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**: 55-76 Bydgoszcz 30 March 2010

Bees of the Wolin National 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. Communities of bees (Apiformes) were studied in the Wolin National Park in 2002-2003. The Park is located on the island of Wolin in northwestern Poland, at the southern coast of the Baltic Sea. In total, 133 bee species were recorded there in various habitats. This study shows that the major role in protection of bee communities is played by xerothermic and sandy grasslands. They are distinguished by the highest species diversity of Apiformes, including *Anthophora bimaculata* and its nest parasite *Ammobates punctatus* (rare in mainland Poland). In contrast, coastal grey dunes support mostly bumblebees, including cuckoo bumblebees.

KEY WORDS: wild bees, Apiformes, Wolin National Park, diversity, ecology, dominance structure, xerothermic grassland, dune, cliff.

INTRODUCTION

The Wolin National Park is situated at the mouth of the river Oder (Odra), on the island of Wolin, near the German border in northwestern Poland (Fig. 1). The area is part of the coastal region of the Baltic Sea. The Park was established in 1960, to preserve the landscape shaped by the last glaciation in an area of 109.37 km^2. However, the Park includes also sea waters of the Pomeranian Bay (Zatoka Pomorska) and internal waters of the Szczecin Lagoon (Zalew Szczeciński), and thanks to this the Wolin National Park has gained the status of the first Polish marine park. It is noteworthy that Poland was the first country to implement the recommendations of the Helsinki Convention, aimed at creating a

system for protection of the marine environment of the Baltic Sea region, i.e. Baltic Sea Protected Areas (BSPAs) (JAKUCZUN 1996).

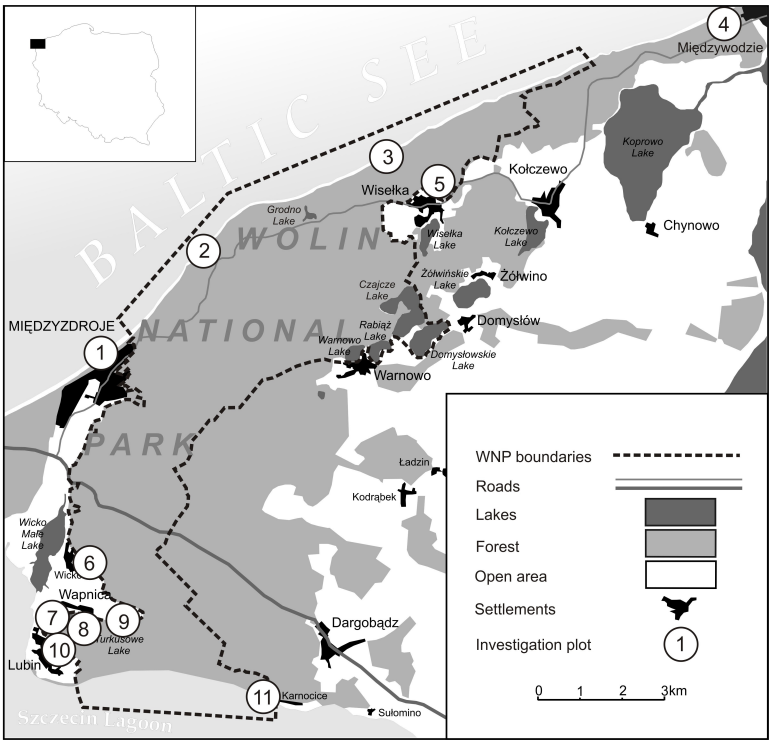

Fig. 1. Map of the Wolin National Park and distribution of research plots: 1 – Międzyzdroje; 2 – Gosań Hill; 3 – Wisełka, coastal dunes; 4 – Międzywodzie; 5 – Wisełka, village; 6 – Wicko; 7 – Wapnica, Lake Turkusowe; 8 – Trzciągowo, dry grassland; 9 – Trzciągowo, beech-oak forest with pine; 10 – Lubin; 11 – Karnocice.

A characteristic feature of the park is the very high sandy cliff coast, whose steep slopes are up to 90 m high. Much if the Park is covered by forests (ca. 45 km^2), mostly pine, beech-pine, and pure beech forests. The dominant forest site types according to the classification used by Polish foresters are: fresh mixed broadleaved forest and fresh mixed coniferous forest (DYLAWERSKA 2001).

In 1973, a preliminary report on Apiformes in the park was published on the basis of specimens collected in 1969-1970 (BANASZAK 1973). Those data were also mentioned in a report concerning the whole Polish coast of the Baltic Sea (BANASZAK 1982). Earlier studies of Apiformes in the vicinity of the study area were conducted by BLÜTHGEN (1919,

1920, 1942). He listed in his articles only about a dozen bee species from Międzywodzie (Heidebrink), located in northeastern part of the island. It must be noted that an article by BERESZYŃSKI et al. (2000), concerned with the whole fauna of the Wolin National Park, is based on those publications but contains some errors, i.e. a wrong number of known bee species and an inexistent name *Bombus muralis*.

My first report, mentioned above, was only preliminary, so in the present study more detailed field research on bee communities was conducted in 2002 and 2003. A larger number of sites were investigated then, and as a result the earlier list of 75 species was greatly expanded.

Acknowledgements

I would like to express my thanks to the former Deputy Director of the Wolin National Park, Dr Bogdan JAKUCZUN, who allowed me to undertake this study, provided me with information about the topography and wildlife of the Park, and with selected weather data from the weather station in Warnowo. I am also grateful to the former Park Ranger, Mr Tertalian DRYL, who took care of the Moericke traps located in the Trzciągowo Valley.

