

ECOLOGY AND HABITAT PREFERENCES OF *ONYCHOGOMPHUS FORCIPATUS* (LINNAEUS, 1758) ODONATA: GOMPHIDAE FROM THE SLOVAK REPUBLIC

Petrovičová K.¹, David S.²

¹Department of Zoology and Anthropology, Faculty of Natural Sciences, Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 74 Nitra, Slovak Republic

²Department of Ecology and Environmentalistics, Faculty of Natural Sciences, Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 74 Nitra, Slovak Republic

E-mail: kornelia.petrovicova@gmail.com

ABSTRACT

Onychogomphus forcipatus is a conspicuous and ecologically interesting dragonfly species with low population density, occurring in lowland and foothill watercourses. In Slovakia, the species is known from 32 localities and 11 orthographic units with a total number of 106 specimens (51♂ 3♀ 14 Ex 38 L). *O. forcipatus* has a double-peak hypsometric distribution of localities with a height of 100-200 m and 400-500 m.a.s.l.. We assume that the atypical occurrence is linked to the preference of a river bed substrate: lithal (from pebbles to fine gravel) part of the watercourse hyporhithral and psammal/psammopelal (sandy-loamy-alumina substrate) part of the stream epipotamal. *O. forcipatus* occurs in the localities along with 36 dragonfly species with a positive correlation to rheophilous species *Platycnemis pennipes*, *Calopteryx splendens*, *C. virgo*, *Ophiogomphus cecilia* and *Gomphus vulgatissimus*. The significance of substrate, longitudinal zonation of the watercourse, and altitude were tested using Monte Carlo permutation test. After removal of the correlation of factors (inflation factor), the test showed statistically significant correlations for substrate types psammal (positive correlation, $p = 0,002$) and pleisopotamal (negative correlation, $p = 0,001$). Our results are consistent with published data.

Key words: *Onychogomphus forcipatus*, dragonflies, ecology, habitat preference, Slovakia

Acknowledgments: The study has been done with support of the project VEGA 1/0232/12: The Current State of Land-Use Changes of the Contact Zones of Water Areas in Relation to Biodiversity.

INTRODUCTION

Onychogomphus forcipatus (Linnaeus, 1758) is a species of Palearctic spread from North Africa and Iberian Peninsula in *O. forcipatus uguiculatus* (Vander Linden, 1823), to southern Sweden and Finland, and from Portugal to the Ural Mountains. It occurs in the southeastern part of the area (Greece, Turkey) in *O. f. albotibialis* (Schmidt, 1954). Regarding origin (faunistic center), *O. forcipatus* belongs to holomediterranean group of dragonflies.

O. forcipatus is a typical rheobiont of lowlands and foothill watercourses with an average width of waterbed from 5 to 10 m (metarhithral, epipotamal) with presence of gravel benches with gravel to sandy bottom. Imagines usually fly along the banks with plenty of rocks suitable for rest. Females lay eggs into gravel and sand in shallow sections with slower flow of water. *O. forcipatus* has one generation in Central Europe, while the development of larvae, depending on the water temperature, usually takes 3 years. Larvae develop in 14 instars, live buried in sediment of the waterbed 1-2 cm deep or among roots of plants (Dolný, 2008). Exuviae are at parts of plants above the water surface or at rocks on shoreline. The factor limiting the occurrence of *O. forcipatus* number of gravel benches and suitable character of waterbed sediments for spawning, quality of water and character of banks. Watercourses regulations have negative impact. Imago is typically yellow-black in color with green eyes and big hook-like appendages at the end of the body. Abdomen is 31-37 mm long; wings are 25-30 mm long. Hatching of imagines lasts from the end of May until the end of July. The most numerous incidence falls into the interval from the first half of June to the second half of July.

Despite *O. forcipatus* having a large area, populations don't reach high abundance. Dolný (2008) for the Czech Republic states 172 findings from 102 localities, only 5% of findings is from heights over 500 m.a.s.l.. In Poland, for example, *O. forcipatus* was detected in 290 out of 3380 quadrates of a 10x10 km network (Bernard, 2009). It is similar also in other regions of Europe. The comparison of occupied grids (50x50 km) in the European part of the area shows the species' population stability and possibly also lower sensitivity to climate change. In the year 1988 were occupied 1040 and in the year even 1363 grids (Hof et al., 2011). Even though *O. forcipatus* listed in the national Red Lists as a rated species, it is not rated in the European Red List of Dragonflies (Kalkman, et al., 2010). The aim of this paper is to handle expansion, hypsometry and habitat requirements of *O. forcipatus* for the Slovak Republic.

