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**: 25-53 Bydgoszcz 30 March 2010

Bees of the Masurian Landscape Park: diversity and ecology (Hymenoptera: Apoidea, Apiformes)

JÓZEF BANASZAK

Kazimierz Wielki University, Institute of Environmental Biology,
Ossolińskich 12, 85-093 Bydgoszcz, Poland, e-mail: lednica@ukw.edu.pl

ABSTRACT. Species diversity and ecology of bees (Apiformes) was studied in the Masurian Landscape Park (NE Poland). The Park is dominated by woodland (50%) and lakes (30%). In total, 153 species were recorded there, which account for 32.6% of the Polish bee fauna. In the study area, the bee fauna is characterized by a lower diversity of Halictidae and a high diversity of Apidae. One of the dominant species is *Andrena lapponica*, with two generations: in early spring (*myrtillus* generation) and spring (*vitis-idaea* generation). This contrasts with earlier reports that this species is univoltine.

KEY WORDS: wild bees, Apiformes, Masurian Landscape Park, early postglacial landscape, diversity, dominance structure, phenology.

INTRODUCTION

The Masurian Landscape Park includes the central part of the Masurian Lakeland in NW Poland (Fig. 1). The Park was established in 1977, to protect and preserve the valuable natural environment: the postglacial landscape shaped during the latest stages of the Vistulian (=Weichselian) glaciation. The Park includes Lake Śniardwy (11 416 ha), which is the largest in Poland, and the northern part of the Pisz Forest (Puszcza Piska) with the river Krutynia. The Park covers 53 655 ha, while its buffer zone, 18 608 ha.

Masuria, and the Park in particular, is one of the most interesting parts of Poland in respect of their conservation value, as it has not been markedly altered by human activity. In that region, arable fields are enclaves surrounded by woods, lakes, and grasslands. The Masurian Landscape Park and the adjacent Polish Great Lakes region (Kraina Wielkich Jezior) in the north as well as the Pisz Forest in the south, were poorly studied in respect of wild bees. Historical data of ALFKEN (1909, 1913) from East Prussia, are concerned with several dozen species. More recent literature on this subject is limited to a report on bumblebees of the Masurian Lakeland by SOWA et al. (1991) and a study by BANASZAK and RASMONT (1994).

Considering all this, it was necessary and urgent to undertake this study on species diversity, dominance structure, and phenology of bees of the Masurian Landscape Park, which is to be transformed into a national park, and currently is protected as a NATURA 2000 site.

Acknowledgements

I would like to express my thanks to the Director of the Masurian Landscape Park, Ir. Grzegorz WAGNER, who allowed me to undertake this research and provided technical support. I am particularly grateful to Mr Wiesław PUPEK, a Park Ranger, who took care of the Moericke traps. I sincerely thank Dr Alicja KRUSZELNICKA and Dr hab. Jerzy KRUSZELNICKI, for information on published literature, topography, and nature of the Park.

STUDY AREA AND METHODS

The Masurian Landscape Park can be divided into two zones: (1) terminal moraines in the north, with variable relief and a wide range of habitats; and (2) outwash plains in the south, poorer and more uniform in terms of environmental conditions.

The area of the Park is distinguished not only by a high specificity of geomorphological conditions but also by diverse plant and animal life (POLAKOWSKI et al. 1997, DĄBROWSKI et al. 1999, RĘKOWSKI 2002, KRUSZELNICKI & KRUSZELNICKA 2001).

Woods of the Pisz Forest account for 50% of the Park area, and are dominated by conifers. The most typical forest community is mixed forest composed of pine, spruce, hornbeam and oak. The sandy outwash plain is mostly covered by fresh (i.e. moderately humid) pine forest, with abundant juniper. In the moraine zone, oak-hornbeam woods are most common, with admixture of linden, aspen, maple, and birch. Also beech is present but infrequent there, reaching the limit of its distribution. Watersides are accompanied by alder carrs, alluvial forests, and willow thickets. Large areas are covered by aquatic, emergent, and peatland vegetation. On lake banks and in open forests in the Park, dry herbaceous communities have developed, with thermophilous species (RĘKOWSKI 2002).

Watercourses and water bodies cover about 30% of the total area of the Park. They include over 60 lakes (surface area >1 ha each). The hydrographic axis of the park is formed by the river Krutynia, flowing out of Lake Krutyńskie. The largest water body is Lake Śniardwy. It is a typical moraine lake, with a well-developed shoreline. Other major lakes in the Park are: Bełdany (941 ha), Mokre (815 ha), Łuknajno (696 ha), and Mikołajskie (498 ha).

Field research was conducted in 2003 and 2004, from April to late September. It covered the area of the Park, its buffer zone, and several sites near the borders of the Park. In July 2000, preliminary observations were made in Kosewo Górne, on Lake Dziadek. In total, 20 research plots were investigated. Traps were placed in three characteristic habitats of the Park: sandy grassland (see Fig. 1, plot 1), oak-hornbeam forest (plot 2) and fresh coniferous forest (plot 3). In each of the habitats, six white pans were placed (directly on the ground or on poles at a height of 0.5 m). The pans contained a mixture of water (95%), ethylene glycol (4.8%), and surfactant (0.2%). The caught insects were collected every 7-10 days. On these plots (1-3) and all the others (4-20), I also caught insects with a sweep net, by searching on flowers and in favourite nesting sites of bees, during my visits in the field: in April and August 2003 as well as in late April, early May, July, and September 2004. Each sweep-netting session lasted about 2 hours per plot.

Characteristics of research plots (Fig. 1)

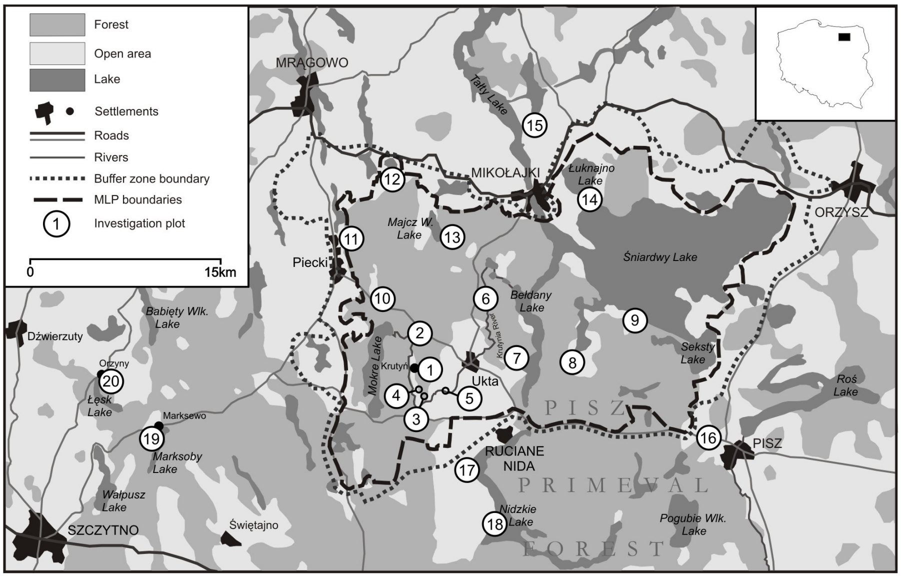

Fig.1. Map of the Masurian Landscape Park and location of research plots: 1 – Krutyń grassland, 2 – Krutyń oak-hornbeam forest, 3 – Rosocha, 4 – Krutyński Piecek, 5 – Wojnowo, 6 – Nowy Most, 7 – Wygryny, 8 – Wejsuny, 9 – Głodowo (Niedźwiedzi Róg), 10 – Dobry Lasek, 11 – Piecki, 12 – Kosewo Górne, 13 – Lisiny foresters cottage, 14 - Łuknajno, 15 – Tałty, 16 – Szczechy, 17 – Pranie, 18 – Krzyże, 19 – Marksewo, 20 – Orzyny.

A - Permanent plots with traps, studied in 2003-2004

1. Krutyń – sandy grassland, developed in fallows (former grassland), located close to a young pine forest (Fig. 2). Sweep-netting was conducted also in the village of Krutyń and its vicinity (Appendix).
2. Near Krutyń – oak-hornbeam forest (forest section 53), *Tilio-Carpinetum typicum* (Fig. 3).
3. Rosocha – typical fresh coniferous forest (section 192), *Peucedano-Pinetum typicum*, with a large contribution of *Vaccinium myrtillus* (Fig. 4). Sweep-netting was conducted also in village of Rosocha on a meadow (4 Aug 2003) on the river Krutynia.

