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Phyllophagous sawflies (Hymenoptera, Symphyta) in pine stands (*Pinus sylvestris*) in a sandy lowland, Slovakia

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Abstract

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In the period of 2008 and 2009, the authors studied and compared taxocoenoses of phyllophagous sawflies (Symphyta, Hymenoptera) on Scotch pine on four study plots in the Borská nížina lowland (southwestern Slovakia). In total, 6 species of sawflies belonging to two families were found. Nursery Pine Sawfly *(Gilpinia frutetorum)* with the markedly highest abundance in all study plots is the most numerous species. The highest total abundance of sawfly larvae was found on 20-year-old pine trees of forest stand wall and in close stand of young 10-year-old pines. According to the dendrogram based on Wishart's index two different groups of sawfly communities are specified: sawfly communities in dense stands in contrast with sawfly communities in open pine stands. Statistically significant difference between the values of Shannon-Wiener's diversity of sawfly communities in open and dense stands was found. The test anosim shows that there is no significant difference between study plots with regard to species composition of a sawfly community and abundance of individual species.

Key words

Borská nížina lowland, pine defoliators, sawflies, southwestern Slovakia

Introduction

Fauna of sawflies (Symphyta) in their larval stage has been insufficiently explored in Central Europe. Most of the works of the Carpathian Basin comes from studies on adult sawflies (Roller and Haris, 2008). From the Slovak territory, there exist only old faunistic data on the occurrence of economically important diprionid species (Symphyta, Diprionidae) as well as from the Borská nížina lowland in the southwestern Slovakia (Mocsáry, 1900; Ortvay, 1902; D´Agnolo, 1940). So far, little attention has been paid to Symphyta larvae on *Pinus* in Slovakia. Jamnický (1963, 1988, 1990) in his studies on biotic and abiotic factors affecting tree species growing in the upper limit of the forest and in the subalpine vegetation zone in the Tatra mountains (High Tatras, Belianske Tatras, West Tatras and Low Tatras) and some other mountains in Slovakia was the one who examined larvae of sawlies (Symphyta). Analyzing insects on two pine species – *Pinus mugo* and *P. cembra* (dwarf pine vegetation tiers) he has extended knowledge on bionomy of dominant phyllophagous species. Hrubík (1988) studied bionomy of two pests of sawflies living on *Pinus sylvestris* in urban areas. Roller (1999) found relatively rich assemblages of sawfly adults sampled by Malaise traps in 4 localities (Pernek, Jakubov, Studienka, Malacky) of Borská nížina lowland (richness of 65 to 132 species). So far, there has been no research of larval stages of sawflies on *Pinus sylvestris* in Slovakia yet.

The main goal of this paper is a comparison of Symphyta larvae on Scotch pine of different age and different structure of pine stands in four plots in the Borská nížina lowland. Study plots belong to biotop of cultivated Pine forests and semi-native pine-oak forests.

Material and methods

Research of Symphyta larvae of Scotch pine (the age of pines 5 to 100 years) was carried out at four study plots in the Záhorie Protected Landscape Area around the village Lakšárska Nová Ves (DFS grid square: 7468/69) in 2008 and 2009. The beating method of 1 m long branches of 50–200 cm above the ground was applied (200 beats = 10 samples on competent plot at each sampling). One sample refered to 20 beats. Each study plot was visited during the vegetation season from April to September at approximately monthly intervals. The larvae were preserved in 70% ethanol and identified in the laboratory. The voucher specimens of all sawfly species detected in the study are deposited in the collections of the authors.

Description of the study plots (the situation in 2008):

Plot 1: Stand of no canopied young pines (free-growing pines of age 20 years) on sand dune gradually going to the stand of about age 100 years.

Plot 2: Dense stand of young pine trees (canopied pines, close forest stand), age 5 years.

Plot 3: Forest stand wall of pines (no shielded pine trees located on the edge of forest stand, open pine stand), age 20 years.

Plot 4: Dense stand of young pine trees (canopied pines), age 10 years.

Determination of Symphyta larvae was made by means of publication Viitasaari and Varama (1987) and Viitasaari (2002).

