole October. It is known that this late period of year is the flying period of several nemoral species connected to deciduous trees which hardly can find any natural nec-

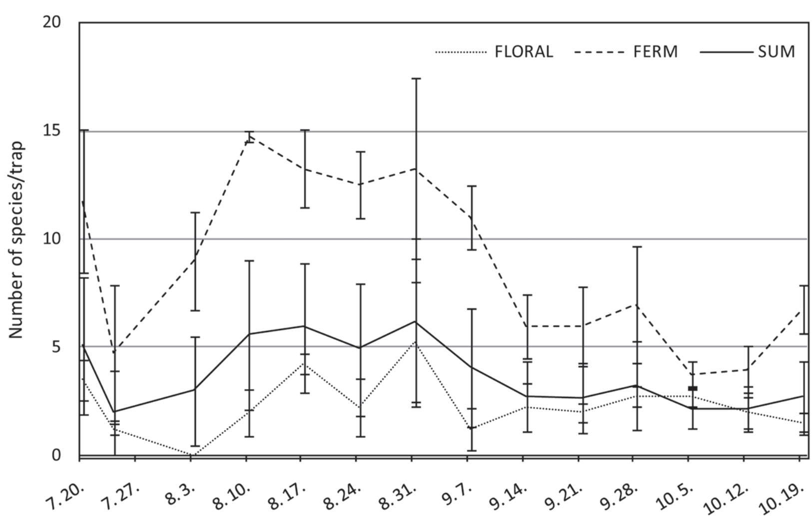

Fig. 2. Temporal changes of mean number of sampled species (species/trap, ±SE; n = 4) in case of different baits (FLORAL and FERM) and the whole sample

Table 2. The Shannon-Wiener diversity (H) of more abundant Noctuidea subfamilies and mean number of sampled individuals belong to different Noctuidea subfamilies and other families per trap by two types of baits and control. n = number of samples; sig: significant differences by Kruskall-Wallis test, NS: not significant, * : 0.05 > p > 0.01, ** : p > 0.01; small arabic letters indicate significant differences by Mann-Whitney U test.

			Controll		FLORAL		FERM	
	H	sig	mean±SE		mean±SE		mean±SE	
Noctuidae								
Acronictinae	0.692	**	0.00±0.00	a	0.00±0.00	a	18.00±5.18	b
Amphipyrinae	0.165	**	0.00±0.00	a	0.00±0.00	a	12.75±2.17	b
Hadeninae	1.475	*	0.00±0.00	a	0.75±0.48	a	21.25±4.66	b
Noctuinae	1.364	*	0.00±0.00	a	1.00±0.71	a	32.25±4.19	b
Plusiinae	1.430	**	0.00±0.00	a	37.00±4.49	b	0.00±0.00	a
Psaphidinae	0.000	*	0.50±0.29	a	0.75±0.48	a	69.75±18.14	b
Xyleninae	2.533	**	0.00±0.00	a	2.25±0.85	a	119.25±6.91	b
Other subfam.		*	0.00±0.00	a	1.25±0.95	ab	4.75±2.84	b
Erebidae		**	0.25±0.25	a	9.25±4.27	b	82.50±6.65	c
Geometridae		*	0.00±0.00	a	6.50±1.50	b	3.00±1.08	b
Sphingidae		NS	0.00±0.00		0.00±0.00		0.25 0.25	
Thyatiridae		**	0.00±0.00	a	0.25±0.25	a	30.25 8.70	b