STUDY AREA AND METHODS

Study area

The postglacial landscape of the island is highly variable in terms of relief. Altitudes range from 0 to 115 m. Characteristic and dominant landforms are morainic hills, which cover ca. 75% of the postglacial area of the Park. In the north, they form steep sandy cliffs along the open sea coast (Fig. 2), while in the south, they slope down to the Szczecin Lagoon (Jakuczun 1996). The open sea coast with high cliffs is ca. 14 km long and up to 95 m high. Due to storms, it retreats at a rate of about 80 cm a year. In the wooded part of the island, near the village of Warnowo, 4 postglacial lakes are located: Warnowskie, Rabiąż, Czajcze, and Domysławskie. Near the village of Wapnica, in a former chalk quarry, Lake Turkusowe is situated.

Forest ecosystems account for over 41% of the area of the Park. They include 15 types of forest and shrub communities, mostly beech forests (*Luzulo-Fagetum*), acidophilous mixed oak forests (*Fago-Quercetum* and *Betulo-Quercetum*) and Subatlantic fresh pine forests (*Leucobryo-Pinetum*). Other communities are represented by small fragmented patches (PIOTROWSKA et al. 2000). No detailed research was conducted in forests, except edges of some of them, as shown in the list of sites below.

In contrast to woodlands, open habitats occupy a relatively small proportion of the Park, but they are the major sites visited by pollinating insects. Open habitats are found mostly at the edges of the Park, i.e. on cliffs of the open sea coast and of the Szczecin La-

goon, in the Trzciągowo Valley, and near Lake Domysławskie (MARKOWSKI et al. 2000). Those sites are refugia of many thermophilous plant species, and thus are favourable for Apiformes, providing them with nesting sites and rich sources of pollen and nectar. Most interesting in this respect are thickets of *Hippophaë rhamnoides*, grasslands of the phytosociological alliance *Koelerion albescentis*, as well as pioneer or thermophilous shrub communities of the class *Prunetalia* (SW part of the Park) on cliffs of the open sea coast, and thermophilous grasslands of the class *Festuco-Sedetalia*, distributed particularly in the Trzciągowo Valley, whose vicinity was explored most thoroughly.

Methods

Field research was conducted in 2002 (20 July-3 August) and 2003 (12-16 May and 1-7 July). Material was collected mostly with a sweep net (by searching on flowers and in favourite nesting sites of bees) Additionally, from mid-May to August 2003, bees were caught in Moericke traps (white pans with fluid) located at 2 sites (with 5 traps each) in Wapnica: on xerothermic grassland (plot 8) and in Pomeranian beech-oak forest with Scots pine (plot 9). Material from traps was collected every 7-10 days.

Characteristics of research plots (Fig. 1)

1. Międzyzdroje (12-14 May 2003) – bees were collected at various sites, i.e. in the park with saltwater springs, in gardens near houses, and on the beach.
2. Gosań Hill (1 Aug 2008) – cliff of the open sea coast. Among bee forage plants, *Trifolium arvense* was visited most often.
3. Wisełka, coastal dunes (2, 7 Jul 2003) – the best-developed dune belt in the Park, with grey dunes covered by communities characteristic of sandy grassland (*Helichryso-Jasionetum*). Bees were collected mostly from flowers of *Rubus* sp., *Rosa rugosa* and *Anchusa officinalis*.
4. Międzywodzie (21, 24, 25 Jul 2002) – wasteland (ruderal site) and emergent vegetation along the Kamień Bay, with abundantly flowering *Melilotus officinalis*, *M. alba*, *Echium vulgare,* yellow-flowered medic (*Medicago lupulina?*), *Cirsium arvense*, and various Apiaceae. Bees were caught also on coastal dunes (grey dune), e.g. on *Eryngium maritimum*.
5. Wisełka – village and its vicinity. Apiformes were caught on several sites:

- edge of pine forest near a road (21 Jul 2002) – bees numerous on flowers of *Thymus* sp. and *Vicia* sp.;
- xerothermic grassland near Lake Zatorek (21 Jul 2002) – abundantly flowering *Centaurea scabiosa* and *Tanacetum vulgare*;
- dry grassland at the edge of pine forest (2 Aug 2002) – on *Cichorium intybus*, *Centaurea scabiosa*, and *Ballota nigra*;
- shrub communities and ruderal sites (15 May 2003) – with flowering apple trees and *Lonicera periclymenum*;

- grey dune (2,7 Jul 2003) – on *Rubus* sp., *Rosa rugosa*, and *Anchusa officinalis*;
- wastelands (3 Jul 2003) – with large patches of *Jasione montana, Senecio jacobaea*, *Epilobium angustifolium, Leontodon* sp., and *Anthemis tinctoria*;
- village, Warszawska Street (2,7 Jul 2003) – with lime trees on one each side of the street flowering abundantly.

6. Wicko (29 Jul 2002) – southern slopes of moraines in the Trzciągowo Valley, covered with sandy and xerothermic grassland (Fig. 3). Major bee forage plants: *Taraxacum officinale*, *Senecio vernalis*, *Ononis spinosa*, *Helichrysum arenarium*, *Centaurea rhenana*, *Melilotus officinalis*, *M. alba.*
7. Wapnica (27 Jul 2002, 16 May 2003) – xerothermic grassland, on slopes of Lake Turkusowe (Fig. 4). Major bee forage plants: *Senecio vernalis*, *Crataegus* sp., *Helichrysum arenarium*, *Centaurea rhenana*, *Berteroa incana.*
8. Trzciągowo (31 Jul 2002, 14, 16 May 2003) – xerothermic grassland, on a slope of a former chalk quarry (Fig. 5). From May to August 2003, bees were caught also in Moericke traps (5 white pans). Major bee forage plants: *Centaurea rhenana*, *C. scabiosa*, *Malva* sp., *Senecio jacobaea*, *Anchusa officinalis*, *Hieracium pilosella.*
9. Trzciągowo – Pomeranian beech-oak forest with Scots pine (*Fago-Quercetum*) in forest section 131b (Fig. 6), from May to August 2003, bees were caught in Moericke traps (5 white pans). Major bee forage plant: *Vaccinium myrtillus*.
10. Lubin, mostly Zielonka Hill (28 Jul 2002, 12 May 2003) – xerothermic grassland and inland dune. Major bee forage plants: *Helichrysum arenarium*, *Centaurea rhenana*, *Berteroa incana*, *Jasione montana*, *Sonchus* sp.
11. Karnocice near the Szczecin Lagoon (30 Jul 2002) – xerothermic grassland, at the edge of pine forest. Major bee forage plants: *Veronica spicata*, *Centaurea rhenana, Jasione montana, Ballota nigra*.

