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Investigations on a Neuropteroid Community by Using Different Methods

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To compare the efficiency of collecting methods by structural characterisation of a neuropteroid community the authors carried out an investigation in a commercial apple orchard at Szigetcsép by using three different trapping techniques, Malaise trap, suction trap and light trap. Considering of the individuals of this community, the suction trap seems to be the most useful sampling device outrunning the material caught by light trap and especially those of Malaise trap.

During the investigation the suction trap and light trap show the numbers of the species and individuals of *Coniopterygidae, Hemerobiidae* and *Chrysopidae* families in a similar way.

To record snake flies, *Raphidiidae,* Malaise trap seems to be the most suitable sampling device while the light trap is the best for sponge flies, Sisyridae.

Abundance of *Hemerobius humulinus* and *Wesmaelius subnebulosus* was underestimated by Malaise trap compared with the records of suction trap; however *Micromus angulatus* and *Micromus variegatus* were overestimated by Malaise trap.

Comparing the results of light trap to suction trap *Hemerobius humulinus, Wesmaelius subnebulosus* and *Chrysoperla carnea* complex were underrepresented while *Micromus angulatus, Micromus variegatus, Chrysopa formosa* and *Chrysopa phyllochroma* were overestimated.

Diversity profiles drawn by different sampling techniques show that the diversity of the suction trap samples, except for the beginning of the scale parameter, is significantly ($p < 0.01$) lower in its total length from the values of light trap and Malaise trap.

In the profile of plots of light trap and Malaise trap the diversity of the samples were not different in the species with medium and higher abundance. In conclusion, the sampling techniques used in the ecological investigations can determine the characteristics of neuropteroid communities. These results show that sampling devices have to be chosen cautiously according to the main aims and the interpretation of investigations.

Keywords: Neuropteroidea, Raphidioptera, Neuroptera, sampling methods.

To record neuropteroids, several collecting methods are known in the literature but only a few authors deal with comparing them to each other (Bowden, 1981; Szabó and Szentkirályi, 1981; Neuenschwander, 1984). It is due to the fact that few research workers carry out investigation primarily for neuropterological purposes. The neuropteroid material is collected from insect samples mostly as secondary products.

The other reason can be that neuropteroids have low abundance when we compare to other insect orders (e.g. Diptera, Hymenoptera, Coleoptera, etc.), which makes the quantitative evaluation of the different collecting devices more difficult.

Every sampling device used has advantages, which contribute to the improvement of different types of traps. At the same time, more or less distortion arises by using different

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sampling techniques. Acknowledging these advantages is especially important for such insect orders as neuropteroids because the increase of the sampling size with one-two dozens can already give a better evaluation of the investigation.

Szabó and Szentkirályi (1981) dealt with comparison of different sampling techniques. In their investigation light trap and suction trap were found to be the most successful sampling devices for studying neuropteroid communities.

The light trap is the most widespread method for collecting neuropteroids as it records the wide range of specimens and species (Killington, 1936; Andersen and Greve, 1975; Honek and Kraus, 1981; Szabó and Szentkirályi, 1981; Zeleny, 1984; Monserrat and Martín, 1994).

Effective recording of neuropteroid samples by suction trap is shown in the papers of Banks (1952), New (1967), Bowden (1981). Bowden (1981) compared the efficiency of collecting by light trap and suction trap in the case of *Chrysoperla carnea.* He stated that, during the full moon, the material caught by suction trap decreased in fewer numbers as to the one caught by light trap.

Beside the above-mentioned two sampling techniques, however, several other collecting methods are known (Neuenschwander, 1984). Malaise trap was used successfully by Vidlicka (1994, 1995) for recording neuropteroid communities.

Materials and Methods

The study was carried out in an apple orchard treated with a wide range of insecticides at Szigetcsép near Budapest in 1997. We choose a conventionally treated orchard as the pest control and the good condition of this plantation made homogeneous environment for both preys (aphids, mites, etc.) and predators. The orchard was planted with different apple varieties Jonathan, Idared, Golden Delicious in 1977.

To record samples the MSZM type suction trap operated on 220 V (55W) and with a capacity of 1000 m^3 airflow per hour (Meszlény and Szalay-Marzsó, 1979) was put up. The trap was set in the plantation at a distance of 35 m from the edge of the orchard. The mouth of the aspirator was 48 cm in diameter and worked at a height of 1.6 m on the canopy level.

One Jermy type (Jermy, 1961) light trap was used at the same apple row at the edge of the plantation and from a distance of 30 m from the suction trap. It was operated by a 160 W HMLI lamp at 1.8 m above the ground on the canopy level as well.

