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It is raining bugs: summer dispersal of aquatic bugs (Hemiptera, Heteroptera: Nepomorpha) in Srebarna Nature Reserve (Bulgaria)

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Abstract: The Srebarna Nature Reserve is a wetland with great conservation value. The dispersal of aquatic bugs in it has not been studied earlier. Acquiring more data about the aquatic bug's species composition and dispersal activity is a prerequisite for future studies on phenology or faunistic studies of the group in the wetland. In the present paper, aquatic bugs attracted to UV light near the Srebarna Nature Reserve were quantified. A total of 4589 individuals of aquatic bugs (Heteroptera, Nepomorpha) were collected during 11 nights of light trapping. Dispersing aquatic bugs were almost exclusively Corixidae (4587 specimens, 13 species in five genera), except for two Notonectidae species. Eleven species, collected during the study have not been registered previously in the Srebarna Nature Reserve. The activity peak of dispersal was registered during the first hour after sunset. Females prevailed in the four most abundant species. The changes in the dispersal activity of the most common species – *Sigara striata* (Linnaeus, 1758), were explained (to a great extent) by changes in air temperature, atmospheric pressure and wind speed.

Key words: Corixidae, light trap, sex ratio, UV, wetland

Introduction

True aquatic bugs (Nepomorpha) are not only a component of many vertebrates' diet (Papáček, 2001), but themselves are predators on a wide range of smaller invertebrate organisms. They often play a part in controlling disease vectors by feeding on the larvae of mosquitoes of *Anopheles*, *Culex* and *Aedes* (Quiroz-Martínez & Rodriguez-Castro, 2007; Kweka et al., 2012). Despite the significant role of aquatic bugs in food webs, very little is known about the dispersal of these insects. For most of the aquatic bug species no clear patterns of dispersal activity have been established yet, although different aspects of aquatic bugs dispersal by flight have been discussed (mostly for the family of Corixidae): sex ratio of the dispersing individuals (Brown, 1954; Pajunen & Jansson, 1969a; Benedek & Jászai, 1973; Kecső & Boda, 2008), diurnal patterns of flight activity (Leston, 1953; Leston & Gardner, 1953; Popham, 1964; Csabai et al., 2006; Boda & Csabai, 2009a), influence of environmental variables on the flight activity (Popham, 1943a, 1943b; Fernando, 1959; Campbell, 1979; Weigelhofer et al., 1992; Csabai & Boda, 2005; Boda & Csabai, 2009a).

The focus of the present work is on dispersing aquatic bugs, attracted by light close to the border of the Srebarna Nature Reserve – a wetland in Northeastern Bulgaria. The Srebarna Lake was declared a protected site in 1942 and in 1948 - a nature reserve. The area is a Wetland of International Importance (a Ramsar site) and is included in the UNESCO list as Biosphere Reserve and as World Natural and Cultural Heritage. It is also a part of the European Important Bird Areas list and of the ecological network NATURA 2000. According to the current national nature protection legislation, the Srebarna Lake is a managed reserve (Uzunov et al., 2012). The great conservation value of the Srebarna Nature Reserve is defined by its rich biodiversity, including both species of conservation significance and priority (from conservation point of view) habitat types.

The main problems for the conservation of the natural ecosystems in the reserve could be defined as follows: the pollution from agriculture, forestry and waste water, as well as the application of inappropriate technology for usage of natural resources and the degradation of the landscape (Updated management plan for maintained reserve "Srebarna" from 2014). There is available reference data about the true bugs found in aquatic habitats within the reserve: aquatic bug species are included in three papers contributing to the macrozoobentic (Marinov, 2000; Uzunov et al., 2001; Varadinova et al., 2011, 2012) and one to the insect fauna (Marinov, 2000), but there are no previously published data about aquatic bugs dispersing in the vicinity of this wetland. Such data could be of use in future studies on the fauna or phenology of the aquatic Heteroptera in the wetland.

The aim of this study is to answer the following questions: (1) Are the species, collected at the UV light (original data) different from those collected by *in situ* sampling (published and original data)? (2) What is the sex ratio of the collected aquatic bugs? (3) What is the influence of environmental variables (such as air temperature, atmospheric pressure and wind speed) on the aquatic bugs' dispersal?