Fig. 2. Cliff along the open sea coast (Photo by B. JAKUCZYN).

Fig. 3. Wicko – slopes of the Trzciągowo Valley (Photo by J. BANASZAK).

Fig. 4. Wapnica – xerothermic grassland on slopes of Lake Turkusowe (Photo by J. BANASZAK).

Fig. 5. Trzciągowo – xerothermic grassland (Photo by J. BANASZAK).

Fig. 6. Trzciągowo – beech-oak forest with pine (Photo by J. BANASZAK).

RESULTS

Species diversity and dominance structure

This work is based on a total of 1538 collected bees. They belong to 133 species (Table 1), which make up 28.0% of the Polish bee fauna. Honey bees were observed at all the studied sites, but they were not caught. Only 33 individuals of this species were found in traps on the dry grassland in Trzciągowo.

Contributions of individual bee families to bee diversity in the Park were compared with their mean contributions in Poland (Fig. 7). The largest difference can be noticed for the Apidae, which constitute 16.5% of all bee species in the Park, i.e. about twice as high than generally in Poland. In contrast, contributions of the Megachilidae and ex-Anthophoridae were lower than generally in Poland. No substantial differences were noticed in contributions of other families.

The most abundant species was *Bombus lucorum*, which accounted for 16.7% of the total catch (Fig. 8), while *Evylaeus morio* for 13.1% and *Andrena flavipes* for 8.6%. Those species are common all over Poland. In the Park, their largest numbers (120-198 individuals) where caught in traps at the same site, on xerothermic grassland in Trzciągowo. This is not surprising for *Andrena flavipes* and *Evylaeus morio*, which are associated with open habitats, although *E. morio* was less abundant at the other sites. In contrast, the high abundance of *B. lucorum* (regarded as a typical forest species) can be explained by the immediate vicinity of pine forest, as that grassland, with numerous bee forage plants, is located at the forest edge.

It is interesting that large numbers of dead or dying bumblebees were observed in the village of Wisełka in Warszawska Street, under the canopy of flowering *Tilia cordata*. On 7 Jul 2003, on the pavement and the road, within a belt about 350 m long and 1.0-1.5 m wide, I found 200 bumblebees, many of them crushed by pedestrians and vehicles. I collected 47 less damaged or live specimens for closer examination. They were identified as *Bombus lucorum*, *B. terrestris*, *B. pratorum*, *B. pascuorum*, *B. lapidarius*, and *Psithyrus quadricolor*. This phenomenon was most probably due to low temperature and rain. Weather data show that on 3-7 July, minimum temperature was about 14°C and it was raining, particularly on 4-5 July but also on 6 July. The bumblebees were "paralysed" by cold and moisture, so they fell down from trees, unable to return to their nests or stay so long on the delicate lime flowers. A similar phenomenon was observed in the Ojców National Park, at a similar temperature (DYLEWSKA & WIŚNIOWSKI 2001). Bumblebees, like other social Aculeata, leave their nests at relatively low temperatures, hence they are particularly prone to the negative effects of low temperature and rain. In that situation, solitary species did not suffer from their effects (no dead specimens were observed), because they leave their nests at much higher temperatures.

Table 1. List of species and number of individuals of Apiformes fauna at the studies sites in the Wolin National Park.

No	Species	BANASZAK 1973	Unpublished data 2002-2003											
			Międzyzdroje	Gosań Hill - cliff	Wiselka - coastal dunes	Międzywodzie	Wiselka - village	Wicko – southern slopes	Wapnica Lake Turkusowe	Trzciągowo – dry grassland	Trzciągowo – forest	Lubin – Zielonka Hill	Karnocice	Total
			-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
1	*Colletes cunicularius* (LINNAEUS, 1761)	+	1						2			10		13
2	*Colletes daviesanus* SMITH, 1846	+				5	40			2		2		49
3	*Colletes fodiens* (FOURCROY, 1785)	+					1	1	10	2		3	1	18
4	*Colletes similis* SCHENCK, 1853									1				1
5	*Colletes succinctus* (LINNAEUS, 1758)	+												
6	*Hylaeus angustatus* (SCHENCK, 1859)						1							1
7	*Hylaeus annularis* (KIRBY, 1802)								1					1
8	*Hylaeus communis* NYLANDER, 1852									3			2	5
9	*Hylaeus difformis* (EVERSMANN, 1852)	+												
10	*Hylaeus gibbus* SAUNDERS, 1850												1	1
11	*Hylaeus gredleri* FÖRSTER, 1871									1				1
12	*Hylaeus hyalinatus* SMITH, 1842												1	1
13	*Hylaeus pictipes* NYLANDER, 1852								1					1

