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The persistence of and changes in a bee fauna over the last century: case of Wielkopolska-Kujawy Lowland in western Poland (Hymenoptera: Apoidea, Apiformes)

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ABSTRACT. The bee (Apiformes) faunas inhabiting Wielkopolska-Kujawy Lowland, as described by Valentin TORKA in 1913, and about the year 2000 were assessed and compared with regard to species diversity, structure and abundance. A total of 317 species were found to live there at present, which proves the persistence of the fauna in a region subjected to most intensive and long-lasting economic pressures. Forty-one (11.4%) rare species were not registered in the area of study, but were found in adjacent regions. Compared to TORKA'S data, there were 79 (22%) new species. The paper also describes the territorial expansion and increased abundance of some species, especially eastward expansion of *Andrena fulva* as well as the appearance of *Bombus semenoviellus* and its expansion westwards.

KEY WORDS: wild bees, Apiformes, Western Poland, Wielkopolska-Kujawy Lowland, changes of fauna.

INTRODUCTION

Decreasing abundances or extinction of species are very popular topics of discussions and research in environmental biology. The readers of some publications may develop an impression that it is actually rather fashionable to write about species extinction, and some authors have been endeavoring to find relevant evidence at all costs, although such evidence is not always convincing in the case of invertebrates, or presenting catastrophic visions that, however, lack a scientific rationale.

The apidological (mellitological) literature contains a sizable body of works on faunal changes written by a number of authors (COLLINS 1987, COLLINS & WELLS 1987, GAULD et al. 1990, DAY 1991, O'TOOLE 1993, 1994, WILLIAMS 1982, 1986, RASMONT et al. 1993,

PEKKARINEN 1999, BANASZAK 1997, BANASZAK et al. 2003, GOULSON et al. 2005, 2008, MARLIN, LABERge 2001, DARVILL et al. 2006, W.A. BANASZAK 2005). Relevant publications include the book *Changes in Fauna of Wild Bees in Europe* with J. BANASZAK as editor (1995), where authors from various European countries describe examples of the disappearance of certain species or decreases in their abundance. Changes of fauna against the background of changes among plants on a regional scale are described in the book *Stepowienie Wielkopolski. Pół wieku później* (BANASZAK 2003). Changes in the bee fauna as an example of faunal changes have been described by BANASZAK (2003).

In the early 20th century, a faunal researcher called Valentin Torka carried out research in Wielkopolska-Kujawy Lowland and published an inventory of bees from the northern part of the region (TORKA 1913). Thanks to his work it is possible to compare the bee fauna of that time with a contemporary inventory. Independently of work by the present author, initiated as early as the mid-1960's and mostly presented in publications (e.g. BANASZAK 1982), a systematic study of the bee fauna "in the wake of TORKA" has been carried out since the mid-1990's, mainly in Bydgoszcz and its environs, Nakło, the environs of Poznań in Wielkopolska National Park, and in the Agroecological Landscape Park in Turew near Kościan. These data have mostly not been published before and form the basis for this paper.

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WIELKOPOLSKA-KUJAWY LOWLAND – GENERAL DESCRIPTION OF THE STUDY AREA

The study area covered a major part of Wielkopolska-Kujawy Lowland (Wielkopolska region), a region characterized by significant human pressure in agriculture, with relatively rare natural enclaves. It forms a broad lowland belt between 14°10' and 19°30' E and between 51°10' and 53°10' N, occupying an area of 38,000 km^2.

The study area was part of the Wielkopolska Lakeland, which belongs to the subprovince of Southern Baltic Lakelands. It is separated from the Pomeranian lakelands by the latitudinal furrow of the Toruń-Ebserswalder glacial valley. The current terrain of the area under study was shaped by two phases of the last glaciation: the Poznań (Frankfurt) and Leszno (Brandenburg) phases. Relief intensity is relatively low. Elevations do not exceed 200 m above sea level, except in the western part of the area. The proportion of lakes is also smaller here compared to Pomerania or Mazury. The southern border of the Wielkopolska Lakelands is also the farthest range of the Vistula glaciation in the Leszno phase. The area of the lakelands is sectioned by latitudinal segments of glacial valleys: the

Toruń-Eberswald glacial valley including the areas around the River Noteć, and latitudinal segments of the lower Warta with its tributary Wełna, and, going further south, the series of latitudinal valleys of the Warta, Obra and Odra Rivers, previously referred to as the Warsaw-Berlin glacial valley (KONDRACKI 1998).

The most typical soils of Wielkopolska are medium sand soils and sandy soils of podzolic type occurring alternately; clay and loam soils and black turf soils are rare (KRYGOWSKI 1958).

Intensive agricultural management in this region with a high degree of mechanization is characterized by a high frequency of chemical use. A characteristic feature of the region is a considerable preponderance of cultivated fields, which occupy over 60% of the surface area.

Mean annual ambient air temperature in Wielkopolska Lowland (=Wielkopolska-Kujawy Lowland) ranges from 7.5°C to 8.4°C. The highest temperatures are noted in the western and south-western periphery of the region (8.2°C), and the lowest are recorded in the north-eastern part (7-6°C). The highest mean temperatures are noted in July (17.6-18°C), and the lowest are recorded in January, ranging between –2.8°C to –1.5°C. Mean annual precipitation in Wielkopolska Lowland ranks among the lowest in Poland (500-600 mm). The least amount of precipitation is received by the central part of the region, i.e. Gniezno Lakeland, part of Kujawy and the Poznań Lakeland, where mean annual precipitation does not exceed 550 mm (WOŚ 1994).

As regards potential natural vegetation, the dominant habitat type is that of mixed broad-leaved forests, namely, the *Galio silvatici-Carpinetum* Middle European Lowland oak-hornbeam forest. The actual forest vegetation is dominated by anthropogenic stands of pine formed as a result of economic forest management. A peculiar feature of the region is the presence of clusters of xerothermic grasslands, found mainly along the edges of the Vistula and Noteć river valleys, and halophytes (Inowrocław, Ciechocinek).

The relatively high average temperatures and low precipitation make the region one of the driest in Poland. The high aridity index favors steppe species, which is confirmed by the occurrence in this region – especially over the Vistula River valley and in the region of the Noteć River – of the richest associations of xerothermic plants (SULMA & WALAS 1963, MATUSZKIEWICZ 2010) and, consequently, a diverse fauna of bees (BANASZAK 1980a).

STUDIES OF APIFORMES IN WIELKOPOLSKA-KUJAWY LOWLAND – A HISTORICAL OVERVIEW

Wielkopolska-Kujawy Lowland is one of the best studied regions of Poland with regard to bee fauna. Importantly, the research has been carried out both in natural areas (Wielkopolska National Park, nature reserves), farmland (environs of Poznań, Agroecological Landscape Park and others), and in cities (Poznań, Bydgoszcz).

The earliest data were collected a hundred years ago by TORKA (1909, 1913, 1916, 1933). Individual species were also described in works concerned with the neighboring regions (ALFKEN 1911, 1912, E. STOECKHERT 1919, F.K. STOECKHERT 1933, EBMER & SCHWAMMBERGER 1986, BLÜTHGEN 1920, ALFKEN 1924). An old, unpublished inventory of bees from before World War II in Bydgoszcz and Gorzów Wielkopolski was described by BANASZAK (2006). Of the approximately 500 individuals of Apiformes in that collection, only a few were labeled with the name of the locality where they were found, i.e. in Bydgoszcz ("Bromberg") and near Gorzów Wielkopolski ("Landsberg W. Umgl."). Some labels also contained information about the collectors. The Bydgoszcz specimens were collected by Oskar (?) MEYER, and those from the environs of Gorzów Wlkp. by Dr G. GÖTZE.

A list of bees from Wielkopolska National Park near Poznań was provided by SZULCZEWSKI (1948), who also mentioned individual bee species in his earlier works (SZULCZEWSKI 1916, 1922, 1927, 1930). Valuable information regarding the bumble bees of Wielkopolska before WWII can be found in the manuscript of B.ENG. thesis by OLSZEWSKI (1937)

In the recent times, studies of bees in Wielkopolska-Kujawy Lowland have mainly been undertaken by Banaszak, whose inventories include BANASZAK 1973, 1982, 1983, 2004, BANASZAK & CIERZNIAK (2000). Owing to CIERZNIAK (2003), Wielkopolska National Park is among the most extensively researched areas at present. The bees of selected seed crops have been studied by WÓJTOWSKI & WILKANIEC (1979), WÓJTOWSKI et al. (1979), and WILKANIEC et al. (1985); bumble bees in red clover crops have been investigated by SOWA et al. (1991), and BILIŃSKI & RUSZKOWSKI (1991). The most extensively studied Polish towns include Bydgoszcz (BANASZAK 2004, 2008) and Poznań (WÓJTOWSKI & SZYMAŚ 1973, BANASZAK 1976, WÓJTOWSKI & FELISZEK 1977, W.A. BANASZAK 2004, 2005, BANASZAK-CIBICKA 2008, 2009).

The most extensive list of species from Wielkopolska-Kujawy Lowland can be found in BANASZAK (1982), who lists 258 species.

A study of bees of the town of Żnin has recently been carried out by Marquardt, who lists 70 species in his unpublished M.A. thesis (MARQUARDT 2002).

TORKA'S BEE STUDIES

TORKA as an apidologist and faunal researcher

In the days of V. TORKA, the area of Poland was divided among Prussia, Russia and Austria as a consequence of partitions in the years 1772-1795. The area where Torka carried out his research belonged to the German Empire and administratively was part of the Poznań Province (Provinz Posen). The city of Bydgoszcz ("Bromberg") was the capital of the Bydgoszcz Regency ("Regenz Bromberg"), subordinated to Poznań.

Valentin TORKA (1867-1952) (Fig. 1) was a German naturalist. He was born in Upper Silesia, but in the years 1906-1920 he worked as a teacher in a junior secondary school in Nakło on the Noteć River near Bydgoszcz. Later, he went on to work in another secondary school in Prudnik in the Opole area until retirement in 1932. In 1945, he left Prudnik with his family and settled down in Württemberg in the then Federal Republic of Germany. He contributed significantly to the study of the physiography of Wielkopolska and that part of Silesia around Opole. He was the author of more than 50 contributions in floral and faunal research, including bees.

As a faunal researcher and apidologist, TORKA was a reliable scholar, as evidenced above all by the long list of bee species he found, identified and later described in this work from 1913 and later addenda from 1933. His collection has not survived and cannot be verified today. All of his collections and materials burned in Prudnik in 1945 (DZIĘCZKOWSKI 1987). However, his published works clearly show that he kept pace with the latest literature and maintained contact with contemporary experts in the area, especially with the prominent expert on bees J.D. ALFKEN (1862-1945) of Bremen, who verified or determined a few species for TORKA, and with the equally prominent apidologist F.K. STOECKHERT (1889-1968) of Erlangen. The two scholars often quoted from TORKA'S 1913 oeuvre in their publications and drew on his knowledge of the bee fauna of both Wielkopolska and Silesia. TORKA was also a friend and collaborator of two local faunal researchers and collectors of bees, namely J.W. SZULCZEWSKI (1879-1969), a teacher in Brudzyń near Żnin in the period between World War I and II, and O. MEYER (1858-1942), an optician from Bydgoszcz.

TORKA'S most comprehensive work about bees is "Die Bienen der Provinz Posen", published in 1913. A short communication from 1933 is an addendum to the original inventory where the author adds new species, clarifies misidentifications, corrects some specific names in keeping with newly accumulated knowledge, and adds information on new localities for some previously described species. Two other communications on individual species (TORKA 1909, 1916) were also concerned with the same area. Collectively, all this testifies to his conscientiousness as a researcher.

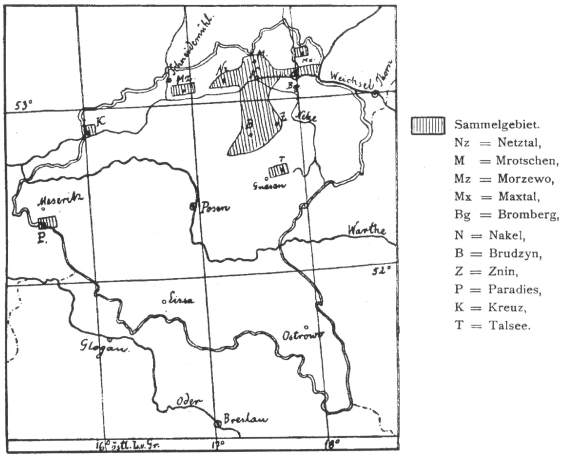
TORKA mainly explored the town of Nakło, where he lived and worked as a teacher, and neighbouring areas along the Noteć River, as illustrated by a facsimile of the original map of location of study sites from his 1913 publication (Fig. 2), all of which were situated between 52^0-54^0 N and 16^0-18^0 E.

His publication of 1913 (Die Bienen der Provinz Posen) lists 271 species. This inventory has now been verified and needs a commentary. A large proportion of the species from the original list are known under synonymous names, which are listed in the inventory in Table 1. Some species listed by TORKA as varieties ("var") are currently regarded as legitimate species, including *Bombus cryparum*, *B. mesomelas*, and *B. distinquendus*. Others, listed as separate species by Torka, are currently grouped together, for example:

- TORKA listed *Prosopis (Hylaeus) cervivornis* Carter and *P. annularus* as separate species; at present *P. cervicornis* is regarded as a synonym for *P. annularis*;

- *Halictus* (s.l.) *fasciatus* Nylander and *H. tumulorum* L. are now the preferred names.

1



2

Figs 1-2. 1- Valentin TORKA (1867-1952), after H. SZAFRANÓWNA (1933). 2 - Facsimile of a hand-drawn outline of TORKA'S study area (1913).

TORKA collected his materials from 12 localities, whose German names (they were all in the German partition at that time) are given with their current Polish names in brackets: Nakel (Nakło), Netzel (Osiek near Wyrzysk), Brudzyn (Brudzyń), Bromberg (Bydgoszcz), Mrotschen (Mrocza), Maxthal (Maksymilianowo near Bydgoszcz), Paradies (Gościkowo/Paradyż near Międzyrzecz), Talsee (Jankowo Dolne near Gniezno), Kreuz (Krzyż), Znin (Żnin), Morzewo (Morzewo), and Dziembowo (Dziembowo near Piła).