B -Sweep-netting sites

4. Krutyński Piecek (17 Jul 2004, 19 Sep 2004) – grassy wasteland at the edge of pine forest. Major bee forage plants: *Jasione montana, Trifolium arvense, Senecio* sp., *Vicia* sp..
5. Wojnowo (24 Apr 2004) – meadow with clumps of willows at its edges.
6. Nowy Most near Nowa Ukta (21 Jul 2004) – dry grassland.
7. Wygryny on Lake Bełdany (19 Jul 2004) – meadow near forest. Major bee forage plants: *Knautia arvensis*, *Vicia* sp.
8. Wejsuny on Lake Warnołty (6 Aug 2003). Major bee forage plants: *Lythurum salicaria, Mentha aquatica*.
9. Głodowo (Niedźwiedzi Róg) on Lake Śniardwy (6 Aug 2003) – meadow. Major bee forage plants: *Cirsium oleraceum, Lythrum salicaria*.
10. Dobry Lasek near Piecki (20 Jul 2004) – edge of pine forest. Major bee forage plants: *Knautia arvensis, Thymus* sp., *Medicago falcata*.
11. Piecki (8 Aug 2003) – dry grassland and adjacent red clover field. Major bee forage plants on dry grassland: *Centaurea scobiosa, Medicago falcata*.
12. Kosewo Górne on Lake Dziadek (15 Jul 2000, 25 Apr 2003) – dry grassland on a slope. Major bee forage plants: *Centaurea renana, Senecio jacobaea, Lotus corniculatus, Jasione montana*, *Echium vulgare* (Fig. 5).
13. Lisiny foresters cottage, Strzałowo Forest District, 2 km from Lake Majcz Wielkie (11-17 Jul 2000) – pine forest, on a clearing.
14. Łuknajno on Lake Łuknajno (21 Jul 2004) – wasteland. Major bee forage plants: *Melilotus alba, Reseda* sp.
15. Tałty on Lake Tałty (7 Aug 2003) – meadow, dominated by *Centaurea jacea*.
16. Szczechy Wielkie near Pisz (1 May 2004) – dry grassland, at the edge of pine forest.
17. Pranie, near forester lodge "Pranie" on Lake Nidzkie (18 Jul 2004) – pine forest. Bumblebees on *Melampyrum sylvaticum*.
18. Krzyże on Lake Nidzkie (5 Aug 2003) – dry grassland. Major bee forage plants: *Trifolium pratense, Helichrysum arenarium, Senecio jacobaea*.
19. Marksewo near Szczytno (2 May 2004) – meadow with *Taraxacum officinale* and *Prunus spinosa* at its edge.

Fig. 2. Krutyń – sandy grassland (Photo by J. BANASZAK).

Fig. 3. Krutyń – oak – hornbeam forest (Photo by W. BZURA).

Fig. 4. Rosocha – typical fresh coriferous forest (Photo by J. BANASZAK).

Fig. 5. Kosewo Górne – dry grassland on a slope (Photo by J. BANASZAK).

20. Orzyny on Lake Łęsk (20 km N of Szczytno) (2 Aug 2003) – dry grassland, near the lake. The richest patch of steppe vegetation in Masuria (POLAKOWSKI 1971). Major bee forage plants: *Cirsium arvense, Medicago falcata, Helichrysum arenarium, Senecio jacobaea*.

RESULTS

Species diversity and dominance structure

This work is based on a total of 4467 collected individuals of bees (Apiformes). They represented 153 species (Appendix), and accounted for 32.6% of the Polish bee fauna.

It is interesting to compare contributions of individual bee families in the study area and generally in Poland (Fig. 6). The fauna of Masuria is characterized by a higher contribution of Apidae (16.3%, compared to 8.5% in Poland) and Melittidae (3.9%, compared to 2.3% in Poland). In contrast, contributions are lower for Halictidae (15.0%, compared to 22.4% in Poland) and ex-Anthophoridae (15.0%, compared to 18.1% in Poland).

The group of dominant species (eudominants, dominants, and subdominants) include members of all families. This reflects large contributions of various habitats, ranging from alluvial vegetation to grassy patches in woodlands. The eudominant was *Osmia rufa*. In the whole collected material (net + traps) it accounted for nearly 35% of the total catch (Fig. 7), while in the material from the traps on 3 plots (coniferous forest, oak-hornbeam forest, and dry grassland), for as much as 45% (Fig. 8). These results were affected by its unusually high abundance in 2004. In that year, as many as 1394 individuals were caught, compared to only 94 in 2003. It is noteworthy that out of the total of 1474 individuals collected in both years, 88 were female, while 1367 were male. Another dominant species was *Andrena lapponica* – the major component of the bee community in coniferous forest. It accounted for 25% of the total catch. Out of the total of 621 individuals collected in both years, 373 were female and 237 were male, so females prevailed only slightly. In the study area, *Bombus lucorum* was a subdominant, reaching less than 10% of the total catch. In contrast to the above-mentioned dominants, it was present in many various ecosystems (Figs 7 and 8).

Beside the group of most frequent species, quite many species in Masuria were characterized by a high constancy in that region. Thus they had lower environmental requirements. They were found on 11 or more sites out of the 23 studied sites (47.8–69.6%), so they can be regarded as characteristic for the study area: *Bombus terrestris* (69.6%), *B. pascuorum*, *B. lucorum*, *Psithyrus bohemicus*, *Halictus sexcinctus*, *Seladonia tumulorum*, *Evylaeus calceatus*, *Lasioglossum leucozonium*, and *Dasypoda hirtipes*.

A large group of 59 species (38.5%) are rare, represented by 1-3 individuals. Among the rarest wild bees in Masuria, Megachilidae were most diverse (20 species). It is difficult to explain why some species that are frequent or common in other parts of the country are represented by very few individuals in the study area, e.g. *Colletes succinctus*, *Evylaeus* *morio*, *Megachile centuncularis*, *M. willughbiella*, *Coelioxys rufa*, *Athophora plumipes* or *Bombus hortorum*.

Other species are generally rare in Poland. Among those recorded in Masuria, several are particularly noteworthy and are briefly described below.

Hylaeus linearis (=*H. lepidulus*) – found in Wejsuny, on Lake Warnołty, 6 Aug 2003, 1 ♂.

Evylaeus linearis – poorly known in Poland, recorded mostly in dry grasslands in the catchment area of the Vistula; not reported from Masuria and the northeastern part of the country before. New record: Pisz Forest, Strzałowo Forest District, 14 Jul 2000, 1♀.

Evylaeus semilucens – in Poland known only from single sites in the lowlands of Central Poland and on Lake Wigry. Not reported from Masuria before. New record: Krutyń, 8 Aug 2003, 1♀.

Osmia uncinata – rather rare in Poland, although reported from various parts of the country. New record: Rosocha, pine forest, 9 May 2003, 1♀; 30 May 2003 1♂.

Hoplitis claviventris – in Poland its distribution is poorly studied, because for a long time it was misidentified as *H. leucomelana*. It has been recorded in the Wielkopolska-Kujawy Lowland and Western Beskid Mts. New records: Pisz Forest, Strzałowo Forest District, coniferous forest, 14 Jul 2000, 1♂; Krutyń, 18 Jul 2004, 1♀; Dobry Lasek, 20 Jul 2004, 1♀.

Megachile apicalis – distributed nearly throughout Poland, but rather rare. New record: Krzyże, dry grassland, 5 Aug 2003, 1♂.

Bombus soroeensis – rare in Poland, which is the western limit of *B. s. soroeensis* and the eastern limit of *B. s. proteus* (REINIG, 1939). The species is associated with forest habitats. In Masuria, only *B. s. soroeensis* was found. Both subspecies have recently been reported from Nidzica, which lies close to the study area (BANASZAK & MOTYKA 2007). New record: Pisz Forest, Kosewo Górne, 17 Jul 2000, 1☿.

Bombus ruderatus – rare in Poland. New record: Pisz Forest, Strzałowo Forest District, 17 Jul 2000, 1♂.

Bombus schrencki – this boreal species in Poland is known only from the Białowieża Forest and the Wigry National Park. First records in Masuria: Rosocha, pine forest, 27 Apr 2004, 1♀; 6 May 2004, 1♀; Piecki, 8 Aug 2003, 1☿; Orzyny, 2 Aug 2003, 1♀; Głodowo on Lake Śniardwy, 6 Aug 2003, 1☿.