The efficiency of the light trap method used here was also discussed in respect to biodiversity surveys targeting mainly aquatic bugs.

Material and Methods

Study area: The study was carried out in the south-eastern part of the reserve: samples were collected from the lake, close to the shore and also from temporary pools near the lake (Table 1). Material was collected also in the Srebarna Village, close to the reserve by a light trap.

Data collection: Aquatic bugs were collected during 11 nights (5–6, 8–9, 11–17 June 2010) of light trapping. Light trapping started at the predicted time of sunset, around 21:30 h, and continued for three hours. In order to examine dispersal changes, the samples were divided into three one hour blocks. A 125 W mercury vapour lamp was mounted on the flat roof of a 3 m high building (44°05'37.66" N, 27°04'04.71" E) at the edge of the Srebarna Village. The bulb was strung at 1 m above the roof, a white sheet spread out on the surface of the roof (Fig. 1). Aquatic bugs were collected by hand (by Merlijn Jocque and Patricia Caballero) and preserved in 70% ethanol. All specimens are stored at the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia.

To gain an insight of species collected by *in situ* sampling, a list of aquatic bugs reported in previous studies from the Srebarna Nature Reserve and sampled during this study with a kick-net was composed (Table 2). Data about collected aquatic bugs using kick-net were used only for checking which of the species collected by the light trap also had been collected from aquatic habitats in the region. In the present study, the quantities of the collected aquatic bugs using each of the two methods were not compared.

The collected aquatic bugs were identified according to Jansson (1986) and Kanyukova (2006).

A VANTAGE VUE weather station was mounted on the same roof to measure every 15 mins temperature (°C), relative humidity (%), atmospheric pressure (mb) and wind speed (m/s,).

The material for the study was collected in accordance with permission № 48-00-264/26.03.2010, issued by the Bulgarian Ministry of Environment and Water.

Data analysis: Graphics and analysis were completed in R (R Core Team, 2016). Differences between the number of collected males and females were tested with Wilcoxon signed-rank test using function wilcox.test from R package MASS (Venables & Ripley, 2002). The same function was used for testing the three one-hour blocks for differences in the number of collected aquatic bugs.

Weather parameters possibly affecting the aerial dispersal of *Sigara striata* (Linnaeus, 1758) were explored by fitting quasi-Poisson generalized linear model (GLM). The model building was performed in the package stats (R Core Team, 2016) using the function glm. The dependent variable was the number of captured *S. striata* individuals for each collecting session. A range of weather variables (tem-

Fig. 1. The light trap setup in this study – a car battery powered UV bulb (125W) strung 1 m above the roof, above a white sheet on the ground.

Table 1. Locations where aquatic bugs have been collected by kick-netting in the course of this study in Silistra Province, Bulgaria (April and June 2010).

Date	Locality	Depth (m)	Vegetation	Latitude	Longitude
11 April 2010	Temporary pool connected to Srebarna Lake	0.45	0	44° 05' 19" N	27° 03' 52" E
7 June 2010	Srebarna Lake	1	1	44° 05' 54" N	27° 04' 15" E
10 June 2010	Ditch near Srebarna Lake	1	1	44° 06' 11" N	27° 03' 49" E
17 June 2010	Srebarna Lake close to the shore	1	1	44° 05' 36" N	27° 04' 08.5" E

Table 2. Species and abundance of aquatic bugs collected using the light trap in this study. The species recorded in previous papers are marked with: "1" for Marinov, 2000 and "2" for Varadinova et al., 2012. Kick-net collections (April and June 2010) are included.

