**Screen traps as an efficient method in faunal research on fungus-feeding
thrips (Tubulifera: Phlaeothripidae)**

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ABSTRACT. Studies on fungus-feeding thrips were carried out in two national parks ranked as biosphere reserves: the Białowieża National Park (north-east Poland) and the Bieszczady National Park (south-east Poland). IBL-2 screen traps were used as the main method in the forest communities. Traps were deployed in managed forests and the strict reserve in the Białowieża NP, and along two trails in the lower forest belt up to its upper border with mountain meadows in the Bieszczady NP. Using IBL-2 traps revealed the presence of ten mycophagous species in the Białowieża NP and six in the Bieszczady NP. In the former *Hoplothrips carpathicus*, *H. fungi*, *H. unicolor* and *H. polysticti*, and in the latter *H. carpathicus* and *Maderothrips longisetis* were recorded for the first time in Poland.

KEY WORDS: mycophagous thrips, passive traps, Białowieża National Park, Bieszczady National Park.

INTRODUCTION

Different methods for collecting insects are used in accordance with the type of habitat studied. In open areas, the entomological sweep net is the most efficient method, which allows one to collect a relatively large number of species. In forest communities where the undergrowth is rather poor (e.g. Norway spruce forest) or develops seasonally (e.g. hornbeam and beech forests in early spring), this method is insufficient and additional ones need to be used. Several types of passive traps are used in studies of species diversity, e.g.

coloured Moericke traps, Malaise traps, screen traps, photoelectors and pitfall traps. The first three types are attractive to insects because they contrast with the surroundings; they detect mainly winged forms (LEWIS 1973). The positive or negative photo- or geotropism exhibited by insects is made use of in the soil or tree photoelectors placed on tree trunks (ZUR STRASSEN 1994, DUBOVSKÝ et al. 2010, MASAROVÍČ et al. 2014). With pitfall traps one can investigate insects – mostly apterous forms – actively moving on the ground or in the leaf litter.

Studies of the species diversity and biology of fungivorous and bark-dwelling thrips are very difficult to carry out because of the concealed lifestyle and wide dispersal of their populations; locally, however, they can be very numerous (KOBRO & SOLHEIM 2002). They live on decaying wood, feeding on the hyphae or spores of fungi (MOUND 2002). Their occurrence depends on the presence of old trees in various stages of decay on the forest floor. This kind of habitat is found more often in natural or semi-natural forests than in managed ones, from which fallen branches and logs are removed. Minimal human intervention maintains a large diversity of tree age, including those in various stages of decay. Such unchanged habitats occur mainly in reserves or national parks.

The IBL-2 screen trap used in the present research was constructed at the Forest Research Institute in Białowieża and, among other methods, was used for monitoring research in strictly protected areas of the Białowieża Primeval Forest. In addition, it was used during studies of the migration intensity of the spruce bark beetle (*Ips typographus* (LINNAEUS, 1758)) – the most serious pest of trees in both protected and managed forests (GUTOWSKI & KRZYSZTOFIK 2005). In addition to the beetles, 35 species from the order Thysanoptera were caught, among them fungi-feeding species, during this study. This inspired us to use this type of trap in research on Thysanoptera species diversity in the Bieszczady National Park. To date no systematic studies of thrips diversity in this region have been carried out.

This paper presents the results of investigations on the species diversity of fungivorous thrips in two national parks in Poland – the Białowieża National Park and the Bieszczady National Park. In the discussion we compare the effectiveness of IBL-2 screen traps with other passive traps used in faunal studies of thrips in woodland habitats.

STUDY AREA AND METHODS

The study was carried out in two national parks – the Białowieża NP (NE Poland) and in the Bieszczady NP (SE Poland) (Fig. 1). The former was established in 1932 and is the last surviving primeval deciduous and mixed forest in the European lowlands, whereas the latter was established in 1973 and is a part of the Eastern Carpathians. Both of them have

the rank of biosphere reserves: the Białowieża Forest Biosphere Reserve and the East Carpathians Biosphere Reserve, respectively. In both regions IBL-2 screen traps were deployed along two transects. In the Białowieża Primeval Forest one straddled the national border between the strict reserve on the Belarussian side and managed forests on the Polish side, while the other followed the “Browska Way”, which runs along the border of a strict reserve in the Białowieża NP. Hornbeam (*Tilio-Carpinetum*) and mixed forests (*Quercus-Piceetum*) were dominant in both plots. In the Bieszczady NP traps were deployed in beech forests (*Dentario glandulosae-Fagetum*) and Norway spruce forests (*Abieti-Piceetum montanum*) in the lower woodland belt. Eight traps were hung along the first trail, from the village of Wołosate (804 m amsl) to Mt. Tarnica. (1346 m amsl) (SW slope), and ten traps along the second trail leading from Zatwarnica (680 m amsl) to Orłowicz Pass (1073 m amsl) (NE slope).