Psithyrus norvegicus – rare in Poland, known from single localities. New record: Rosocha, pine forest, 24 May 2003, 1♀; 11 Jul 2003, 1♂.

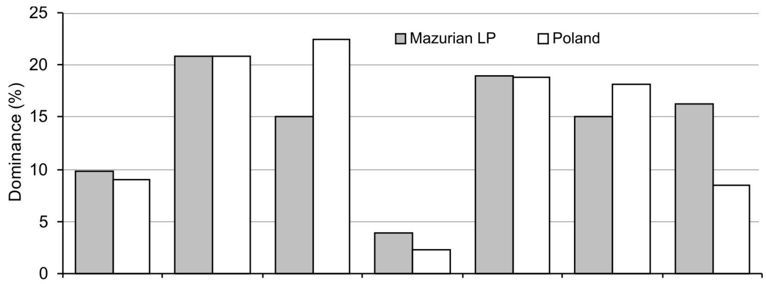

Fig.6. Comparison of contribution of bee families among bees collected in Masuria Landscape Park (traps + net) and in Poland.

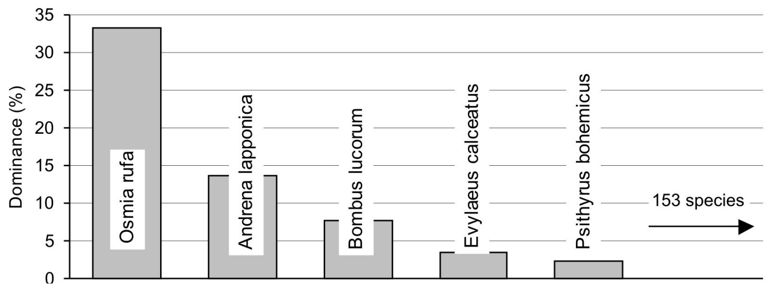

Fig.7. Dominance structure of bees in Masurian Landscape Park (traps + net).

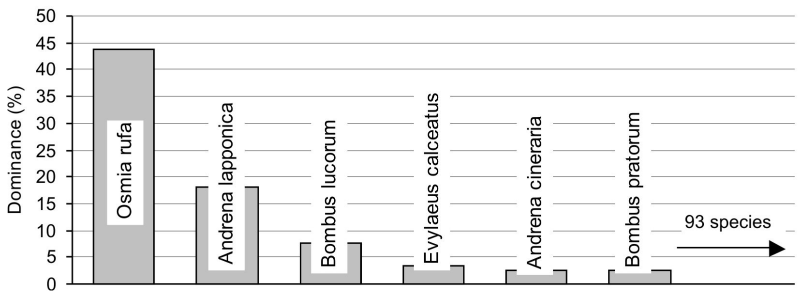

Fig.8. Dominance structure of bees in Masurian Landscape Park (Moericke traps): *Tilio – Carpinetum*, xerothermic sward (Krutyń), *Peucedano – Pinetum* (Rosocha).

Characteristics of bee communities in the studied habitats

Dry grasslands. The sandy grassland in the village of Krutyń was studied most extensively (plot 1, Fig. 2), as bees were caught in traps there. Additionally, bees were caught with a sweep net at this site and on other plots (9, 10, 11, 13, 15, 17, 18, 20, 25). The sandy grassland in Krutyń probably had the richest bee fauna, as 65 bee species were recorded there. *Osmia rufa* was surprisingly abundant (78.7% of the total catch) while other species were infrequent, e.g. *Evylaeus calceatus*, *Colletes cunicularius*, or *Andrena nitida* (Fig. 9). It is noteworthy that *Osmia rufa*, the most common bee species in Poland among wild bees, is very plastic, both in respect of the range of its forage plants (polylectic), and selection of nesting sites, i.e. in various substrates (in wooden buildings, hollow dry stems, snail shells, etc.). However, its high abundance was not stable, as 1455 individuals were trapped in 2004, whereas only 33 in the preceding year.

Another surprising finding was made on a dry grassland in Kosewo Górne (Fig. 5). On that site, in mid-July 2000, a record abundance of wild bees was observed, reaching 8200 individuals per hectare with the strongly dominant *Anthophora bimaculata* (52.4%). Density of that species reached 4300 individuals per hectare. Two other most abundant species were *Bombus lapidarius* (25.6%) and *B. lucorum* (12.8%). During the spring visit (25 Apr 2003) to this site, a very large colony of *Andrena vaga* was found. The above examples confirm a high diversity of dry and warm sites, which differ in vegetation and create optimum conditions for nesting species, particularly in the soil.

Oak-hornbeam forest *Tilio-Carpinetum*, Krutyń (Fig. 3). In spite of two years of field research with the use of traps, only 29 species were recorded there. The dominant species was *Bombus lucorum* (28.9%) with the subdominant *Andrena cineraria* (16.7%) and quite abundant *A. subopaca* (9.9%) and *A. haemorrhoa* (5.4%) (Fig. 10).

Pine forest, Rosocha (Fig. 4). Two years of research with the use of traps, provided information about a total of 61 species. In both years, *Andrena lapponica* strongly dominated. It accounted for nearly a half of the total catch (n = 611) (Fig. 11). The species is associated with *Salix* spp. in early spring, and later mostly with *Vaccinium myrtillus* and *V. vitis-idaea*. *Bombus lucorum* was a subdominant (14.1%), which is a typical forest species.

Meadows. Meadow plots were explored only occasionally, with the use of a sweep net. Data were collected from various types of meadows (8, 14, 19, 21, 22, 23, 24). In those habitats, varying in humidity and species number (9-20 species), 65 bees were caught. The most numerously represented genera are: *Andrena* (17 species) and *Bombus* (15 species) The most abundant species were: *Andrena haemorrhoa*, *A. praecox*, *A. vaga*, *Halictus sexcinctus*, *Bombus pascuorum*, and *B. ruderarius*.

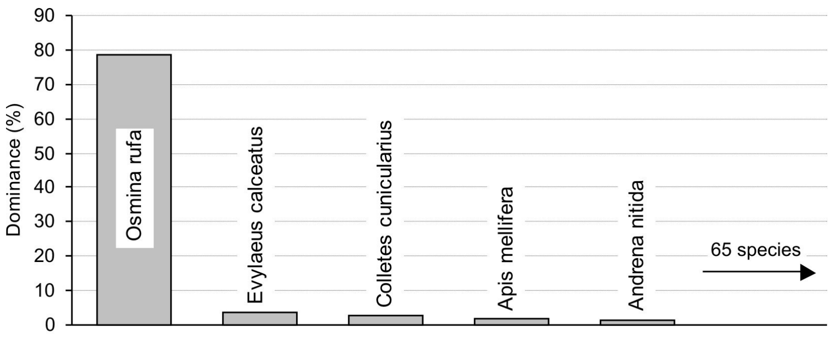

Fig. 9. Dominance structure of bees in Krutyń – xerothermic sward (Moericke traps).

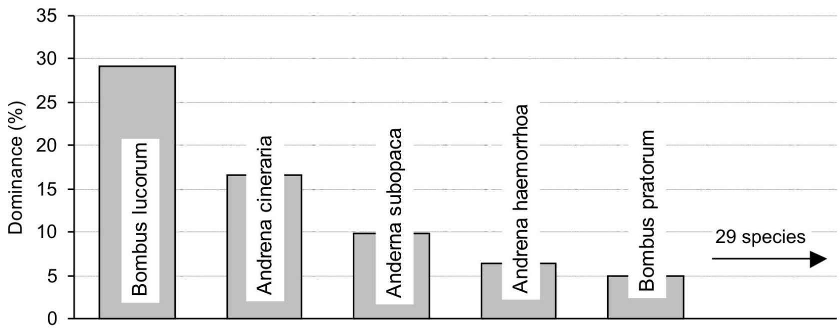

Fig. 10. Dominance structure of bees in *Tilio – Carpinetum* (Krutyń) (Moericke traps).