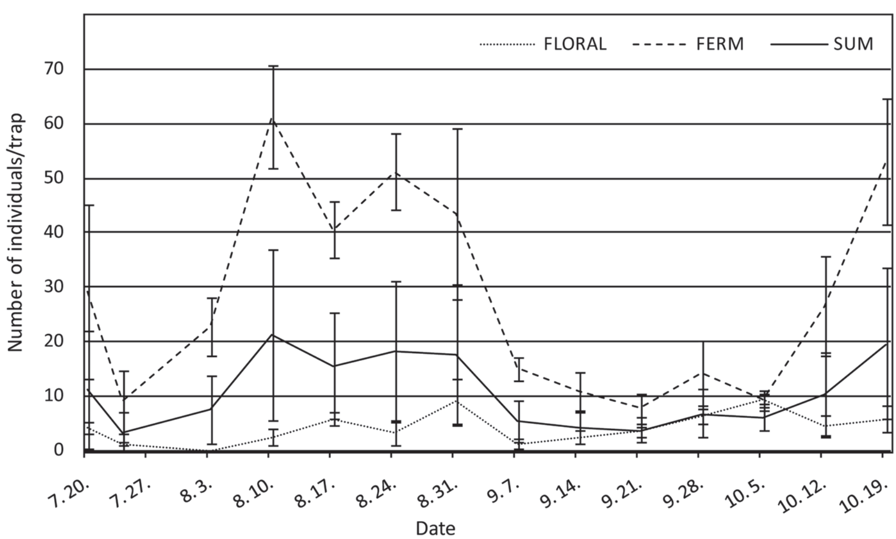

Fig. 3. Temporal changes of mean number of sampled individuals (individuals/trap, ±SE; n = 4) in case of different baits (FLORAL and FERM) and the whole sample

tar sources but are well known strongly attracted by saps of trees but also by artificial baits. The attractivity of used mixtures proved generally similar but differently selective concerning both species – and individual numbers (Figs 1–3). The difference of the attractivity was clearly significant in different taxa (K-W: $H = 6.719–10.456$, $df = 2$, $n = 12$, $p > 0.035$), with the exception of Sphingidae which were only captured accidentally. From the subfamilies of Noctuidae, only Plusiinae and Heliothinae (*Heliothis armigera*) were more attracted by FLORAL but the others significantly stronger by FERM (containing red wine). The FERM proved significantly more attractive also for Erebidae but nearly ineffective (as also FLORAL) for Thyatiridae and Geometridae (Table 2). The seasonal differences were also the most pronounced in the case of this mixture while the FLORAL mixture has shown a moderate attractivity during the whole survey period (Figs 1–3).

We also calculated the Shannon-Wiener diversity (Table 2) of the dominant family (Noctuidae) including its subfamilies. In Noctuidae we observed the highest species diversity at the late summer faunal wave since this is the swarming period of the second generation of most bivoltine species (Varga *et al*. 2004). The subfamilies Xyleninae, Hadeninae, Plusiinae and Noctuinae have shown higher values of diversity (Table 2). While the caterpillars of the species of latter three subfamilies are mostly feeding on herbaceous plants, the bulk of larvae of Xyleninae species are feeding on scrubs and trees. The most common two species (*Trachea atriplicis* and *Allophyes oxyacanthae*) do not have any economic importance. Some captured species feeding on herbaceous

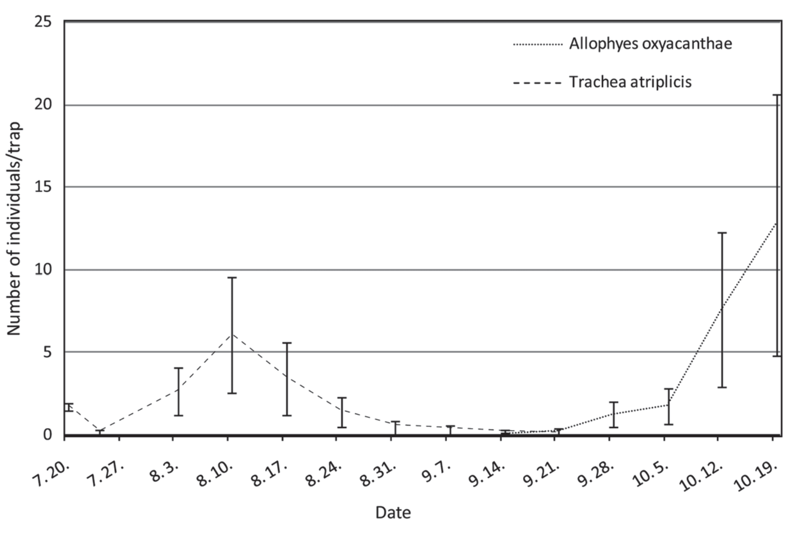

Fig. 4. Phenological curves (mean number of sampled individuals per trap) of the dominant summer and autumnal species