Fig. 1. Location of the study areas.

Fig. 1. IBL-2 screen trap in the Bieszczady National Park.

An IBL-2 trap consists of a triangular screen made from translucent white foil (length of side = 90 cm; area = ca 0.4 m²) and a polythene funnel affixed to a 1 litre bottle filled with an aqueous solution of ethylene glycol as preservative. The upper side of the inverted triangle is covered by a small roof (Fig. 2). No attractants were used in these traps. Traps were hung about a metre above the ground between the trunks of the tree species predominating in the sampling plots and, depending on the weather, they were emptied every 10-14 days from May to October. In the Białowieża NP the insects were taken from the Forestry Research Institute's collection – they had been collected between 1999 and 2001. In the Bieszczady NP materials were collected in the second half of 2012 and in 2013 by the present authors (KUCHARCZYK & WYROZUMSKI 2015).

After selection from the catch, all specimens were preserved in 70% ethyl alcohol and then mounted in Berlese fluid or Canada balsam (MOUND & KIBBY 1998); they were identified according to the key by SCHLIEPHAKE & KLIMT (1979). Species of the *Hoplothrips* AMYOT & SERVILE 1843 genus were identified according to KOBRO

& RAFOSS (2006). All the specimens collected are deposited at the Department of Zoology, Maria Curie-Skłodowska University, Lublin, Poland.

RESULTS

During the study period in the Białowieża NP 35 thrips species were caught in the screen traps: 21 (60%) were dendrophilous, and ten of these in turn were fungus-feeding species. Four species of the genus *Hoplothrips* – *H. carpathicus* PELIKÁN, 1961, *H. fungi* (ZETTERSTEDT, 1828), *H. unicolor* (VUILLET, 1914) and *H. polysticti* (MORISON, 1949) are new to the Polish fauna – and *Holothrips schaubegeri* (PRIESNER, 1920) is new to the Białowieża Primeval Forest. *Hoplothrips pedicularius* HALIDAY, 1836 and *H. carpathicus* were the most numerous and frequently caught on both transects. The other species, apart from *H. schaubegeri*, were recorded singly.

In the Bieszczady NP 20 thrips species were selected from screen traps; 13 (65%) were dendrophilous and six of these were fungivorous. *H. pedicularius* and *H. carpathicus* were caught the most often. *Maderothrips longisetis* (BAGNALL, 1910) is a species new to the Polish fauna: on both transects it was caught in traps deployed in beech forests with many fallen trees. *Hoplothrips corticis* (DE GEER, 1773) was noted in different forest communities, at both the lowest and the highest altitudes along both transects, which may suggest its large environmental tolerance.

Table 1. Checklist of thrips species (with their food preferences) collected in IBL-2 traps in the Białowieża and Bieszczady National Parks, I and II – number of transect, D – dendrophilous species, Fl – flower feeder, Fu – fungus feeder, G – grass feeder, L – leaf feeder, P – predator.

Thrips species	Białowieża		Bieszczady		Food preferences
	I	II	I	II	
<i>Aeolothrips intermedius</i> BAGNALL, 1934	•	•			P
<i>Aeolothrips melaleucus</i> HALIDAY, 1852	•	•			D, P
<i>Aeolothrips versicolor</i> UZEL, 1895				•	D, P
<i>Aeolothrips vittatus</i> HALIDAY, 1836		•			D, P
<i>Chirothrips hamatus</i> TRYBOM, 1895		•			G
<i>Chirothrips manicatus</i> HALIDAY, 1836		•	•		G
<i>Chirothrips pallidicornis</i> PRIESNER, 1925	•				G
<i>Dendrothrips degeeri</i> UZEL, 1895			•		D, L
<i>Frankliniella intonsa</i> (TRYBOM, 1895)		•			Fl
<i>Frankliniella tenuicornis</i> (UZEL, 1895)		•			G
<i>Limothrips denticornis</i> HALIDAY, 1836	•	•			G
<i>Mycterothrips consociatus</i> (TARGIONI-TOZZETTI, 1886)	•	•	•		D, L
<i>Mycterothrips latus</i> (BAGNALL, 1912)			•		D, L
<i>Mycterothrips salicis</i> (O.M. REUTER, 1879)	•	•	•	•	D, L

Table 1. Continued.