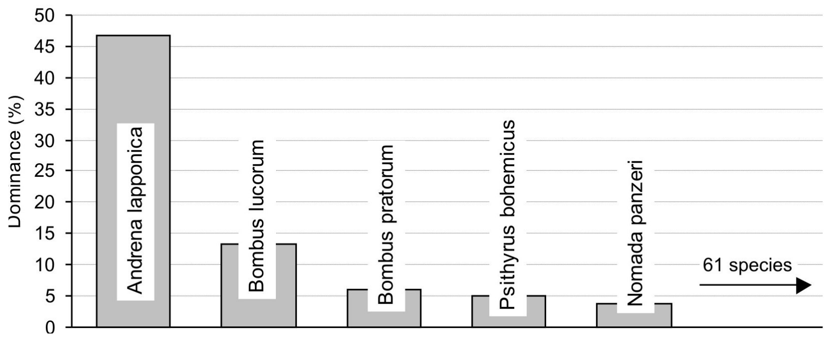

Fig. 11. Dominance structure of bees in *Peucedano – Pinetum* (Rosocha) (Moericke traps).

Phenology of Apiformes

The analysis of bee community dynamics is based on all caught speciments.

The timing of emergence of Apiformes during the growing season is presented in Fig. 12. The curve has two conspicuous peaks: in spring and in summer. The clear increase in bee diversity in spring in mid-April reaches its maximum in late April and early May. Depending on year, it reached about 20 species (in 2003) to 45 species (in 2004). From mid-May till late June, in the study area, bee diversity is rather stable: 10-20 species. The summer peak was earlier in 2004 (about 20 July, nearly 60 species) and later in 2003 (early August, 70 species). The most abundant bees in spring were: *Andrena haemorrhoa*, *A. vaga*, *A. lapponica*, *Colletes cunicularius*, *Osmia rufa*, *A. cineraria*, and *Evylaeus calceatus*. In June, other species start to prevail: *Andrena lapponica* (2nd generation) *Bombus lucorum, Osmia rufa.* In summer, the most abundant species are: *Halictus sexcinctus*, *Anthophora bimaculata* (locally?), *Seladonia tumulorum*, and *Bombus lucorum*.

The pattern of bee abundance dynamics was different from the above-mentioned pattern of bee diversity dynamics. Curves from the last two years show that bee abundance was the highest in spring (late April and early May) and later decreased. It must be emphasized that bee abundance greatly differed between years. In 2004, during the peak at the beginning of May, about 750 individuals of Apoidea were caught, whereas in the next few weeks, only 100 to 200 bees were caught per week. By contrast, in the preceding year (2003) the abundance of wild bees was particularly low. In the peak period, i.e. in the first week of May, only about 200 individuals of Apoidea were caught (Fig. 13). The abundance of bees in spring was determined mostly by the large numbers of *Osmia rufa* in 2004 (see Fig. 14), and *Andrena lapponica* (Fig. 15). The latter species is particularly noteworthy so its population dynamics is analysed in detail in the Discussion.

Changes in abundance of these insects in individual ecosystems markedly deviate from the synthetic dynamics of bee abundance in the whole study area (Fig. 12). Only the pattern of bee abundance dynamics in the grassland is similar to the above-mentioned general dynamics, i.e. with one peak in spring (*Osmia rufa*) (Fig. 16). In contrast, the curve of bee abundance dynamics has two clear peaks, in spring and summer in *Tilio-Carpinetum* (Fig. 17), or even more peaks in pine forest *Peucedano-Pinetum*, distinguished by a large number of dominants (Fig. 18): *Andrena lapponica, Bombus lucorum, B. pascuorum, B. pratorum, Lasioglossum quadrinotatum, L. lativentre,* and *Psithyrus bohemicus.*

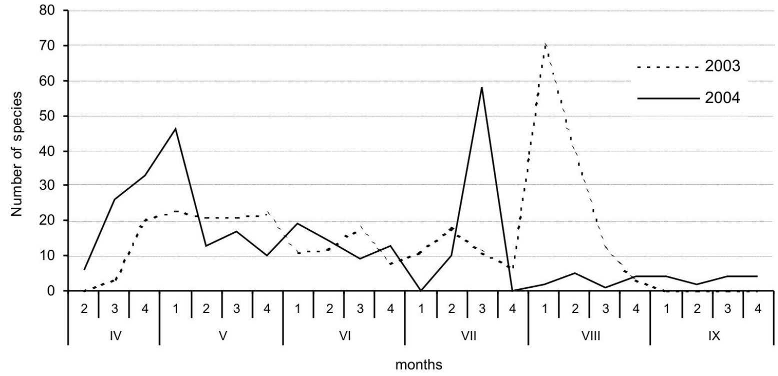

Fig. 12. Dynamics of appearance of Apifomes in the Masurian LP.

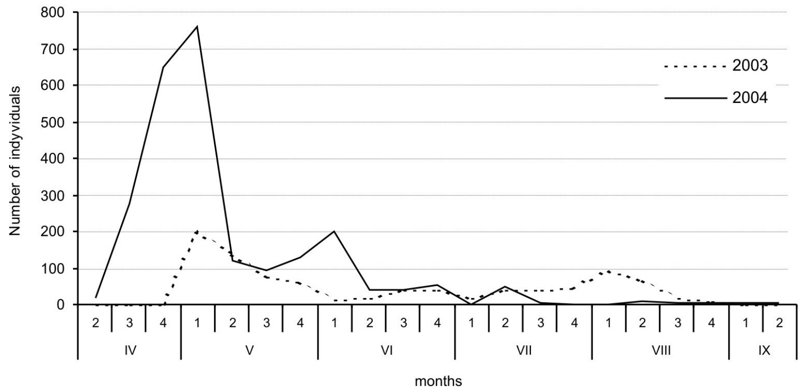

Fig. 13. Dynamics of bee abundance in Masurian LP (Moericke traps).

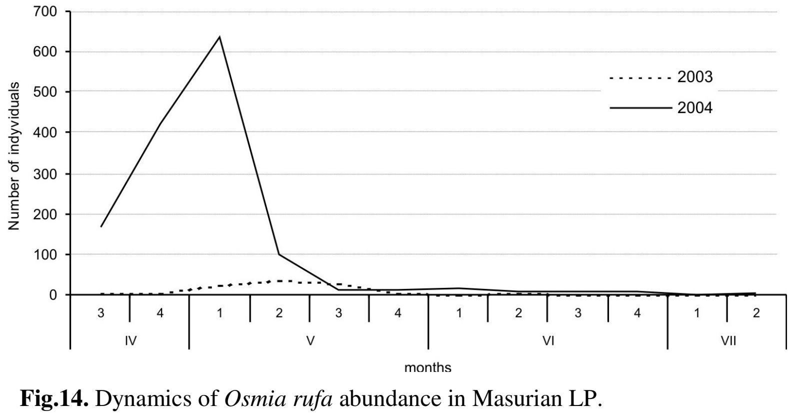

Fig.14. Dynamics of *Osmia rufa* abundance in Masurian LP.

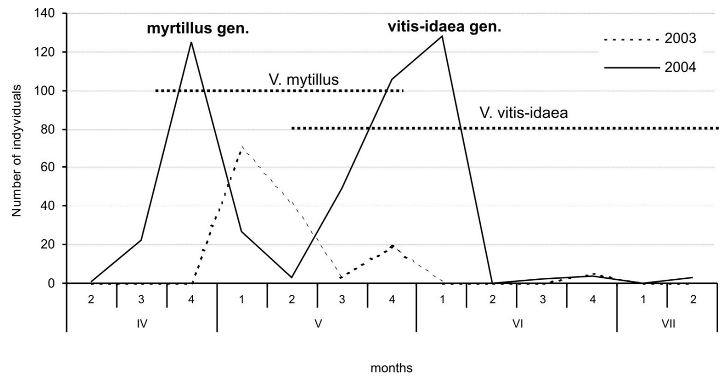

Fig. 15. Dynamics of *Andrena lapponica* in Masurian LP (blooming after MAKSYMIUK 1986 and RUSZKOWSKI et al. 2004).

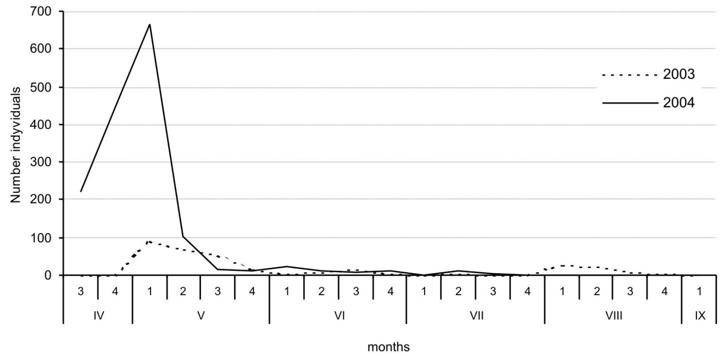

Fig. 16. Dynamics of bee abundance in xerothermic sward in the Masurian LP.