The cluster analysis of the communities was performed using the computer program NCLAS (Podani, 1993). The clustering method complete linkage in combination with Wishart's similarity ratio was used (Wishart, 1969). Species communities were compared using Principal Component Analysis (PCA) as an indirect gradient method (Ter Braak and Šmilauer, 1998). Diversity was characterised using the Pielou's index of equitability (e), Shannon-Wiener's index of total species diversity (H') and Simpson's index of dominance (c) (Ludwig and Reynolds, 1988; Poole, 1974).

Analysis of similarities (anosim) was used to compare communities between the groups of site classes. anosim is a nonparametric procedure that evaluates whether the average similarities between samples within individual groups are closer than the average similarities of all pairs of replicates between groups (Clarke, 1993). For significance testing, the ranked similarity within and between groups is compared with the similarity that would be generated by chance. Essentially the samples are randomly assigned to groups 10,000 times, and Rank similarity (R) is calculated for each permutation. The observed value of R is then tested to determine significant difference from random distribution. For anosim was used PAST 1.95 software (Hammer et al., 2001).

Results and discussion

In the studied area six species of sawflies, belonging to two families – Diprionidae (genera *Gilpinia* and *Diprion*) and Pamphiliidae (genus *Acantholyda*), were found. Nursery Pine Sawfly (*Gilpinia frutetorum*) with the markedly highest abundance in all study plots is the most numerous species (Table 1, Figs 1–3). *Gilpinia virens* was also recorded in all plots (Table 1, Figs 1–3). The highest total abundance of larvae was found in 2008 on the plot 3 (20-year pines of forest stand wall) and in 2009 on the plot 4 (dense stand of young 10-year pines) (Figs 1–2). Larvae of web-spinning pine-sawfly (*Acantholyda hieroglyphica*) were found only on 5 year old and 20 year old pines – plots (Table 1). According to the published observations they usually prefer 2–5 or 3–4 year old pines (Pschorn-Walcher, 1982;

Table 1. Overview of sawfly species found on study plots

Species	Study plot/Abundance				Abundance together
	A	B	C	D	
Gilpinia frutetorum (Fabricius, 1793)	32	20	44	23	119
Gilpinia virens (Klug, 1812)	6	8	4	6	24
Gilpinia pallida (Klug, 1812)	0	3	3	8	14
Gilpinia variegata (Hartig, 1834)	1	4	3	5	13
Diprion similis (Hartig, 1837)	0	0	1	1	2
Acantholyda hieroglyphica (Christ, 1791)	0	2	1	0	3
Total abundance	39	37	56	43	175

A = plot 1, B = plot 2, C = plot 3, D = plot 4.

Achterberg and Aartsen, 1986). Based on the zoogeographic distribution the found species belong to a group of Eurosibirian faunal elements. Of them *G. frutetorum* and *Diprion similis* were introduced to North America and/or Canada (*G. frutetorum*) (Pschorn-Walcher, 1982). Both species have a relatively high tendency to outbreaks (Herz and Heitland, 2002). Also *G. frutetorum* may cause significant damages on pines as it showed highest abundance in studied plots (Table 1, Figs 1–3).

Dendrogram constructed on the basis of abundance similarity (Wishart's similarity ratio) identified two clusters of coenoses. The first cluster consists of sawfly community of sparse 20-year pine stand (free-growing young pines) gradually going to the stand of age of about 100 years – open pine stand (study plot 1) and