Thrips species	Białowieża		Bieszczady		Food preferences
	I	II	I	II	
<i>Odontothrips phaleratus</i> (HALIDAY, 1836)			•		Fl
<i>Oxythrips ajugae</i> UZEL, 1895	•	•			D, Fl & L
<i>Oxythrips bicolor</i> (O.M REUTTER, 1879)	•	•			D, Fl & L
<i>Sericothrips bicornis</i> (KARNY, 1910)		•			Fl
<i>Stenothrips graminum</i> UZEL, 1895				•	G
<i>Taeniothrips inconsequens</i> UZEL, 1895		•			D, Fl & L
<i>Taeniothrips picipes</i> (ZETTERSTEDT, 1828)	•		•		Fl
<i>Thrips atratus</i> HALIDAY, 1836		•			Fl
<i>Thrips calcaratus</i> UZEL, 1895	•				D, L
<i>Thrips flavus</i> SCHRANK, 1776			•		Fl
<i>Thrips fuscipennis</i> HALIDAY, 1836				•	Fl
<i>Thrips major</i> UZEL, 1895		•			Fl
<i>Thrips minutissimus</i> LINNAEUS, 1758	•	•			D, Fl & L
<i>Thrips physapus</i> LINNAEUS, 1758		•			Fl
<i>Thrips pini</i> (UZEL, 1895)	•	•		•	D, L
<i>Thrips simplex</i> (MORISON, 1930)	•				Fl & L
<i>Haplothrips aculeatus</i> (FABRICIUS, 1803)	•	•	•		G
<i>Haplothrips subtilissimus</i> (HALIDAY, 1852)	•				D, P, L
<i>Holothrips schaubergeri</i> (PRIESNER, 1920)	•	•			D, Fu
<i>Hoplothrips carpathicus</i> PELIKÁN, 1961	•	•	•	•	D, Fu
<i>Hoplothrips corticis</i> (DE GEER, 1773)		•	•	•	D, Fu
<i>Hoplothrips fungi</i> (ZETTERSTEDT 1828)	•				D, Fu
<i>Hoplothrips pedicularius</i> (HALIDAY 1836)	•	•	•	•	D, Fu
<i>Hoplothrips polysticti</i> (MORISON 1949)		•			D, Fu
<i>Hoplothrips unicolor</i> (VUILLET 1914)	•				D, Fu
<i>Liothrips setinodis</i> (O.M. REUTER, 1880)				•	D, L
<i>Maderothrips longisetis</i> (BAGNALL, 1910)			•	•	D, Fu
<i>Phlaeothrips coriaceus</i> HALIDAY, 1836	•		•	•	D, Fu
<i>Phlaeothrips denticauda</i> PRIESNER, 1914	•				D, Fu
<i>Xylaplothrips fuliginosus</i> SCHILLE, 1911		•	•		D, P, Fu
No. of species:	22	26	15	11	–
No. of fungus-feeding species:	7	6	6	5	–

All the mycophagous species collected were from the Phlaeothripinae subfamily. There were no clear differences between the number of fungivorous species on the transects either in the Białowieża NP or in the Bieszczady Mts. Five species were common to both regions, five were caught only in the former and one only in the latter region (Table 1). The greatest number of species was recorded on the plot in the strict reserve in the Białowieża NP. From one to three species were caught in all traps located along transect I in the Bieszczady NP, but there were no fungivorous thrips in four of ten traps on transect II. However, the largest number of fungus-feeding species (four) was found in a trap situated in a spruce forest with a large proportion of artificial plantings of larch (*Larix decidua* MILLER, 1768).