The extent of identification was very uneven. As the author gave the abbreviated town name in the entry for each species, it was easy to calculate totals: 262 species were collected in Nakło, 111 in Bydgoszcz, 109 in Brudzyń, 81 in Paradyż, 66 in Osiek, 47 in Mrocza, 35 in Morzewo and Dziembowo, 28 in Żnin, 20 in Krzyż, and 10 species in Jankowo Dolne. The surprising number of 262 species from Nakło, nearly equalling the overall number of species listed from this part of Wielkopolska-Kujawy Lowland, can be attributed to two factors. Most importantly, as Torka himself stated, the locality actually extended beyond Nakło, covering an area within a radius of 10 km; secondly, Nakło was where he lived and where he could make frequent trips to collect new specimens. The relatively many (111) bees captured in Bydgoszcz were actually collected by Oskar MEYER, an amateur faunal researcher who lived there and offered his collections to Torka for further study. Similarly, the Brudzyń collections were captured and offered by Wojciech SZULCZEWSKI, a fellow teacher.

Table 1. List of bee species recorded in Wielkopolska-Kujawy Lowland in the years 1909-2010.

No.	Species	Torka 1909, 1913, 1916, 1933.	Banaszak unpublished data	References	
				Banaszak 1982, 2008, Banaszak et all. 2004	Cierzniak 2003
1	*2*	*3*	*4*	*5*	*6*
	Colletidae				
1	*Colletes cunicularius* (LINNAEUS, 1761)	+	+	+	+
2	*Colletes daviesanus* SMITH, 1846	+	+	+	+
3	*Colletes floralis* EVERSMANN, 1852 *Colletes montanus* MOR.	+	-	-	-
4	*Colletes fodiens* (FOURCROY, 1785)	+	+	+	+
5	*Colletes marginatus* SMITH, 1846	+	+	+	-
6	*Colletes nasutus* SMITH, 1853	+	-	-	-
7	*Colletes similis* SCHENCK, 1853 *Colletes picistigma* THOMS.	+	+	+	+
8	*Colletes succinctus* (LINNAEUS, 1758)	+	+	+	-
9	*Hylaeus angustatus* (SCHENCK, 1859)	+	+	+	+
10	*Hylaeus annularis* (KIRBY, 1802) *Hylaeus cervicornis* COSTA.	-	+	+	+
11	*Hylaeus annulatus* (LINNAEUS, 1758)	+	-	+	+
12	*Hylaeus bisinuatus* FÖRSTER, 1871	+[i]	+	-	-
13	*Hylaeus brevicornis* NYLANDER, 1852	+	+	+	+
14	*Hylaeus cardioscapus* COCKERELL, 1924	-	+	-	-
15	*Hylaeus clypearis* (SCHENCK, 1853)	-	-	+	-
16	*Hylaeus communis* NYLANDER, 1852	-	+	+	+
17	*Hylaeus confusus* NYLANDER, 1852	+	+	+	+
18	*Hylaeus cornutus* CURTIS, 1831	+	+	+	-
19	*Hylaeus difformis* (EVERSMANN, 1852)	-	+	+	+
20	*Hylaeus gibbus* SAUNDERS, 1850	+	+	+	+
21	*Hylaeus gracilicornis* (MORAWITZ, 1867)	-	+	+	+
22	*Hylaeus gredleri* FÖRSTER, 1871	-	+	+	-
23	*Hylaeus hyalinatus* SMITH, 1842	-	+	+	+
24	*Hylaeus moricei* (FRIESE, 1898)	-	+	-	-
25	*Hylaeus nigritus* (FABRICIUS, 1798)	+	+	+	-
26	*Hylaeus paulus* (BRIDWELL, 1919) *Hylaeus lepidulus* COCK.	-	+	+	-
27	*Hylaeus pectoralis* FÖRSTER, 1871	-	+	+	+
28	*Hylaeus pictipes* NYLANDER, 1852	+	+	+	+
29	*Hylaeus punctatus* (BRÜLLÉ, 1832)	-	+	+	+
30	*Hylaeus punctulatissimus* SMITH, 1842	-	+	-	-
31	*Hylaeus signatus* (PANZER, 1798) *Hylaeus pratensis* GEOFFR.	+	+	-	+
32	*Hylaeus sinuatus* (SCHENCK, 1853)	-	+	-	-
33	*Hylaeus styriacus* FÖRSTER, 1871	-	+	+	-
34	*Hylaeus variegatus* (FABRICIUS, 1798)[ii]	-	+	+	-
	Andrenidae				
35	*Andrena alfkenella* PERKINS, 1914	-	+	-	+
36	*Andrena apicata* SMITH, 1847	+	+	+	+
37	*Andrena argentata* SMITH, 1844	+	-	-	-
38	*Andrena assimilis* RADOSZKOWSKI, 1876	-	-	+	-
39	*Andrena barbilabris* (KIRBY, 1802) *Andrena sericea* CHR.	+	+	+	+
40	*Andrena bicolor* FABRICIUS, 1775 *Andrena gwynana* K.	+	+	+	+
41	*Andrena bimaculata* (KIRBY, 1802)	+	+	+	+
42	*Andrena chrysopyga* SCHENCK, 1853	+	-	+	-
43	*Andrena chrysosceles* (KIRBY, 1802)	+	+	+	+
44	*Andrena cineraria* (LINNAEUS, 1758)	+	+	+	+
45	*Andrena clarkella* (KIRBY, 1802)	+	+	+	+
46	*Andrena coitana* (KIRBY, 1802) *Andreana shawella* K.	+	-	-	-
47	*Andrena* combinata (CHRIST, 1791)	+	-	+	+
48	*Andrena curvungula* THOMSON, 1870	+	+	+	-
49	*Andrena denticulata* (KIRBY, 1802)	-	+	+	-
50	*Andrena dorsata* (KIRBY, 1802)	+	+	+	+
51	*Andrena falsifica* PERKINS, 1915	-	+	+	+
52	*Andrena flavipes* PANZER, 1799	+	+	+	+
53	*Andrena florea* FABRICIUS, 1793	-	+	+	-
54	*Andrena floricola* EVERSMANN, 1852 *Andrena ochropyga* ALFKEN	+	-	+	+
55	*Andrena fucata* SMITH, 1847	+	+	+	+
56	*Andrena fulva* (MÜLLER, 1766)	+	+	+	+
57	*Andrena fulvago* (CHRIST, 1791)	+	-	+	-
58	*Andrena fuscipes* (KIRBY, 1802)	+	+	+	-
59	*Andrena gelriae* VAN DER VECHT, 1927	-	+	+	+
60	*Andrena gravida* IMHOFF, 1899	+	+	+	+
61	*Andrena haemorrhoa* (FABRICIUS, 1781) *Andrena albicans* MÜLL.	+	+	+	+
62	*Andrena hattorfiana* (FABRICIUS, 1775)	+	+	+	-
63	*Andrena helvola* (LINNAEUS, 1758)	+	+	+	+
64	*Andrena humilis* IMHOFF, 1832	+	+	+	+
65	*Andrena jacobi* PERKINS, 1921 *Andrena trimmerana* K.	+	+	+	+
66	*Andrena labialis* (KIRBY, 1802)	+	+	+	-
67	*Andrena labiata* FABRICIUS, 1781 *Andrena cingulata* FABR.	+	+	+	+
68	*Andrena lapponica* ZETTERSTEDT, 1838	+	+	+	+
69	*Andrena lathyri* ALFKEN, 1899	+	-	-	-
70	*Andrena lepida* SCHENCK, 1859 *Andrena separanda* SCHMIDEK.	+	+	-	-
71	*Andrena limata* SMITH, 1853	-	+	+	-
72	*Andrena marginata* FABRICIUS, 1776	+	-	+	-
73	*Andrena minutula* (KIRBY, 1802)	+	+	+	+
74	*Andrena minutuloides* PERKINS, 1914 *Andrena sparsiciliata* ALFK.	-	+	+	+
75	*Andrena mitis* SCHMIEDEKNECHT, 1883	-	+	-	-

1	2	3	4	5	6
76	*Andrena morawitzi* THOMSON, 1872 *Andrena bluthgeni* STOECK.	+	+	+	-
77	*Andrena morio* BRULLÉ, 1832	+	-	-	-
78	*Andrena nana* (KIRBY, 1802)	+	-	-	-
79	*Andrena nanula* NYLANDER, 1848	-	-	+	+
80	*Andrena nasuta* GIRAUD, 1863	+	-	+	-
81	*Andrena nigriceps* (KIRBY, 1802)	+	+	+	-
82	*Andrena nigroaenea* (KIRBY, 1802)	+	+	+	+
83	*Andrena nitida* (MÜLLER, 1776)	+	+	+	+
84	*Andrena nitidiuscula* SCHENCK, 1853	-	-	+	-
85	*Andrena niveata* FRIESE, 1887	-	-	+	-
86	*Andrena nycthemera* IMHOFF, 1866	+	+	-	-
87	*Andrena ovatula* (KIRBY, 1802) *Andrena alfeliella* K.	+	+	+	+
88	*Andrena pilipes* FABRICUS, 1781	-	+	+	-
89	*Andrena polita* SMITH, 1847	+	-	+	-
90	*Andrena potentillae* PANZER, 1809	+	-	+	-
91	*Andrena praecox* (SCOPOLI, 1763) *Andena torkai* ALFK.	+	+	+	+
92	*Andrena proxima* (KIRBY, 1802)	+	+	-	-
93	*Andrena pusilla* PÉREZ, 1903	+	-	-	-
94	*Andrena rosae* PANZER, 1801	+	+	+	-
95	*Andrena ruficrus* NYLANDER, 1848	-	-	-	+
96	*Andrena schencki* MORAWITZ, 1866	-	-	+	-
97	*Andrena similis* SMITH, 1849	+	-	-	-
98	*Andrena simillima* SMITH, 1851 *Andrena bremensis* ALFK.	+	+	-	-
99	*Andrena subopaca* NYLANDER, 1848	-	+	+	+
100	*Andrena suerinensis* FRIESE, 1884	+	+	+	-
101	*Andrena symphyti* SCHMIEDEKNECHT, 1883	-	+	+	-
102	*Andrena synadelpha* PERKINS, 1914	-	+	-	-
103	*Andrena tarsata* NYLANDER, 1848	+	-	-	-
104	*Andrena thoracica* (FABRICIUS, 1775)	+	-	-	-
105	*Andrena tibialis* (KIRBY, 1802)	+	+	+	+
106	*Andrena vaga* PANZER, 1799	+	+	+	+
107	*Andrena varians* (ROSSI, 1781)	+	-	+	+
108	*Andrena ventralis* IMHOFF, 1832	+	+	+	+
109	*Andrena viridescens* VIERECK, 1916	-	-	+	+
110	*Andrena wilkella* (KIRBY, 1802) *Andrena xanthura* K.	+	+	+	+
111	*Panurgus calcaratus* (SCOPOLI, 1763)	+	+	+	+
	Halictidae				
112	*Dufourea dentiventris* (NYLANDER, 1848)	+	-	-	-
113	*Dufourea inermis* (NYLANDER, 1848)	+	-	+	-
114	*Rhophitoides canus* (EVERSMANN, 1852)	+	+	+	-
115	*Rhophites algirus trispinosus* PÉREZ, 1903	+[iii]	+	-	-
116	*Rophites quinquespinosus* SPINOLA, 1808	+	+	+	-
117	*Systropha curvicornis* (SCOPOLI, 1770)	+	+	+	-
118	*Nomioides minutissimus* (ROSSI, 1790)	-	-	+	-

1	2	3	4	5	6
119	*Halictus compressus* (WALCKENAER, 1802) (=*eurygnatus* =*tetrazonius*)	+	-	-	-
120	*Halictus maculatus* SMITH, 1848	+	+	+	+
121	*Halictus quadricinctus* (FABRICIUS, 1776)	+	+	+	+
122	*Halictus rubicundus* (CHRIST, 1791)	+	+	+	+
123	*Halictus sexcinctus* (FABRICIUS, 1775)	+	+	+	+
124	*Halictus simplex* BLÜTHGEN, 1923 *Halictus tetrazonius* KLG.	+	-	+	-
125	*Seladonia confusa* (SMITH, 1853)	-	+	+	+
126	*Seladonia leucahenea* (EBMER, 1972)	+	+	-	+
127	*Seladonia semitecta* (MORAWITZ, 1874)	-	+	-	-
128	*Seladonia subaurata* (ROSSI, 1792)	+	+	+	+
129	*Seladonia tumulorum* (LINNAEUS, 1758) *Halictus fasciatus* NYL.	+	+	+	+
130	*Lasioglossum costulatum* (KRIECHB., 1873)	+	-	+	-
131	*Lasioglossum laevigatum* (KIRBY, 1802)	+	+	-	+
132	*Lasioglossum lativentre* (SCHENCK, 1853)	-	+	+	+
133	*Lasioglossum leucozonium* (SCHRAN 1792)	+	+	+	+
134	*Lasioglossum majus* (NYLANDER, 1852)	-	+	+	-
135	*Lasioglossum prasinum* (SMITH, 1848)	+	-	-	-
136	*Lasioglossum quadrinotatum* (KIRBY, 1802)	+	+	+	+
137	*Lasioglossum sexmaculatum* (SCHENCK, 1853)	-	+	-	-
138	*Lasioglossum sexnotatum* (KIRBY, 1802)	+	+	+	+
139	*Lasioglossum sexnotatulum* (NYLANDER, 1852)	+	-	-	-
140	*Lasioglossum subfasciatum* (IMHOFF, 1832)	+	+	+	+
141	*Lasioglossum xanthopus* (KIRBY, 1802)	+	+	+	-
142	*Lasioglossum zonulum* (SMITH, 1848)	+	+	+	-
143	*Evylaeus aeratus* (KIRBY, 1802)	-	-	+	+
144	*Evylaeus albipes* (FABRICIUS, 1781)	+	+	+	+
145	*Evylaeus brevicornis* (SCHENCK, 1863)	+	+	+	-
146	*Evylaeus calceatus* (SCOPOLI, 1763)	+	+	+	+
147	*Evylaeus convexiusculus* (SCHENCK, 1853) *Halictus appropinquans* SCHCK.	+	-	+	-
148	*Evylaeus euboeensis* STRAND, 1909	+[iv]	-	-	-
149	*Evylaeus fratellus* (PÉREZ, 1903) *Halictus frey-gessneri* ALFK.	+	+	-	+
150	*Evylaeus fulvicornis* (KIRBY, 1802)	+	+	+	+
151	*Evylaeus intermedius* (SCHENCK, 1868)	-	-	+	+
152	*Evylaeus interrupus* (PANZER, 1798)	+	-	+	+
153	*Evylaeus laevis* (KIRBY, 1802)	+	-	+	+
154	*Evylaeus laticeps* (SCHENCK, 1868) *Halictus mendax* ALFK.	+	+	+	+
155	*Evylaeus leucopus* (KIRBY, 1802)	+	+	+	+
156	*Evylaeus linearis* (SCHENCK, 1868) *Halictus longuloides* E.STRAND	+	+	+	-
157	*Evylaeus lucidulus* (SCHENCK, 1861) *Halictus gracilis* MOR.	+	+	+	+
158	*Evylaeus malachurus* (Kirby, 1802)	-	+	+	+
159	*Evylaeus minutissimus* (Kirby, 1802)	+	+	-	+
160	*Evylaeus minutulus* (SCHENCK, 1853) *Halictus semipunctulatus* SCHCK.	+	-	-	-
161	*Evylaeus morio* (FABRICIUS, 1793)	+	+	+	+
162	*Evylaeus nigripes* (LEPELETIER, 1841)	-	+	+	-