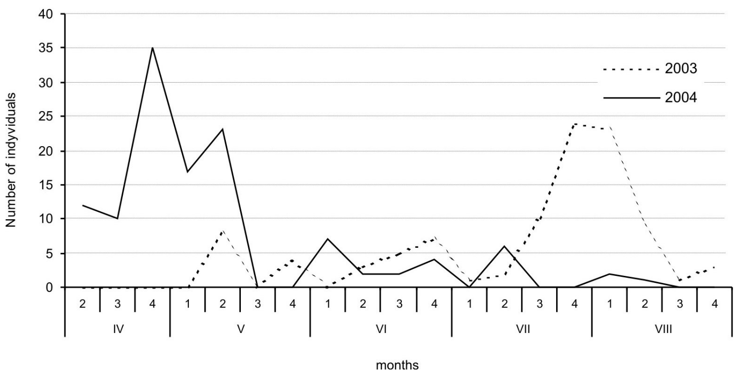

Fig. 17. Dynamics of bee abundance in *Tilio – Carpinetum* in the Masurian LP.

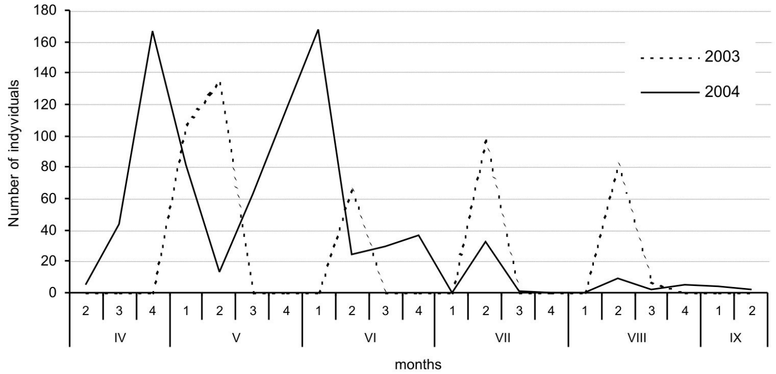

Fig. 18. Dynamics of bee abundance in *Peucedano – Pinetum* in the Masurian LP.

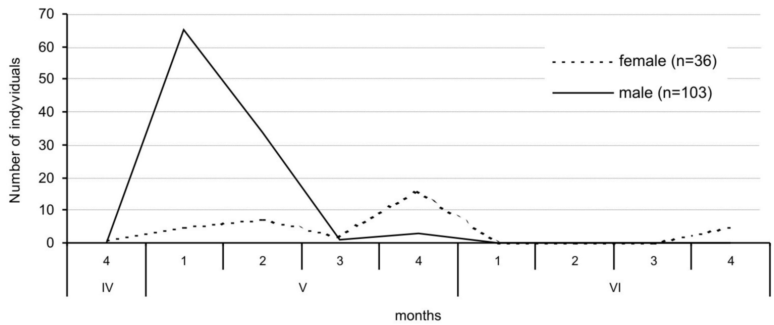

Fig. 19. Dynamics of numbers of *Andrena lapponica* in Masurian LP. in 2003 year.

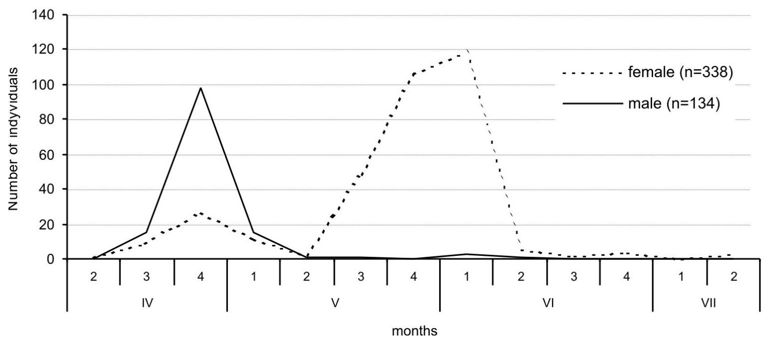

Fig. 20. Dynamics of numbers of *Andrena lapponica* in Masurian LP. in 2004 year.

DISCUSSION AND CONCLUSIONS

In spite of its high environmental attractiveness and high degree of preservation of the natural environment, Masuria before my investigations was very poorly studied in respect of the bee fauna. The above-mentioned ALFKEN'S publications (1909, 1913) concern mostly the vicinity of Kaliningrad (Königsberg), while the area of the present Masurian Landscape Park and its buffer zone were visited by him only occasionally. In a work summarizing his research (ALFKEN 1913) he mentioned 25 bee species from the Park. The present study provided information about as many as 153 species of Apiformes. This number is comparable with the number of bee species in, for example, the Białowieża National Park (NP), Narew NP, or Drawa NP (Table 1). However, some species have not been found again, e.g. *Bombus laesus* (Morawitz) and *Psithyrus quadricolor* Lepeletier, caught in Mikołajki and reported by ALFKEN (1909). The bumblebee was probably in fact a closely related species, i.e. *Bombus maculidorsis* Skorikov, which has been recently separated from *Bombus laesus* (PANFILOV 1956). Both species were also not detected by Sowa et al. (1991), although those authors intensively studied the pollinators of red clover in the Masurian Lakeland. Anyway, *Bombus maculidorsis* may exist in the study area, as it was caught near Białystok by RUSZKOWSKI et al. (1980).

Table 1. Comparison of number of the bee species recorded in selected lowlands in national parks and in Masurian Landscape Park.

Park	**Area (ha)**	**Forest area %**	**No. of species**	**% of Polish fauna**	**References**
Drawa NP	11342	82.0	121	25.5	BANASZAK et al. 2009
Bory Tucholskie NP	4798	79.0	101	21.1	BANASZAK & WENDZONKA 2002
Wigry NP	15085	62.7	191	40.7	BANASZAK & KRZYSZTOFIAK 1996
Wiekopolska NP	7620	58.3	226	48.2	BANASZAK 1987 BANASZAK & CIERZNIAK 1994 CIERZNIAK 2003
Kampinos NP	38554	75.0	180	38.2	BANASZAK & PLEWKA 1981
Narew NP	7350	12.0	125	26.4	BANASZAK 2006
Mazurian LP	53665	50.0	153	32.6	BANASZAK 2010
Białowieża NP	10517	96.0	181	30.6	BANASZAK & JAROSZEWICZ 2009

The bee fauna of Masuria is surprising in many respects. First of all, in comparison with the whole country, the contribution of Apidae is much higher (according to the older division into families, without Anthophoridae), and the markedly lower contribution of Halictidae (Fig. 6).

The high contribution of Apidae is due to the presence of 19 species of *Bombus* (63.3% of their total number in Poland) and 5 species of *Psithyrus* (62.5% of their total number in Poland). Similar numbers of bumblebee species in the Masurian Lakeland were also reported by SOWA et al. (1991), but *Bombus pomorum* (PANZER), *B. distinquendus* Morawitz, and *Bombus confusus* SCHENCK were missing in my study. However, these species are currently very rare in Poland, or more frequent only locally. I also failed to confirm the presence of *Bombus schrencki* (MORAWITZ 1881), which was reported from the Wigry NP (KRZYSZTOFIAK 1992). Generally, specificity of the bee fauna of Masuria is due to groups of forest species, which results from the dominance of forests and lakes, and thus also watersides. In this regard, the Masurian Landscape Park is similar to the Białowieża NP or the Narew NP.

In the study area, only 23 species of Halictidae were recorded, which account for 15% of the fauna of the whole study area, compared to 22.4% generally in Poland. This value is the lowest contribution of halictids to the total bee fauna among all parts of Poland studied so far, comparable only to the Bory Tucholskie NP, which is dominated by woodland (BANASZAK & WENDZONKA 2002) or with wetlands of the Narew NP (BANASZAK 2006). Halictidae are associated mostly with open and dry habitats. It contrasts with, for example, results of research on dry grasslands in the lower Vistula valley, where members of the family account for 27% (BANASZAK et al. 2006).

Among the dominant forest habitats, the best studied were: pine forest (Rosocha) and oak-hornbeam forest (Krutyń). They greatly differed in species diversity of bees, i.e. 61 and 29 species, respectively. Oak-hornbeam forests are favourable habitats, mostly for spring bees (e.g. BANASZAK 1983, BANASZAK & JAROSZEWICZ 2009).