On the edge of the orchard a white coloured Townes-type Malaise trap (Townes, 1962) with a catching area of 4.8 m^2 was installed.

All the traps operated from mid-March to mid-November were emptied at 8 in the morning each day. The material recorded by light trap and Malaise trap was preserved dry while the material coming from the suction trap was put into 70% ethanol.

Divord 1.9 program (Tóthmérész, 1995) was used to compute the diversity ordination of three the different samples.

Results

In the course of the investigation 1621 specimens belonging to 37 Neuropteroidea species were collected *Raphidiidae* 2 species, 6 individuals; *Coniopterygidae* 9 species, 412 individuals; *Sisyridae* 2 species, 5 individuals; *Hemerobiidae* 9 species, 408 individuals; *Chrysopidae* 11 species, 783 individuals; *Myrmeleontidae* 4 species, 7 individuals altogether.

Considering species richness and number of individuals, the suction trap was the most efficient one followed by the light trap. The Malaise trap was the least efficient among three.

The difference in number of individuals between suction trap and light trap was about 25%, while the 16% difference in the species richness was not too considerable. The differences in the sample size were caused by the individuals of *Chrysoperla carnea* complex caught by suction trap *(Table 1).*

Species of *Raphidiidae* family were not recorded by suction trap, however, only one individual ($p_i = 0.001$) was collected by light trap. The Malaise trap caught two species with higher relative frequency ($p_i = 0.081$) than that of the light trap.

By studying the family *Coniopterygidae* it can be stated that the species recorded by suction trap were of the highest number (9), there were only 5 species in the material of the light trap and the material of the Malaise trap did not contain any individuals at all.

Considering the specimens there were not too many differences in the material caught by suction trap and light trap, the species having high value of relative abundance were trapped by the light trap in as high number as by the suction trap, therefore, calculated by Horn index, the similarity of *Coniopterygidae* assemblages trapped by both methods was rather high. The abundant species were *Coniopteryx borealis* ($p_i = 0.34$), *Coniopteryx tjederi* ($p_i = 0.31$) and *Coniopteryx esbenpeterseni* ($p_i = 0.24$). It can be noticed that species having low relative abundance were not collected by light trap *(Table 1).*

The species belonging to *Sisyridae* ($p_i = 0.007$) with low relative abundance were recorded only by the light trap. The only 2 species caught with low abundance show that the light trap is a useful sampling technique to collect Sisyridae species even if they have low frequency.

The species of *Hemerobiidae* were collected by three sampling methods; with suction trap 9 species, 203 individuals with the value of $p_i = 0.232$; with Malaise trap 2 species, 24 individuals with value of $p_i = 0.393$, with light trap 7 species, 181 individuals with the value of $p_i = 0.263$.

As to the dominant species there was a considerable difference in the sampling techniques. The suction trap collected *Hemerobius humulinus* and *Wesmaelius subnebulosus* with high value of relative abundance while the Malaise trap did not catch any of these two species. The light trap also underrepresented them with low values. *Micromus angulatus* and *Micromus variegatus* were dominant and subdominant species in the material of the Malaise trap and the light trap, while they had lower values in the material of suction trap than in the other two trap types.

No other conclusion can be drawn from the other species caught with low number of individuals.

Table 1

Number of *Neuropteroidea* species and specimens collected by different sampling techniques at Szigetcsép in 1997

Species	Suction trap	Malaise trap	Light trap
Raphidiidae			
Dichrostigma flavipes Stein	0	3	1
Xanthostigma xanthostigma Schummel	0	2	0
Coniopterygidae			
Coniopteryx arcuata Kis	2	0	0
Coniopteryx borealis Tjeder	70	0	72
Coniopteryx esbenpeterseni Tjeder	57	0	42
Coniopteryx hoelzeli Aspöck	5	0	4
Coniopteryx lentiae Aspöck et Aspöck	5	0	0
Coniopteryx pygmaea Enderlein	6	0	0
Coniopteryx renate Rausch et Aspöck	1	0	0
Coniopteryx tjederi Kimmins	70	0	61
Semidalis aleyrodiformis Stephens	7	0	10
Sisyridae			
Sisyra nigra Fabricius	0	0	4
Sisyra terminalis Curtis	0	0	1
Hemerobiidae			
Hemerobius humulinus Linnaeus	105	0	18
Hemerobius micans Olivier	8	0	0
Hemerobius nitidulus Fabricius	1	0	1
Micromus angulatus Stephens	9	12	32
Micromus variegatus Fabricius	24	12	95
Sympherobius elegans Stephens	2	0	1
Sympherobius pygmaeus Rambur	2	0	6
Wesmaelius nervosus Fabricius	1	0	0
Wesmaelius subnebulosus Stephens	51	0	28
Chrysopidae			
Chrysopa formosa Brauer	6	0	32
Chrysopa nigricostata Brauer	0	0	2
Chrysopa pallens Rambur	16	1	7
Chrysopa perla Linnaeus	3	0	10
Chrysopa phyllochroma Wesmael	0	1	13
Chrysoperla carnea Stephens	407	29	242
Cunctochrysa albolineata Killington	0	0	1
Dichochrysa flavifrons Brauer	4	0	1
Dichochrysa prasina Burmeister	4	0	0
Nineta flava Scopoli	1	0	1
Nineta guadarramensis Pictet	2	0	0
Myrmeleontidae			
Distoleon tetragrammicus Fabricius	1	0	0
Euroleon nostras Fourcroy	1	1	0
Myrmeleon incospicuus Rambur	0	0	1
Megistopus flavicornis Rossi	3	0	0
Abudance:	874	61	686
Number of species:	29	8	25