MATERIAL AND METHODS

After excluding the inaccurate and incomplete historical data we have at disposal the presence of *O. forcipatus* from 32 localities in 11 orographic units, 107 adults (51♂ 3♀ 14 exuviae and 38 larvae), table 1. We used data on abundances on localities for ordination analyses. The tested environmental variables were type of biotope, type of substrate (Šporka, Krno, 2003) and altitude of locality. Dominance was calculated according to the formula $D = n_i/N * 100$ (%). The cenotic characteristic was processed by the analysis of species composition of odonatocenoses from the localities with occurrence of *O. forcipatus*. Test of normality of hypsometric data was processed using the Statistica.cz software (StatSoft, Inc., 2004). The ordination species analysis and testing of the environmental variables was carried out using the Canoco software Canoco (TerBraak, Šmilauer, 2002). The data in data matrix were filtered from database of authors' own and excerpted data on dragonflies in Slovakia.

RESULTS AND DISCUSSION

After excluding inaccurate and incomplete data we processed data on *Onychogomphus forcipatus* from 32 localities from 11 orographic units with a total number of 106

specimens. Data on the occurrence with the hypsometric characteristics of localities in orographic units are listed in Tab. 1.

Tab. 1 Location and hypsometric data of *O. forcipatus*

DSF	Geomorphological units		Number		Altitude
	Name	Specimens	Localities		
350	Krupina plain	2	2	153-253	
360	Zvolenbasin	6	2	303-315	
391	Ipeľbasin	1	1	127	
470	Javorníky	12	2	369-400	
510	Turzovskáhighlands	53	11	422-590	
720	Bukovskéhills	5	2	280-375	
790	Danubian plain	1	1	134	
801	Trnava upland	1	1	170	
805	Ipeľ upland	15	4	103-128	
804	Hron upland	8	4	128-154	
820	Eastern Slovak plain	2	2	99-100	
Σ11	DFS=Databank of Slovak fauna	N = 106	Σ32		

In cenoses with occurrence of the species were identified 36 more rheophilous and stagnicolous species. Eudominant species in the cenosis of *O. forcipatus* are rheophilous *Platycnemispennipes* (D = 30,18) and *Calopteryxsplendens* (D = 24,24). Dominant are: eurytopic damselflies *Ischnuraelegans* (D = 6,51), *Gomphusvulgatissimus* (D = 6,00) and *O. forcipatus* (D = 6,00), what confirms the rheophilous ecological characteristics of the evaluated species. Rheophilous communities are species-poor and small in number. There are 4 subdominant species, e.g. *Calopteryxvirgo*, *Gomphuiflavipes* (D = 2,10-3,62), also 4 recedentspecies and up to 24 subrecedent species(D = 0.06-0,91).

We used altitude of localities (Tab. 1) as hypsometric characteristics. To check normality of hypsometry, we used 2D Histograms (the normal function fitted to histograms)with Shapiro-Wilks' s test (Fig.1). This test is also suitable for small data sets.

We tested the null hypothesis H_0 : sample comes from a set with normal distribution. If $p > p_\alpha \Rightarrow$ we can't reject the null hypothesis H_0 with a level of statistical significance 95 % ($p_\alpha = 0,05$). Hypsometric distribution is significantly double-peaked (we reject H_0 , $p = 0,00$ $1 < p_\alpha$). The majority of findings (N=12) of *O. forcipatus* comes from the height interval 100-200 m and (N=10) from the interval 400-500 m.a.s.l.. Our findings support the literary data on the occurrence of species from lowlands to foothill level (Dolný, 2008; Sternberg, Buchwald, 2000). However, why do we lack findings in the height level 200 – 400 m? Even if we consider the insufficient exploration of the area of Slovakia, we believe that the important factor is the absence of habitats (gravel benches with sandy sediment) suitable for *O. forcipatus* larvae in the uplands level.

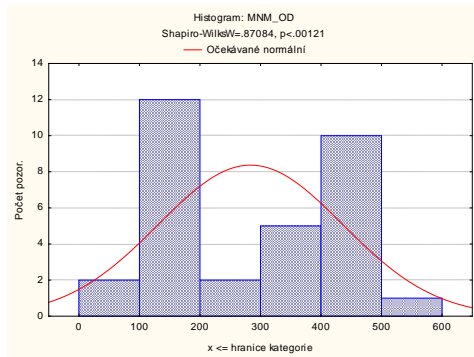


Fig. 1 Histogram of hypsometric occurrence of *O. forcipatus* localities in Slovakia