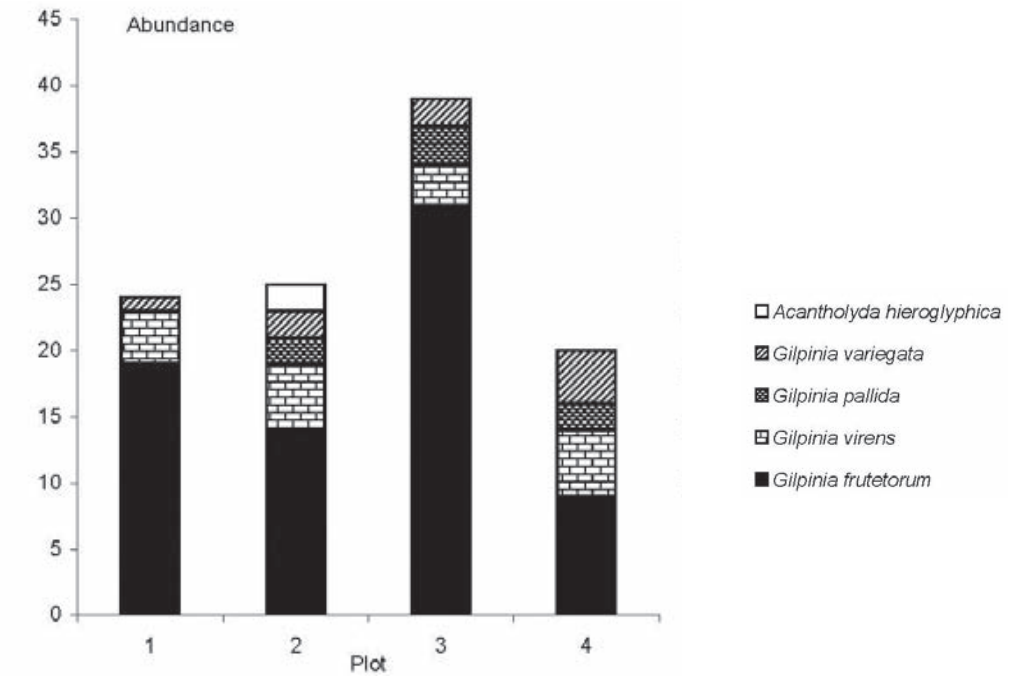

Fig. 1. Proportion of sawfly species in 2008 found on four study plots.

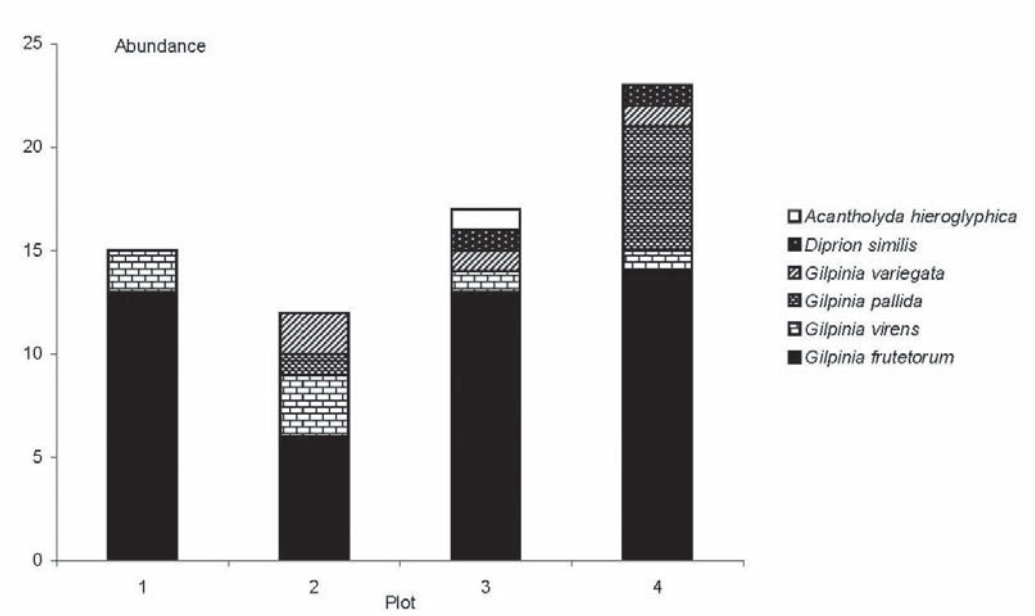

Fig. 2. Proportion of sawfly species in 2009 found on four study plots.