Family	Species	Light trapping		Kick-net			Ref.
		f	m	f	m	juv	
Corixidae	*Cymatia coleoptrata* (Fabricius, 1777)	1	0	0	0	0	1, 2
	Cymatia rogenhoferi (Fieber, 1864)*	207	110	0	0	0	
	Corixa affinis Leach, 1817*	0	1	0	0	0	
	Corixa panzeri Fieber, 1848*	0	1	0	0	0	
	Corixa punctata (Illiger, 1807)*	1	0	0	0	0	
	Hesperocorixa linnaei (Fieber, 1848), (as *H. limnaei* (F.) in: 2)	5	4	50	31	0	1, 2
	Paracorixa concinna (Fieber, 1848)*	59	7	0	1	0	
	Sigara (*Halicorixa*) *stagnalis pontica* Jaczewski, 1961*	26	5	1	0	0	
	Sigara (*Pseudovermicorixa*) *nigrolineata* (Fieber, 1848)	0	0	1	0	0	1, 2
	Sigara (*Retrocorixa*) *limitata* (Fieber, 1848) *	0	1	0	0	0	
	Sigara (s.str.) *assimilis* (Fieber, 1848) *	3	5	0	0	0	
	Sigara (s.str.) *striata* (Linnaeus, 1758)	1435	566	20	21	0	1, 2
	Sigara (Subsigara) falleni (Fieber, 1848)	0	0	0	0	0	1, 2
	Sigara (*Subsigara*) *iactans* Jansson, 1983*	395	263	3	3	0	
	Sigara (*Vermicorixa*) *lateralis* (Leach, 1817)	858	634	4	3	0	1, 2
	Corixidae gen. sp.	0	0	0	0	18	
Naucoridae	*Ilyocoris cimicoides* (Linnaeus, 1758)	0	0	1	3	47	
Notonectidae	*Notonecta* (s.str.) *glauca* (Linnaeus, 1758)*	1	0	5	2	4	
	Notonecta (s.str.) *viridis* (Delcourt, 1909)*	1	0	0	0	0	
Nepidae	*Nepa cinerea* Linnaeus, 1758 (as *N. rubra* Linnaeus. in 1, 2)	0	0	0	0	0	1, 2
	Ranatra (s.str.) *linearis* (Linnaeus, 1758)	0	0	0	0	5	2
Pleidae	*Plea minutissima* Leach, 1817	0	0	2	0	0	1, 2

*New records for the Srebarna Nature Reserve

perature, air pressure, wind speed, humidity) were considered as predictors. In the first step for building the generalized linear model, the selected predictor variables were tested for correlation by calculating Spearman correlation matrix using function rcorr 3.17-2 in the package Hmisc (Harrell, 2016) and for collinearity using the function vif from the package rms (Harrell, 2017). No significant correlation or multicollinearity was detected – the variance of the inflation factor (ranging from 1 to 7.9) for the selected predictor variables was below the commonly accepted threshold of 10. In the second step, the variables without significant contribution to the model were omitted stepwise, starting with the least significant variable.

Results

Species composition and abundance: A total of 4814 individuals of 19 aquatic bug species belonging to nine genera and five families were collected during the study (Table 2). The majority (4589 individuals) was collected using UV light: 4587 of Corixidae (13 species, five genera and two subfamilies) and two of Notonectidae (two species, one genus). The remaining 225 individuals, belonging to 11 species of nine genera and five families, were collected using a kick-net (Table 2). Seven species captured using the light trap were not found in the kick-net samples, while four species collected using kick-net were not observed in the light trap (Table 2).

The majority (97%) of the specimens, collected at the light trap, belonged to four species - *Sigara striata*, *S. lateralis* (Leach, 1817), *S. iactans* Jansson, 1983, *Cymatia rogenhoferi* (Fieber, 1864). These four species constituted 44%, 32%, 14% and 7% of all aquatic bugs collected at the light trap, respectively. The numeric dominance of these four species changed over the survey nights. On four nights (see Table 3), *S. striata* was the most abundant species, representing 39-75% of the collected individuals per night. On five nights, *S. lateralis* was the prevailing species and constituted 51-67% of the individuals per night. On the rest two nights of the study, the most numerous species was *S. iactans,* representing 35% and 39% of the individuals per night, respectively.

Sex ratio: Females were dominant for 11 of the 15 species, collected at the light trap. For *S. striata* and *S. iactans* the number of females exceeded the number of males during all sampling sessions and the sex ratio males:females varied over the study from 12:88 to 43:56 and from 33:67 to 46:54, respectively. For *C. rogenhoferi*, the males were dominant (52:48) on one of the nights, on the rest – females prevailed (sex ratio from 0:100 to 44:56).

