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**INFLUENCE OF COLOUR OF MOERICKE TRAPS ON NUMBERS
AND DIVERSITY OF COLLECTED BEES
(APOIDEA, HYMENOPTERA)**

**WPLYW BARW PUŁAPEK MOERICKEGO NA LICZEBNOŚĆ
I ZRÓŻNICOWANIE POZYSKIWANYCH PSZCZÓŁ
(APOIDEA, HYMENOPTERA)**

In deciduous and pine forests the effect of white, yellow and blue Moericke traps on numbers and species diversity of *Apoidea* was assessed. It was proven that the most useful in forest are white traps. They caught several times greater numbers of bees. The white traps caught also over 90% of all determined species while the yellow ones 56.4% and the blue traps only 31.6%.

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1. INTRODUCTION

Moericke traps (Moericke 1951) are today quite commonly used method of collecting insects. For instance institute of Zoology of the Polish Academy of Sciences in Warsaw has been using it for years in zoocenological studies on forests and grasslands (Bańkowska 1989, Bańkowska et al. 1984). In these studies yellow traps are used what suggests that this colour is the most universal for attracting insects. From available literature on catching *Aculeata* results that yellow colour is not the best for attracting these insects. Among others the studies by Haeseler (1972), Goos et al. (1976) and Laroca (1980) indicate that the authors do not give univocal answer to the question what colour is the best for *Aculeata*.

Hence, starting investigations into spatial differentiation of *Apoidea* in forests and on their trophic relations with feed plants the first issue to be recognized was to determine what tray colour should be used to gather possibly most numerous and differentiated material.

2. METHODS AND STUDY SITE

To evaluate the effectiveness of bee catching plastic dish 20 cm diameter and depth 12 cm were used. They were filled with liquid containing: water 94.2%, ethylene glycol 5.6%, detergent 0.2% (mixture: 5 l water and 0.3 l ethylene glycol and 0.01 l detergent).

The dishes were in three colours: white (natural colour of plastic), yellow – inner and outer walls of a dish painted with phthalate paint similar to the colour of rapeseed flowers; blue – also phthalate paint was used.

The traps were emptied from insects every seven days supplementing the liquid if necessary.

The investigations were carried out in the Wielkopolski National Park (Western Poland) in three forest communities: natural oak-hornbeam forest – *Galio silvatici-Carpinetum* Oberd. 1957, modified oak forest – *Galio silvatici-Carpinetum* Oberd. 1957 and pine forest – *Leucobryo-Pinetum* Mat. (1962) 1973.

Two variants of trap distribution were used in each forest community: traps placed in a layer of herbs directly on the ground three dishes in each colour, traps hung in tree crowns (pine, oak, hornbeam) three dishes in each colour in a given community.

The study was carried out in 1987–1988 from April to October.

The relations observed from the results of catching with Moericke traps were verified with the method of multifactor analysis of variance.

3. RESULTS OF CATCHING BEES IN COLOUR TRAPS

3.1. EVALUATION OF THE NUMBERS OF CAUGHT INSECTS

Forests, in contradistinction to open areas, are not the places frequented by bees. Earlier studies made in various ecosystems of the Wielkopolski National Park confirm this observation (Banaszak 1983).

The result of two years long investigations in the Wielkopolski National Park 992 bees were collected what can be considered a large number. This material proves that the applied colours of the traps are attractive for bees and the Moericke trap method itself is a good way of collecting quantitative material on *Apoidea*.

The best result was obtained with white traps. The number of *Apoidea* caught in white traps was in 1987 four times and in 1988 seven times greater than that caught in yellow traps. The attractiveness of blue colour was studied only in 1988 but also in this case the white colour had five-fold advantage (Tab. I). It should be noted that this result was obtained in all three forest communities (Tab. II) and on the two investigated forest floors (Tab. III).

Table I

Comparison of mean number of *Apoidea* caught by Moericke traps in investigated forest community (1987-1988)

Colour of trap	Number of traps	Number of individuals		Mean number of individuals/traps/season	
		1987	1988	1987	1988
White	18	487	273	27.4	15.4
Yellow	18	124	39	6.8	2.2
Blue	18	—	54	—	3.0

Table II

Mean number of *Apoidea* caught by Moericke traps in three forest communities

Community	Mean number of <i>Apoidea</i> /traps/season					
	white		yellow		blue	
	1987	1988	1987	1988	1987	1988
Oak-hornbeam forest	12.2	15.5	4.8	2.7	—	2.8
Oak forest	20.2	12.5	10.0	2.3	—	1.8
Pine forest	50.0	18.2	5.7	1.5	—	4.3

Table III

Mean number of *Apoidea* caught by Moericke traps in investigated forest floor (together)

Forest floor	Mean number of individuals/traps/season					
	white		yellow		blue	
	1987	1988	1987	1988	1987	1988
Herbs layer	34.1	18.3	8.4	2.9	-	4.9
Tree crowns	20.8	12.4	5.2	1.4	-	1.1

From multifactor analysis of variance it was found that colour (white) has a significant influence on the numbers of caught insects. However it was impossible to prove (with t-Student test, $\alpha = 0.05$) significant difference between the number of *Apoidea* caught in yellow and blue traps.