			-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
14	*Andrena barbilabris* (KIRBY, 1802)						1		2			1		4
15	*Andrena bicolor* FABRICIUS, 1775						1							1
16	*Andrena bimaculata* (KIRBY, 1802)	+					1							1
17	*Andrena denticulata* (KIRBY, 1802)								1					1
18	*Andrena dorsata* (KIRBY, 1802)					4								4
19	*Andrena flavipes* PANZER, 1799	+	1			1	1	5	1	120	2	1		132
20	*Andrena fulva* (MÜLLER, 1766)	+	1				2			2				5
21	*Andrena fulvida* SCHENCK, 1853	+												
22	*Andrena fuscipes* (KIRBY, 1802)	+												
23	*Andrena gravida* IMHOFF, 1899	+						3		4				7
24	*Andrena haemorrhoa* (FABRICIUS, 1781)	+	6					6		12	2			26
25	*Andrena helvola* (LINNAEUS, 1758)							1						1
26	*Andrena humilis* IMHOFF, 1832										1	9		10
27	*Andrena jacobi* PERKINS, 1921							3		4	1			8
28	*Andrena labialis* (KIRBY, 1802)	+							1				1	2
29	*Andrena labiata* FABRICIUS, 1781	+						1						1
30	*Andrena nigriceps* (KIRBY, 1802)	+												
31	*Andrena nigroaenea* (KIRBY, 1802)	+							1					1
32	*Andrena nitida* (MÜLLER, 1776)	+	12					1		12				14
33	*Andrena ovatula* (KIRBY, 1802)	+						2				1		3
34	*Andrena pilipes* NOSKIEWICZ, 1924	+												
35	*Andrena subopaca* NYLANDER, 1848	+								5				5
36	*Andrena tibialis* (KIRBY, 1802)							1					1	2

			-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
37	*Andrena vaga* PANZER, 1799									1				1
38	*Andrena varians* (ROSSI, 1781)	+												
39	*Andrena wilkella* (KIRBY, 1802)	+								2				2
40	*Andrena* sp.								1					1
41	*Halictus quadricinctus* (FABRICIUS, 1776)									4				4
42	*Halictus rubicundus* (CHRIST, 1791)	+								1				1
43	*Halictus sexcinctus* (FABRICIUS, 1775)					1	26			13		1		41
44	*Seladonia confusa* (SMITH, 1853)	+						3						3
45	*Seladonia subaurata* (ROSSI, 1792)	+												
46	*Seladonia tumulorum* (LINNAEUS, 1758)	+				1		3	1	12			1	18
47	*Lasioglossum lativentre* (SCHENCK, 1853)						1							1
48	*Lasioglossum leucozonium* (SCHRANK 1792)						3			5		2	1	11
49	*Lasioglossum quadrinotatum* (SMITH, 1848)			1										1
50	*Lasioglossum sexnotatum* (KIRBY, 1802)		1				6			1	1			9
51	*Lasioglossum subfasciatum* (IMHOFF, 1832)			2			5							7
52	*Lasioglossum xanthopus* (KIRBY, 1802)	+												
53	*Lasioglossum zonulum* (SMITH, 1848)	+												
54	*Evylaeus albipes* (FABRICIUS, 1781)	+												
55	*Evylaeus calceatus* (SCOPOLI, 1763)	+					1	3	1	20		3	2	30
56	*Evylaeus laticeps* (SCHENCK, 1868)							1						1
57	*Evylaeus leucopus* (KIRBY, 1802)		1							2				3
58	*Evylaeus lucidulus* (SCHENCK, 1861)							2	2					4
59	*Evylaeus morio* (FABRICIUS, 1793)	+								198	2	2		202

			-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
60	*Evylaeus nitidulus* (FABRICIUS, 1804)	+								2				2
61	*Evylaeus parvulus* (SCHENCK, 1853)												8	8
62	*Evylaeus pauxillus* (SCHENCK, 1853)		1				2	5		29	1		1	39
63	*Evylaeus quadrinotatulus* (SCHENCK, 1861)							1						1
64	*Evylaeus sexstrigatus* (SCHENCK, 1868)									1				1
65	*Evylaeus villosulus* (KIRBY, 1802)					1				1		1		3
66	*Sphecodes albilabris* (FABRICIUS, 1793)	+						9	4			3		16
67	*Sphecodes crassus* THOMSON, 1870							2	1					3
68	*Sphecodes ephippius* (LINNAEUS, 1767)								1	3				4
69	*Sphecodes monilicornis* (KIRBY, 1802)							1	2					3
70	*Sphecodes pellucidus* SMITH, 1845	+						1				2		3
71	*Melitta leporina* (PANZER, 1799)	+					2	3						5
72	*Macropis europaea* WARNCKE, 1973	+				5	1	1						7
73	*Macropis fulvipes* (FABRICIUS, 1804)					1								1
74	*Dasypoda hirtipes* (HARRIS, 1780)					2	9	3	1			7		22
75	*Anthidium manicatum* (LINNAEUS, 1758)	+				5		3		1				9
76	*Anthidiellum strigatum* (PANZER, 1805)					4	2							6
77	*Stelis punctulatissima* (KIRBY, 1802)	+				1								1
78	*Heriades crenulatus* NYLANDER, 1856									1				1
79	*Heriades truncorum* (LINNAEUS, 1758)	+	1			2	1		11	3		4		22
80	*Chelostoma rapunculi* (LEPELETIER, 1841)										1			1
81	*Hoplitis adunca* (PANZER, 1798)	+							1	2				3

			-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
82	*Hoplitis leucomelana* (KIRBY, 1802)								1					1
83	*Osmia fulviventris* (PANZER, 1798)									1				1
84	*Osmia leaiana* (KIRBY, 1802)									1		1		2
85	*Osmia rufa* (LINNAEUS, 1758)	+	1				1	2		1				5
86	*Chalicodoma ericetorum* (LEPELETIER, 1841)					1								1
87	*Megachile centuncularis* (LINNAEUS, 1758)	+				1		1						2
88	*Megachile circumcincta* (KIRBY, 1802)											1		1
89	*Megachile leachella* CURTIS, 1828	+				1		3	1				1	6
90	*Megachile maritima* (KIRBY, 1802)	+						1						1
91	*Megachile versicolor* SMITH, 1844											1		1
92	*Megachile willughbiella* (KIRBY, 1802)	+		2		8								10
93	*Coelioxys conoidea* (ILLIGER, 1806)							1	1					2
94	*Coelioxys mandibularis* NYLANDER, 1848								1					1
95	*Coelioxys quadridentata* (LINNAEUS, 1758)	+												
96	*Anthophora bimaculata* (PANZER, 1798)	+						3	3	4		9	9	28
97	*Anthophora plagiata* (ILLIGER, 1806)	+												
98	*Anthophora plumipes* (PALLAS, 1772)	+	1							2				3
99	*Anthophora retusa* (LINNAEUS, 1758)	+												
100	*Melecta albifrons* (FÖRSTER, 1771)	+												
101	*Nomada alboguttata* HERRICH-SCHÄFFER, 1839	+												
102	*Nomada fucata* PANZER, 1798	+						3						3
103	*Nomada goodeniana* (KIRBY, 1802)	+												