Females of *S. lateralis* prevailed at a ratio from 20:80 to 47:53, except for two nights when the ratios were 56:44 and 76:24, respectively. The difference between the number of collected males and females (per session) was significant for *S. iactans* ($V = 55$, $P = 0.006$) and *S. striata* ($V = 66$, $P = 0.004$), and marginally significant for *C. rogenhoferi* ($V = 53$, $P = 0.01$) and *S. lateralis* ($V = 55$, $P = 0.05$).

Flight activity by hours: During all sampling sessions, most of the individuals (77–100%) were collected in the first hour after sunset – between 21:30 and 22:30 h (Fig. 2). Significant difference between the collected insects from 21:30 to 22:30 h and those collected in the two following hours was detected, respectively: from 22:30 to 23:30 ($V = 65$, $P = 0.002$); from 23:30 to 00:30 ($V = 66$, $P = 0.001$). The difference in the aquatic bug abundance between the second (22:30–23:30h) and the third (22:30–23:30h) hour after sunset was marginally significant ($V = 53$, $P = 0.011$).

Influence of environmental variables: During all of the light trap sessions the temperature was above 14°C and the hourly average wind speed was not more than 1.6 m/s (with two exceptions: 5.6 m/s on 5th of June and 4.8 m/s on 17th of June). Corixids were observed at each of the sampling nights, even when the hourly average wind speed was above 4.0 m/s.

According to the performed GLM, the number of collected *S. striata* increased proportionally with the decrease of the minimum air temperature in the evening. The model also revealed significant influence of the atmospheric pressure and wind speed during the light trap sessions on the number of collected dispersing *S. striata* (Table 4). The residuals were normally distributed (Fig. 3a) and were equally spread along the predictor ranges (Fig. 3b).

The highest numbers of migrating *S. striata* were collected on two of the nights: 5th and 6th of June with 866 and 1135 observed individuals, respectively. These values were 180% and 270% higher than the average *S. striata* individuals collected per night during the study. These were the two nights with the lowest minimum air temperature (18.4°C and 14.2°C) and highest air pressure (1052 mb and 1014 mb) recorded during light trap sessions in the study. On these two nights, maximums of dispersing insects were not observed for the rest of the Corixidae species (except for *S. lateralis*). On 16th of June there was a peak of the flight activity of all four most numerous species. That night, the numbers of collected *S. striata* and *S. lateralis* were with about 60% and these of *S. iactans* and *C. rogenhoferi* with over 140%

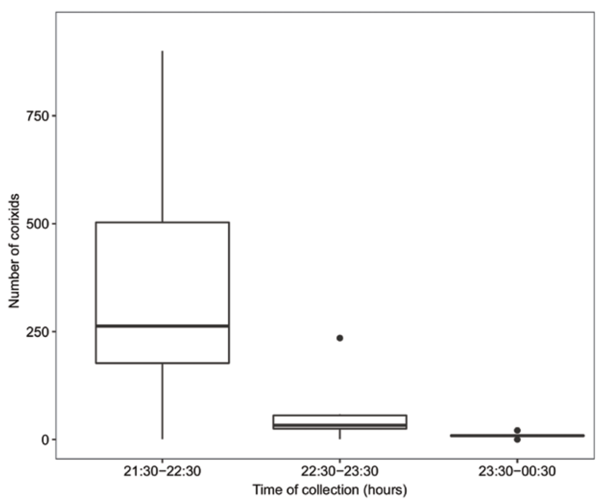

Fig. 2. Average number of Corixidae collected using the light trap in each of the three hour blocks after sunset. Averages are calculated over all the sample events over 11 nights. Asterisk marks the hour block in which the number of collected corixids is significantly different from the number of corixids collected during each of the two other hour blocks.