In the studied pine forest, it was surprising that *Andrena lapponica* accounted for more than a half of the total catch, whereas only single specimens were caught at the other sites. It constituted about 19-29% of the total catch in various forest types (mostly coniferous) in the Bory Tucholskie National Park (BANASZAK & WENDZONKA 2002). This species characteristic of coniferous forests is associated mostly with *Vaccinium myrtillus,* and to a lesser extent with *V. vitis-idaea*, as reported by KARCZEWSKI (1973), as well as with *V. uliginosum*. It sporadically visits also other flowers, listed by RUSZKOWSKI et al. (2004). Those authors report, in total, 32 plant species of 13 families. *Andrena lapponica* is most abundant and most frequent on *Vaccinium myrtillus* and *Salix* spp.; frequent and sometimes abundant on *V. vitis-idaea*, and on other plant species, e.g. *Tussilago farfara, Taraxacum officinale*.

Various authors consistently report that *Andrena lapponica* is univoltine, i.e. has one generation per year. However, large differences can be noticed between data on its flight season provided by individual authors from lowlands of Central Europe: in Germany (Bremen), mid-April to mid-May (ALFKEN 1913) or early May till late June (SCHMID-EGGER & SCHEUCHEL 1997); in former Czechoslovakia, mid-April to mid-May (KOCOUREK, 1966); in Ukraine, May to June (OSYTSCHNJUK 1977); and in Poland, April to May (♂ in early April on *Salix*, next ♀ and ♂ in May on *Vaccinium*) (DYLEWSKA 1974). The presented results indicate that that the flight season of *A. lapponica* in the lowlands of Central Europe is extremely long, lasting 3 months (in mountains till July). Results of my research in Masuria seem to explain these disparities and doubts. Two clear peaks of its abundance in spring can be noticed (Fig. 15), i.e. 24 April and 27 May to 3 June, separated by a period of its absence in mid-May. It is noteworthy that such a situation was observed in both years, although with a slight time shift. The dynamics of emergence of males and females in both years shows similar trends (Figs. 19 and 20). This suggests that *A. lapponica* has in fact two generations: one in early spring (April to mid-May) and the other in late spring (late May to mid-June). The first generation is associated with flowering *Salix* spp. but mostly with *V. myrtillus* (*myrtillus* generation), while the second one mostly with *V. vitis-idaea* (*vitis-idaea* generation). *Andrena lapponica* is thus bivoltine, i.e. has two generations per year.

Open habitats (arable fields, meadows, pastures, and dry grasslands) cover only about 1/6 of the total area of the Park, but support the richest and most diverse bee fauna. On the sandy grassland (Krutyń) as many as 67 bee species were recorded. Moreover, *Osmia rufa* accounted for nearly 80% of the total catch (Fig. 9). Its extremely high abundance must have been determined by other factors rather than the dry soil (Fig. 2), e.g. the vicinity of pine forest or of the village of Krutyń. This habitat was probably only its foraging site. This can be confirmed by the fact that on highly variable dry grasslands in the lower Vistula valley, *Osmia rufa* did not exceed 1% of the total catch (BANASZAK et al. 2006).

Field research on a dry grassland in Kosewo Górne on Lake Dziadek revealed an exceptionally high density of *Anthophora bimaculata*, visiting *Centaurea rhenana*. In July 2000, in an area of 200 m^2, as many as 86 individuals of this species were found, which can be expressed as 4300 individuals per ha. In turn, in April 2003, a very large colony of *Andrena vaga* was found at the same site. This confirms that dry grasslands are both foraging sites and both nesting sites for some species.

Another surprising finding is a low abundance of several species that are frequent or common in other parts of Poland. For example, *Anthophora plumipes* is common everywhere in Poland (even in urban areas), and *Evylaeus* is also one of the most common bees in Poland. Both species in Masuria occurred singly (in spite of the high diversity of collection sites and methods. Also some bumblebee species are common in other parts of the country: *Bombus terrestris*, *B. pascuorum*, *B. sylvesrtis*, and *B. lapidarius*. According to SOWA et al. (1991), *B. terrestris* was the most common species on red clover. Those authors, regarded Masuria as a potentially good region for red clover seed production. However, the small numbers of bumblebees observed in this study, even of those classified as common in other parts of Poland, may be due to their generally low density in a given year. Bumblebee density can differ greatly between years, as confirmed by data of SOWA et al. (1991) from the village of Piecki (covered also by the present study), where their number per 1 ha of red clover field reached 1200 in 1972 and 2950 in 1974, but was absent in 1973 and 1975.

REFERENCES

ALFKEN J.D. 1909. Betraig zur Kenntnis der Apidenfauna von Ostpreussen. Schr. Phys.-Ökonom. Gessel. Königsberg, **50**: 320-345.

ALFKEN J.D. 1913. Die Bienenfauna von Ostpreussen. Schr. Phys.- ökon. Ges. Königsberg, **53**: 114-182.

BANASZAK J. 1983. Ecology of bees (Apoidea) of agricultural landscape. Pol. Ecol. Stud., **9**(4): 421-505.

BANASZAK J. 2006. Bees (Hymenoptera: Apiformes) in the Narew National Park. Pol. Pismo Ent., **75**: 511-537.

BANASZAK J., RASMONT P. 1994. Occurance and distribution of the subgenus *Bombus* Latreille sensu stricto in Poland (Hymenopera, Apidae). Pol. Pismo Ent., **63**: 337-356.

BANASZAK J., KRZYSZTOFIAK A. 1996. The natural wild bees resources (Hymenoptera:Apoidae) of the Wigry National Park.

BANASZAK J., WENDZONKA J. 2002. Bees (Hymenoptera: Apoidea) of the Bory Tucholskie National Park (NW Poland).Pol. Pismo Ent., **71**: 327-350.

BANASZAK J., CIERZNIAK T., KRIGER R., WENDZONKA J. 2006. Bees of the xerothermic swadrs in lower Vistula valley: diversity and zoogeographic analyses (Hymenoptera: Apoidae: Apiformes). Pol. Pismo Ent. **75**: 105-154.

BANASZAK J., MOTYKA E. 2007. Zróżnicowanie gatunkowe trzmieli (*Bombus* LATREILLE, 1802) i trzmielców (*Psithyrus* LEPELETIER, 1833) w wybranych rezerwtach przyrody na obszarze północnej Polski. Parki Nar. Rez. Przyr. **26**(2): 75-92.

BANASZAK J., JAROSZEWICZ B. 2009. Bees of the Białowieża National Park and adjacent areas, NE Poland (Hymenoptera:Apoidea, Apiformes). Pol. Journ. Ent., **4**: 281-313.

BANASZAK J., KRIGER R., CIERZNIAK T. 2009. Bees (Hymenoptera: Apoidae: Apiformes) of the Drawa National Park. Pol. Pismo Ent. **78**: 135-156.

DĄBROWSKI S., POLAKOWSKI B., WOŁOS L. 1999. Obszary chronione i pomniki przyrody województwa Warmińsko – Mazurskiego. Urząd Wojewódzki w Olsztynie, 138 pp.

DYLEWSKA M.1974. Klucze do oznaczania owadów Polski. Cz. XXIV, Z. 68d. Pszczołowate – Apidae, Podrodzina Andrenidae, PWN, 78 pp.

KARCZEWSKI J. 1962. Znaczenie borówki czernicy (*Vaccinium myrtillus* L.) dla entomofuny leśnej. Folia Forest. Pol., Ser. A, 9:3-201.

KARCZEWSKI J. 1973. Przyczynek do poznania fauny sustynentów borówki bagiennej (*Vaccinium uliginosum* L., Ericaceae). Sylwan, **10**: 26-34.

KOCOUREK M. 1996. Prodromus der Hymenopteren der Tschechoslowakei, Pars 9: Apoidea, 1, Acta Faun. Entomol. Mus. Nat. Pragae, 12, Suppl.

KRUSZELNICKI J., KRUSZELNICKA A. 2001. Mazurski Park Krajobrazowy. MPK, Krutyń, 64 pp.

KRZYSTOFIAK A. 1992. Bombus schrencki Mor. (Apidae, Hymenoptera) w Polsce. Przeg. Zool. **34**(1-4): 157-159.

MAKSYMIUK W. 1986. Przyrodnicze podstawy produkcji pasiecznej Polski środkowowschodniej. Woj. Ośr. Post. Roln. w Halasach, Biała Podlaska, 48 pp.