By exploring the *Chrysopidae* family there were considerable differences between the values of relative frequencies. All of the three sampling methods show that the dominant species were *Chrysoperla carnea* complex, however, the suction trap and the Malaise trap collected them with mostly the same values of relative frequency, while the light trap underestimated them compared with the other two trap types. Another difference was that the species recorded by light trap with high number of individuals such as *Chrysopa formosa, Chrysopa perla, Chrysopa phyllochroma* were not recorded or underrepresented by the suction trap, compared with the material caught by the light trap *(Table 2).*

Table 2

Relative abundance (p_i) of species of *Coniopterygidae, Hemerobiidae* and *Chrysopidae* sampled by different methods; those that showed higher densities are shown by bold numbers (Coniopterygidae $p_i = 1$, Hemerobiidae $p_i = 1$, Chrysopidae $p_i = 1$)

Species	Suction trap	Malaise trap	Light trap
Coniopterygidae			
Coniopteryx borealis	**0.31**	–	**0.38**
Coniopteryx esbenpeterseni	**0.25**	–	**0.22**
Coniopteryx tjederi	**0.31**	–	**0.32**
Semidalis aleyrodiformis	**0.03**	–	**0.05**
Hemerobiidae			
Hemerobius humulinus	**0.52**	–	0.10
Micromus angulatus	0.04	**0.50**	**0.18**
Micromus variegatus	0.12	**0.50**	**0.52**
Wesmaelius subnebulosus	**0.25**	–	0.15
Chrysopidae			
Chrysoperla carnea	**0.92**	**0.93**	**0.78**
Chrysopa formosa	0.01	–	**0.10**
Chrysopa phyllochroma	0.00	–	**0.04**
Chrysopa pallens	0.03	–	0.02
Chrysopa perla	0.07	–	**0.03**

Due to the low number of individuals collected by the Malaise trap no conclusion can be drawn regarding the other *Chrysopidae* species.

In conclusion if the material recorded by the suction trap is considered to be of least distorted one from methodological point of view (Vas et al., 2001), the number of the individuals and relative abundance in the material of Malaise trap, *Hemerobius humulinus, Wesmaelius subnebulosus* were considerably underrepresented, *Micromus angulatus, Micromus variegatus* were overrepresented.

Hemerobius humulinus, Wesmaelius subnebulosus and *Chrysoperla carnea* complex were also underestimated in the light trap material compared with the material of the suction trap while *Micromus angulatus, Micromus variegatus, Chrysopa formosa* and *Chrysopa phyllochroma* species were overestimated in the recorded materials.

By studying the diversity patterns of neuropteroid community using Rényi diversity formula it can be concluded that both the Malaise trap and the light trap material were more

diverse than the material of suction trap *(Fig. 1).* The diversity values of the suction trap on the whole scale parameter showed significant differences ($p < 0.01$) compared with the diversity profile of light trap *(Table 3).* However, comparing the diversity profiles of the Malaise trap and the suction trap, except at the beginning of scale parameter, the section being sensitive to rare species, we did not find any real differences. Although in the middle part, sensitive to frequent and common species, the differences were already significant ($p < 0.1$) *(Table 3).*