3.2. EVALUATION OF SPECIES COMPOSITION

Species of all caught *Apoidea* was determined. This facilitates evaluation of effect of colour of applied traps on species composition of collected *Apoidea*. Generally from all the traps 55 *Apoidea* species belonging to 5 families were caught. For most of found species the most attractive colour was white. In the white Moericke traps were caught almost 91% of all the species. Much less effective were yellow dishes where 56.4% of species were found. The blue dishes used only in 1988 caught 31.6%. In the same year in the yellow traps were 31.6% while in the white ones as much as 86.8% of species (Tab. IV). Analysis of the number of each species also indicates

Table IV

Number of species caught by Moericke traps in three forest communities in 1987 and 1988

Colour of traps	Number of species					
	oak-hornbeam forest		oak forest		pine forest	
	1987	1988	1987	1988	1987	1988
White	24	20	28	11	35	25
Yellow	12	5	11	4	18	6
Blue	-	7	-	7	-	8

deceptive preference for the white colour. The investigated group of insects appeared in much smaller number in the yellow and blue dishes. This is clearly illustrated on an example of dominating species in Tab. V. There is absolutely no basis for stating that any of the 55 species markedly showed preference for yellow or blue colour.

Table V

Atractiveness of colour for most numerous species in three forest communities (1987–1988)

Species	Number of individuals			
	white traps	yellow traps	blue traps	total
<i>Apis mellifera</i> L.	240	33	7	280
<i>Andrena haemorrhoa</i> (Fabr.)	83	16	5	104
<i>A. lapponica</i> Zett.	65	30	5	100
<i>Bombus lucorum</i> (L.)	68	7	6	81
<i>Andrena helvola</i> (L.)	30	13	4	47
<i>A. sobopaca</i> Nyl.	32	11	0	43
<i>Bombus pascuorum</i> (Scop.)	14	2	4	20
<i>Halictus subfasciatus</i> (Imh.)	12	11	0	23
<i>Andrena armata</i> (Gmel.)	15	4	0	19
<i>Bombus pratorum</i> (L.)	15	1	1	17

BUZ

Multifactor analysis of variance proved significant statistically effect of colour on a numbers of species caught by the traps. Beside of that it was tested the influence of type of forest and the placing of trap above the ground on the numbers of *Apoidea* (Tab. VI).

Table VI

Influence of particular factors on the numbers of *Apoidea* caught by Moericke traps based on analysis of variance
(+ significant; – insignificant)

Season	1987	1988
Colour	+	+
Type of forest	+	–
Place of the traps	+	+
Colour and place	–	–
Type forest and place	+	+
Colour and type forest	+	–

4. DISCUSSION

The results of this study univocally indicate that on forest areas white traps are the best for catching *Apoidea*. The yellow and blue traps are much less effective. This concerns both the total numbers of caught bees and their species diversity. These results seem worth propagating also to present how specific group are *Apoidea* and to understand how difficult it is to find an universal method for insect studies. Haeseler (1972) proved how different reactions to trap colour have representatives of each *Hymenoptera* groups. Concerning *Apoidea* he obtained the results different than those presenting in this work. According to him (Haeseler 1972) the most effective for catching bees are blue traps (45–50%) with white and yellow being less effective. However, we must add here that his study was carried out in open areas, forest clearing and gravel pit. After Laroča (1980), in a set of colored traps (light-blue, white, yellow, black and red), specimens of wild bees were more frequent in the light-blue trap (42.2% of the total). Ratio for each of the other traps was as follows: white – 33.9%, yellow – 22.2%, black – 1.7% and red – 0.0%). The degree of attractiveness of colour traps depends certainly on a number of factors as Heydemann (1958) observed. One of them which should be discussed here seems to result also from the data presented above. Attractiveness of colour traps depends on the environment. The same or similar traps are differently perceived by bees in a forest than in an open area. This issue needs further studies. The results obtained in this study can be confirmed by findings of Goss et al. (1976) who in field experiments (rapeseed and sugar beet) also found greater attractiveness of white Moericke traps for *Aculeata* than of the yellow ones.

The attractiveness of colour can be also determined by weather conditions, e.g. cloudiness but this was not proven in this work. Haeseler (1972) suggests that blue traps are more attractive for *Apoidea* during fine sunny weather.

Perhaps for some species colour is not important at all. According to some authors the *Hylaeus* Fabr. species should be attracted only by smell of flowers and not by colour (Lehmann 1961). Maybe it explains the fact that into the traps placed in the Wielkopolska National Park fell only few *Hylaeus* Fabr. specimens.

Generally, however, the study indicated great usefulness of the traps, particularly the white ones, in catching *Apoidea*. Application of the traps has particular importance in studies on forest communities and tree crowns.

The traps open throughout the whole vegetative season also catch rare species difficult to be encountered by a researcher during usually not too long stay in the field. This is especially important in spring at variable weather and short term warm periods when bee flights are possible.

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6. SUMMARY

W lesie liściastym i sosnowym oceniono wpływ białych, żółtych i niebieskich pułapek Moerickego na liczebność i zróżnicowanie pozyskiwanych *Apoidea*. Wykazano, że najbardziej przydatne do odławiania *Apoidea* w lasach są pułapki białe. Stwierdzono kilkakrotnie wyższe liczebności pszczoł odłowionych przez białe pułapki. Trafiło też do nich ponad 90% wszystkich stwierdzonych gatunków, podczas gdy do żółtych 56.4% i 31.6% do niebieskich.

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