1	2	3	4	5	6
163	*Evylaeus nitidiusculus* (KIRBY, 1802)	+	+	+	+
164	*Evylaeus nitidulus* (FABRICIUS, 1804) *Halictus smethmanellus* auct. nec (K.)	+	+	+	-
165	*Evylaeus parvulus* (SCHENCK, 1853)	-	-	+	+
166	*Evylaeus pauxillus* (SCHENCK, 1853)	+	+	+	+
167	*Evylaeus politus* (SCHENCK, 1853) *Halictus nanulus* SCHCK.	+	-	-	-
168	*Evylaeus punctatissimus* (SCHENCK, 1853)	+	+	+	+
169	*Evylaeus quadrinotatulus* (SCHENCK, 1861)	+	+	+	+
170	*Evylaeus quadrisignatus* (SCHENCK, 1853)	-	+	-	-
171	*Evylaeus rufitarsis* (ZETTERSTEDT, 1838)	-	+	-	+
172	*Evylaeus semilucens* (ALFKEN, 1914)	-	+	+	+
173	*Evylaeus setulosus* (STRAND, 1909)	-	-	+	-
174	*Evylaeus sexstrigatus* (SCHENCK, 1868)	+	+	+	+
175	*Evylaeus tarsatus* (SCHENCK, 1868)	-	-	+	+
176	*Evylaeus villosulus* (KIRBY, 1802)	+	+	+	+
177	*Sphecodes albilabris* (FABRICIUS, 1793) *Sphecodes fuscipennis* GERM.	+	+	+	+
178	*Sphecodes crassus* THOMSON, 1870 *Sphecodes variegatus* HAG.	+	+	+	-
179	*Sphecodes ephippius* (LINNAEUS, 1767) *Sphecodes similis* WESM.	+	+	+	+
180	*Sphecodes ferruginatus* HAGENS, 1882	+	+	+	+
181	*Sphecodes geofrellus* (KIRBY, 1802) *Sphecodes affinis* HAG.	+	-	+	+
182	*Sphecodes gibbus* (LINNAEUS, 1758)	+	+	+	+
183	*Sphecodes hyalinatus* HAGENS, 1882	+	+	+	+
184	*Sphecodes longulus* HAGENS, 1882	+	+	+	+
185	*Sphecodes monilicornis* (KIRBY, 1802) *Sphecodes subquadratus* SM.	+	+	+	+
186	*Sphecodes marginatus* HAGENS,1882	-	+	-	+
187	*Sphecodes miniatus* HAGENS, 1882 *Sphecodes dimidiatus* HAG.	+	+	+	+
188	*Sphecodes niger* HAGENS, 1882	+	+	+	-
189	*Sphecodes pellucidus* SMITH,1845 *Sphecodes pilifrons* THOMS.	+	+	+	+
190	*Sphecodes puncticeps* THOMSON,1870	+	+	+	+
191	*Sphecodes reticulatus* THOMSON,1870	+	-	+	+
192	*Sphecodes rufiventris* (PANZER,1798)	-	+	+	-
193	*Sphecodes ruficrus* (ERICHSON,1835)	+	-	-	+
194	*Sphecodes spinulosus* HAGENS,1875	+	-	-	-
	Melittidae				
195	*Melitta haemorrhoidalis* (FABRICIUS,1775)	+	+	+	-
196	*Melitta leporina* (PANZER,1799)	+	+	+	+
197	*Melitta nigricans* ALFKEN, 1905	+	+	+	+
198	*Melitta tricincta* KIRBY, 1802 *Melitta melanura* NYL.	+	+	+	+
199	*Macropis europaea* WARNCKE, 1973	+	+	+	-
200	*Macropis fulvipes* (FABRICIUS, 1804)	+	-	-	+
201	*Dasypoda aurata* RUDOW,1881 *Dasypoda thomsoni* SCHLETT.	+	-	-	-
202	*Dasypoda argentata* PANZER,1809	+	-	+	-
203	*Dasypoda hirtipes* (HARRIS, 1780) *Dasypoda plumipes* (PANZ.)	+	+	+	+
	Megachilidae				
204	*Trachusa byssina* (PANZER, 1798)	+	+	+	-

1	2	3	4	5	6
205	*Anthidium manicatum* (LINNAEUS, 1758)	+	+	+	+
206	*Anthidium punctatum* LATREILLE, 1809	+	-	-	-
207	*Proanthidium oblongatum* LATREILLE, 1809	-	+	+	+
208	*Anthidiellum strigatum* (PANZER, 1805)	+	+	+	+
209	*Stelis breviuscula* (NYLANDER, 1848)	+	-	+	-
210	*Stelis minuta* LEPELETIER AND SERVILLE, 1825	+	-	+	+
211	*Stelis ornatula* (KLUG, 1807)	+	-	-	-
212	*Stelis phaeoptera* (KIRBY, 1802)	+	-	+	-
213	*Stelis punctulatissima* (KIRBY, 1802) *Stelis aterrima* PANZ.	+	+	+	-
214	*Stelis signata* (LATREILLE, 1809)	+	-	+	-
215	*Heriades crenulatus* NYLANDER, 1856	-	+	+	+
216	*Heriades truncorum* (LINNAEUS, 1758)	+	+	+	+
217	*Chelostoma campanularum* (KIRBY, 1802)	+	+	+	+
218	*Chelostoma florisomne* (LINNAEUS, 1758)	+	+	+	+
219	*Chelostoma foveolatum* (MORAWITZ, 1868)	-	+	-	-
220	*Chelostoma rapunculi* (LEPELETIER, 1841) *Eriades fuliginosus* PANZ.	+	+	+	+
221	*Anthocopa bidentata* (MORAWITZ, 1876)	-	-	+	-
222	*Anthocopa papaveris* (LATREILLE, 1799)	+	+	+	-
223	*Anthocopa spinulosa* (KIRBY, 1802)	+	+	+	-
224	*Hoplitis adunca* (PANZER, 1798)	+	+	+	+
225	*Hoplitis anthocopoides* (SCHENCK, 1853) *Osmia spinolae* SCHCK.	+	+	+	-
226	*Hoplitis claviventris* (THOMSON, 1872)	+	+	-	-
227	*Hoplitis leucomelana* (KIRBY, 1802)	+	+	+	+
228	*Hoplitis tridentata* (DUFOUR AND PERRIS, 1840)	+	+	+	-
229	*Osmia aurulenta* (PANZER, 1799)	+	+	-	-
230	*Osmia bicolor* (SCHRANK, 1781)	+	+	+	-
231	*Osmia brevicornis* (FABRICIUS, 1798) *Osmia panzeri* MOR.	+	+	+	-
232	*Osmia coerulescens* (LINNAEUS, 1758)	+	+	+	+
233	*Osmia fulviventris* (PANZER, 1798)	+	+	+	+
234	*Osmia inermis* (ZETTERSTEDT, 1838)	+	+	-	-
235	*Osmia leaiana* (KIRBY, 1802)	+	+	+	-
236	*Osmia mustelina* GERSTAECKER, 1869	+	+	+	-
237	*Osmia nigriventris* (ZETTERSTEDT, 1838)	+	-	-	-
238	*Osmia pilicornis* SMITH, 1846	-	+	-	-
239	*Osmia rufa* (LINNAEUS, 1758)	+	+	+	+
240	*Osmia uncinata* GERSTAECKER, 1869	+	-	+	-
241	*Chalicodoma ericetorum* (LEPELETIER, 1841)	+	+	+	-
242	*Megachile alpicola* ALFKEN, 1924	+	+	+	+
243	*Megachile apicalis* SPINOLA, 1808	+	-	+	-
244	*Megachile argentata* (FABRICIUS, 1793)	+	-	-	-
245	*Megachile centuncularis* (LINNAEUS, 1758)	+	+	+	+
246	*Megachile circumcincta* (KIRBY, 1802)	+	+	+	+
247	*Magachile genalis* MORAWITZ, 1880	-	+	-	-
248	*Megachile lagopoda* (LINNAEUS, 1761)	+	-	+	+

1	*2*	*3*	*4*	*5*	*6*
249	*Megachile lapponica* THOMSON, 1872	+	-	-	-
250	*Megachile leachella* CURTIS, 1828	-	+	+	-
251	*Megachile ligniseca* (KIRBY, 1802)	+	+	+	+
252	*Megachile maritima* (KIRBY, 1802)	+	+	+	-
253	*Megachile octosignata* NYLANDER, 1852	+	-	-	-
254	*Megachile pilidens* ALFKEN, 1923	+	-	+	-
255	*Megachile rotundata* (FABRICIUS, 1784)	+	+	+	-
256	*Megachile versicolor* SMITH, 1844	+	+	+	+
257	*Megachile willughbiella* (KIRBY, 1802)	+	+	+	+
258	*Coelioxys afra* LEPELETIER, 1841	+	-	-	-
259	*Coelioxys aurolimbata* FÖRSTER, 1853	-	-	+	-
260	*Coelioxys brevis* EVERSMANN, 1852	+	-	-	-
261	*Coelioxys conoidea* (ILLIGER, 1806)	+	+	+	-
262	*Coelioxys elongata* LEPELETIER, 1841	+	+	+	-
263	*Coelioxys inermis* (KIRBY, 1802) *Coelioxys acuminata* NYL.	+	-	+	-
264	*Coelioxys mandibularis* NYLANDER, 1848	+	+	-	-
265	*Coelioxys polycentris* FÖRSTER, 1853	+	-	-	-
266	*Coelioxys quadridentata* (LINNAEUS, 1758)	+	+	+	+
267	*Coelioxys rufescens* LEPELETIER, 1825	+	-	+	-
268	*Coelioxys rufocaudata* SMITH, 1854	-	-	+	-
	Apidae				
269	*Anthophora bimaculata* (PANZER, 1798)	+	+	+	+
270	*Anthophora furcata* (PANZER, 1798)	+	+	+	+
271	*Anthophora* plagiata (ILLIGER, 1806)	+	+	+	-
272	*Anthophora plumipes* (PALLAS, 1772)	+	+	+	+
273	*Anthophora pubescens* (FABRICIUS, 1781)	+	-	+	-
274	*Anthophora retusa* (LINNAEUS, 1758)	+	+	+	-
275	*Anthophora quadrimaculata* (PANZER 1806)	+	+	+	-
276	*Amegilla quadrifasciata* (VILLERS, 1789)	+	-	-	-
277	*Melecta luctuosa* (SCOPOLI, 1770)	+	-	+	+
278	*Melecta punctata* (FABRICIUS, 1775) *Melecta albifrons* FORST.	+	+	+	+
279	*Thyreus orbatus* (LEPELETIER, 1841)	-	-	+	-
280	*Eucera interrupta* BAER, 1850	+	-	+	-
281	*Eucera longicornis* (LINNAEUS, 1758)	+	+	+	-
282	*Tetralonia dentata* (KLUG, 1835)	+	-	+	-
283	*Tetralonia macroglossa* ILLIGER, 1806	+	+	+	-
284	*Tetralonia salicariae* (LEPELETIER, 1841)	+	-	-	-
285	*Ceratina cyanea* (KIRBY, 1802)	+	+	+	+
286	*Nomada armata* HERRICH-SCHÄFFER, 1839	+	-	-	-
287	*Nomada artroscutellaris* STRAND, 1921[V]	+	-	-	-
288	*Nomada bifasciata* OLIVIER, 1811	-	+	+	+
289	*Nomada braunsiana* SCHMIEDEKNECHT, 1882	+	-	-	-
290	*Nomada castellana* DUSMET, 1913	-	+	-	-
291	*Nomada conjugens* HERRICH-SCHÄFFER, 1839	+	+	-	-

1	*2*	*3*	*4*	*5*	*6*
292	*Nomada errans* LEPELETIER, 1841	+	-	-	-
293	*Nomada fabriciana* (LINNAEUS, 1767)	+	+	+	+
294	*Nomada femoralis* Morawitz, 1869	+	-	+	-
295	*Nomada ferruginata* (LINNAEUS, 1767) *Nomada xanthostica* K.	+	+	+	+
296	*Nomada flava* PANZER, 1798	-	-	+	+
297	*Nomada flavoguttata* (KIRBY, 1802)	+	+	+	+
298	*Nomada flavopicta* (KIRBY, 1802)	+	+	+	-
299	*Nomada fucata* PANZER,1798	+	+	+	+
300	*Nomada fulvicornis* FABRICIUS,1793	+	+	+	+
301	*Nomada furva* PANZER, 798	-	-	+	+
302	*Nomada fuscicornis* NYLANDER,1848	-	-	+	-
303	*Nomada goodeniana* (KIRBY,1802)	+	+	+	+
304	*Nomada guttulata* SCHENCK,1861	+	-	-	-
305	*Nomada lathburiana* (KIRBY,1802)	+	+	+	+
306	*Nomada leucophthalma* (KIRBY,1802) *Nomada borealis* ZETT.	+	+	+	+
307	*Nomada marshamella* (KIRBY, 1802)	+	+	+	+
308	*Nomada moeschleri* ALFKEN, 1913	+	+	+	+
309	*Nomada mutabilis* MORAWITZ, 1871	+	-	+	-
310	*Nomada ochrostoma* ZETTERSTEDT, 1838	+	+	+	+
311	*Nomada opaca* ALFKEN, 1913	-	+	-	-
312	*Nomada panzeri* LEPELETIER, 1841	-	+	+	+
313	*Nomada rhenana* MORAWITZ, 1872	+	-	-	-
314	*Nomada roberjeotiana* PANZER, 1799	+	+	+	-
315	*Nomada ruficornis* (LINNAEUS, 1758)	+	+	+	+
316	*Nomada rufipes* FABRICIUS, 1793	+	+	+	-
317	*Nomada sexfasciata* PANZER, 1799	+	+	-	-
318	*Nomada sheppardana* (KIRBY, 1802)	-	+	-	-
319	*Nomada signata* JURINE, 1807	-	+	+	+
320	*Nomada stigma* FABRICIUS, 1804	-	-	+	-
321	*Nomada striata* FABRICIUS, 1793	+	+	+	-
322	*Nomada zonata* PANZER, 1798	+	+	-	+
323	*Ammobates punctatus* (FABRICIUS, 1804)	+	+	-	-
324	*Biastes brevicornis* (PANZER, 1798)	+	-	-	-
325	*Biastes truncatus* (NYLANDER, 1848)	+	-	-	-
326	*Epeolus cruciger* (PANZER, 1799)	+	+	+	+
327	*Epeolus schumeli* SCHILING, 1848	+	-	-	-
328	*Epeolus variegatus* (LINNAEUS, 1758)	+	+	+	+
329	*Epeoloides coecutiens* (FABRICIUS, 1775)	-	+	-	-
330	*Bombus confusus* SCHENCK, 1859	+	-	-	-
331	*Bombus cryptarum* FABRICIUS, 1775	-	+	+	+
332	*Bombus distinguendus* MORAWITZ, 1869	+	+	+	+
333	*Bombus hortorum* (LINNAEUS, 1761)	+	+	+	+
334	*Bombus humilis* ILLIGER, 1806 *Bombus solstitialis* PANZ.	+	+	+	-
335	*Bombus hypnorum* (LINNAEUS, 1758)	+	+	+	+