			-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
104	*Nomada lathburiana* (KIRBY, 1802)	+						1						1
105	*Nomada marshamella* (KIRBY, 1802)							5						5
106	*Nomada ruficornis* (LINNAEUS, 1758)							1						1
107	*Nomada stigma* FABRICIUS, 1804	+												
108	*Ammobates punctatus* (FABRICIUS, 1804)											4		4
109	*Epoloides coecutiens* (FABRICIUS, 1775)					1								1
110	*Epeolus variegatus* (LINNAEUS, 1758)	+						2	3				1	6
111	*Ceratina cyanea* (KIRBY, 1802)	+							3					3
112	*Bombus cryptarum* FABRICIUS, 1775									1	2			3
113	*Bombus distinguendus* MORAWITZ, 1869	+												
114	*Bombus hortorum* (LINNAEUS, 1761)					1	1					1	1	4
115	*Bombus hypnorum* (LINNAEUS, 1758)	+			1									1
116	*Bombus jonellus* (KIRBY, 1802)	+												
117	*Bombus lapidarius* (LINNAEUS, 1758)	+		1	2	7	11	2		1	1	1	3	29
118	*Bombus lucorum* (LINNAEUS, 1761)	+		4	10	9	35	2	1	167	21	5	2	256
119	*Bombus muscorum* (LINNAEUS, 1758)	+						3						3
120	*Bombus pascuorum* (SCOPOLI, 1763)	+	2	6	3	7	5			3	1	3	2	32
121	*Bombus pratorum* (LINNAEUS, 1761)	+	1		15		11			12	7			46
122	*Bombus ruderarius* (MÜLLER, 1776)	+					2			1				3
123	*Bombus subterraneus* (LINNAEUS, 1758)	+												
124	*Bombus sylvarum* (LINNAEUS, 1761)	+												
125	*Bombus terrestris* (LINNAEUS, 1758)	+	1	1	3	10	20	4		20	1	1	1	62

			-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
126	*Bombus veteranus* (FABRICIUS, 1793)	+					1							1
127	*Psithyrus bohemicus* (SEIDL, 1837)	+		2	3	21	32			12	8	1	3	82
128	*Psithyrus campestris* (PANZER, 1801)					1	8	1					1	11
129	*Psithyrus quadricolor* LEPELETIER, 1832	+			14		2			2	7			25
130	*Psithyrus rupestris* (FABRICIUS, 1793)	+		10		3	10		2				4	29
131	*Psithyrus sylvestris* LEPELETIER, 1832				1		3			2	2			8
132	*Psithyrus vestalis* (GEOFFROY in FOURCROY, 1785)	+												
133	*Apis mellifera* LINNAEUS, 1758	+	+	+	+	+	+	+	+	33	+	+	+	33
	Number of individuals		20	29	52	104	249	100	62	733	61	80	48	1538
	Number of species	76	15	10	10	27	35	42	30	48	18	28	23	133

The large numbers of *Evylaeus morio* enabled an analysis of its seasonal dynamics during the growing season. Earlier research conducted in Poland indicates that both sexes are active throughout the season, but the proportion of males increases in late summer and autumn, while females are most abundant in early May and mid-July (PESENKO et al. 2000). Data from Wolin confirm the long flight season of this species (May-August), but most of the caught individuals were females (199 out of the total catch of 202). The curve plotted on the basis of the collected material (Fig. 9) shows an increasing trend, reaching a peak in early July. This peak is followed by a rapid decline in abundance, most probably due to rainy weather. In the curve from Wolin, no spring peak is visible, probably because the trapping was started too late.

Apart from the group of dominant species, quite many species in the Park were characterized by a high constancy, i.e. were found at many sites, which means that they had lower environmental requirements. Out of the 12 studied plots, at least 6 plots were visited by the following bee species, so they can be regarded as characteristic for the study area: *Colletes fodiens*, *Seladonia tumulorum*, *Evylaeus calceatus*, *E. pauxillus*, *Dasypoda hirtipes*, *Heriades truncorum*, *Anthophora bimaculata*, *Bombus lapidarius*, *B. pascuorum*, *B. pratorum*, and *B. terrestris*.

Some bees with specific environmental requirements sometimes formed large colonies, but only small numbers of them were caught. This applies to *Colletes cunicularius*, and its parasite, *Sphecodes albilabris* (large colonies nesting on sands, Lubin, Międzyzdroje), *Andrena vaga*, *Dasypoda hirtipes*, or *Andrena fulva* associated with woody vegetation (e.g. the park in Międzyzdroje).

A large group composed of 57 species (42.8%), are rare bees, represented by 1-3 individuals. It is difficult to explain the absence or small contributions of some bumblebee species that are frequent or common in other parts of Poland, e.g. *Bombus ruderarius* or *B. veteranus*. No specimens of *B. sylvarum*, *B. subterraneus*, *B. jonellus* and *B. distinguendus* were caught. Also *B. muscorum* was represented by single specimens, but it has recently become infrequent also in other parts of the country. Similarly, some species from other families, recorded earlier in the Park, were not caught during this study, e.g. *Colletes succinctus*, *Hylaeus difformis*, *Andrena fulvida*, *A. fuscipes*, *A. nigricepes*, *A. pilipes*, *A. varians*, *Seladonia sabaurata*, *Lasioglossum xanthopus*, *L. zonulum*, *Evylaeus. albipes*, *Nomada goodeniana*, *N. stigma*, and *Anthophora retusa*. The same applies to *Anthophora plagiata*, and it must be stressed that although this species used to be common in some parts of the country, and formed large colonies on clay walls of old buildings, now it is one of the rarest species in Poland, classified in the red list as vulnerable (BANASZAK 2002, W.A. BANASZAK 2005).

