P O L I S H J O U R N A L O F E N T O M O L O G Y
P O L S K I E P I S M O E N T O M O L O G I C Z N E

VOL. **79**: 283-290 Bydgoszcz 30 September 2010

Comparison of the collecting of the parasitoids belonging to the *Pimplina* subfamily (Hymenoptera, Ichneumonidae)

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ABSTRACT. Comparison was carried out between the collecting methods of insects in different habitats. In this aim statistical models for a factorial experiment and a variance analysis (ANOVA) was applied. Further on multiple comparisons for the collecting methods and for habitats with the application of the Tukey's method were presented. On basis of received results was estimated, which method of assembling parasitoids is more suitable.

KEY WORDS: ANOVA, boxplot, multiple comparisons, parasitoids, *Pimplinae*, statistical models.

INTRODUCTION

The basic methods for collecting Ichneumonidae imagines used in faunistic studies are sweeping or selected specimen methods. Ichneumonidae can also be obtained from their habitat with the use of sticky traps, generally yellow MOERICKE traps. In Poland this method was first applied by SAWONIEWICZ (1979) while examining an Ichneumonidae community in the crowns of older pine communities. It was decided to compare the usefulness of sweeping and Moericke yellow traps for determining the quality-quantity structure of parasitoid communities of the *Pimplinae* subfamily which occur in refugium habitats such as shrubberies, field borders, roadsides and forest edges in a complex type of agricultural landscape in central Wielkopolska, Poland.

MATERIALS AND METHODS

Materials

The study was conducted in the years 1994-1995 in central Wielkopolska, Poland, on the croplands in Strzeszyn (UTM: XT21). It was a complex agricultural landscape with a high degree of mosaic traits. The share of non-cultivated land was 33.4%. The parasitoids for research were caught from May to October each year. At each site two methods were used simultaneously, namely the sweeping and Moericke yellow traps. The insects caught in 25 sweeps were considered a sample. The sweeping was performed twice a month. 5 traps were located at each site 0.5-1.5 m above the ground. One sample was composed of the insects caught within 10 days. A detailed description of the method is presented in the study by Piekarska-Boniecka (2005). 31 sweeping trials in total were performed at each site, which makes 124 trials in 2 years. On the other hand, Moericke yellow traps were used to execute 35 trials at each site, i.e. 140 trials in 2 years.

Methods

The data were preliminarily analysed with the graphical method, then three linear models were defined. The first one describes a linear experiment of 3-factorial design with all the second-order interaction effects. Than an ANOVA table and interactive charts were created for that model. Next a linear model was developed to describe an experiment of 3-factorial design along with significant second-order interaction effects. Similarly to the first model, an ANOVA table was presented and a linear model was developed to describe an experiment of 3-factorial design with no interactive effects along with an ANOVA table. Finally multiple comparisons were conducted with the Tukey method for habitats and multiple comparisons for collecting methods.

RESULTS

The data were preliminarily analysed with the boxplot (Fig. 1). It was found that the collecting methods (sweeping or traps) do not differ for the habitats of the shrubbery and roadside, and are the same for the field border and forest edge. In addition, there are some outliers.