1	2	3	4	5	6
336	*Bombus jonellus* (KIRBY, 1802)	+	+	+	-
337	*Bombus lapidarius* (LINNAEUS, 1758)	+	+	+	+
338	*Bombus lucorum* (LINNAEUS, 1761)	+	+	+	+
339	*Bombus magnus* VOGT, 1911	-	+	+	-
340	*Bombus muscorum* (LINNAEUS, 1758)	+	+	+	+
341	*Bombus pascuorum* (SCOPOLI, 1763) *Bombus agrorum* (FABR.)	+	+	+	+
342	*Bombus pomorum* (PANZER, 1805)	+	+	+	-
343	*Bombus pratorum* (LINNAEUS, 1761)	+	+	+	+
344	*Bombus ruderarius* (MÜLLER, 1776)	+	+	+	+
345	*Bombus ruderatus* (FABRICIUS, 1775)	+	-	+	-
346	*Bombus semenoviellus* SKORIKOV, 1910	-	+	+	-
347	*Bombus soroeensis* (FABRICIUS, 1776)	+	+	-	-
348	*Bombus subterraneus* (LINNAEUS, 1758)	+	+	+	+
349	*Bombus sylvarum* (LINNAEUS, 1761) *Bombus sylvarum v. equestris* (FABR.)	+	+	+	+
350	*Bombus terrestris* auct. nec (LINNAEUS, 1758)	+	+	+	+
351	*Bombus veteranus* (FABRICIUS, 1793)	+	+	+	-
352	*Psithyrus barbutellus* (KIRBY, 1802)	+	+	+	-
353	*Psithyrus bohemicus* (SEIDL, 1837)	+	+	+	+
354	*Psithyrus campestris* (PANZER, 1801)	+	+	+	+
355	*Psithyrus rupestris* (FABRICIUS, 1793)	+	+	+	+
356	*Psithyrus sylvestris* LEPELETIER, 1832	-	+	+	+
357	*Psithyrus vestalis* (GEOFFROY IN FOURCROY, 1785)	+	+	+	+
358	*Apis mellifera* LINNAEUS, 1758	+	+	+	+
	Suma	279	257	275	181

[i] Recorded from Nakło by STOECKHERT (1933), after V. TORKA
[ii] One specimen (1♂) collected in the environs of Gorzów Wielkopolski (Landsberg) by G. GÖTZE in 1927 (BANASZAK 2006) ; also reported from Wielkopolska National Park by SZULCZEWSKI (1948)
[iii] Reported from Poznań ("Posen") by STOECKHERT (1933)
[iv] Reported from Poznań ("Posen") by STOECKHERT (1933)
[v] A specimen from Bydgoszcz was found by STOECKHERT (1933) in R. MEYER'S collection

Description of the bee fauna around the year 1900

Species composition

Following verification of species names listed in TORKA'S work of 1913, and taking into account his later addenda (1916, 1933) and publications of other researchers of that time, the number of bee species collected by TORKA is 279. A list of these species, including their names as given by TORKA, can be found in Table 1. It needs to be noted that this number is high and comparable to species numbers reported from the neighbouring regions at that time. BLÜTHGEN (1919, 1942), for example, listed 273 species from Western Pomerania; ALFKEN (1912) listed 272 species from Gdańsk Pomerania (West Preussen), DITTRICH (1903) found 315 species in Silesia, and ŁOZIŃSKI (1920) reported 274 species from Małopolska.

Abundance

In TORKA'S times, faunal research consisted in capturing all individuals of species occurring sporadically or relatively rarely and only some individuals of more frequent or common species. The size of that part was an arbitrary decision, a fact usually not mentioned by authors, and quantitative studies were not yet practiced. Faunal researchers of the time assessed abundance individually, categorizing species as: occurring as isolated individuals, very rare or rare, frequent, and common. Table 2 lists the species which were described by TORKA (1913) as "frequent" and "common" or "rare".

TORKA regarded the following frequent species as common to the area of study: *Hylaeus annulatus, Andrena flavipes, Evylaeus calceatus, E. albipes, E. morio, Osmia rufa, Anthidium manicatum, Bombus terrestris, Psithyrus vestalis.* To this group can be added several colony-forming species, often found in very large numbers, such as *Andrena vaga*, *A. labialis*, *Dasypoda hirtipes*, or *Anthophora plumipes.*

Between the group of species classified as "rare", captured as isolated individuals (66), and those referred to as "frequent" or "common" (72) are 136 "indistinct" species, i.e. not very frequent though distributed all over the study area.

Table 2. List of "frequent" and "rare" species in Wielkopolska-Kujawy Lowland in TORKA'S times (1913).

Species	Frequent	Rare
1	*2*	*3*
Colletes cunicularius	+	
Colletes daviesanus	+	
Colletes floralis		+
Colletes fodiens		+
Colletes nasutus		+
Colletes similis		+
Colletes succinctus	+	
Hylaeus angustatus		+
Hylaeus annulatus	+	
Hylaeus nigritus		+
Hylaeus pictipes		+
Andrena bicolor	+	
Andrena chrysosceles		+
Andrena clarkella		+
Andrena curvungula	+	
Andrena flavipes	+	
Andrena fucata		+
Andrena fulva		+
Andrena haemorrhoa	+	
Andrena labialis	+	
Andrena lapponica	+	
Andrena lepida		+
Andrena minutula	+	
Andrena morio		+
Andrena nigroaenea	+	
Andrena ovatula	+	
Andrena pilipes	+	
Andrena praecox	+	
Andrena pubescens	+	
Andrena rosea		+
Andrena similis		+
Andrena suerinensis		+
Andrena vaga	+	
Andrena varians	+	
Andrena wilkella	+	
Rhophitoides canus	+	
Systropha curvicornis	+	
Seladonia subaurata		+
Halictus compressus		+
Halictus quadricinctus	+	
Halictus sexcinctus	+	
Lasioglossum sexnotatum	+	
Lasioglossum leucozonium	+	
Lasioglossum sexnotatulus		+
Lasioglossum xanthopus	+	
Evylaeus albipes	+	
Evylaeus brevicornis		+
Evylaeus calceatus	+	
Evylaeus convexiusculus		+
Evylaeus fratellus		+
Evylaeus fulvicornis	+	
Evylaeus interrupus	+	
Evylaeus laevis		+
Evylaeus linearis		+
Evylaeus lucidulus		+
Evylaeus minutissimus		+
Evylaeus morio	+	
Evylaeus nitidiusculus	+	
Evylaeus politus		+
Evylaeus punctatissimus	+	
Evylaeus quadrinotatulus	+	
Evylaeus sexstrigatus		+
Evylaeus villosulus	+	
Dufourea dentiventris		+
Sphecodes crassus		+
Sphecodes ferruginatus		+
Sphecodes gibbus	+	
Sphecodes longulus		+
Sphecodes miniatus	+	
Sphecodes monilicornis	+	
Sphecodes niger		+
Sphecodes pellucidus	+	
Sphecodes puncticeps	+	
Sphecodes reticulatus		+
Sphecodes spinulosus	+	
Melitta leporina	+	
Melitta tricincta		+
Dasypoda argentata		+
Dasypoda hirtipes	+	
Dasypoda thomsoni=aurata		+
Anthidium manicatum	+	
Anthidium punctatum		+
Anthidiellum strigatum	+	
Stelis signata		+
Stelis breviuscula		+
Stelis minuta		+
Stelis ornatula		+
Chelostoma campanularum		+
Chelostoma florisomne	+	
Anthocopa papaveris		+
Anthocopa spinulosa		+
Hoplitis adunca	+	
Hoplitis tridentata		+
Osmia rufa	+	
Osmia bicolor		+
Osmia inermis		+

1	*2*	*3*
Osmia mustelina		+
Osmia nigriventris		+
Osmia uncinata		+
Megachile circumcincta	+	
Megachile maritima	+	
Megachile octosignata		+
Megachile rotundata		+
Megachile versicolor		+
Coelioxys afra		+
Coelioxys quadridentata	+	
Coelioxys rufescens	+	
Anthophora plumipes	+	
Amegilla quadrifasciata		+
Eucera longicornis	+	
Melecta luctuosa		+
Nomada armata		+
Nomada conjugens		+
Nomada errans		+
Nomada flavoguttata	+	
Nomada fucata	+	
Nomada fulvicornis	+	
Nomada goodeniana	+	
Nomada guttulata		+

1	*2*	*3*
Nomada rhenana		+
Nomada ruficornis	+	
Ammobates punctatus		+
Biastes truncatus		+
Bombus pascuorum	+	
Bombus confusus		+
Bombus veteranus		+
Bombus hortorum	+	
Bombus humilis	+	
Bombus hypnorum	+	
Bombus lapidarius	+	
Bombus lucorum	+	
Bombus pomorum	+	
Bombus pratorum	+	
Bombus soroeensis		+
Bombus terrestris auct	+	
Psithyrus campestris	+	
Psithyrus rupestris	+	
Psithyrus vestalis	+	
Total	72	66

PRESENT-DAY BEE FAUNA

While earlier studies by J. BANASZAK and his students T. CIERZNIAK and W. BANASZAK (later known as BANASZAK-CIBICKA) did furnish a large amount of data on the present-day fauna of Wielkopolska-Kujawy Lowland (see p. 368), they were actually generally limited to the central part of the region, i.e. Poznań and its environs with Wielkopolska National Park and the Kościan area with the Agroecological Landscape Park. Comparison of the bee fauna as it was 100 years ago and today's fauna of bees required additional field work in the main area of TORKA'S explorations, i.e. along the River Noteć. The plan was helped by the author's move from Poznań to Bydgoszcz to work there, which made the exploration of the land along the Noteć much easier.

Study area and methods

The research project under the working title "In the Wake of TORKA" was commenced in 2000 and completed in 2010. The area of study extended over a large part of Wielkopolska-Kujawy Lowland, mainly areas along the Noteć, particularly those between Nakło and Bydgoszcz, but also the environs of Żnin and Gniezno, the drainage basin of the River Główna near Poznań (Wierzonka-Wierzenica), and additionally also Wielkopolska National Park (WNP) and the General Dezydery Chłapowski Agroecological Landscape Park (Turew and the environs of Kościan). WNP and the Agrocecological Landscape Park were included as part of a programme investigating local faunal changes at permanent sites over a period of 10 years. Our core objective was to visit all localities previously studied by TORKA (Fig. 1). Individual localities/study sites were visited once or more than once. Most of these visits were to sites in Bydgoszcz and smaller neighbouring towns. The total num-

ber of localities (towns and villages) was 51; however, since 10 sites were visited in the city of Bydgoszcz, the total number of study sites amounted to 61. A list of these sites with short descriptions is given below (Fig. 3). Specimens were collected by the author as well as by students whose M.A. theses the author supervised. The theses were mostly concerned with bumble bees. The remaining abundant materials were handed over to the present author and subsequently used in the preparation of this paper.

Bees were collected into aerial nets and MOERICKE'S pitfall traps, i.e. yellow or white bowls filled with liquid (water, ethylene glycol, washing-up detergent). Traps were emptied once a week. Traps were placed only on permanent sites serviced by the author's M.A. students.

For abundant species, the aerial net was only used for collecting representatives of species to document their presence at a site. This practice was used especially in the case of species forming large colonies, such as *Colletes cunicularius, Andrena vaga, A. clarakella,* or *Dasypoda hirtipes*. One such colony numbers from several dozen up to several thousand individuals. Care was taken to limit the catches of legally protected species to a minimum.

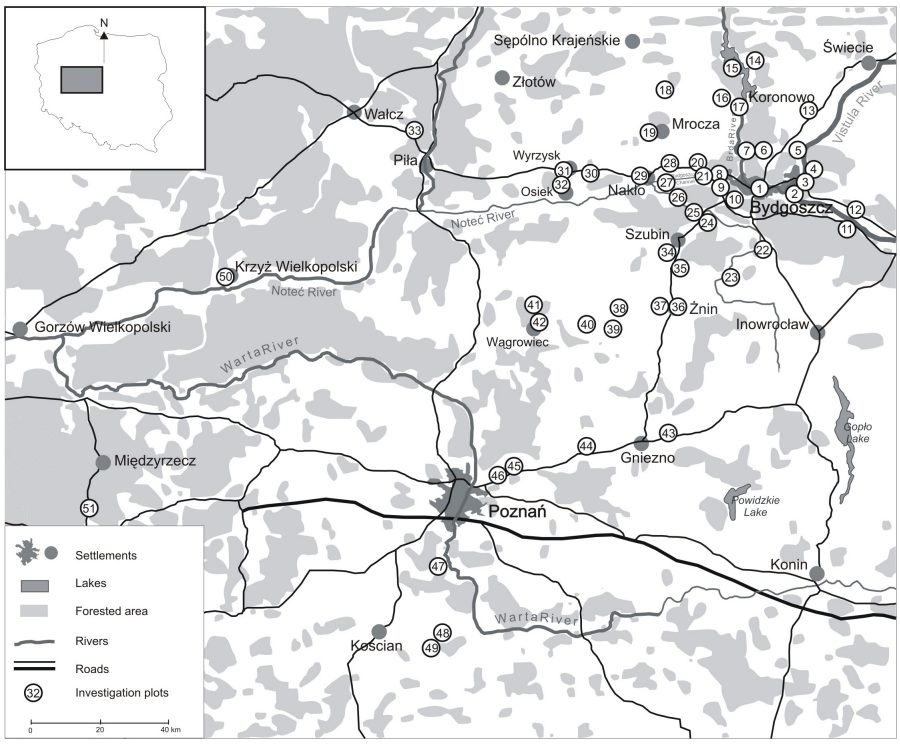


Fig. 3. Wielkopolska-Kujawy Lowland, study sites in the years 2000-2010: see text for explanation.