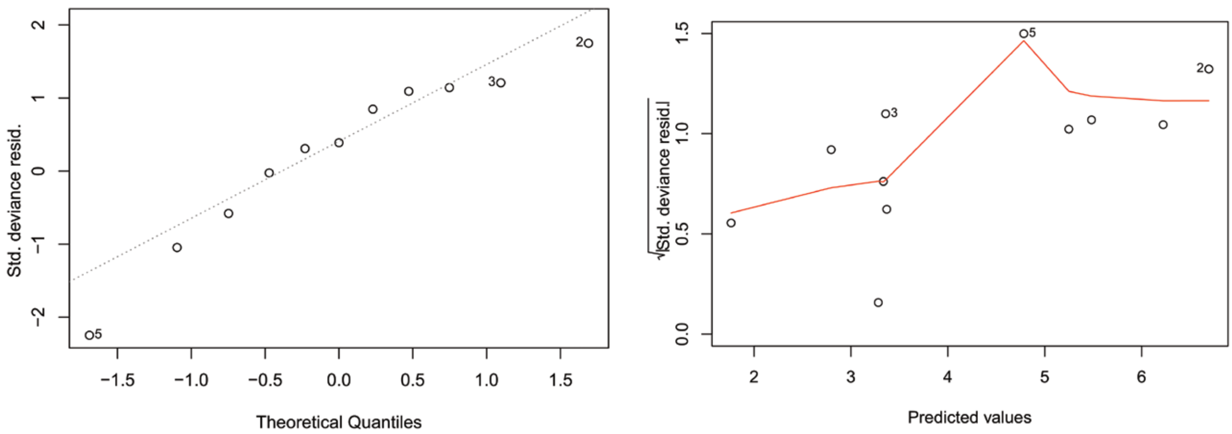

Fig. 3. Diagnostic plots for general linear model with a dependent variable the number of S. striata specimens and independent variables recorded during each light trapping session: lowest temperature (°C), average atmospheric pressure (mb), maximal wind speed (m/s): a) normal quantile-quantile plot, b) spread-location plot.

higher than their average numbers in the study, respectively. This was the session with the lowest average wind speed and there was a decrease in the minimal air temperature during this session (21.3°C) compared to the previous four nights, during which the minimum temperature for a session raised from 23.1°C to 26.2°C.

Discussion

Species composition and abundance: Nine species of Corixidae and two of Notonectidae were found for the first time in the region of the Srebarna Nature Reserve during the present study. Six of the corixid species have been reported previously from this wetland (Marinov, 2000; Uzunov et al., 2001; Varadinova et al., 2011, 2012) and only two of them, *Sigara falleni* (Fieber, 1848) and *S. nigrolineata* (Fieber, 1848), were not collected at the light trap in the present study. Instead of *S. falleni* in the samples was found its sibling species *S. iactans,* observed mainly in South-eastern Europe (Fent et al., 2011), which could be expected for this region.

Four species were collected using kick-net but not observed at the light trap: *S. nigrolineata*, *Ilyocoris cimicoides* (Linnaeus, 1758), *Ranatra linearis* (Linnaeus, 1758) and *Plea minutissima* Leach, 1817. All individuals of *S. nigrolineata* are capable of flight. However the females of the summer generations develop their flight muscles when the egg formation is completed (Young, 1965). Flying adult individuals of *R. linearis* have been registered (e.g. Aukema et al., 2002). However, in the kick-net samples we found only nymphs of *R. linearis*. Probably the study in Srebarna was performed too early for observation of flying *S. nigrolineata* and *R. linearis.* Dispersing by flight individuals of *I. cimicoides* and *P. minutissima* have been reported in very few studies (e. g. Csabai et al., 2006, 2012). Most of the specimens of *I. cimicoides* are incapable of flight as their flight muscles are reduced (Brown, 1951). The dispersion ability of *P. minutissima* has not been studied in detail yet (Aukema et al., 2002).