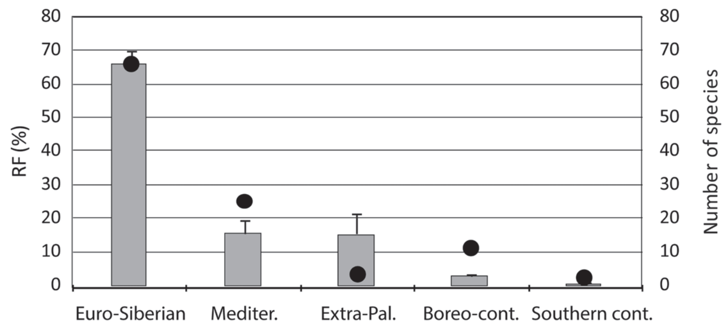

Fig. 5. Number of species belong to different faunal types (black dots) and mean relative frequencies of these types per traps (±SE) on the basis of abundance data of species sampled by baited traps in Velyka Dobron in 2014. Abbreviations: Medit. = Mediterranean, Extra-Pal. = Extra-Palaearctic, Boreo-cont. = Boreo-continental, Southern cont. = Southern continental

plants are well known, however, as agricultural pests (e.g. *Autographa gamma, Xestia c-nigrum, Agrotis segetum*).

Despite of the limited phenological data we could clearly separate two periods. Each can be characterised by a dominant species (*Trachea atriplicis* vs *Allophyes oxyacanthae*, see Fig. 4). The larva of the former species is extremely polyphagous and feeds mostly on different herbaceous plants but also on certain woody plants and has two generations per year while the latter is feeding on scrubby Rosaceae (mostly *Crataegus* but also *Prunus* spp.) and is strictly univoltine. The dominant species of this late summer period was *Trachea atriplicis*, of which the second generation has shown the top number of imagoes on the week of 10th August (Fig. 4). Most species of this phenological period feeding on herbaceous plants are also bivoltine in the Carpathian Basin. These species

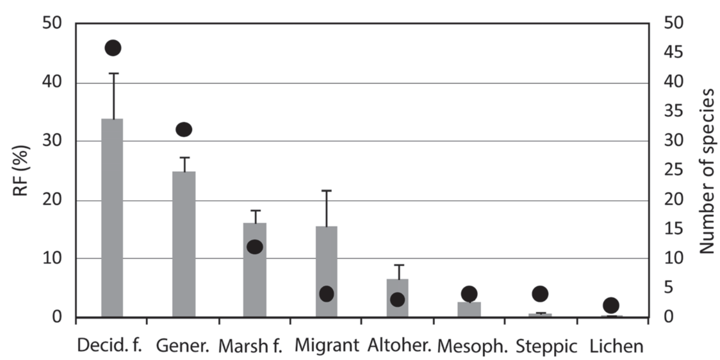

Fig. 6. Number of species belong to different faunal components (ecological groups) (black dots) and mean relative frequencies of these groups per traps (±SE) on the basis of abundance data of species sampled by baited traps in Velyka Dobron in 2014. Abbreviations: Decid. f. = decidious forest, Gener. = generalist, Marsh f. = marshy forest, Altoher. = altoherbosa, Mesoph. = mesophilous

disappear, however, until the end of August or early September and they are replaced by monovoltine autumnal species, feeding mostly on woody plants (*Agrochola, Tiliacea, Xanthia, Conistra, Lithophane,* etc.) and by the absolutely dominant *Allophyes oxyacanthae* (Table 1). The peak of activity of the latter species was observed in the second half of October (Fig. 4). Some frequent species were relatively evenly observed in all phenological periods. These are bi- or trivoltine species in which the swarming period of generation is nearly continuous, without expressed peaks (e.g. *Hoplodrina ambigua, Xestia c-nigrum*).

The composition of the observed species can be characterised by the proportion of faunal types. Figure 5 shows clearly that the bulk of the species belongs to the widely distributed Euro-Siberian ones. These species have a wide amplitude of tolerance and they are generally distributed and mostly frequent in the Carpathian Basin, occurring also in farmlands and in other secondary, disturbed habitats. On the basis of species number the other biogeographically significant faunal elements are Mediterranean (*Tiliacea aurago*, *Agrochola macilenta*, *Hoplodrina ambigua*, etc.) and Boreo-continental (*Catocala fraxini*, *C. electa*, *Enargia paleacea*, etc.) ones. The Extra-Palaearctic elements are represented by some southern, migrant species only, and reached relatively high frequencies.