In a few sites (Wągrowiec, Werkowo near Węgrowiec, Bydgoszcz, the area around Koronowo near Bydgoszcz), nest traps were additionally mounted in order to assess the abundance of Aculeata species. A nest trap consisted of 150 fragments of a 25 cm long reed stem placed in PVC tubes of the same length.

2000-2010 study sites

1. Bydgoszcz (Fig. 3)

a. City centre, 31 Gdańska St. – flower boxes with Bidens (*Bidens ferulifolium*) on a balcony (2nd floor). Bees were collected by the author from flowers with an aerial net and into white and yellow bowls, 2000-2003.

b. Fordon – peripheries of housing estates in Fordon. We studied slopes of the Vistula glacial valley with plots of grasslands and meadows with *Pruno-Crataegetum* shrubs. At the base of the hill in Fordon is an *Arrhenatheretum medioeuropaeum* mesic hay meadow, and higher up are patches of *Pruno-Crataegetum* shrubs in various stages of development mixed with a xerothermal grassland of the class *Festuco-Brometea*, with a high contribution of *Papilionaceae* and, sometimes, plots of *Calamagrostis epigejos*. Bee-attracting species include large plots of *Rosa canina*, *Anchusa officinalis*, *Echium vulgare*, *Salvia officinalis*, *Rubus* sp., *Cichorium intybus*, *Senecio jacobaea*, *Umbelliferae*, *Carlina vulgaris* and others. Bees were also captured over a large area of feral vegetation on former arable land extending over the slopes which supported a succession stage of psammophilous grassland evolving towards *Diantho-Armerietum* community, with fragments of meadow communities. The bee-attracting species found here included particularly large plots of *Hieracium pilosella*, *Jasione montana*, *Helichrysum arenarium*, *Trifolium arvense*, *Vicia villosa*, *Senecio jacobaea*, and *Tanacetum vulgare*. Bees were collected by the author with aerial nets from 2005 to 2008.

c. Fordon – a housing estate along Wyzwolenia St. – bees were collected with aerial nets and into Moericke's yellow bowls in 2003 (N. ROMANOWSKA) and, in the same year, in Zaruskiego St. in Osiedle Tatrzańskie estate (M. PILARSKA).

d. Fordon - Wyszogród – the slopes of a mediaeval fortress with a xerothermal grassland and sandy or clayey walls. Bees were collected on 15 June 2003, mainly from *Echium vulgare* and *Centaurea scabiosa* (J. BANASZAK).

e. Szwederowo – Gackowskiego St. – house gardens and lawns in a densely built-up area. Bees were collected with aerial nets and into Moericke's yellow bowls in 2003 (M. PILARSKA).

f. Góra Zamkowa (Zamczysko) – an outcrop on a plateau supporting a mediaeval fortress. Bees were collected on one occasion (24 June 2000) on a slope with a xerothermal grassland (J. BANASZAK).

g. Myślęcinek – Botanical Gardens (within an escarpment of the Vistula glacial valley) – a grassland with plots of *Helichrysum arenarium*, *Hypochoeris radicata*, *Jasione montana*, *Medicago, Senecio jacobaea, Solidago virga-aurea, Picris hieracioides, Cichorium intybus*,

Cornus mas, and *Salix* sp. Bees were collected by the author on 25 June 2000 and 17 March 2002.

h. Botanical Garden of Kazimierz Wielki University (since 1927) – situated in the centre of the city at the intersection of CHODKIEWICZA St., NIEMCEWICZA St. and Powstańców Wielkopolskich St., 2.3 ha in area. The vegetation comprises 204 spontaneous species, and 310 introduced trees and shrubs. Bees were mainly collected into MOERICKE'S traps and sporadically into aerial nets in the growing season of 2003 (D. DELTOW) and 2006 (M. BOBOWSKI). Some findings were described in the unpublished M.A. theses of both collectors (DELTOW 2004, BOBOWSKI 2007).

i. Miedzyń – an undeveloped area between Świdnicka St.–Polanicka St. and Oleśnicka St., near the Bydgoszcz Canal with a psammophilous grassland and ruderal areas with *Taraxacum officinale*, *Echium vulgare*, *Vicia* sp., *Melilotus albus*, *Centaurea rhenana*, *Linaria vulgaris*, *Ballota nigra*, and *Lamium album*. Bees were collected by the author into aerial nets from 2005 to 2008.

j. Institute Environmental Biology – the backyard supports a lawn community floristically resembling pastures with solitary trees of *Acer platanoides*, *Tilia cordata*, and *Aesculus hippocastanum*, and herbaceous plants, including *Bellis perennis, Crepis biennis*, *Taraxacum officinale*, *Leontodon autumnalis*, and *Bryonia alba*. Catches were carried out rather regularly by the author in 2007 and 2010. Also in 2003, nest traps (strands of reed) were put out and subsequently colonized by *Osmia caerulescens* (G. WUDZIŃSKA).

k. Viridary of Kazimierz Wielki University – a rectangular green (0.34 ha) surrounded on all sides by university walls at 30 Chodkiewicza St. Floral census revealed the presence of 153 taxa of vascular plants forming 18 communities with a dominant grassland community, with plots of *Convolvulo-Brometum inermis*, *Arrhenatheretum medioeuropaeum*, *Lolio-Cynosuretum*, *Urtico-Aegopodietum*, *Alliario-Chaerophylletum*, *Chelidonium majus* community, and others. Bee-attracting trees include *Robinia pseudoacacia*, *Tilia cordata*, and *Prunus spinosa*. Bees were captured from March to September 1999 (T. MARQUARDT) into 21 MOERICKE'S traps. Some of the findings were presented in the unpublished M.A. thesis by T. MARQUARDT (2000).

2. Mała Kępa Ostromecka – a riverine flood meadow. Bees were collected into an aerial net by the author on 20 July 2003.

3. Wielka Kępa reserve, Ostromecko (27.6 ha) – a riparian forest along the Vistula with alder and field maple. Bees were collected into yellow bowls and aerial nets by J. GŁOWACKI and the author in 2002.

4. Ostromecko near Bydgoszcz – palace park. Bees were collected with an aerial net from *Lamium album, L. purpureum,* and *Taraxacum officinale*, and from flowers of *Aesculus hippocastanum* on 2 May 2000.

5.Strzelce Dolne near Bydgoszcz – a fragment of the Vistula floodplain approximately 80 ha in area, with in-field clumps of trees with *Salix fragilis*, a hay meadow, abandoned land, a poplar riparian forest, a *Salix* stand with *Salix alba*, *S. fragilis* and *S. viminalis*, numerous herbaceous plants, including *Symphytum officinale, Lamium purpurea, L. album*, *Ae-*

gopodium podagraria, Trifolium pratense, Taraxacum oficinale, Lathyrus pratensis, Vicia cracca, Carduus crispus, Cirsium arvense, and *Lythrum salicaria*. Collections with yellow bowl traps and aerial nets were carried out in 2001 by the author's M.A. students K. MORZYŃSKA and J. POPA. The author collected bees with an aerial net on 22 April 2006. Some of the findings were presented in the unpublished M.A. thesis of K. MORZYŃSKA (2002).

6. Maksymilianowo near Bydgoszcz – the edge of a pine forest near a railway station with a contribution of *Melilotus officinalis* and *Hieracium* sp. Bees were collected by the author with an aerial net on 11 May 2000 and 5 June 2002.

7. Bożenkowo near Bydgoszcz – a xerothermal grassland with a high contribution of *Helichrysum arenarium, Jasione montana* and *Senecio jacobaea*. Bees were collected by the author with an aerial net on 13 August 2000.

8. Pawłówek near Bydgoszcz – a wasteland in the vicinity of a pine forest with a rich herbaceous cover including *Jasione montana, Hieracium pilosella,* and *Carduus* sp. Bees were collected by the author with an aerial net on 10 August 2003.

9. Łochowice near Bydgoszcz – pine forest, a culture with *Calluna vulgaris*. Bees were collected by the author with an aerial net on 11 September 2004.

10. Trzciniec near Bydgoszcz – a pine forest with *Juniperus communis, Vaccinium myrtillus,* and *Rubus* sp. Bees were collected by the author with an aerial net from flowers of *Tanacetum* sp. *Calluna vulgaris*, *Campanula rotundifolia* and *Melampyrum pratense* on 15 August 2000.

11. Przyłubie near Solec Kujawski – a dune in a pine forest. Bees were collected by the author with an aerial net on 2 August 2001.

12. Czarnowo near Bydgoszcz – flood meadows on the Vistula with *Salix fragilis, S. caprea* and other species. Catches into MOERICKE'S traps and aerial nets by J. KARBOWNIK in the years 2008-2010.

13. Żołędowo near Bydgoszcz – the edge of a pine forest. Bees were collected by the author with an aerial net on 9 August 2003.

14.,16.,17. Koronowo–Skarbiewo–Cierplewo – small towns on Koronowo Reservoir, where nest traps (strands of reed) were put out to allow nesting of stinging wasps. The following five bee species were reared: *Hylaeus communis, Chelostoma rapunculi, Osmia caerulescens, O. rufa,* and *Megachile rotundata* (TOMASIK 2007).

15. Sokole-Kuźnica, Pobrdzie forester's hut on Koronowo Reservoir near Bydgoszcz – a xerothermal grassland and pine forest. Catches by author on 6-9 July 1999.

18. "Wawelno" Reserve near Sośno near Bydgoszcz – *Galio sylvatici–Carpinetum* Middle European Lowland oak-hornbeam forest (BOIŃSKI 1973). In 2003 and 2004, bees were collected into Moericke's yellow bowl traps and aerial nets by the author's M.A. student I. SŁOMA. Some of the findings were presented in the unpublished M.A. thesis, concerned only with bumble bees (SŁOMA 2005).

19. Mrocza near Nakło – a pine forest. Bees were collected by the author with an aerial net from flowers of *Sorbus aucuparia* on 11 May 2000 and from *Veronica chamaedrys* on 18 May 2002.
20. Kruszyniec near Bydgoszcz – meadows along the Bydgoszcz Canal. Bees were collected into MOERICKE'S pitfall traps. There was a massive appearance of *Osmia bicolor* (J. WENDZONKA).
21. "Kruszyn" Landscape Reserve near Bydgoszcz – wooded slopes of the Noteć glacial valley with fragments of slope-associated oak-hornbeam forest representing features of *Tilio-Carpinetum* or *Galio-Carpinetum* (KOMENDARCZYK 1993). Bees were collected in 2003 and 2004 into MOERICKE'S pitfall traps (white bowls) and aerial nets by the author's M.A. student A. SZCZEPIŃSKA. Some of the findings regarding bumble bees were the basis for her unpublished M.A. thesis (SZCZEPIŃSKA 2005).
22. "Dziki Ostrów" Reserve near Brzoza near Bydgoszcz – a thinned oak wood with belts of *Convallaria majalis*, and isolated individuals of *Polygonathum odoratum* and other species. Bees were collected by the author with an aerial net on 20 May 2009.
23. Lubostroń near Bydgoszcz – palace park. Bees were collected by the author from 2002 to 2006. These results have been published (BANASZAK 2008).
24. Ostrów Małe Rudy near Szubin – a small (approx. 6 ha) island of xerothermal vegetation amongst mesic meadows in the Noteć River Valley. The thinned forest stand is dominated by *Quercus petraea*, *Populus tremula* and *Betula pendula.* A total of 160 vascular plant species have been found here (KRASICKA-KORCZYŃSKA, KORCZYŃSKI 2003). Bee-attracting plants include *Primula veris*, *Frangula alnus, Helichrysum arenarium*, *Sedum maximum, Salix rosmarinifolia, S. cinerea*, *Fragaria vesca, Potentilla arenaria*, *Crataegus monogyna, Trifolium arvense, T. repens*, *Lotus corniculatus*, *Armeria maritima* ssp. *elongata, Symphytum officinale, Echium vulgare, Linaria vulgaris, Veronica chamaedrys, V. spicata, Stachys officinalis, Thymus serpyllum, Solidago virgaurea, Cirsium arvense, Senecio jacobaea*, and other species. Bees were collected regularly by the author in 2004 and 2005.
25. Rynarzewo near Bydgoszcz – a hay meadow in the Noteć River Valley with a considerable contribution of bee host plants, such as *Arabis arenosa, Lamium purpureum, L. album, Taraxacum officinale*, *Symphytum officinale*, *Lychnis flos-cuculi, Potentilla anserina, Anthriscus sylvestris*, *Lysimachia vulgaris, Eupatorium cannabinum. Linaria vulgaris, Capsella bursa-pastoris, Stellaria palustriss, Rorippa sylvestris,* and *Cirsium arvense*. Bees were collected regularly by the author in 2006 and 2007 (14 visits).
26. Tur near Bydgoszcz – meadows in the Noteć River valley. Bees were collected by the author in April and May 2001.
27. Gorzeń near Bydgoszcz – a pine forest with *Hieracium pilosella*, *Rubus* sp., and large plots of blooming *Cytisus scoparius* and a meadow with *Symphytum officinale*. Bees were collected by the author with an aerial net on 19 May 2002.
28. Ślesin near Nakło, "Skarpy Ślesinskie" reserve, a xerothermal grassland with *Primula veris, Rosa canina, Prunus spinosa, Anchusa officinalis, Echium vulgare, Taraxacum offi-*

cinalis, *Galium sp., Salvia officinalis, S. pratensis, Senecio vernalis, Potentila argentea, Campanula sibirica, Reseda lutea, Onobrychis viciaefolia*, and other species. Bees were collected by the author with an aerial net on 7 and 28 June 2001; 18 May and 19 June 2002; and 6 and 25 May 2003.

29. Nakło – meadows along the River Noteć with willows and *Taraxacum officinale* and escarpments in front of an entrance into the town with numerous blooming individuals of *Prunus spinosa*. Bees were collected by the author with an aerial net on 4 May 2001 and also in meadows along the Noteć with *Lythrum salicaria* and *Tanacetum* sp. on 11 August 2001.

30. Samostrzel near Nakło – a grassland on a slope among fields. Bees were collected by the author with an aerial net on 17 July 2003.

31. Wyrzysk – a meadow with numerous individuals of *Taraxacum officinale*, *Berteroa incana* and other species. Bees were collected by the author with an aerial net on 17 July 2003 and 2 May 2007.

32. "Zielona Góra" reserve near Wyrzysk –*Galio-sylvatici-Carpinetum* Middle European Lowland oak-hornbeam forest (NAWROT 1992). Bees were regularly collected into Moericke's white bowls and aerial nets in the years 2003-2005 by the author's M.A. student R. NOWAK-KAŁUŻNA (unpublished M.A. thesis in 2006).