The prevalence of Corixidae species among the aquatic bugs collected using the light trap is not surprising as this group has remarkable potential for dispersal by flight (Stonedahl, 1986). The ability to move from one habitat to another allows Corixidae species to occupy a wide variety of habitats, including temporary ones (Stonedahl, 1986). Corixidae species differ in their dispersal potential (Macan, 1939; Popham, 1964; Benedek & Jászai, 1973; Weigelhofer et al., 1992) and species frequent in temporary habitats usually have higher migration rates than those in permanent water bodies (Macan, 1939; Brown, 1951, 1954; Fernando, 1959; Pajunen & Jansson, 1969b). *Sigara lateralis* and *S. striata* were the two species collected in the greatest numbers during the present study. *Sigara lateralis* inhabits mostly temporary aquatic habitats and is a migratory species, often observed flying *en mass* (Fernando, 1959; Popham, 1964; Benedek & Jászai, 1973; Macan, 1976; Weigelhofer et al., 1992; Boda & Csabai, 2009b). *Sigara striata* is found mostly in permanent water bodies, including running waters, and according to Leston (1953), although the species is commonly found at UV traps, has little tendency to migrate. In the present study, *S. striata* was very abundant at only two of the nights. During the rest of the period, on average *S. striata* was represented by fewer specimens (71 per night) than *S. lateralis* (122 per night). The current results to a great extent confirm the previous observations

Table 3. Number of specimens per night for the four most abundant species in the study.

Species	5 June	6 June	8 June	9 June	11 June	12 June	13 June	14 June	15 June	16 June	17 June
S. striata f	410	604	37	85	22	28	24	23	8	184	10
S. striata m	98	249	28	42	6	8	16	3	2	108	6
S. lateralis f	113	79	55	70	55	124	113	94	4	143	8
S. lateralis m	143	50	49	29	32	69	86	70	1	76	25
S. iactans f	28	44	83	39	23	52	25	10	7	84	0
S. iactans m	24	22	48	24	15	36	21	8	4	60	0
C. rogenhoferi f	15	27	22	14	24	5	4	44	2	50	0
C. rogenhoferi m	16	14	3	7	8	4	3	32	0	23	0

Table 4. Results of quasi-Poisson generalised linear models (GLM) exploring factors affecting the abundance of *S. striata* in the light trap samples. Explained deviance = 93.1%.

Factors/intercept	Estimate	Standard error	t	Pr(>|t|)
Min T (°C)	-0.29671	0.03972	-7.470	0.000141 ***
Atmospheric pressure (mb)	0.08607	0.01911	4.504	0.002784 **
Max wind speed (m/s)	-0.26010	0.06688	-3.889	0.005984 **
Intercept	-74.71377	18.89530	-3.954	0.005503 **

*** significance at the 0.001 level, **significance at the 0.01 level

of *S. lateralis* dispersing more actively than *S. striata* (Brown, 1951; Popham, 1964; Benedek & Jászai, 1973; Macan, 1976; Weigelhofer et al., 1992; Boda & Csabai, 2009b). Nevertheless, flying *S. striata* could be observed also in extremely high numbers, at least during short periods.

Sex ratio: The sex ratios of dispersing individuals can reveal the relation between reproductive cycle and migration of aquatic insects (Boda & Csabai, 2009b), including aquatic bugs. In Corixidae, dispersal differences between sexes have been discussed only for few species (Brown, 1954; Pajunen & Jansson, 1969a; Benedek & Jászai, 1973; Kecső & Boda, 2008; Boda & Csabai, 2009b). In a study by mark-recapture technique on the dispersal of *Arctocorisa carinata* (Sahlberg, 1819) and *Callicorixa producta* (Reuter, 1880), Pajunen & Jansson (1969a) report no difference in dispersal activity of the two sexes. Weigelhofer et al. (1992) used Jermy-type light trap to study the night migration activity of aquatic bugs near the banks of the Danube River in Austria and found significant dominance of males over females for *Hesperocorixa linnaei* (Fieber, 1848). For the rest of the collected species Weigelhofer et al. (1992) has reported no significant deviation from 1:1 sex ratio. Earlier Brown (1954) reports ratio close to 1:1 between the sexes for migrating corixids collected in the autumn, but female prevalence for those collected in the spring. According to the author, these results could be due to "differential survival-rate of the sexes over the winter" (Brown, 1954). Based on data about corixids attracted by light in Hungary, Benedek & Jászai (1973) conclude that there is a decrease in the ratio males:females towards the end of the warmer period of the year (May-October). In the same study, in July the four most numerous species (*S. lateralis*, *C. rogenhoferi*, *S. striata*, and *S. falleni*) have been represented by more males (up to about 80%) than females. Kecső & Boda (2008), contrastingly, report female prevalence on almost each of the sampling days in most of the aquatic bugs (including *S. lateralis*) collected using shiny black plastic sheets in Hungary.