Another species generally rare in Poland, but worthy of note, is the cleptoparasite *Ammobates punctatus*. Its presence is associated with nests of its host: *Anthophora bimaculata*. Widespread in southern and central Europe; in Poland rare (in spite of the common occurrence of the host species), but reported from various parts of the country. In Pomerania

listed by BLÜTHGEN (1942) from Szczecin. New record: Lubin, Zielonka Hill, 28 Jul 2002, 3♀♀, 1♂.

Hylaeus gredleri for a long time was not identified in Poland, but only recently reported by Celary (1999) from the Kraków-Częstochowa Upland in southern Poland. Since then, it has been recorded in various parts of the country. New record: Trzciągowo, xerothermic grassland, 31 Jul 2002, 1♀.

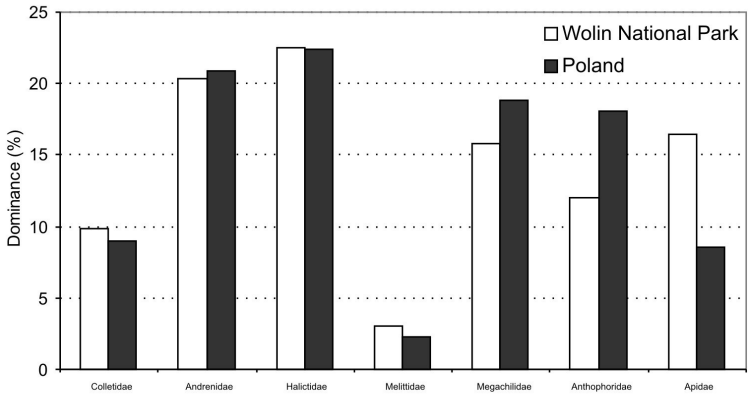

Fig. 7. Comparison of contributions of bee families among bees collected in the Wolin National Park and generally in Poland.

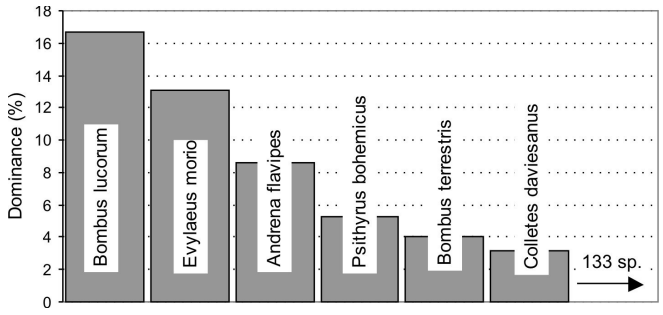

Fig. 8. Dominance structure of bees in the Wolin National Park.

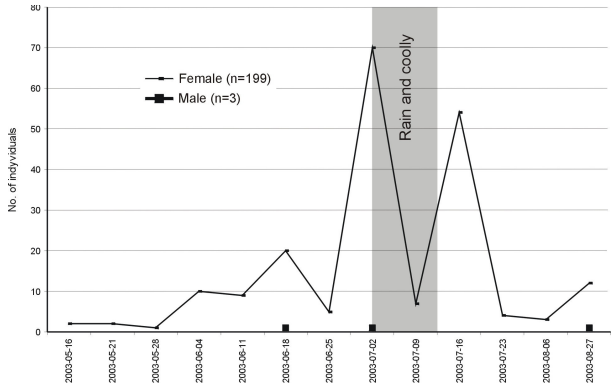

Fig. 9. Seasonal variation in abundance of *Evylaeus morio* on xerothermic grassland in Trzciągowo.

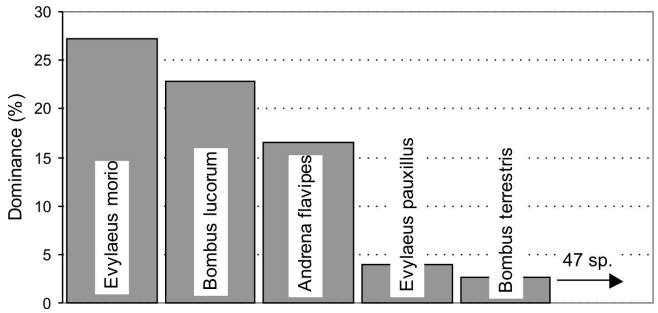

Fig. 10. Dominance structure of bee communities on xerothermic grassland in Trzciągowo (Moericke traps).

Characteristics of bee communities in the studied habitats

The major objective of this study was to supplement the list of species recorded earlier in the study area. It was not possible to carry out longer, more detailed ecological studies, e.g. with the use of Moericke traps in various habitats. Nevertheless, the collected data enable preliminary description of bee communities of some habitat types. These include mostly dry grasslands (xerothermic and sandy), and, to a very limited extent, cliffs (of the open sea coast and of the lagoon), dunes (grey), and beech-oak forest with Scots pine.

Xerothermic and sandy grasslands were relatively well studied, both thanks to direct penetration of several sites (plots 5, 6, 7, 8, 10, 11), and application of Moericke traps on xerothermic grassland in Trzciągowo, from May to August 2003 (plot 8). On the grassland

in Trzciągowo, 733 bees were caught, representing 48 species with 3 dominants: *Evylaeus morio*, *Andrena flavipes*, and *Bombus lucorum* (Fig. 10). In total, in the studied grasslands, 93 bee species were recorded, which account for 70% of the total number of species of Apiformes in the study area. Generally it can be concluded that Apiformes in the Park are dominated by bees that colonize grasslands: xerothermic and sandy. Both qualitatively and quantitatively, this group of species dominates on the slopes of the Trzciągowo Valley. Their southern aspect and high carbonate content in some parts are the major reasons of the large contributions of xero- and thermophilous plants (*Koeleria glauca*, *Silene otites*, *Dianthus carthusianorum*), including many bee forage plant species. Species typical of these habitats, besides the dominant *Evylaeus morio* and *Andrena flavipes*, include also the relatively abundant *Colletes cunicularius, Evylaeus calceatus*, *E. pauxillus*, *Anthophora bimaculata*, *Andrena vaga*, *A. nitida, Dasypoda hirtipes*, etc.