33. Łubianka near Piła – a pine forest with *Calluna vulgaris*. Bees were collected by the author with an aerial net on 3 August 2002.

34. "Folusz" proposed reserve near Szubin near Bydgoszcz – a dune hill among meadows. Bees were collected by the author over several years. The results have been published (BANASZAK et al. 2004).

35. Wąsosz near Szubin – a wasteland and meadows over Lake Zędowskie with *Cirsium palustre, Berteroa incana* and other species. Bees were collected by the author with an aerial net on 11 July 2003.

36. Żnin – an escarpment supporting a xerothermal grassland with *Achillea millefolium*, *Lotus corniculatus*, *Centaurea scabiosa,* and *Jesione montana*. Bees were collected by the author with an aerial net on 5 August 2001.

37. Sarbinowo near Żnin – a winter rape plantation and a roadside area with a blooming *Crataegus* sp. Bees were collected by the author with an aerial net on 26 May 2001.

38. Damasławek – 15 km W of Żnin – a xerothermal grassland with *Salvia pratensis*. Bees were collected by the author with an aerial net on 25 May and 6 July 2001.

39. Brudzyń, 20 km SW of Żnin – an agricultural landscape, winter rape plantations and a roadside belt near an in-field clump of trees. Bees were collected by the author with an aerial net on 26 May 2009 and 6 July 2009.

40. Rąbczyn - 10 km E of Wągrów – a pine thicket. Bees were collected by the author with an aerial net on 26 May 2001 from *Hieracium pilosella* and *Cytisus scoparius.*

41. "Dębina" Reserve near Wągrowiec (23 ha) – an oak-hornbeam stand at the edge of a forest. Bees were collected by the author in 1969-70. The results have been published (BANASZAK 1977).

42. Wągrowiec and its surroundings – The occupancy of nest traps (reed stems) by stinging wasps was studied in the town and its surroundings (J. GIRUS, unpublished M.A. thesis, 2006). Nest traps of reed stems were also employed by N. KĘDZIORA in her work in the village of Werkowo and its surroundings, 10 km east of Wągrowiec, in the study season of 2005 (KĘDZIORA, unpublished M.A. thesis, 2006).
43. Jankowo Dolne near Gniezno – a wasteland near a railway station with *Carduus* sp., *Senecio jacobaea, Jasione montana, Helichrysum arenarium,* and other species. Bees were collected by the author with an aerial net on 14 July 2002 and 16 July 2003, mainly in search of *Megachile octosignata* (unsuccessful).
44. Dziekanowice near Gniezno – bees were collected by the author over a period of several years (1994-2007) in Lednica Landscape Park; these results have not been published. This locality contains the only present-day site of *Anthophora plagiata* (BANASZAK 1996, BANASZAK W.A. 2005).
45.,46. Wierzenica-Wierzonka-Kicin near Poznań – an agricultural landscape. Bees were collected by the author with an aerial net on 6 July 2001 and 1-2 May 2003 on roadside strips and in-field clumps of trees.
47. Wielkopolska National Park – bees have been collected by the author over several years, also as part of a project to assess local faunal changes over a period of 10 years. Relevant publications have included BANASZAK 1997, BANASZAK et al. 2003.
48., 49. Turew and Rogaczewo near Kościan (appr. 50 km S of Poznań) – study sites selected by the author in an agricultural landscape (in-fields clumps of trees) as part of a project to assess changes in the local bee fauna over a period of 10 years. Relevant publications: BANASZAK (1997), BANASZAK et. al. (2003).
50. Krzyż Wielkopolski – disused railway tracks near a railway station with grassland and ruderal vegetation with numerous presence of *Echium vulgare, Anchusa officinalis, Centaurea scabiosa*, *C. rhenana*, and *Medicago* sp. Bees were collected with an aerial net on 9 August 2002, 15 July 2003 and 15 July 2010, mainly in search of *Anthophora quadrifasciata* (unsuccessfully!).
51. Gościkowo-Paradyż – a diversified site near a disused railway station comprising a railway track, a grassland, a field of blooming rape, and a wasteland with a belt of *Senecio vernalis*; Bees were collected by the author with an aerial net on 28 April 2007. Bees were also collected on hill slopes among fields near Paradyż on 29 April 2007. Plots of *Cytisus scoparius* were frequented by numerous flying insects, mainly bumble bees.

Description of the bee fauna around the year 2000
Species composition and dominance patterns

A total of 20,883 individuals of Apiformes were captured in the 2000-2010 decade. This collection, together with data gathered by the author in the years 1970-2000 and published in previous papers, forms a basis for the present analysis and comparison with V. TORKA'S data from the turn of the 20th century.

This newest investigation has identified 257 species in the area of study. Supplemented with some of the species identified in earlier studies (BANASZAK 1982, 2008, BANASZAK et al. 2004), mainly around Poznań or steppe reserves along the Noteć and Vistula (Bydgoszcz area), the total contemporary inventory of bee species from Wielkopolska-Kujawy Lowland amounts to 317 species (Table 1). The present-day fauna of bees in this region thus accounts for approximately 67% of the entire native bee fauna in Poland.

The identification of such a high number of species is owed to the collection of ample material thanks to a variety of collection techniques and the large and diversified area of study. Even so, the abundances of individual species vary widely, from a few individuals to numbers in excess of one thousand for the most common species. It needs to be noted that collection by stalking deliberately did not involve capturing all individuals of the most abundant or common species, such as those forming colonies of several dozen to several hundred individuals (e.g. *A. vaga* and *A. fulva*). Some bumble bees were also not massively captured on account of their protected status.

In order to present differences in abundance, the species were divided into 6 classes of abundance (Table 3).

Table 3. Abundance classes of bees in Wielkopolska-Kujawy Lowland in the 2000-2010 decade.

Category	Range (N of individuals)	Number of species	%	Species group
I	1 – 10	136	52.9	Very rare
II	11 – 20	37	14.4	Rare
III	21 – 100	43	13.2	Frequent
IV	101 – 500	36	14.0	Abundant
V	501 – 1000	3	1.2	Very abundant
VI	> 1000	2	0.8	Common

Each of these classes (species groups) needs to be described in greater detail and merits a commentary.

Very rare species, class I (1–10 individuals). This group contains species classified into various categories of endangerment: those known only from a few sites in the country, species that are rare but found in scattered localities across the country or in one part of Poland, or even those occurring quite commonly all over the country but rarely captured, for unclear reasons, during this study. This latter group includes: *Rhophitoides canus, Evylaeus brevicornis, E. quadrinotatulus, Lasioglossum quadrinotatum, L. zonulum, Andrena labialis* (often in large colonies), *A. lapponica* (found at all *Vaccinia* sites), *A. albofasciata, Megachile rotundata* (also domesticated), *M. apicola, Chalicodoma ericetorum, Osmia caerulescens, O. fulviventris,* and *O. brevicornis*. A special group is that of parasitic bees, which require the use of special search techniques near their hosts' nests and, for this

reason, were not caught in large numbers in our study, although some are classified as fairly frequent or frequent in Poland, including *Sphecodes pellucidus, S. gibbus, S. longulus, S. crassus, Epeolus variegatus, E cruciger, Psithyrus vestalis, Ps. barbutellus, Coelioxys quadridentata, Nomada fuvicornis, N. succincta, N. zonata, N. flavopicta, N. sexfasciata, N. striata, N. rufipes, N. panzeri,* and *Anthophora furcata.* Less common, though scattered all across Poland (or in the greater part of the country), are the following species: *Evylaeus rufitarsis, E. punctatissimus, E. laevis (=lativentris), Lasioglossum majus, L. subfasciatum, Sphecodes miniatus, S. puncticeps, S. niger, S. ferruginatus, S. hyalinatus, Andrena bimaculata, A. denticulata, A. fuscipes, A nigriceps, A. rosae, A. wilkella, Osmia mustelina, O. aurulenta, Megachile anthocopoides, M. leucomelana, Coelioxys mandibulata, C. conoidea,* and *Bombus jonellus.*

Truly rare species occurring rarely all over the country and mostly known from few sites constitute a large group, with *Hylaeus nigritus*, *H. cardioscapus*, *H. cornutus*, *Rophites algirus*, *Bombus distinguends*, *B. magnus*, *B. pomorum*, *B. ruderatus*, *B. semenoviellus*, *B. soroeensis proteus*, *B. subterraneus*, *B. jonellus*, *Sphecodes marginatus*, *S. rufiventris*, *Andrena blüthgeni*, *A. curvungula*, *A. florea*, *A. lepida*, *A. mitis*, *A. nycthemera*, *A. similima, A. suerinensis, A. synadelpha, A. alfkenella, Megachile genalis, Hoplitis tridentata, Megachile pilidens, Anthocopa spinulosa, Hoplitis claviventris, Athophora plagiata*, *A. pubescens, A. retusa, Tetralonia macroglossa, Epeoloides caecutiens, Nomada opaca, N. bifasciata, N. zonata, N. sheppardana, N. castellana, N. conjungens, Hylaeus moricei luteifrons, H. bisinuatus, H. punctatissimus, H. signatum, H. styriacus, Melitta tricincta, Chelostoma foveolatum, Rophites quinquespinosus, Systropha curvicornis, Seladonia semitecta, Evylaeus fratellus, Evyleus nigripes, E. semilucens, and Lasioglossum sexmaculatum.*

The species known from single sites in Poland merit more attention:

Hylaeus cornutus – a Mediterranean species; in Poland, it was previously recorded from the Noteć valley as far as Bydgoszcz and from Puławy. New localities: Bydgoszcz – Fordon 27 June 1999, 2♀♀, 14 July 1998, 1♀, by R. KRIGER; Strzelce Dolne near Bydgoszcz, 23 July 1999, 1♀, by R. KRIGER.

Andrena blüthgeni – its status as a separate species is not fully established. Some researchers treat *Andrena blüthgeni* as a synonym of *A. bimaculata* (KIRBY, 1802), for example DYLEWSKA (1987), GUSENLEITNER & SCHWARZ (2002). On the other hand, OSYTSHNIJUK (197) considers *A. blüthgeni* to be a synonym of *A. morawizi* THOMSON, 1872. In turn, WARNCKE (1967) regards both *A. blüthgeni* and *A. morawitzi* as subspecies of *A. bimaculata*. SHMIDT, EGGER & SCHEUCHL (1997) view all three as separate taxa. This problem requires further studies as the character used for distinguishing *A. bimaculata* and *A. blüthgeni,* i.e. the colour of the tibia and metatarsus of the hind legs, does not appear to be a robust character for distinguishing species. In view of the above controversies, the distribution of *Andrena blüthgeni* in Poland is unclear. New localities: "Wąwelno" reserve near Sośno, oak-hornbeam forest, 1 Apr 2004, 1♀, by SŁOMA; Bydgoszcz, 31 Gdańska St., 4

Apr 2001, 1♀, by J. BANASZAK. BANASZAK (2004) treats these three taxa as one (*Andrena bimaculata)* in his inventory of Polish bees.

Andrena florea – a species found across central and southern Europe, Asia Minor and Central Asia. Associated mainly (males) with *Bryonia alba* and *Bryonia vulgare*. In Poland, it is rare and has an insular distribution, though it can be more abundant at localities where its host plants grow. New localities: Bydgoszcz – Arboretum, 13 June 2006, 2♂♂, by M. BOBOWSKI; Bydgoszcz – lawn at Institute of Environmental Biology, June 2003, 1♀, by T. CIERZNIAK; 9 June 2010, numerous ♀♀ and ♂♂ on *Bronia alba*, by J. BANASZAK.

Andrena mitis – found in southern and central Europe and in Turkey. In Poland, it has been recorded only in the south, from Silesia and Cracow and from the environs of Tarnów. New localities: Bydgoszcz, Arboretum, 11 May 2003, 1♂, by D. DELTOW; Strzelce Dolne, Vistula flood plain, 3 May 2002, 1♂, by J. POPA, K. MORZYŃSKA; Wielka Kępa Ostromecka, 18 Apr 2002, 1♂, by GŁOWACKI; Kruszyn, 10 Apr 2004, 1♂, by A. SZCZEPIŃSKA.

Andrena nycthemera – a European species recorded in Poland from few scattered localities. New localities: Nakło, meadow, 4 May 2007, 1♀ on a *Salix* sp., by J. BANASZAK; Strzelce Dolne, meadow, 26 Apr 2001, 1♀, 18 Apr 2002, 1♀, by J. POPA, K. MORZYŃSKA.

Andrena synadelpha – distributed mostly in the West of Europe, reaching Poland and Turkey eastwards; very rare in the Czech Republic and eastern part of Germany. In Poland, it has been only recorded from the environs of Opole (DYLEWSKA 2000). New localities: Milno near Poznań, in-field clump of trees, 1♀, by T. CIERZNIAK; Strzelce Dolne, a *Salix cinerea* stand, 28 June 2001, 2♀, by J. POPA, K. MORZYŃSKA; Ślesin, escarpments, 18 May 2001, 1 ♀, by J. BANASZAK.

Megachile genalis – a widely distributed species occurring from southern and western Europe, to the Caucasus, western Kazakhstan, Central Asia, Mongolia, Siberia, and the Russian Far East, China and Japan. A Palaearctic species, in Europe it has been found in the southern and western part of the continent. It has been only recently discovered in Poland, although it occurs along the entire German-Polish border in Germany (RUHNKE 1998). In Poland, it has only been reported from Ojców National Park (CELARY & WIŚNIOWSKI 2002) and from Poznań (WENDZONKA 2005). New locality: Małe Rudy "Ostrów" near Szubin, 19 June 2006, 1♀, by J. BANASZAK.

Hoplitis claviventris – a widely distributed species found in an area ranging from Europe to the Caucasus, Kazakhstan, Siberia, the Russian Far East, and Mongolia. In Poland, its distribution has been poorly studied, since for a long time it was confused with *Hoplitis leucomelana*. Confirmed localities have been identified in Wielkopolska-Kujawy Lowland and Western Beskid Mts. New locality: Krzyż, railway ground – old railway track, 15 July 2010, 1♀, by P. SZEFER.

Anthophora plagiata – as late as the 1970's this species was known for its abundant, or sometimes massive, nesting in clay walls of buildings in the Polish lowlands (BANASZAK 1971); currently known only from one site in Dziekanowice near Gniezno (W.A. BANASZAK 2005).

Nomada opaca – a European species occurring north of 61°N. In Poland it has been known only from single localities in the Pomeranian Lakeland, Mazurian Lakeland, Mazovian Lowland, Upper Silesia and Sandomierz Lowland. New locality: Wyrzysk, "Zielona Góra" reserve, oak-hornbeam forest, 22 Aug 2003, 1♀.