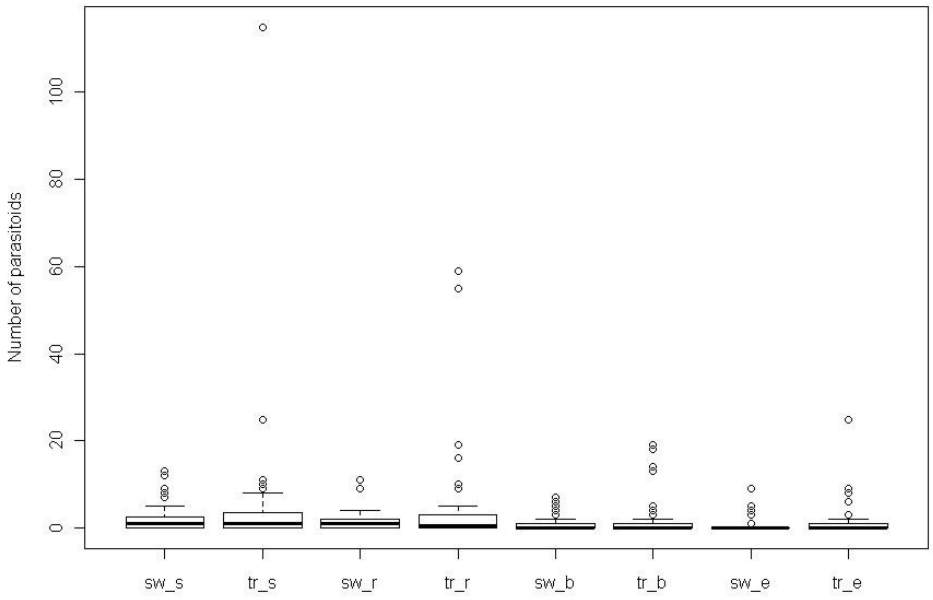

Fig. 1. Boxplot of the number of parasitoids for the two collecting methods (sw-sweeping, tr-trap in four habitats: s – shrubbery, r – roadside, b – field border and e – forest edge).

ANOVA

A linear model with all the second-order interactions, i.e. the following model was examined:

(1) response ~ species + collecting + habitats + species*collecting + species*habitats + collecting*habitats

For a model this specified a variance analysis was performed and the results are presented in Table 1.

The variance analysis proves that for the habitats Pr(F) = 0.0081, for the collecting Pr(F) = 0.0002, while the for the species Pr(F) = 1.1e-14. Therefore it can be concluded that a) the tested habitats differ significantly, b) collecting methods differ very significantly c) the species differ very significantly. Furthermore, it should be noted that, since for the species*collecting interaction Pr(F) = 5.3e-09, so the species*collecting interaction is highly significant. Graphic interpretations of this interaction are presented in Fig. 2.

Table 1. Variance analysis for the model (1) with all the second-order interactions.

Source	Df	Sum Sq	Mean Sq	F value	Pr(F)
species	43	8155.2	189.7	5.6445	1.1e-14 ***
collecting	1	489.3	489.3	14.5617	0.0002 ***
habitats	3	413.3	137.8	4.1007	0.0081 **
species*collecting	43	5348.1	124.4	3.7016	5.3e-09 ***
species*habitats	129	5003.8	38.8	1.1544	0.2079
collecting*habitats	3	97.7	32.6	0.9694	0.4094
residuals	129	4334.4	33.6		

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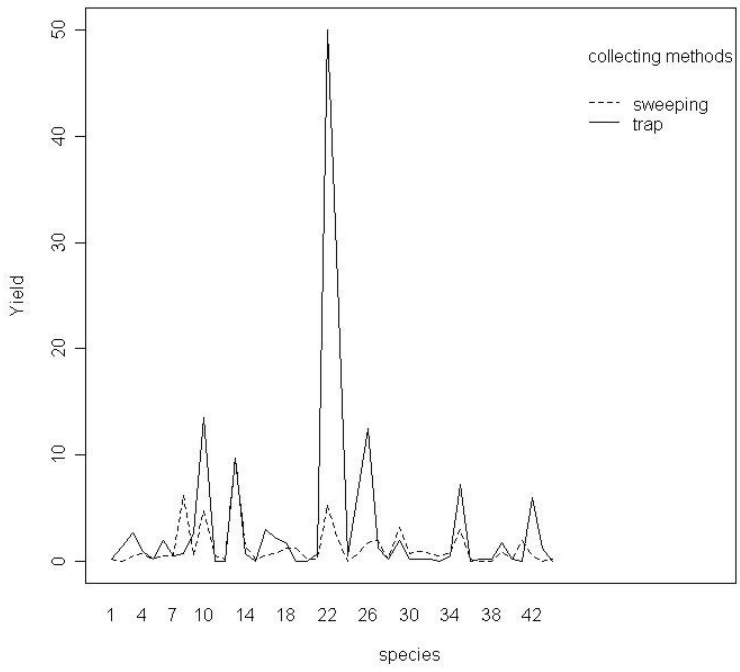

Fig. 2. Interactions plot between species and collecting methods.