Cliffs of the open sea. It is difficult to compare this habitat with sunny grasslands in the Trzciągowo Valley, both qualitatively and quantitatively, because cliffs are much poorer, although also visited by bees. These habitats are mostly their foraging sites, rather than nesting sites, because of frequent sliding of the sandy slopes. The slopes are partly overgrown by patches of *Hippophaë rhamnoides*, and, to a lesser extent, by herbaceous vegetation. *Trifolium arvense* was visited by pollinating insects most often. Among the bees on cliffs, bumblebees (including cuckoo bumblebees) were caught most often; in total, 10 bee species were recorded on the cliff of Gosań Hill (Table 1).

Coastal dunes. Mostly grey dunes were studied, in the villages Wisełka and Międzywodzie (plot 3, 4). On plants typical of dunes, e.g. *Eryngium maritimum*, *Rosa rugosa*, *Rubus* sp., or on *Anchusa officinalis*, nearly exclusively bumblebees (including cuckoo bumblebees) were collected (Table 1).

Pomeranian beech-oak forest with Scots pine. At this site a relatively small number of bees were caught, in spite of the use of Moericke traps in 2003. In total, 61 bees were caught of 18 species, mostly bumblebees, with the dominant *Bombus lucorum.* Among forests of the Park, quite interesting is the open and dry beech-oak forest *Fago-Quercetum*, particularly its variant with Scots pine. Patches of *Vaccinium myrtillus* and *Calluna vulgaris*, found in the herb layer, are visited quite numerously by the late bee summer species. During my earlier study (BANASZAK 1973) I recorded there quite frequently *Colletes succinctus*, *Andrena fuscipes*, *Sphecodes albilabris*, *Psithyrus rupestris*, and *P. vestalis*.

DISCUSSION AND CONCLUSIONS

Although the Wolin National Park was established 50 years ago, its fauna is still poorly known. This applies particularly to insects, including Hymenoptera (BANASZAK et al. 2004, BERESZYŃSKI et al. 2000).

The present study provides information about as many as 110 species. If we add 23 species recorded earlier (BANASZAK 1973), although not detected in the present study, the total reaches 133 species. This number is comparable with the number of bee species in, for example, the Drawa NP, Bory Tucholskie NP, or Narew NP (Table 2).

Table 2. Comparison of numbers of bee species recorded in selected Polish lowland national parks and in the Wolin National Park.

Park	Area (ha)	Forest area (%)	No. of bee species	% of Polish fauna	References
Bory Tucholskie NP	4798	79.0	101	21.1	BANASZAK & WENDZONKA 2002
Drawa NP	11342	82.0	121	25.5	BANASZAK et al. 2009
Narew NP	7350	12.0	125	26.4	BANASZAK 2006
Wolin NP.	10937	41.0	133	28.0	BANASZAK 2010
Masurian LP.	53665	50.0	153	32.6	BANASZAK 2010
Białowieża NP.	10517	96.0	181	30.6	BANASZAK & JAROSZEWICZ 2009
Wigry NP.	15085	62.7	191	40.7	BANASZAK & KRZYSZTOFIAK 1996
Wielkopolski NP.	7620	58.3	226	48.2	BANASZAK 1987 BANASZAK & CIERZNIAK 1994 CIERZNIAK 2003

It should be noted, however, that the true number is probably higher, as the spring bee fauna has not been studied sufficiently (early spring in particular). This study was started as late as in mid-May. In the future, detailed research should be conducted in beech forests and other forest types, with the use of Moericke traps.

The currently known number of species of Apiformes from Wolin constitutes 48.7% of bees reported from Pomerania by BLÜTHGEN (1919, 1942). It is also interesting to compare it with the number of bee species recorded on East Frisian Islands, which were studied for many years by Prof. V. HAESELER. That author explored 11 islands on the North Sea and recorded there 152 bee species. It must be noted, however, that the landscape of these islands is dominated by sand dunes (HAESELER 2008).

It is surprising that as many as 23 species recorded in Wolin in the 1960s (BANASZAK 1973) were not found during the present study. Some of them could be overlooked, as they are extremely rare in Poland. This applies especially to *Anthophora retusa, Bombus distinguendus*, and *B. subterraneus.* However, it is difficult to explain the absence of *B. sylvarum*, although its abundance varies widely between regions and years. The same may apply to *B. jonellus*. To attempt finding *Anthophora plagiata* it is necessary to penetrate steep slopes along the Szczecin Lagoon, as well as remnants of old clay buildings.

Exploration of moors in autumn should enable confirmation of occurrence of *Andrena fuscipes* and *A. nigripes*, or *Colletes succinctus*. Field research in April should confirm the presence of *A. varians* and provide information about other early spring *Andrena* spp., which have not been recorded yet.

The bee fauna of the study area is characterized by a high contribution of Apidae. As many as 15 species of *Bombus* and 6 species of *Psithyrus* were recorded there, with the absolute dominance of *B. lucorum* and a high contribution of the nest parasite *P. bohemicus*. This results from the large contribution of forests in the Park and a rich food base at forest edges. The applied method of direct collection (sweep-netting on flowers and in their favourite nesting sites) is subjective and selective to some extent, but provides at least rough estimates of relative abundance, e.g. of the rarest and most abundant species.