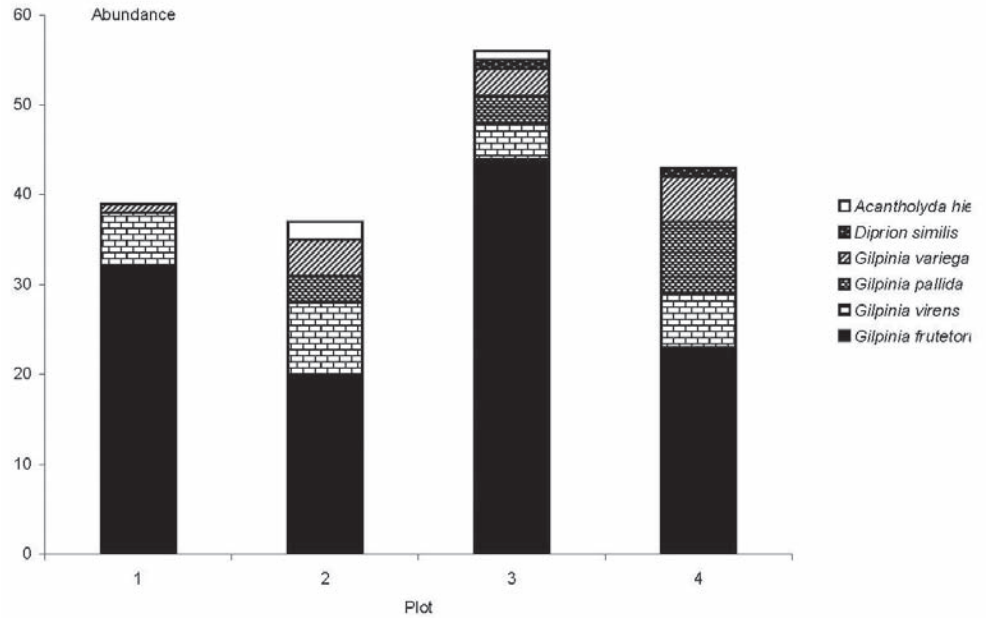

Fig. 3. Proportion of sawfly species in 2008 and 2009 found on four study plots.

sawfly community of marginal 20-year old open pine stand (forest stand wall) (study plot 3). The second cluster consists of sawfly community on young pines in a closed forest stand (communities on study plots 2 and 4). Both clusters are linked to the relatively high level of similarity. It is likely due to a relatively short distance of compared study plots. Communities on plots 1 and 3 and also on plots 2 and 4 are connected to a very high level of similarity (Fig. 4).

The distribution of the study plots and sawfly species in the space of the first two axes of Principal Component Analysis (PCA) is shown in Fig. 5. The groups of

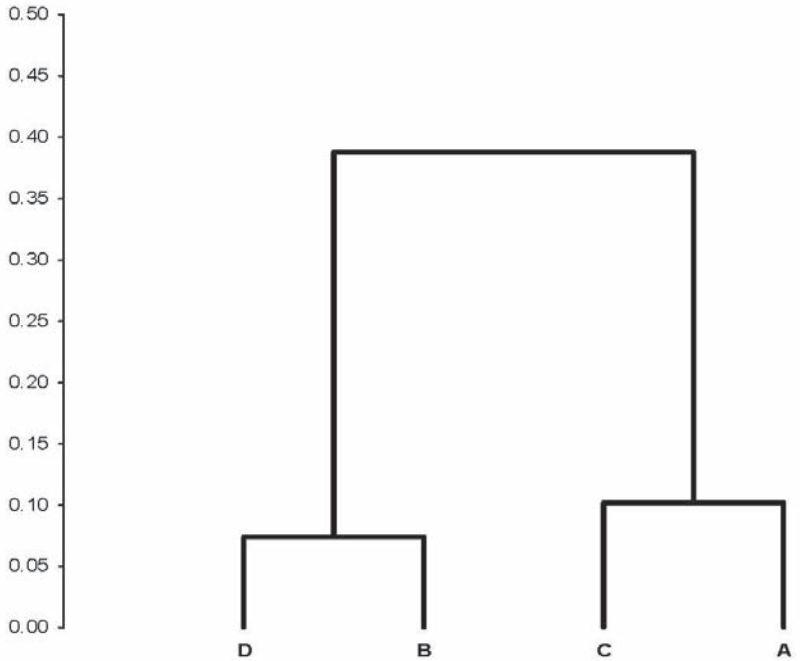

Fig. 4. Hierarchical classification of pine sawfly taxocoenoses on four study plots according to abundance similarity (Wishart similarity ratio, complete linkage) (vertical axis – dissimilarity). A = plot 1, B = plot 2, C = plot 3, D = plot 4.

species were determined on the basis of the dendrogram of abundance similarity resulting from the position of study plots and species in the ordination space of the first four PCA axes. Study plots and species were located along the first axis which has the largest information statement. On the right side of the crossing point the plots of no canopied pines (fragmented study plots) are located – plots 1 and 3 and on the left side the stands of canopied pines (closed forest stands) are present – plots 2 and 4. Euryvalent species *G. frutetorum* was more numerous in both fragmented stands – plots 1 and 3 compared with canopied stands – plots 2 and 4 (Fig. 3).