Nomada bifasciata – distributed from northern Africa to southern and central Europe up to 51°N. In Poland it has previously been listed from single sites in Cracow–Wieluń Upland, Małopolska Upland, and the Western and Eastern Beskids. The new localities extend its range northwards: Bydgoszcz – Myślęcinek, 14 May 2000, 1♀; Bydgoszcz – Fordon, 10 May 2001, 1♀, by J. BANASZAK; Bydgoszcz Wyszogród, 20 May 2005, 2♀, by A. OLEKSA; Świecie, 22 May 1999, 1♀, by R. KRIGER.

Nomada sheppardana – Northern Africa and Europe up to 53°N. In Poland it has previously been listed only from single sites in Cracow-Wieluń Upland. New localities: Mrocza, 11 May 2000, 2♂, by J. BANASZAK.

Nomada castellana – reported from southern and central Europe up to 51°N. In Poland, it has only been listed from single sites in Cracow–Wieluń Upland and from Pieniny Mts. The new locality extends its range northwards: Ślesin, escarpments, 7 June 2001, 1♂, by J. BANASZAK; "Kruszyn" Reserve near Bydgoszcz, oak-hornbeam forest, 21 June 2003, 1♀, by A. SZCZEPAŃSKA.

Hylaeus moricei luteifrons – In Europe, it occurs in the central, southern and eastern part of the continent, and in the Caucasus. In Poland, it has only been listed from single sites in Wielkopolska–Kujawy Lowland. New localities: Dziekanowice on Lake Lednickie, 8 July 1994, 1♀, 5 July 1996, 1♀, by J. BANASZAK.

Rophites algirus – A Western-Palaearctic species, represented in Europe by ssp. *trispinosus*, mainly in the south and sporadically in Central Europe. It is very rare in Poland, and has previously been listed from Poznań (STOECKHERT 1933) and Bydgoszcz (EBMER & SCHWAMMBERGER 1986) and from two contemporary localities in south-eastern Poland (PESENKO et. al. 2000). New locality: Kozielec near Bydgoszcz, 27 May 2000, 2♀, 1♂; 10 June 2000, 2♀, 1♂; 22 June 2000 1♀, by R. KRIGER.

Evyleus quadrisignatus – a Western palaearctic species mainly associated with steppe. It is very rare in Poland and has only been listed from two localities in Pomerania and Sandomierz Lowland. New localities: Strzelce Dolne, meadow, 6 Aug 2002, by K. MORZYŃSKA and J. POPA.

Lasioglossum sexmaculatum – scattered from Europe to Yakutsk, Buryatia and northern China in the east. It Poland it is very rare and has only been found in two localities in Pomerania and Upper Silesia. New locality: Krzyż Wielkopolski, an old track in a railway station, 15 July 2010, 1♀, by P. SZEFER.

Sphecodes marginatus – a Western Palaearctic species. In Poland it has been only found in Pomerania. New localities: Rąbczyn near Wągrowiec, 26 May 2001, Bydgoszcz – Osowa Góra, 20 July 2003, 2♀, by J. BANASZAK.

Bombus magnus – distributed widely from Europe to Mongolia and China. Its first record in Poland is relatively recent, from the 1980's, and, consequently, its range is rather

poorly identified (BANASZAK 1994, RASMONT 1984). New localities: "Wąwelno" Reserve near Sośno, oak-hornbeam forest, 13 Aug 2004, 1 worker, by J. SŁOMA; Bydgoszcz – Miedzyń, 25 July 2009, 1 worker, by J. BANASZAK.

Bombus soroensis proteus – a subspecies of a species rare in Poland, known mostly from the north-west of the country. New locality: Strzelce Dolne near Bydgoszcz, Vistula flood plain (*Salix cinerea* stand), 9 May 2003, 1♀, by K. MORZYŃSKA and J. POPA.

Rare species, category II (11–20 individuals)

This category is made up of the following 37 species*: Hylaeus gibbus, H. pectoralis, Colletes similis, Andrena apicata, A. bicolor, A. clarkella, A. labiata, A. nigroaenea, A. symphyti, Panurgus calcaratus, Halictus rubicundus, Seladonia leucahenea, S. subaurata, Lasioglossum laevigatum, and L. xanthopus, Evylaeus albipes, E. leucopus, E. linearis, E. malachurus, E. minutissimus, E. nitidiculus, E. villosulus, Specodes albilabris, Melitta haemorrhoidalis, Anthidium strigatum, Heriades truncorum, Chelostoma florisomne, Hoplitis anthocopoides, Osmia fulvientris, Megachile maritima, M. centuncularis, Coelioxys elongata, Eucera longicornis, Ceratina cyanea, Nomada fucata, N. signata, Psithyrus sylvestris.* As with the previous category, the catches revealed the presence of species that are genuinely uncommon in other areas in Poland, such as *Hylaeus pectoralis, Colletes similis,* or *Andrena symphyti*. However, most of the species in this category are actually relatively frequent or frequent all over Poland, especially *Sphecodes albilabris, Andrena clarkella* (locally), *A. nigroaenea, Evylaeus albipes,* or *Seladonia subaurata* and *Lasioglossum xanthopus.*

Frequent species, category III (21–100)

This group is composed of 43 species, namely: *Hylaeus punctatus, H. annularis, H. confusus, Colletes succinctus, C. marginatus, C. daviesanus, C. fodiens, Andrena barbilabris, A. gravida, A. jacobi, A. minutuloides, A. nigroaenea, A. ovatula, A. pilipes, A. proxima, A. tibialis, Halictus maculatus, H. quadricinctus, Seladonia confusa, Evylaeus lucidulus, E. sexstrigatus, Lasioglossum leucozonium, L. sexnotatum, Sphecodes ephippius, S. monilicornis, Anthidium manicatum, Heriades crenulatus, Chelostoma rapunculi, Megachile willughbiella, M. circumcincta, M. versicolor, Anthophora bimaculata, Nomada fabricina, N. flavoguttata, N. lathburiana, N. ochrostoma, N. ruficornis, B. cryptarum, B. humilis, B. muscorum, B. veteranus, Psithyrus campestris, and Ps. rupestris.*

It needs to be noted that most of the species listed above fit the description of "frequent species" in Poland, with the obvious caveat about this categorization being a very broad and imprecise one. At the same time, there are at least two species in this group, namely, *Andrena proxima* and *Bombus humilis*, that merit a comment.

Andrena proxima – while it has usually been listed from a relatively small number of localities in Poland, this study's materials contained a total of 58 individuals (37♀♀, 21♂♂) from two sites: one in the Kruszyn Reserve and one in Strzelce Dolne near Bydgoszcz. The capture of such a large number of individuals of this relatively rare species is owed to the

use of MOERICKE'S traps in the Kruszyn Reserve. Thus, *Andrena proxima* can reach very high abundances locally.

Bombus humilis – it was not recorded at all sites and, where it did occur, the abundance was usually rather low, although it was more abundant in certain localities, such as an old railway track near the railway station in Krzyż, where it was registered in considerable numbers over the three years of catches (2002, 2003, 2010).

Abundant species, category IV (101–500)

This group also comprises a large number of 36 species, namely*: Hylaeus communis, H. hyalinatus, Colletes cunicularius, Andrena chrysosceles, A. cineraria, A. dorasta, A.flavipes, A. fucata, A. fulva, A. helvola, A minutula, A. nitida, A. praecox, A. subopaca, A. vaga, A. ventralis, Halictus sexcinctus, Seladonia tumulorum, Evylaeus fulvicornis, E. laticeps, E. morio, E. pauillus, Melitta leporina, Dasypoda hirtipes, Osmia bicolor, Osmia rufa, Anthophora plumies, Nomada moeschleri, Bombus hortorum, B. hypnorum, B. lapidarium, B. lucorum, B. pratorum, B. ruderarius, B. sylvarum, and Psithyrus bohemicus.*

It may be pointed out that all these species rank among those occurring most commonly in Poland. It needs to be stressed that the species nesting in colonies reached very high abundances at some localities and lower, or were less frequently observed, at other sites, including *Colletes cunicularius*, *A. fulva* or *A. vaga*. Let us add that the life span of a colony may be very long even in the presence of apparent intense anthropic pressure, as exemplified by the finding of a large colony of *Andrena fulva* in Poznań, in a green area behind the opera building in a bifurcation of streets, one of which was a very busy thoroughfare. The green itself is usually the site of some maintenance work. This colony has been present there with unchanged abundance and area of occupancy at least since the late 1960's.

The use of colour traps (white and yellow bowls) also yielded data on species that can reach mass abundances locally even if earlier faunal searches had established the view that that particular species was relatively not numerous, as was the case of the three species: *Hylaeus hyalinatus*, *Andrena ventralis*, and *Osmia bicolor*, and others.

Special attention is due to *Hylaeus hyalinatus*, only isolated individuals of which were collected into aerial nets at various locations in Bydgoszcz, but yellow bowls put out on a third-floor balcony in the very centre of the city and over the busiest street gave a yield of 209 (167♀♀, 42♂♂) individuals (BANASZAK 2008).

Andrena ventralis – despite the relatively good penetration of the area, this species was only found in three localities, though sampling into MOERICKE'S traps in Strzelce Dolne yielded 111 males.

Osmia bicolor was caught into aerial nets at 6 sites as isolated individuals, while yellow bowls placed in meadows in Kruszyniec near Bydgoszcz yielded a total of 328 individuals (21♀♀, 307♂♂).

Species occurring very abundantly and common species – category V (501–1000) and VI (>1000 individuals)

Both groups contain only 5 species each; however, some colony-forming species can also be included here, including *Andrena fulva* or *A. vaga*. Two species of bumble bee: *Bombus terrestris* and *B. pascuorum*, occur commonly throughout the region of Wielkopolska and across Poland, though they differ in their ecological requirements: *B. terrestris* is associated with open areas to a greater extent, and *B. pascuorum* is associated with trees and shrubs. *Evylaeus calceatus* also ranks among the most common species all over Poland. A comment is due regarding *Evylaeus nitidulus*, which was caught in large numbers into yellow bowls placed near pots of *Bidens ferulifolium* on a second-floor balcony in the very centre of Bydgoszcz (31 Gdańska St.) (BANASZAK 2008). Let us add that it was not identified in Wielkopolska outside Bydgoszcz. This species has previously been known from several dozen sites scattered all around the country, especially in the south, and single sites in Pomerania and Mazury. The present study revealed that local abundances can sometimes be very high. The nesting patterns of *Evylaeus nitidulus* are poorly known. However, the finding of such high numbers of individuals of this species reaching flowers in an upper storey of a building may suggest that it forms nests in old wooden constructions, such as timber roof trusses and other partly rotten wooden parts. The building and adjacent houses are approximately 200 years old. Some *Halictidae* can make nests by biting a plant substrate, e.g. in old rotten, and consequently soft, wood (RADCHENKO & PESENKO 1994). The fact that a considerably high number of individuals of *Evylaeus nitidulus* were collected continuously throughout the growing season sheds new light on the biology of this species. On the basis of earlier phenological data, PESENKO et al. (2000) suggest that it is actually a eusocial species. The new data obtained in the present study - notably, from only one site - basically confirm this view. However, according to the authors quoted above, the males make flights from the end of June to the end of September. At the same time, the Bydgoszcz collections demonstrate that males appeared as early as about the 10th of May, i.e. more than a month earlier than was previously believed. The question thus arises of the degree of sociality of this species.

The above analysis of contributions of individual Apiformes species in Wielkopolska-Kujawy Lowland depicts the current status of the bee fauna of this region and, in a way, reflects the overall status of pollinating insects in the Polish Lowlands, with a potential for extrapolation to Central Europe. On the one hand, it shows the main contributors to plant pollination, and on the other it reveals that nearly 50%, which is a high number, are rare species, registered as single specimens. Higher-risk species, including those requiring protection programs, have been presented in greater detail.

The use of MOERICKE'S traps along with stalking as the basic sampling technique revealed inadequacies of the latter. The current study thus more realistically reflects the abundance of certain species, providing some quite surprising data, as in the case of *Hylaeus hyalinatus* or *Evylaeus nitidiusculus*. Traps that are active throughout the season

and 24 hours a day serve to capture species during short spells of good weather and short periods of massive appearances of males of some species, which are very difficult to notice for a researcher exploring an area with an aerial net, of necessity only on selected and rare occasions when the weather does not necessarily invite bees to be active.

An abridged and simplified presentation of the results of analysis of the contributions of the species collected in this study is a diagram presenting the patterns of dominance among Apiformes in Wielkopolska-Kujawy Lowwland (Fig. 4)

A similar diagram has been prepared for bumble bees (Fig. 5). It shows the importance of these most important, along with *Apis mellifera,* pollinators of plant in the fauna. The diagram indicates a prominent role of *Bombus pascuorum*, which accounts for a third of all bumble bee species, with *Bombus terrestris* as a subdominant (20.5%).

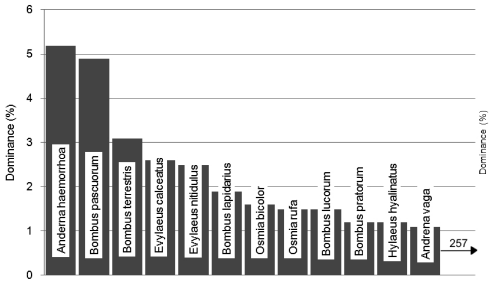


Fig. 4. Dominance patterns of bees in Wielkopolska-Kujawy Lowland in the years 2000-2010.

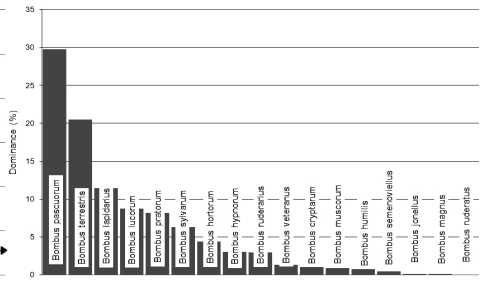


Fig. 5. Dominance patterns of bumble bees in Wielkopolska-Kujawy Lowland in the years 2000-2010.

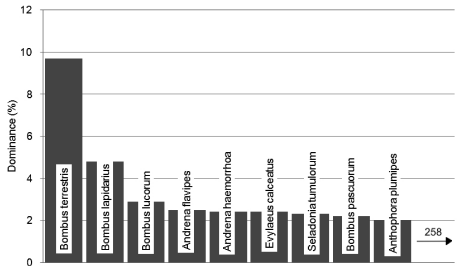


Fig. 6. Dominance patterns of bees in Wielkopolska-Kujawy Lowland in the years 1966-1988 (BANASZAK 1982).