OSYTSCHNJUK A. Z. 1977. Fauna Ukrainy. T.12. Bdžolyni, Bdžolyni - Andrenidy, Naukova Dumka, Kyiv, 328 pp.

PANFILOV D.V. 1956. Materialy po sistematice smelej (Hymenoptera, Bombinae) s opisaniem novych form. Zool. Žurn., **35**:1325-1330.

POLAKOWSKI B. 1971. Świat roślinny Warmii i Mazur. Wydawnictwo "Pojezierze", Olsztyn, 248 pp.

POLAKOWSKI B., JUTRZENKA-TRZEBIATOWSKI, HOŁDYŃSKI Cz. 1997. Roślinność rzeczywista Mazurskiego Parku Krajobrazowego. Mapa przyrodniczo-turystyczna. Wyd. ART. Olsztyn.

REINIG W.F. 1939. Synopsis der in Europa nachgewiesenen Hummel – nnd Schmarotzerhummelarten (Hymenoptera, Bombidae). Spixiana **4**(2): 159-164.

RĘKOWSKI G. 2002. Parki krajobrazowe w Polsce. Instytut Ochrony Środowiska, Warszawa, 79 pp.

RUSZKOWSKI A, ANASIEWICZ A., SOWA St. 1980. Polskie trzmiele (*Bombus* LATREILE) z podrodzaju Laesobombus Skorikov (Hymenoptera, Apidae). Pol. Pismo Ent., **50**: 509-513.

RUSZKOWSKI A., GOSEK J., BILIŃSKI M., KACZMARSKA K. 2004. Znaczenie gospodarcze i baza pokarmowa pszczół samotnic z rodziny pszczolinkowatych - Andrenidae (Apiformes, Aculeata, Hymenoptera). Zeszyty Nauk. JSK, Monografie i rozprawy, Puławy, 182 pp.

SCHMID-EGGER Ch., SCHEUCHL E. 1997. Illustrierte Bestimmungstabellen der Widbienen Deutschlands und Österreichs. Band III: Schlüssel der Arten der Familie Andrenidae.Erschinen im Eigenverlag, Velden/ Vils, 180 pp.

SOWA S., DYLEWSKA M., RUSZKOWSKI A. 1991. Trzmiele Pojezierza Mazurskiego. Pszczelnicze Zeszyty Naukowe, **35**: 103-111.

Received: July 15, 2009
Accepted: September 02, 2009

Appendix. List of species and number of indyviduals of Apiformes found at studied sites in Mazurian Landscape Park.

No.	Species	Moericke traps			Net																			
		Krutyń-grassland	Krutyń-oak-hornbeam forest	Rosocha-fresh conifer-ous forest	Lisiny foresters cottage	Dobry Lasek (Piecki)	Głodowo	Krutyń *	Krutyński Piecek	Krzyże	Leśniczówka Pranie	Łuknajno	Marksewo	Nowy Most (Ukta)	Orzyny	Piecki	Rosocha - meadow	Szczechy Wlk.	Tałty	Wejsuny	Wojnowo	Wygryny	Kosewo Górne	TOTAL
		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-
1	*Colletes cunicularius* (L., 1761)	54						5																59
2	*Colletes daviesanus* SMITH, 1846				1			3		10														14
3	*Colletes fodiens* (FOURCROY, 1785)	2						11	1	6				1	3								1	25
4	*Colletes marginatus* SMITH, 1846								2															2
5	*Colletes similis* SCHENCK, 1853							3		1														4
6	*Colletes succinctus* LINNAEUS, 1768									2														2
7	*Hylaeus* annularis (KIRBY, 1802)	1			1	1				1					1							1		6

		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-
8	*Hylaeus brevicornis* NYLANDER, 1852			2		1																		3
9	*Hylaeus communis* NYLANDER, 1852	2	1	2	7	6		1				1							1					21
10	*Hylaeus confuses* NYLANDER, 1852	1										1												2
11	*Hylaeus gibbus* SAUNDERS, 1850	1																						1
12	*Hylaeus gredleri* FÖRSTER, 1871					10								1										11
13	*Hylaeus paulus* BRIDWELL, 1919																			2				2
14	*Hylaeus nigritus* (FABRICIUS, 1798)				1																			1
15	*Hylaeus sinuatus* (SCHENCK, 1853)				2																			2
16	*Andrena alfkenella* PERKINS, 1914	1																						1
17	*Andrena argentata* SMITH, 1844								2															2
18	*Andrena bimaculata* (KIRBY, 1802)							1										3			3			7
19	*Andrena chrysosceles* (KIRBY, 1802)			1																				1
20	*Andrena cineraria* (LINNAEUS, 1759)	13	37	39									1											90
21	*Andrena denticulata* (KIRBY, 1802)			1	1	1		9	1										7					20
22	*Andrena dorsata* (KIRBY, 1802)	9						4										1			1			15
23	*Andrena flavipes* PANZER, 1799	7				1		8										3			3		1	23
24	*Andrena fucata* SMITH, 1847			1																				1
25	*Andrena fulva* (MÜLLER,1766)	3		1									1					1						6
26	*Andrena fulvago* (CHRIST, 1791)	6		1																				7

		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-
27	*Andrena fuscipes* KIRBY, 1802	1		1																				2
28	*Andrena gravida* IMHOFF, 1899	4		1	2			3													3			13
29	*Andrena haemorrhoa* (FABRICIUS, 1781)	12	14	31				8					12								8			85
30	*Andrena hattorfiana* (FABRICIUS, 1775)					3		1						1								8		13
31	*Andrena helvola* (LINNAEUS, 1758)	1	7	1																				9
32	*Andrena jacobi* PERKINS, 1921		2	2																				4
33	*Andrena lapponica* ZETTERSTEDT, 1838	2	3	603				2													1			611
34	*Andrena minutula* (KIRBY, 1862)	9			1			4														1		15
35	*Andrena minutuloides* PERKINS, 1914				3										1									4
36	*Andrena nigroaenea* (KIRBY, 1802)			4																				4
37	*Andrena nitida* (MÜLLER, 1776)	24		12									2											38
38	*Andrena ovatula* (KIRBY, 1802)	4						8							4	12			2					29
39	*Andrena pilipes* FABRICIUS, 1781															1			2					3
40	*Andrena praecox* (SCOPOLI, 1763)	2						1													7			10
41	*Andrena rosae* PANZER, 1801												1								1			2
42	*Andrena subopaca* NYLANDER, 1848	3	22		3			2															1	31
43	*Andrena tibialis* (KIRBY, 1802)			2																				2
44	*Andrena vaga* PANZER, 1799	13						3										2			7		9	34
45	*Andrena ventralis* IMHOFF, 1832	6						3										5						14

		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-
46	*Andrena wilkella* (KIRBY, 1862)	2		1				2	1															6
47	*Panurgus calcaratus* (SCOPOLI, 1791)																			1				1
48	*Halictus quadricinctus* (FABRICIUS, 1776)														1	1						2		4
49	*Halictus rubicundus* (CHRIST, 1791)	4			1			2	2			1			1							1		12
50	*Halictus sexcinctus* (FABRICIUS, 1775)	1		1		2		11	18			1		1	15	5	7			2		5		69
51	*Seladonia confusa* (SMITH, 1853)	5		3				1							1							1		11
52	*Seladonia tumulorum* (LINNAEUS, 1758)	14		3	3	1		12				3			3	6	1		1	1		1		49
53	*Lasioglossum costulatum* (KRIECHB., 1873)								1															1
54	*Lasioglossum lativentre* (SCHENCK, 1853)	2	6	13				1								1								23
55	*Lasioglossum leucozonium* (SCHRANK, 1781)	3		1			1	1	5	1					3	1	1			5		1		23
56	*Lasioglossum quadrinotatum* (KIRBY, 1802)		2	6				1																9
57	*Lasioglossum zonolum* (SMITH, 1848)	1		4																				5
58	*Evylaeus albipes* (FABRICIUS, 1781)	3	3	15				2																23
59	*Evylaeus calceatus* (SCOPOLI, 1763)	66	7	40	13			12	1			2	3			1				2	4	1		152
60	*Evylaeus linearis* (SCHENCK, 1869)				1																			1
61	*Evylaeus morio* (FABRICIUS, 1793)	2			1																			3
62	*Evylaeus semilucens* (ALFKEN, 1914)	1																						1
63	*Sphecodes albilabris* (FABRICIUS, 1793)							3															2	5
64	*Sphecodes ephippius* (LINNAEUS, 1767)	1	1	4		1																	1	8