Sawfly communities in canopied stands (plots 2 and 4) have higher values of Shannon-Wiener's diversity and equitability (evenness) (Tab. 2). Statistically significant difference was found between the values of Shannon-Wiener's diversity of sawfly communities in open and closed stands (Tab. 2).

With the exception of *G. frutetorum* and *D. similis* the other species seem to be more adapted to canopied

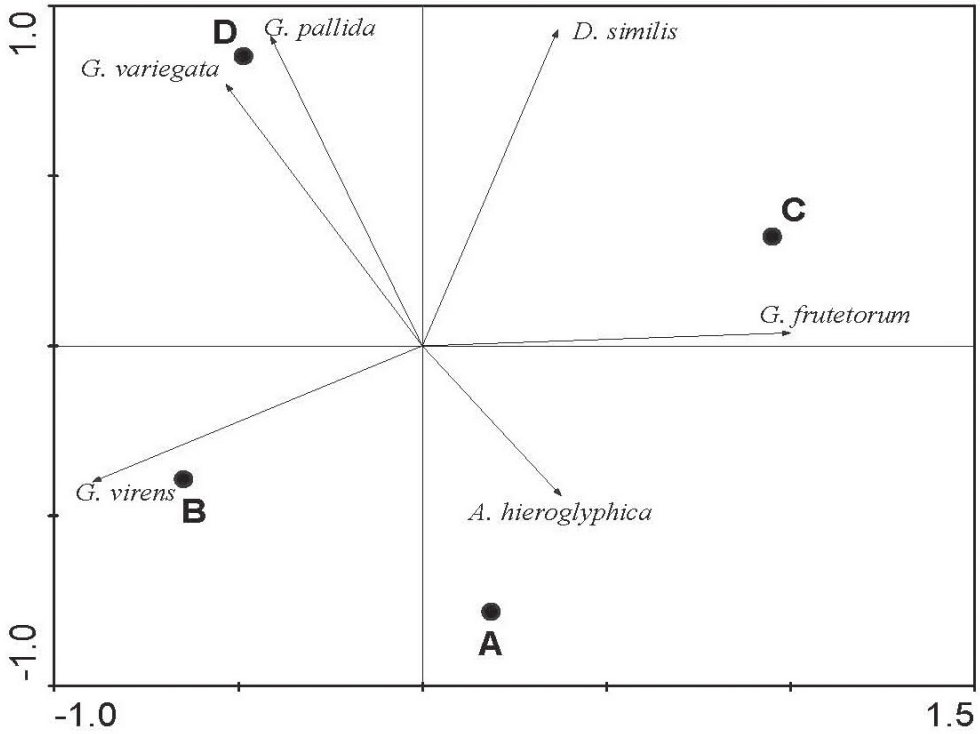

Fig. 5. PCA ordination diagram of the study plots and sawfly species score. A = plot 1, B = plot 2, C = plot 3, D = plot 4.

Table 2. Species diversity test (Poole, 1974) and basic coenological characteristics of sawfly communities on four study plots in 2008 and 2009

Study plots	Value	A	B	C	D
	spp	4	5	6	5
	e	0.467	0.786	0.494	0.783
	c	0.664	0.360	0.608	0.354
	H'	**0.648**	**1.266**	**0.885**	**1.260**
A	**0.648**	0.000	76.756	95.608	77.864
B	**1.266**	3.087**	0.000	93.626	76.820
C	**0.885**	1.099ns	1.843ns	0.000	98.212
D	**1.260**	3.229**	0.031ns	1.910ns	0.000

A = plot 1, B = plot 2, C = plot 3, D = plot 4, ssp = number of species, e = Pielou's index of evenness, c = Simpson's index of dominance, H' = Shannon-Weaver's index of species diversity. Significance levels: ** = 0.001 < P < 0.01; ns = 0.05 < P (non-significant).

forest stands. The most species were found on the plot 3 which all the species were present during the research on (Table 1, Fig. 3). The lowest richness refers to the most photic stand – plot 1 (sand dune with sparse pine stand exposed to insolation) (Table 1, Fig. 3).