For the species*habitats interaction Pr(F) = 0.2079, so the species*habitats interaction is also insignificant. Graphic interpretations of this interaction are presented in Fig. 3.

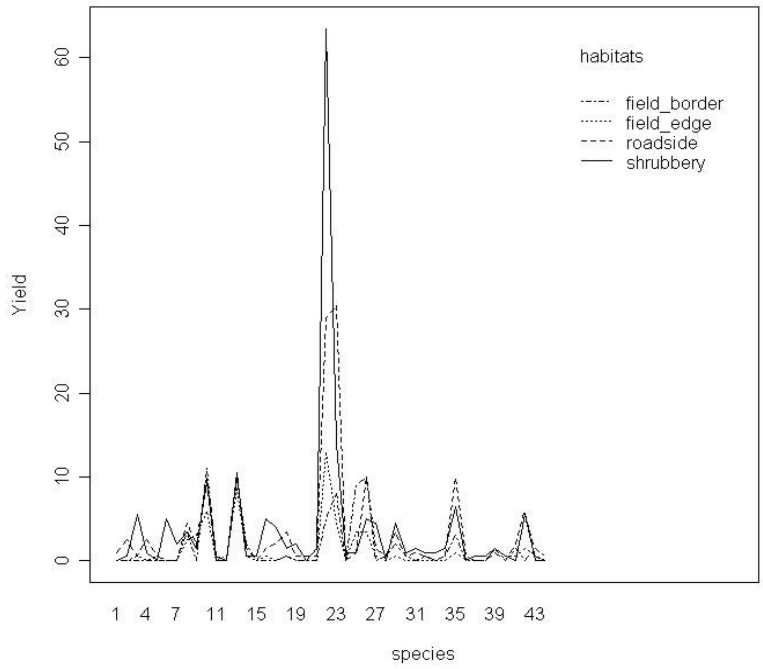

Fig. 3. Interactions plot between species and habitats.

On the other hand, for the collecting*habitats interaction Pr(F) = 0.4094, than the collecting*habitats interaction is not significant. Graphic interpretations of the collecting*habitats interaction are presented in Fig. 4.

An analysis of model (1) proves that the model that takes into account only the collecting:species interaction better describes the relationship. It can be described as follows:

(2) response ~ species + collecting + habitats + species*collecting

For such a model a variance analysis was performed and the results are shown in Table 2.