In the present study, for the first time observations on the sex ratio of dispersing by flight *S. iactans* are reported. We registered prevalence of the females not only for this species but also for most of the collected Corixidae species. To a great extent the current paper confirms the observations of Kecső & Boda (2008). Sex differences in the developmental rates of some species could serve as an explanation for the observed ratio. In a number of corixid species, population seasonal changes in the sex ratio have been reported (Pajunen & Jansson, 1969b; Aiken, 1982; Aiken & Malatestinic, 1995; Barahona et al., 2005) and, therefore, it is unclear whether the higher number of females collected in the present study is due to sex-related differences in dispersal activity or due to an asymmetric sex ratio of the adult individuals in the population.

Flight activity by hours: In Great Britain, an emigration of corixids was observed in the afternoon: *Corixa punctata* migrating from a small pond between 11:00 and 14:30 h during an unusually warm September day (Richardson, 1907) and between 13:15 and 16:30 h in April (Fernando, 1959), migration of *S. lateralis* between 16:30 and 17:30 h in a warm day in May (Macan, 1939). Popham (1964) describes migration of *C. punctata* – individuals flying off the surface of a pond between 10:00 h and 13:30 h, on three consecutive days at the end of August. The highest migration rates have been registered between 12:00 h and 13:30 h. In a number of studies in Hungary, with the use of polarising surfaces for attraction and sampling carried out between March and July (or later) during a twenty-four-hour period every week, most specimens of all observed corixid species (except *S. lateralis*) were collected in the evening hours around sunset (Csabai et al., 2006; Boda & Csabai, 2009a, 2009b, 2013; Csabai et al., 2012). Most specimens of *S. lateralis*, similarly, were collected in the evening at 21:00, but also a local peak in the morning was observed (Csabai et al., 2012). In accordance with the described above pattern of corixids' flight activity (Csabai et al., 2012), we observed maximal dispersal immediately after sunset (between 21:30 h and 22:30 h) and it was followed by a rapid decrease through the next two hours. The rare stragglers later during the night confirm the observation of Boda & Csabai (2009a, 2009b) that dispersing individuals could be observed also by moonlight during the night. However, in the present study the numbers of the individuals collected during the darker collecting period were very low. The hour after sunset coincides with one of the three periods (around nightfall, mid-morning, around noon) optimal for positively polarotactic aquatic insects to disperse and detect new aquatic habitats (Csabai et al., 2006). The flight activity of Corixidae could be strongly influenced by the insect's ability to tolerate desiccation (Oloffs & Scudder, 1966 after Stonedahl, 1986). At high air temperatures water loss could be especially rapid because of instability of the cuticular wax layer (Oloffs & Scudder, 1966 after Stonedahl, 1986). In the morning and at nightfall, usually air temperature is low and humidity is high, while, at noon, usually air temperature is maximal and humidity is low (Csabai et al., 2006). As higher humidity is advantageous for flying aquatic insects, due to the reduced risks of dehydration, dawn and dusk are optimal for flight (Csabai et al., 2006) during warm periods (mostly in the summer). In Bulgaria, *C. punctata* specimens were observed migrating between 13:06 and 13:45 from the Dragashka bara River near the Dragash Voyvoda Village (Northern Bulgaria, close to the Danube River) on October 25th 2016 (N. Simov in litt.). During a spring day (mid-April 2005), around noon, many Corixidae specimens were observed landing on the surface of a car (metallic dark red colour) near State Hunting Area "Voden-Iri Hissar" (close to the Ostrovo Village, North-eastern Bulgaria: N. Simov in litt.). These observations suggest that in Bulgaria, during the spring and autumn, the temperatures in the noon hours could be high enough to enable corixids to fly. Therefore, during these seasons more intensive migration of corixids could be expected at midday.