With regard to the Simpson's index of dominance it was confirmed that sawfly communities in the open stands (plots 1 and 3) had a „dominance concentration" to the species of *G. frutetorum* (Table 2, Fig. 3). On the other hand dominance (according to Simpson's index of dominance) of sawfly communities in canopied stands (plots 2 and 4) was spread over a larger number of species (Fig. 3).

The test ANOSIM shows that there is no significant difference between study plots with regard to species composition of sawfly community and abundance of individual species. In other words, the variability in species composition of sawfly community and abundance of individual species within each study area is not significantly different from the variability between plots (Table 3).

Table 3. Pairwise tests of ANOSIM.
Full data ANOSIM – R = –0.21, p = 0.84

p-values	A	B	C	D
A	x	1	0.664	0.660
B	1	x	1	1
C	0.664	1	x	1
D	0.660	1	1	x

A = plot 1, B = plot 2, C = plot 3, D = plot 4.

Regarding the occurrence of larvae during the season *Gilpinia frutetorum* had two abundance peaks, the first in mid May and the second in early October (records from late April to early October). The seasonal records of other, less numerous species are as follows: *G. virens* – from mid May to early October, *G. pallida* – from late April to the first third of June, *G. variegata* – from early June to early September, *Diprion similis* and *Acantholyda hieroglyphica* – from the second third of May to early September.

In conclusion we can say that the study plots are relatively poor in sawfly species. None of the found species showed significant increased abundance compared, for instance, with *Neodiprion sertifer* (Geoffroy, 1785) – pest of *Pinus mugo* from the family Diprionidae in the Giant Mountains (NEHRING, 1894; RÖHRING, 1895) or with the pests of *Pinus cembra* in Tatras – *Acantholyda erythrocephala* (Linnaeus, 1758) from the family Pamphiliidae and *Microdiprion pallipes* (Fallén, 1808) from the family Diprionidae (JAMNICKÝ, 1988).

It would be necessary to perform long-term monitoring of abundance of individual sawfly species on Scots pine to make more precise and comprehensive conclusions in Borská nížina lowland.

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References

ACHTERBERG, C. VAN, AARTSEN, B. VAN 1986. The European Pamphiliidae (Hymenoptera: Symphyta), with special reference to the Netherlands. *Zool. Verhandel., Leiden,* 234:1–98.

CLARKE, K.R. 1993. Non-parametric multivariate analysis in community structure. *Austral. J. Ecol.*, 18: 117–143.

D´AGNOLO 1940. Pred novou hmyzou kalamitou v borových lesoch na okolí Malaciek [Before the new insect calamity in the pine forests around Malacky]. *Les a Drevo*, 6: 2–3.

HAMMER, O., HARPER, D.A.T., RYAN, P.D. 2001. PAST – Paleontological statistics software package for education and data analysis. *Paleont. electr.* 4: 1–9.

HERZ, A., HEITLAND, W. 2002. Comparison of the fat allocation in female pine sawflies (Hymenoptera, Diprionidae). *Eur. J. Ent.*. 99: 117–120.

HRUBÍK, P. 1988. *Živočíšni škodcovia mestskej zelene* [Animal pests of urban greenery]. Bratislava: Veda. 196 p.

JAMNICKÝ, J. 1963. Hrebeňovky (Diprionidae) žijúce na borovici limbe (Pinus cembra L.) [Pine Sawflies (Diprionidae) living on arolla pine (Pinus cembra L.)]. In *Sborník prác o Tatranskom národnom parku* 6. Bratislava: Obzor, p. 63–74.

JAMNICKÝ, J. 1988. Hmyz (Insecta) žijúci na borovici limbe (Pinus cembra L.) [Insects (Insecta) living on arolla pine (Pinus cembra L.)]. In *Zborník prác o Tatranskom národnom parku 28*. Martin: Osveta, p. 5–54.

JAMNICKÝ, J. 1990. Hmyz (Insecta) žijúci na borovici kosodrevine (Pinus mugo Turra) [Insects (Insecta) living on mugo pine (Pinus mugo Turra)]. In *Zborník prác o Tatranskom národnom Parku* 30. Martin: Osveta, p. 5–42.

LUDWIG, J.A., REYNOLDS, J. 1988. *Statistical ecology: a primer of methods and computing*. New York: Wiley-Interscience Public. 337 p.