To analyze the structure of communities with *O. forcipatus* we used a trend-riddencorrespondence analysis (DCA) in the software Canoco. We examined heterogeneity of data with a resulting Lengths of gradient (=SD) = 3.3. For the result of the DCA analysis of species data see fig.2, cumulative percentage variance of species data: 21.6 (Axis 1) a 43.1 (Axis 4). *O. forcipatus* has the expected position among rheophilous species *P. pennipes*, *G. vulgatissimus*, *C. splendens*, *C. virgo*, *O. cecilia*, but also a stagnicolousspecies *Sympetrum pedemontanum* and euryoecious damselfly *Aeshnacyanea*. The link to habitats was investigated using the RDA analysis (Fig. 2) and we used the Monte Carlo test to determine the significance of substrate (terminology according to the Directive on Water) and reference of sections of watercourses (terminology according to Šporka, Krno, 2003). High correlation factors were altitude (inflation factor 19,2), psammal substrate (18,3), mesolihthal (16,4) and more. After removing altitude, the highest value was mesolihthal with inf. factor 10,5(metarhithrál). Statistically significant variables were shown to be pleisopotamal (dead arm) with P-value 0.002 and psammal substrate (sand, sandy muddy sediments) with P-value 0.010. This is in accordance with the published data.

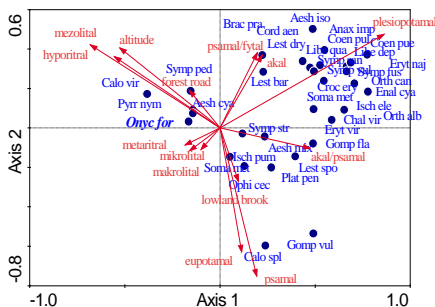


Fig. 2 Correlation between *O. forcipatus* with substratum and watercourse

CONCLUSIONS

The evaluation of the data on *O. forcipatus* from Slovakia (106 specimens from 32 localities) showed that the species occurs in the localities as dominant along with other 36 species of dragonflies. Several of them are flying imagines, e.g. *Sympecma fusca*, *Crocothemis erythraea*, *Smptetrumpedemontanum*. Eudominant and dominant are rheophilous species *Platycnemis pennipes*, *Calopteryx splendens*, *Ischnura elegans* a *Gomphus vulgatissimus*. Rheophilous biotopes have low species richness and abundance. In our material there is up to 24 subrecent species. Hypsometric occurrence is double-peaked, with occurrence in lowlands and submontane level with significant absence of the species in hilly areas. The species prefers lowland (epipotamal) and piedmont (hyporhithral) parts of watercourses. One statistically significant habitat factor ($p = 0,01$) is psammal (sand and sandy-loamy-muddy sediments) substrate type with a positive correlation of species. Another statistically significant factor ($p = 0,002$) is pleisopotammal (dead river arm) with negative correlation of *O. forcipatus* to this factor. Our results confirm the published data.

REFERENCES

- BERNARD R., BUCZYŃSKI P., TOŃCZYK G. & WENDZONKA J., 2009: *A distribution Atlas of Dragonflies (Odonata) in Poland*. Bogucki Wyd. Naukowe, Poznań, 256 s.
- DOLNÝ, A., 2008: *Onychogomphus forcipatus*. In: Dolný, A., Bárta, D., Waldhauser, M., Hof, C., et al. (2012). "Habitat Stability Affects Dispersal and the Ability to Track Climate Change." *Biology letters*, 8 (4): 639-643.
- KALKMAN, V.J., BOUDOT, J.-P., BERNARD, R., CONZE, K.-J., DE KNIJF, G., DYATLOVA, E., FERREIRA, S., JOVIĆ, M., OTT, J., RISERVATO, E., SAHLÉN, G., 2010. *Europe and Red List of Dragonflies*. Luxembourg: Publications Office of the European Union, 28 p.
- STATSOFT, INC. (2004). *STATISTICA Cz [data analysis software]*, verze 7. www.StatSoft.Cz.
- STERNBERG, K., BUCHWALD, R. (EDS.), 2000: *Die Libellen Baden – Württembergs*, Bd. 1.: *Allgemeiner Teil Kleinlibellen (Zygoptera)*, 468 s., Bd. 2: *Großlibellen (Anisoptera)*, Verlag Eugen Ulmer GmbH & Co., Stuttgart, 712 s.
- ŠPORKA, F., KRNO, I., 2003: Úvod. s. 11-22. In: Šporka, F. (Ed.) 2003: *Vodné bezstavovce (makrovertebráta) Slovenska, súpis druhova a ekologické charakteristiky*. Slovenský hydrometeorologický ústav Bratislava, 590 s.
- TERBRAAK, C. J. F., ŠMILAUER, P. 2002. *CANOCO Reference Manual and CanoDraw for Windows User's Guide: Software for Canonical Community Ordination (version 4.5)*. USA : Ithaca, NY, 2002, (www.canoco.com): Microcomputer Power