		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-
65	*Sphecodes gibbus* (LINNAEUS, 1758)	1						1																2
66	*Sphecodes monilicornis* (KIRBY, 1802)	4			13			1							2									20
67	*Sphecodes pellucidus* SMITH, 1845	1																2					1	4
68	*Sphecodes puncticeps* THOMSON, 1870	1		1				1																3
69	*Sphecodes reticulatus* THOMSON, 1870					1		1	2						3									7
70	*Sphecodes rufiventris* (PANZER, 1798)			1																				1
71	*Melitta leporina* (PANZER, 1779)	2				7		2	4	1				1	7	7			3	1				35
72	*Melitta haemorrhoidalis* (FABRICIUS, 1775)				2																			2
73	*Mellita nigricans* ALFKEN, 1905															4	1		1					6
74	*Mellita tricincta* KIRBY, 1802																1		7					8
75	*Macropis europea* WARNCKE, 1973						1													4				5
76	*Dasypoda hirtipes* (HARRIS, 1780)	5		1	5			20	2					1		1			3	3		2	2	45
77	*Trachusa byssima* (PANZER, 1798)	1							6													3	1	11
78	*Anthidiellum strigatum* (PANZER, 1805)														1		1							2
79	*Stelis breviuscula* (NYLANDER, 1848)				1					1														2
80	*Stelis ornatula* (KLUG, 1807)					1																		1
81	*Heriades crenulatus* NYLANDER, 1856																		3					3
82	*Heriades truncorum* (LINNAEUS, 1758)				4			6	2	7					1							1		21

		-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-	-24-	-25-
83	*Chelostoma campanularum* (KIRBY, 1802)							1																1
84	*Chelostoma disctinctum* STOECKHERT, 1929							2																2
85	*Chelostoma florisomne* (LINNAEUS, 1758)	1		2																				3
86	*Chelostoma rapanculi* (LEPELETIER, 1841)			1				2																3
87	*Hoplitis adunca* (PANZER, 1798)	1			1				6			1												9
88	*Hoplitis anthocopoides* (SCHENCK, 1853)													1										1
89	*Hoplitis claviventris* (THOMSON, 1872)				1	1		1																3
90	*Hoplitis leucomelana* (KIRBY, 1802)							1																1
91	*Osmia bicolor* (SCHRANK, 1781)		1															1						2
92	*Osmia fulviventris* (PANZER, 1798)	1																						1
93	*Osmia leiana* (KIRBY, 1802)								1															1
94	*Osmia rufa* LINNAEUS, 1758)	1455	1	18				13													1			1488
95	*Osmia uncinata* GERSTAECKER, 1869			2																				2
96	*Megachile alpicola* ALFKEN, 1924														1					2				3
97	*Megachile apicalis* SPINOLA, 1808									1														1
98	*Megachile centuncularis* (LINNAEUS, 1758)				1															1				2
99	*Megachile ligniseca* (KIRBY, 1802)	1			1		1								1		2		1				1	8
100	*Megachile maritima* (KIRBY, 1802)							2	2															4
101	*Megachile versicolor* SMITH, 1844	4					2																	6

		-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-	-24-	-25-
102	*Megachile willughbiella* (KIRBY, 1802)								2															2
103	*Coelioxys conoidea* (ILLIGER, 1806)								1															1
104	*Coelioxys elongata* LEPELETIER, 1841	1																						1
105	*Coelioxys rufescens* LEPELETIER, 1825																1							1
106	*Antophora bimaculata* (PANZER, 1798)				1	1		1	4										1				17**	25
107	*Anthophora furcata* (PANZER, 1798)		1		2		1																	4
108	*Anthophora plumipes* (PALLAS, 1772)							3																3
109	*Ceratina cyanea* (KIRBY, 1802,)			1																				1
110	*Nomada armata* ? HERRI.-SCHÄF, 1839																					6		6
111	*Nomada bifasciata* OLIVIER, 1811			1														1						2
112	Nomada *fabriciana* LINNAEUS,1767	1			1			3																5
113	*Nomada flavoguttata* (KIRBY, 1802)		8	2																				10
114	*Nomada ferruginata* (LINNAEUS, 1767)			4				1																5
115	*Nomada flava* PANZER, 1798			1																				1
116	*Nomada flavopicta* (KIRBY, 1802)	1						3	1	1					1	1	1			1		7		17
117	*Nomada fulvicornis* FABRICIUS 1793							4	1															5
118	*Nomada lathburiana* (KIRBY, 1802)			1														6						7
119	*Nomada moeschleri* ALFKEN, 1913	1		1																				2
120	*Nomada panzeri* LEPELETIER, 1841	2	4	49																				55

		-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-	-24-	-25-
121	*Nomada ruficornis* (LINNAEUS, 1758)	3	1	2				1																7
122	*Nomada roberjeotiana* PANZER, 1799							8	6	1										1				16
123	*Nomada similis* MORAWITZ 1872							3																3
124	*Nomada succincta* PANZER, 1798			1																				1
125	*Nomada zonata* PANZER, 1798	1																						1
126	*Epeolus cruciger* (PANZER, 1799)					1		4															1	6
127	*Epeolus verigatus* (LINAEUS, 1758)							9		2														11
128	*Epeoloides coecutiens* (FABRICIUS, 1775)																			1				1
129	*Bombus cryptarum* FABRICIUS, 1775	1	5	4			1	2					2			1	2						4	22
130	*Bombus hortorum* (LINNAEUS, 1761						1									2			1	2				6
131	*Bombus humilis* ILLIGER, 1806																						1	1
132	*Bombus hypnorum* (LINNAEUS, 1758)	1	3	4	2					1	2				1									14
133	*Bombus jonellus* (KIRBY, 1802)			1				1									1							3
134	*Bombus lapidarius* (LINNAEUS, 1758			1	5		1			1					1	4		1		2			2	18
135	*Bombus lucorum* (LINNAEUS, 1761)	23	64	173	14	1	5	4	1	15	22			2	1	13	3						1	342
136	*Bombus magnus* VOGT, 1911	1	3	6			4		1							1								16
137	*Bombus muscorum* (LINNAEUS,. 1758)						1																	1
138	*Bombus pascuorum* (SCOPOLI, 1763)	6	3	32	5		5	4	3	2	1					4	2		3	1	2			73

		-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-	-24-	-25-
139	*Bombus pratorum* (LINNAEUS, 1761)		11	77	7			1			2										2	1		101
140	*Bombus ruderarius* (MÜLLER, 1776)							2	1				3	2	3	9	1		4	4		2		31
141	*Bombus ruderatus* (FABRICIUS, 1775)				1																			1
142	*Bombus schrencki* (MORAWITZ, 1881)			2			1								1	1								5
143	*Bombus soroeensis* (FABRICIUS, 1776)																						1	1
144	*Bombus subterraneus* (LINNAEUS, 1758)			2			1																	3
145	*Bombus sylvarum* (LINNAEUS,1761)						1					1			1	4			2	1				10
146	*Bombus terrestris* (L.,1758)	1	3	4		1	2	2	1			2	2		4	6		2	3	1	2		1	37
147	*Bombus veteranus* (FABRICIUS, 1793)											1												1
148	*Psithyrus bohemicus* (SEIDL, 1838)	7	5	67		2	6	2		2					7	1	4	2	1					108
149	*Psithyrus campestris* (PANZER, 1801)		1		1		1	1							1		2							7
150	*Psithyrus norvegicus* SPARRE-SCHN., 1918		1	4				1																6
151	*Psithyrus rupestris* (FABRICIUS, 1793)	2		2	1			1									3		1					10
152	*Psithyrus sylvestris* LEPELETIER, 1832		3	23	1																			27
153	*Apis mellifera* LINNAEUS, 1758	37	1	2				4	1												1			46
	Number of indyviduals	1852	223	1289	111	43	36	250	82	56	25	14	27	11	70	87	34	30	46	38	47	44	46	4461
	Number of species	67	29	61	36	19	18	67	30	18	4	10	9	9	27	23	17	13	20	20	15	17	17	

* for one season, bees were caught in Moericke traps also in alluvial forest on the river Krutynia. ** *Antophora bimaculata*: on that site, exceptionally high abundance of this species was observed. Thus the number of individuals caught with the sweep net does not reflect its true abundance.