Influence of environmental variables: According to Popham (1964), corixids move between habitats exclusively during periods with little or no wind. In recent studies, migration of aquatic beetles and bugs (Csabai & Boda, 2005) and of *S. lateralis* (Boda & Csabai, 2009b) has not been observed during periods with wind speed above 3.3 m/s and 3.1 m/s, respectively. The occurrence of wind with speed from 1.6 to 3.3 m/s and from 0.55 m/s to 3.1 m/s was negatively correlated with the number of collected migrating aquatic bugs and beetles (Csabai & Boda, 2005) and *S. lateralis* (Boda & Csabai, 2009b), respectively. The authors explain the lower threshold for *S. lateralis* with higher sensitivity of smaller species to the effect of wind speed (Boda & Csabai, 2009b).

In the present study, corixids (including *S. lateralis*) were observed even when the hourly average wind speed was higher (5.6 m/s) than the threshold values observed in the above-cited studies (Csabai & Boda, 2005; Boda & Csabai, 2009b). Nevertheless, the best fitted GLM confirmed the previous results (Popham, 1964; Csabai & Boda, 2005; Boda & Csabai, 2009b) by connecting the decrease in the wind speed with an increase of the collected migrating *S. striata*.

Temperature also could significantly influence corixids' flight initiation and dispersal activity (Popham, 1964; Weigelhofer et al., 1992; Boda & Csabai, 2009b). Popham (1964) suggests that corixids initiate flight only when the surrounding temperature exceeds a minimum value. For example, *S. lateralis* and *S. nigrolineata* fly out of the water when its temperature is at least 12°C and *S. falleni* and *C. praeusta* when it is at least 15°C. On the banks of the Danube River in Austria, in a Jermy type light trap no Corixidae were collected at nights with average air temperatures below 12.2°C (Weigelhofer et al., 1992). In the same study, positive correlation between air temperature and the number of collected corixids has been detected. A study in Hungary, contrastingly, shows a negative correlation between the air temperature and the number of *S. lateralis* attracted to polarizing surfaces (Boda & Csabai, 2009b), but in agreement with Weigelhofer et al. (1992) also in Hungary migrating individuals were not observed bellow 12.98°C.

During each of the light trapping sessions in the present study, the temperature was above 14°C and corixids were observed on each of the sampling nights. In accordance with Boda and Csabai (2009b) the best fitted GLM shows that a decrease in the minimum air temperature during the three hours after sunset could result in an increase of the dispersing *S. striata*. During periods with high temperatures, Corixidae could be dispersing more intensively on cooler nights to minimize water loss. Campbell (1979) mentions similar influence of temperature on dispersal of *Trichocorixa verticalis* (Fieber, 1851) – an invasive corixid species for Europe.

In the present study, the highest numbers of *S. striata* have been collected on the two nights with the highest atmospheric pressure, registered per session. The GLM confirms that an increase in the atmospheric pressure could result in increase in the number of the migrating *S. striata*.

According to the present study, corixids could disperse also in periods when wind speed exceeds previously observed thresholds (Csabai & Boda, 2005; Boda & Csabai, 2009b). It could be speculated that during warm periods more *S. striata* specimens could be collected at nights with relatively low air temperatures, higher atmospheric pressure and lower maximal speed of the wind (compared to the previous or the following couple of nights).

Efficiency of the UV light trap method: In the present study, seven of the 11 new for the studied area species, were found only in the light trap catch (dispersing individuals), but not in aquatic habitats, sampled by hybrobiological net earlier (Marinov, 2000; Uzunov et al., 2001; Varadinova et al., 2011, 2012) or during the study. Before including these seven species to the Heteroptera fauna list of the Srebarna Nature Reserve, an additional study of aquatic bugs from aquatic habitats in the studied area is needed. Light trapping could be very useful for phenological studies as it gives a solid proof of adult corixids' presence during the sampling period. In studies on the biodiversity of wetlands, light trapping could give a rough idea about the corixid fauna of the habitats drying out in the studied region (Popham & Lansbury, 1960); therefore it could be an appropriate addition to the sampling in aquatic habitats.

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