MOCSÁRY, S. 1900. Ordo Hymenoptera. In PASZLAVSKY, J. (ed.). *Fauna Regni Hungariae*. Budapest: Regia Societas Scientiarum Naturalium Hungarica, p. 7–113.

NEHRING, A. 1894. Raupenfrass am Knieholz des Riesengebirges. *Forstw. Centralbl*., 16: 328–329.

ORTVAY, T. 1902. *Pozsonyvármegye és a területén fekvő Pozsony, Nagyszombat, Bazin, Modor, S. Szentgyörgy városok állatvilága. Állatrajzi rész* [Animal world of Bratislava and its wider surroundings (Trnava, Pezinok, Modra, Svätý Jur.). Part zoology]. Pozsony. 948 p.

Podani, J. 1993. *Syntax. Version 5.0 Computer programs for multivariate data analysis in ecology and systematics. User's guide*. Budapest: Scientia Publishing. 104 p.

Poole, R.W. 1974. *An introduction to quantitative ecology*. New York: McGraw-Hill. 532 p.

Pschorn-Walcher, H. 1982. Unterordnung Symphyta, Pflanzenwespen. In Schwenke, W. (ed.). *Die Forstschädlinge Europas 4. Hautflügler und Zweiflügler.* Hamburg, Berlin: Parey, p. 1–234.

Roller, L. 1999. *Spoločenstvá hrubopásych (Hymenoptera: Symphyta) vybraných zoogeografických regiónov Slovenska* [Communities of sawflies (Hymenoptera: Symphyta) of selected zoogeographical regions of Slovakia]. PhD thesis. Bratislava: Institute of Zoology of the Slovak Academy of Sciences. 180 p.

Roller, L., Haris, A. 2008. *Sawflies of the Carpathian Basin, history and current research.* Natura Somogyiensis series, 11. Kaposvár: Somogy County Museum. 273 p.

Röhring, G. 1895. Lophyrenfrass am Knieholz des Riesengebirges im Jahre 1893. *Forstwiss*. *Centralbl*., 17: 215–219.

Ter Braak, C.J.F., Šmilauer, P. 1998. *CANOCO references manual and user's guide to Canoco for Windows: software for canonical community ordination (version 4)*. Ithaca, NY, USA: Microcomputer Power. 352 p.

Viitasaari, M. 2002. The Northern European taxa of Pamphiliidae (Hymenoptera). In Viitasaari M. (ed.). *Sawflies I*. Helsinki: Tremex Press, p. 235–358.

Viitasaari, M., Varama, M. 1987. *Sahapistiaiset 4. Havupistiaiset (Diprionidae) Julkaisuja 10* [Sawflies 4. Conifer sawflies (Diprionidae) Report 10]. Helsinki: University of Helsinki, Department of Agricultural and Forest Zoology. 79 p.

Wishart, D. 1969. An algorithm for hierarchical classifications. *Biometrics*, 22: 165–170.

Fylofágne piliarky (Hymenoptera, Symphyta) borovicových porastov (*Pinus sylvestris*) v nížinách na viatych pieskoch, Slovensko

Súhrn

V období rokov 2008 a 2009 autori študovali a porovnávali na štyroch študijných plochách v oblasti Borskej nížiny (juhozápadné Slovensko) na borovici lesnej taxocenózy fylofágnych piliarok (Hymenoptera, Symphyta). Celkove zistili 6 druhov piliarok patriacich do 2 čeľadí. Najpočetnejším druhom je hrebenárka samotárska (*Gilpinia frutetorum*) s výrazne najvyššou početnosťou na všetkých študijných plochách. Celková najvyššia početnosť lariev piliarok sa zistila na 20-ročných boroviciach porastovej steny a v uzavretom poraste mladých 10-ročných borovíc. Podľa dendrogramu na základe Wishartovho indexu sa vyčlenili 2 odlišné skupiny spoločenstiev piliarok (spoločenstvá piliarok v uzatvorených porastoch v protiklade so spoločenstvami piliarok v otvorených borovicových porastoch). Zistil sa štatisticky preukazný rozdiel medzi hodnotami Shanonovho indexu pri spoločenstvách piliarok otvorených a uzatvorených porastov. Test anosim nepotvrdil signifikantný rozdiel medzi študijnými plochami vzhľadom k druhovému zloženiu spoločenstva piliarok a abundancii jednotlivých druhov.

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