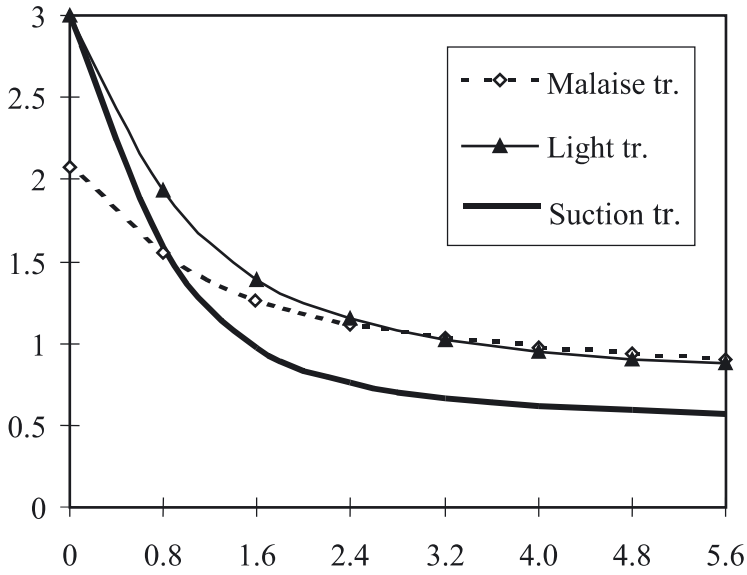

Fig. 1. Rényi diversity profiles of a *Neuropteroidea* community sampled by different methods at Szigetcsép in 1997 (The *Coniopterygidae* were excluded from the sampling data)

Table 3

Comparison of Rényi diversity values of a *Neuropteroidea* community investigated by different methods *t*-test

	α scale parameter						
	0.8	1.6	2.4	3.2	4	4.8	5.6
Suction tr. – Malaise tr.	n.s.	+	+	+	+	+	+
	0.3206	2.0400	2.2941	2.2220	2.1396	2.0858	2.0551
Suction tr. – Light tr.	**	**	**	**	**	**	**
	4.4170	5.2069	4.9432	4.7803	4.7008	4.6614	4.6416
Malaise tr. – Light tr.	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	3.1434	0.8726	0.1821	0.0452	0.1226	0.1506	0.1612

(+ = p< 0.1 ; * = p< 0.05 ; ** = p < 0.01; n.s. = non significant; = t values)

By using Horn index the similarities of neuropteroid assemblages recorded by three different sampling techniques showed low values when excluding *Coniopterygidae* species as the Malaise trap was unsuitable for collecting Coniopterygids due to its 2.0-millimetre mesh. The similarity of neuropteroid assemblages recorded by the suction trap and the light trap was 0.41, it was 0.32 in case of the suction trap and the Malaise trap, and 0.39 in case of the light trap and the Malaise trap. So there was significant segregation when studying the same community with different sampling techniques on the basis of their similarities.

Discussion

According to these results, from the studied sampling techniques only Malaise trap is suitable for collection of *Raphidiidae* species. This conclusion is proved by our previous investigation (Vas et al., 2001) in which Malaise trap was found the most efficient for collecting this order. Both suction trap and light trap are useful collecting devices for *Coniopterygidae* as it is shown by the quality and the quantities of the recorded material. Possibilities of collecting *Coniopterygidae* species by using light trap are confirmed by Killington (1936) and Monserrat and Martín (1992).

The species belonging to *Sisyridae* were exclusively taken by light trap although their abundance was low. The other two trap types did not show the occurrence of this family. The data referring to the samples of the family collected by us do not make any kind of conclusion possible but it may be assumed that light trap can be used for collecting *Sisyridae* family. This conclusion is proved by the investigation made by Andersen and Greve (1975) who collected large number of *Sisyra nigra* by using light trap (125 W mercury vapour bulbs).

The light trap as well as the suction trap is suitable for collecting *Hemerobiidae* shown by the results of Szabó and Szentkirályi (1981), Szentkirályi (1992) and Vas et al. (2001). The number of species collected by the Malaise trap is considerably less than the samples of the other two trap types, therefore this trap with larger guiding-wings (battle) is worth being operated for collecting brown lacewings species (Vas et al., 2001). Simultaneous use of several Malaise traps also resulted proper sample size for recording flight activity of *Hemerobiidae* (Vidlicka, 1994, 1995).

The species belonging to *Chrysopidae* were collected by all of three sampling techniques, but the most effective was the suction trap, then the light trap, followed by the Malaise trap. As these results show, the species sampled by different methods can be recorded with different number and different relative abundance.

In conclusion, the methods used, depending on the species composition of neuropteroids, can represent the species, the orders or the families of the neuropteroid assemblages at a different extent. The result of this case study showes that the sampling techniques used basically determine the characteristics of the neuropteroid samples. Therefore adequate methods have to be chosen very carefully as well as the given results have to be correctly interpreted according to the main aims set by study.

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