This study shows that the major role in protection of bee communities is played by xerothermic and sandy grasslands, which are found mostly in the western part of the Park, on Lubin-Wolin Hills (Pagórki Lubińsko-Wapnickie). They are distinguished by the highest species diversity of Apiformes. The characteristic bee species of this area are *Anthophora bimaculata* and its nest parasite *Ammobates punctatus*, rare in mainland Poland. In contrast, coastal dunes (grey dunes in particular) are the least transformed by human activity and support mostly bumblebees.

REFERENCES

BANASZAK J. 1973. Pszczołowate (Apoidea) Wolińskiego Parku Narodowego. Bad. Fizjograf. Pol. Zach., 26, Ser. B-Biologia: 79-88.

BANASZAK J. 1982. Pszczoły (Hymenoptera, Apoidea) Polskiego Pobrzeża Bałtyku. Bad. Fizjograf. Pol. Zach., 33, Ser. C-Zoolgia: 7-38.

BANASZAK J. 1987. Pszczoły (Hymenoptera, Apoidea) wybranych zespołów roślinnych Wielkopolskiego Parku Narodowego. Bad. Fizjograf. Pol. Zach., 35, Ser. C-Zoolgia: 5-23.

BANASZAK J. 2002. Apoidea Pszczoły [in:] Red list of threatened animals in Poland, Z. GŁOWAINSKI ed., Instytut Akademii Nauk PAN, Kraków, 69-74pp.

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

BANASZAK J. 2010. Bees of the Masurian Landscape Park: diversity and ecology (Hymenoptera: Apoidea, Apiformes). Pol. Journ. Ent. **79**(1): 25-53.

BANASZAK J., CIERZNIAK T. 1994. Spatial and temporal differentiation of bees (Apoidea) in the forests of Wielkopolski National Park, Western Poland. Acta Univ. Lodz, Fol. Zool., **2**: 3-28.

BANASZAK J., JAROSZEWICZ B. 2009. Bees of the Białowieża National Park and adjacent areas, NE Poland (Hymenoptera: Apidea, Apiformes). Polish Entomol. Journ. **78**(4): 281-313.

BANASZAK J., KRZYSZTOFIAK A. 1996. The natural Wild resources (Hymenoptera: Apoidea) of the Wigry National Park. Polskie Pismo Entomol. **65**: 33-50.

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

BANASZK J., BUSZKO J., CZACHOROWSKI St., CZECHOWSKI W., HEBDA G., LIANA A., PAWŁOWSKI J., SZEPTYCKI A., TROJAN P., WĘGIEREK P. 2004. Przegląd badań inwentaryzacyjnych nad owadami w parkach narodowych Polski. Wiad. Entomol., 23 Supl. **2**: 5-56.

BANASZAK J., KRIGER R., CIERZNIAK T. 2009. Bees (Hymenoptera: Apoidea, Apiformes) of the Drawa National Park. Polish Entomol. Journ. **78**: 135-156.

BANASZAK W. A. 2005. What has caused the decline of the solitary bee *Anthophora plagiata* (ILLIGER, 1806) (Hymenoptera: Apidea) in the Wielkopolska-Kujawy Lowland in West Poland? Polskie Pismo Entomol. **74**: 157-185.

BERESZYŃSKI A., DYLAWERSKI M., JAKUCZUN B., JURCZYSZYN M., MACIOROWSKI G. 2000. Stan zachowania fauny Wolińskiego Parku Narodowego oraz perspektywy jej ochrony i restytucji. Klify, **4**: 171-184.

BLÜTHGEN P. 1919. Die Bienenfauna Pommerus. Stettin. Ent. Ztg., **80**: 65-131.

BLÜTHGEN P. 1920. Die Deutschen Arten Bienengattung Halictus Latr. D. Ent. Zeitschr., 1920/21: 81-132, 267-302.

BLÜTHGEN P. 1942. Die Bienenfauna Pommerens. (2. Nachtrag). **103**(1): 81-91.

CELARY W. 1999. New and rare species of the genus *Hylaeus* Fabricius, 1793 for the fauna of Poland (Hymenoptera: Apoidea: Colletidae). Acta zool. Cracov., **42**(2): 259-264.

CIERZNIAK T. 2003 Changes in the bee fauna (Apoidea) of the Wielkopolska National Park over the last half century. Fragm. Faun. **46**: 151-170.

DYLAWERSKA J. 2001. Woliński Park Narodowy, [in:] Polska Parki Narodowe, ed. D. CYRUL, Sport i Turystyka – Muza S.A, Warszawa, 304-317 pp.

DYLEWSKA M., WIŚNIOWSKI B. 2001. Pomór trzmieli *Bombus* Latr. i trzmielców *Psithyrus* Lep. Chrońmy Przyr. Ojcz., **57**(3) 122-126.

HAESELER V. 2008. Ameisen, Wespen and Bienen der Ostfriesischen Inseln (Hymenoptera: Aculeata). Schriftenreiche Nationalpark Niedersächsisches Watternmeer **11**: 299-312

JAKUCZUN B. 1996. Woliński Park Narodowy pierwszym polskim parkiem morskim. Klify, **3**: 175-182.

MARKOWSKI R., PIOTROWSKA H., FAŁTYNOWICZ W., SĄGIN P. 2000. Zróżnicowanie nieleśnych zbiorowisk roślinnych i wybrane problemy ich ochrony na obszarze morenowej części Wolińskiego Parku Narodowego. Klify, **4**: 149-155.

PESENKO Yu. A., BANASZAK J., RADCHENKO V.G., CIERZNIAK T. 2000. Bees of the family Halictidae (excluding Sphecodes) of Poland: taxonomy, ecology, bionomics. Wyd. Uczeln. WSP w Bydgoszczy, Bydgoszcz, 348 pp.

PIOTROWSKA H., FAŁTYNOWICZ W., MARKOWSKI R., SĄGIN P. 2000. Wybrane problemy ochrony ekosystemów leśnych. Klify, **4**: 157-164.

Received: December 01, 2009
Accepted: January 12, 2010