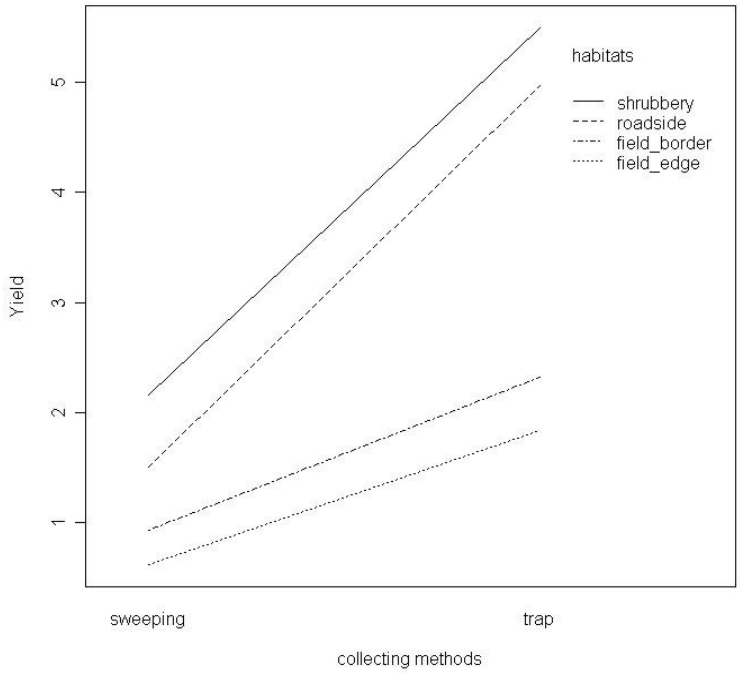

Fig. 4. Interactions plot between collecting methods and habitats.

Table 2 Variance analysis for the model (2) with a significant second-order collecting: species interaction

Source	Df	Sum Sq	Mean Sq	F value	Pr(F)
species	43	8155.2	189.7	5.2460	< 2.2e-16 ***
collecting	1	489.3	489.3	13.5335	0.0003 ***
habitats	3	413.3	137.8	3.8111	0.0106 *
species*collecting	43	5348.1	124.4	3.4402	4.5e-10 ***
residuals	129	9435.9	36.2		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The third model presented in this study is a linear model that describes a 3-factorial design experiment without interactions, i.e. the following one:

(3) response ~ habitats + collecting + species

The results are presented in Table 3.

Table 3. Variance analysis for the model (3) without interaction effects.

Source	Df	Sum Sq	Mean Sq	F value	Pr(F)
habitats	3	413.3	137.8	2.8332	0.0384 *
collecting	1	489.3	489.3	10.0609	0.0017 **
species	43	8155.2	189.7	3.8999	1.6e-12 ***
residuals	304	14784.0	48.6		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Multiple comparisons

The last part of the analysis presented herein shows the comparison between the habitats and between the collecting methods with the application of the Tukey Honest Significant Differences while specifying confidence intervals (MILLER, 1981 or YANDELL, 1997). The results are presented in Table 4 and Table 5.

Table 4. Comparisons of habitats with the Tukey method.

Habitats	Diff	Lwr	Upr	P-adj
field border – roadside	-1.6136	-4.3295	1.1022	0.4179
forest edge – roadside	-2.0114	-4.7272	0.7045	0.2246
shrubbery – roadside	0.5909	-2.1249	3.3068	0.9432
forest edge – field border	-0.3977	-3.1136	2.3181	0.9815
shrubbery – field border	2.2045	-0.5113	4.9204	0.1564
shrubbery – forest edge	2.6022	-0.1136	5.3181	0.0659

Table 5. Comparisons of collecting methods with the Tukey method.

Collecting methods	Diff	Lwr	Upr	P-adj
trap – sweeping	2.3579	0.8951	3.8208	0.0017

CONCLUSION

The statistical methods for compare the ways of assembling the parasitoids of the *Pimplinae* subfamily occur (Hymenoptera, Ichneumonidae) were used. First for three statistical models the ANOVA variance analysis was performed. In the next stage of the analysis multiple comparisons were presented with the corresponding confidence intervals with the application of the Tukey method. Received results permit to affirm, that the trap collecting method is more suitable to assembling the parasitoids.

Acknowledgments

The authors wish to thank the reviewer comments and suggestions that improved our manuscript.

REFERENCES

MILLER R.G. 1981. Simultaneous Statistical Inference. Springer.

PIEKARSKA-BONIECKA H. 2005. The dynamics of Pimplinae (Hymenoptera, Ichneumonidae) in the agricultural landscape of central Wielkopolska. Rocz. AR Pozn., 366, 204 pp.

SAWONIEWICZ J. 1979. The effect of shrub layer on the occurrence of the Ichneumonidae (Hymenoptera) in pine stands on different sites. Memorabilia Zool., 30: 89-130.

YANDELL B.S. 1997. Practical Data Analysis for Designed Experiments. CHAPMAN and HALL.

Received: January 26, 2010
Accepted: July 08, 2010