The proportion of the faunal components reflects the demands on habitats of the species (Fig. 6). Based on the vegetation of the region we expected the high number and proportion of the deciduous forest and generalist species. It means that a significant part of the species assemblage is connected to the nature-like vegetation. The marshy forest component is also represented in the collected material but with a lower proportion. The grasslands of the surveyed area are less extended and mostly secondary. Thus, the presence of the steppic species is rather low. Since a great part of the region is affected by canalisation and drainage, the representation of the mesophil species is also limited. Number of migrant species was low however they provide more than 15% of sampled individuals in average.

DISCUSSION

Despite of the short sampling period we registered a relatively large number of species of night-active macro-moths, mostly from Noctuidae. The effectivity of the survey was limited by the circumstance that the data only refer to the second half of the vegetation period. Therefore we can provide a rather incomplete information on the species composition of the faunal assemblage. Additionally, we have used bait mixtures with different attractivity in four repetitions. Although our results and conclusions are very preliminary, we could signalise several new species for the fauna of the surveyed region (Table 1). In details, Geometridae (2), Erebidae (5) and mostly, Noctuidae (23) were represented by hitherto unrecorded species (see Szanyi 2015, Supplement).

Both of the applied types of bait traps (FERM vs FLORAL) proved to be significantly selective but with strikingly different attractivity in favour of the alcoholic mixture (with red wine content). In accordance with some former surveys (Tóth *et al.* 2002, Nagy *et al.* 2014) only Plusiinae and Heliothinae (*Heliothis armigera*) were more attracted by FLORAL while other Noctuidae, mostly Hadeninae and Xyleninae (important genera see below) were much more attracted by FERM (containing red wine). The differences were even much striking in the individual numbers which was partly connected with the rather high frequency of the two seasonally dominant species (see below) but also strongly enhanced by the dominance of some autumnal, monovoltine nemoral species (e.g. *Agrochola, Cirrhia, Conistra, Eupsilia, Lithophane, Tiliacea*) connected to deciduous trees. In this late flying period the moths of these genera hardly can find any natural nectar sources but are well known strongly attracted by saps of trees but also by artificial baits (Ronkay 1997, Yela & Holyoak 1997). For instance, nine from the 30 hitherto unrecorded species belong to these groups (Table 1). It means that an approximately complete faunal list of the night-active Macro-moths can be only compiled by the application of different, and differently selective trapping methods.

We recorded a peak of species numbers at the mid-summer which is known as the period of highest species diversity of the nocturnal moths (Rézbányai 1974, Leskó *et al.* 1994, 2001, Nowinszky 2003, Szabó *et al.* 2007, Végvári *et al.* 2014). The individual numbers, however, showed two maxima. The first peak was formed by the frequent appearance of the second generation of polyphagous, generalist bivoltine species (Table 1, Fig. 1) with mostly herbaceous larval food plants (Hacker *et al.* 2002, Fibiger *et al.* 2009, 2010, Végvári *et al.* 2014). The depression of individual number at the early autumn was, however, followed by significant growths of the number of trapped individuals. This second peak was mostly formed by monovoltine autumnal species with woody-scrubby larval food plants (Figs 1–3). The two main phenological periods of maximum activity were characterised by two contrastingly dominant species: the bivoltine *Trachea atriplicis*, being polyphagous on different herbaceous species, while the monovoltine *Allophyes oxyacanthae* is connected to scrubby Rosaceae food plants (Fig. 4).

However, the relative frequency of biogeographical and ecological components of the faunal assemblage proved to be similar to the data of the earlier light trapping surveys (Szanyi 2015). The relatively low proportion of southern (Mediterranean s.l.) and the even lower partition of Boreo-continental species seem to be connected with the continentally influenced climate of this region which is cooler than in other parts of the Pannonian lowland (Magura *et al.* 1997, Ködöböcz & Magura 1999, Baranyi 2009, Szanyi 2015). Furthermore, more than the half of the species is connected with woody types of vegetation (nemoral boadleaved forests, hardwood gallery forests, poplar-willow stands, etc.), i. e. that despite the radical anthropogenous changes (drainage of the original peatland, extensive logging, abandoning the traditional land use, etc., see Magura *et al.* 1997, Ködöböcz & Magura 1999) the natural woodland fauna was not yet suppressed which gives some changes for nature conservation measures in the nearest future.

*

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