DISCUSSION

To date 34 fungivorous thrips species are known to the Polish fauna: six represent the genera *Bolothrips* PRIESNER, 1926, *Cryptothrips* UZEL, 1895, *Megathrips* TARGIONI-TOZZETTI, 1881 and *Megalothrips* UZEL, 1895 of the Idolothripinae subfamily, while the remainder come from the Phlaeothripinae subfamily (KUCHARCZYK 2007, VIERBERGEN 2013 and unpublished data). Because of the concealed lifestyle and wide dispersal of their populations, fungus-feeding thrips are difficult to study. In Poland they were collected singly, mainly in forest habitats (KUCHARCZYK 1994, 1999, 2004, KUCHARCZYK & KUCHARCZYK 2011, KUCHARCZYK & WYROZUMSKI 2015). An entomological sweep net was the usual method in faunal research, but while this method allows one to collect large numbers of both specimens and species inhabiting the forest undergrowth, it is insufficient for collecting species that live on dead wood (LEWIS 1973). In the latter case different types of passive traps are more effective. Moericke water traps and screen traps were used during monitoring studies of the invertebrates of the Białowieża Primeval Forest in 1989-99. With the former method seven fungivorous species were collected, of which *Hoplandrothrips bidens* (BAGNALL, 1910), *Hoplandrothrips williamsianus* PRIESNER, 1923 and *Phlaeothrips annulipes* O.M. REUTER, 1880 were not found in the present study. Similarly, *Acanthothrips nodicornis* (O.M. REUTER, 1880) and *Hoplothrips ulmi* (FABRICIUS, 1781), caught in screen traps, were not noted later (KUCHARCZYK 2004). Between 1999 and 2001 GUTOWSKI & KRZYSZTOFIK (2005) carried out research on saproxylic beetles in the Białowieża forests using IBL-2 screen traps. This method proved to be effective for collecting fungivorous thrips, which constituted of about 28% (ten species) of all recorded thrips species. The data on new species to the Polish fauna added in the present paper and those published earlier raise the number of fungus-feeding thrips species in the Białowieża Primeval Forest to 15. A similar proportion – 30% (six species) consisted of fungivorous species caught in IBL-2 traps during the present studies in the Bieszczady NP; except for *M. longisetis*, they were the same as in the Białowieża NP. With the additional data on *M. longisetis* and *H. carpathicus* in the Bieszczady Mts., the number of fungivorous species recorded in the Polish Carpathians increased to 12 (KUCHARCZYK & STANISŁAWEK 2010, SIERKA et al. 2008).

Passive traps have been also used by other researchers in studies of thrips in forest environments. White water traps suspended at different heights were used by JENSER (1993), who carried out studies on the species composition in an oak forest near Eger in the Bükk Mountains (Hungary). As a result he collected 40 species, eight (20%) of which were mycophagous. Only *H. corticis*, *Phlaeothrips coriaceus* HALIDAY, 1836 and *P. denticauda* PRIESNER, 1914 were the same as in our studies (JENSER 1993). Using tree photoelectors, DUBOVSKÝ et al. (2010) noted 35 thrips species in the Martinský Les oak forest in

Slovakia; nine of these species (25%) were mycophagous. Single specimens of all of them were collected. In High Tatra forest ecosystems 53 thrips species were collected with soil and tree photoeclectors. Only six species (8%), including *H. unicolor* and *H. polysticti* – new to the Slovakian fauna – were fungivorous (MASAROVÍČ et al. 2014). In SE Finland KETTUNEN (2007) investigated thrips species diversity in pine forests. That author deployed two types of trunk window traps – freely hanging and attached to trunks; most of the saproxylic species were caught in the latter type. Fourteen (26%) of the 54 thrips species he caught were fungi-feeders, *H. carpathicus* being the most numerous. In Norway KOBRO (2001) collected bark from spruce logs infested by fungi. Using Berlese funnels this author selected six species of fungivorous thrips, among which the brachypterous form of *H. polysticti* was dominant.

In populations of bark-dwelling thrips structural differences between and within sexes are observed, e.g. allometry of the wings, legs and antennae (CRESPI 1986, MOUND 2002). MOUND (1976) considers that the presence of apterous or macropterous forms in fungus-feeding thrips is related to the availability of food during larval development. Most of the thrips specimens collected using IBL-2 screen traps in our investigations were macropterous adults, which may suggest that they were caught during their migration to wintering areas or a new food source (KUCHARCZYK & WYROZUMSKI 2015).

Although using passive traps provides little information on the structure of insect populations and their biology, it does yield fresh data on the biodiversity of the habitats surveyed. Moreover, the minimal impact of IBL-2 traps on the environment and their efficacy – similar to that of other types of passive traps – makes them particularly useful for investigations in protected areas.

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