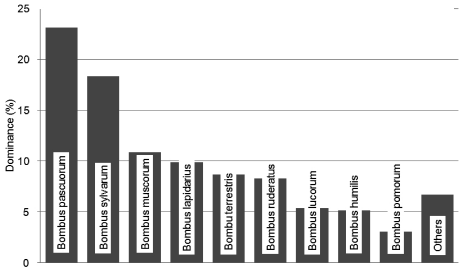


Fig. 7. Dominance patterns of bumble bees on red clover in Wielkopolska-Kujawy Lowland in the years 1936-1937 (OLSZEWSKI 1937).

In the context of assessment of the entire Apiformes fauna, it is interesting to compare the composition and dominance patterns of bees from 30 years ago (BANASZAK 1982) in basically the same area, though with greater focus on the bee fauna of the areas around Poznań. The historical study also yielded fewer individuals (6,353), collected only into aerial nets. Figure 6 shows that the group og dominant species was composed exclusively of bumble bees (*Bombus terrestris*, *B. lapidarium*, *B. lucorum*, and *B. pascuorum)*. *Bombus terrestris* (9.7%) was a prominent dominat then with *B. lapidarium* (4.8%) as a subdominant.

PRELIMINARY ASSESSMENT OF CHANGES IN BEE FAUNA OVER THE LAST 100 YEARS

It is reasonable to begin by asking the question of what the term "faunal changes" actually refers to and whether, given access to data from a hundred years ago and present-day data, one is able to provide a reliable answer to that question. Does the identification in a particular area of a species regarded as rare in the country, or not recording a species that was previously registered in a given area signify a faunal change or it is an artifact stemming from inadequate study techniques? It is also true that, as shown in p. 379, that the use of coloured bowl traps in the contemporary studies led to the capturing of large numbers of some species considered rare both in the past and at present. This situation is a clear example of how the research method can influence our results and interpretation. Let us quote a specific example: *Nomada fabriciana* was captured as single tons from five sites over several dozen years of study, while the catches into Moericke's traps in Strzelce Dolne near Bydgoszcz yielded as many as 83 individuals. Had it not been for Moericke's traps, *Nomada fabriciana* would be classified as a low-abundance species! Thus, drawing conclusions regarding faunal changes by comparing studies utilising different collection methods demands separate and detailed analyses. The term "faunal changes" should be applied to cases of a prolonged increase or decrease in abundance or the shrinking or widening of ranges of individual species. The characteristic "prolonged" is of importance here. The current study has revealed some such clear-cut examples of change, though it would be precarious to speak of faunal changes with regard to some other species.

Taking the above reservations into account, our comparison of the bee fauna resources of Wielkopolska-Kujawy Lowland of one hundred years ago and today has concentrated on the following aspects:

- overall number of species (comparison),
- previously and currently abundant species,
- confirmation of the occurrence of rare species,
- species not confirmed in the contemporary studies,
- evident faunal changes.

Comparison of overall number of species

Table 1 shows the overall number of bees recorded over the last century, with a total of 358 species. Thus, over the last 100 years, the bee fauna of Wielkopolska-Kujawy Lowland constituted 75.5% of Apiformes species known from Poland. TORKA reported 281 species one hundred years ago, and our contemporary studies revealed the presence of 317 species of bees. The number of species found in both lists is 232, and these are the species that have been present in this area throughout the one hundred years and testify to the persistence of the fauna.

Numerous and common species

With bees playing an important role in the ecosystem as pollinators, the stability of occurrence of the most numerous and common species is an important aspect. As described in p. 378, TORKA considered as many as 72 species to be frequent ("häufig", "überal häufig"), and at least 13 to be common. The most abundant species were *Hylaeus annulatus, Andrena flavipes, Osmia rufa, Anthidiellum strigatum, Bombus terrestris, Psithyrus vestalis, Evylaeus calcatus, E. albipes, E. morio, Andrena vaga, A. labialis, Dasypoda hirtipes,* and *Anthophora aervorum*. All these species are abundant, very abundant or common in Wielkopolska even today, as is particularly clearly showing in the figure showing the dominance patterns of contemporary Apiformes (Fig. 4).

The contemporary list of abundant species also contains species that reach very high local abundances, as was revealed by collections from colour traps (e.g., *Evylaeus mitidulus, Osmia bicolor*), which Torka was unable to register. Other most abundant species recorded today, apart from those mentioned above, include especially *Bombus pascuorum* and *Andrena haemorrhoa*. Some, even according to the new data, can be classified as frequent, including *Evylaeus brevicornis, E. minutissimus, Seladonia subaurata,* and *Sphecodes crassus*, locally abundant (*Andrena clarkella, Anthocopa papaveris*), or even common, as the spring Andrena bee *Andrena fulva*, which nests in towns, often forming large colonies.

At the same time, 41 species that were rare in Torka's time were not found in the contemporary studies. They are listed in p. 398.

Confirmation of the occurrence of rare species

The confirmation of the presence of species regarded as rare is a hallmark sign of faunal persistence. The region of Wielkopolska has ranked among the most agriculturally developed areas in Poland at least since the 19th century. The consequences of degradation of the natural environment in Wielkopolska were noted with concern already before World War II, when researchers used the term "steppe transformation" to describe negative trends, such as lower water levels in the landscape. The best document of those times and nature research carried out in that era is the book "Stepowienie Wielkopolski" (WODZICZKO 1947), edited by Adam WODZICZKO, professor of Poznań University and an eminent Polish

naturalist and specialist in nature protection. It is worthwhile to add at this point that, somewhat in response to that book, another one was published 50 years later, describing further consequences of environmental degradation (overdrying, deforestation, application of fertilisers, chemical plant protection, eutrophication of water, etc.). It was a collective work edited by J. BANASZAK under the title "Stepowienie Wielkopolski – pół wieku później" (BANASZAK 2003). Multidirectional environmental changes and degradation will have left their mark not only on the bee fauna (BANASZAK 2003).

Table 2 lists the 66 species considered rare by TORKA (1913). Most of them have been confirmed in the contemporary studies. It is interesting to compare the abundance of bumble bees at the turn of the 20th century and at present. TORKA (1913) regarded the following bumble bee species rare or locally rare:

Bombus soroeensis proteus – captured as single individuals; same at present;

Bombus confusus – captured as single individuals; at present it is also locally rare;

Bombus veteranus – locally rare, present all over the area; this has not changed at present;

Bombus humilis – frequent near Nakło; at present it is also recorded only locally, sometimes reaching high abundances;

Bombus subterraneus – infrequent and not recorded every year; this has not changed at present;

Bombus distinguendus – infrequent; extremely rare in the contemporary studies;

Bombus ruderatus – not as frequent as *B. hortorum* – found very occasionally at present.

This comparison of the most recognisable bees shows that the situation of so-called rare species is generally the same today. Untoward changes have occurred with regard to *Bombus distinguendus* and *B. ruderatus*.

Species not recorded by TORKA, but reported in the contemporary studies

The contemporary studies found as many as 79 (22%) species in Wielkopolska-Kujawy Lowland that Torka did not include either in his list of 1913 or in the latter addenda: *Hylaeus annularis, H. cardioscapus, H. clypearis, H. communis, H. difformis, H. gracilicornis, H. gredleri, H. hyalinatus, H. moricei, H. paulus, H. pectoralis, H. punctatus, H. punktulatissimus, H. sinuatus, H. styriacus, H. variegates, Andrena alfkenella, A. assimilis, A. denticulata, A. falsifica, A. florae, A. gelriae, A. limata, A. minutuloides, A. mitis, A. nanula, A. nitidinscula, A. niveata, A. pilipes, A. ruficrus, A. schencki, A. subopaca, A. symphyti, A. synadelpha, A. viridescens, Nomioides minutissima, Seladonia confuse, S. semitecta, Lasioglossum sexmaculatum, L. lativentre, L. majus, Evylaeus aeratus, E. intermedius, E. malachurus, E. nigripes, E. parvulus, E. quadrisignatus, E. rufitarsis, E. semilucens, E. setulosus, E. tarsatus, Sphecodes marginatus, S. rufiventris, Proanthidium oblongatum, Heriades crenulatus, Chelostoma foveolatum, Anthocopa bidentata, Osmia pilicornis, Megachile genalis, M. leachella, Coelioxys aurolimbata, C. rufocundata, Thyreus orbatus, Nomada atroscutellaris, N. bifasciata, N. castellana, N. furva, N. fuscicornis, N.*

flava, N. opaca, N. panzeri, N. sheppardana, N. signata, N. stigma, Epeoloides coecutiens, Bombus cryptarum, B. magnus, B. semenoviellus, Psithyrus sylvestris.

This long list of species new to the area undoubtedly represents an achievement in faunal studies. The causes underlying the finding of such a high number of bee species merit a comment. Particularly conspicuous is the high number of 16 species of the genus *Hylaeus*. The small size and rare occurrence of some of these species make them very difficult to find. Their identification should be more correctly ascribed to technical advances in research, with more intensive exploration of the area in the contemporary studies and greater possibilities for the identification of representatives of this genus. By and large, the same also applies to the other species, not least to representatives of the genera *Nomada* and *Halictus* s.l. At the same time, *Bombus cryptarum* and *B. magnus* were not differentiated as valid species in Torka's times. TORKA may also have simply failed to notice some of the remaining species.

A noteworthy fact is the finding of *Megachile genalis*, whose site in Wielkopolska is merely the third contemporary locality of this species in Poland (see p. 389).

Species not recorded in the contemporary studies in Wielkopolska-Kujawy Lowland

The contemporary studies failed to confirm the presence of the following 41 (11.4%) species previously listed from Wielkopolska-Kujawy Lowland: *Colletes floralis, C. nasutus, Andrena argentata, A. coitana, A. lathyri, A. morio, A. nana, A. pusilla, A. similis, A. tarsata, A. thoracica, Dufourea dentiventris, Halictus compressus, Lasioglossum prasinum, L. sexnotatulum, Evylaeus euboeensis, E. minutulus, E. politus, Sphecodes spinulosus, Dasypoda aurata, Anthidium punctatum, Stelis ornatula, Osmia nigriventris, Megachile argentata, M. lapponica, M. octosignata, Coelioxys afra, C. brevis, C. polycentris, Amegilla quadrifasciata, Tetralonia salicariae, Nomada armata, N. atrosentellaris, N. braunsiana, N. errans, N. quttulata, N. rhenana, Biastes brevicornis, B. truncatus, Epeolus schumeli,* and *Bombus confusus.*

All of those species were captured by TORKA as single individuals, which means that they probably occurred at isolated sites; all are also classified as rare species in Poland today and often have an insular distribution.

Beyond doubt, *Anthophora quadrifasciata* is not present today at the site in Krzyż, which was visited three times in the period of the species' seasonal activity during contemporary studies. The occurrence of this species in Poland has recently been confirmed at a site in Stanisławów in Mazovia (KOWALCZYK et al. 2009). The Polish sites lie outside of the contiguous range of this species and form an insular pattern.

The site in Jankowo Dolne near Gniezno was also visited in order to confirm *Megachile octosignata* there, but the visit was unsuccessful. ALFKEN (1924) also listed Poznań ("Posen") as a site where this species occurred, but he may have been quoting from TORKA (1913), and therefore used the name „Posen".

Some of the remaining species also merit a comment:

Colletes nasutus – TORKA listed this species from Nakło and from Osiek on the Noteć. This subpontine species is known in Poland from a few sites in Pomerania, Mazury, Lower Silesia and Sandomierz Lowland, but it is nevertheless very rare.

Evylaeus euboeensis – listed from Bydgoszcz ("Bromberg") by BLÜTHGEN (1920), with the same author listing it also from Szczecin ("Stettin"). Contemporary studies have identified only four individuals from south-eastern Poland (PESENKO et al. 2000). It is a steppe species, although it is widely distributed in Europe, North Africa, Asia and Asia Minor. It is associated with dry and warm areas.

Lasioglossum sexnatatulum – TORKA (1913) listed only one female from Nakło. This species has only been known in Poland from two sites near Legnica and Wrocław, where it was also registered in the early 20th century, and has not been confirmed in present-day research. There is a possibility of it being mistaken for *Lasioglossum sexmaculatum.*

Rophites algirus trispinosus – This rare species was listed by STOECKHERT (1933) from Poznań and by EBMER & SCHWAMMBERGER (1986) from Bydgoszcz. Nowadays, it has been recorded in two sites in south-eastern Poland (PESENKO et al. 2000).

Dufourea dentiventris – TORKA (1913) found only one male near Nakło. Confirmed sites of this species in Poland are in mountainous areas (Sudetes, Carpathians, Southern and Silesian Uplands). Thus, the Wielkopolska locality is an isolated lowland site.

Nomada armata – TORKA (1913) captured single individuals near Nakło. This species has been known from all over Poland. It is a parasite of *Andrena hattorfiana.*

Nomada guttulata – TORKA (1913) listed this species from Brudzyń near Gniezno and from the environs of Nakło. This species has been known from all over Poland. It is a parasite of *Andrena pauxilla, A. labiata,* and *A. potentillae.*

Nomada rhenana – TORKA (1913) listed only one male from the environs of Nakło. It is a rare species, recorded from a few sites in Poland, a parasite of *Andrena ovatula.*

Nomada atroscutellaris – TORKA could not have listed this species, which was only described by Strund in 1921. However, STOECKHERT (1933) listed it from Bydgoszcz ("Bromberg"), after identifying an individual in the collection of R. MEYER.

Biastes truncatus – Torka (1913) reported this rare species from the environs of Nakło. It is a parasite of *Dufourea dentiventris* and *D. inermis* (STOECKHERT 1933).

Bombus confusus – TORKA (1913) noted single individuals from around Nakło, nearby Mrocza and Bydgoszcz. It has been very rarely observed all around Poland. However, contemporary studies in the north of Poland have confirmed its occurrence (SZEFER 2010).

Osmia nigriventris – TORKA (1913) listed only one female from Osiek on the Noteć near Wyrzysk. It was also listed from Western Pomerania and Trzebiatów Hills, but only historically.

Anthidium punctatum – TORKA (1913) listed two individuals from Osiek on the Noteć near Wyrzysk and from the environs of Bydgoszcz. This species has been recorded all over Poland, but it has been rarely observed.

Stelis ornatula – TORKA (1913) listed two female individuals from Nakło. This species has rarely been reported from Poland, but has been found nearly throughout the country.

Coelioxys polycentris – TORKA (1916) caught it on several occasions only in Potulice near Bydgoszcz. In Poland, it has also been listed from Mazovian Lowland. It is a parasite of *Tetralonia nana* MORAWITZ, 1874, a species not reported from Poland to date.

Coelioxys afra – TORKA (1913) listed four individuals from Krzyż. This species has a scattered distribution and is present in most regions of Poland.

Dasypoda aurata (= *thomsoni*) – TORKA (1913) caught single individuals near Nakło. In Poland, this species has been known from several scattered localities and has recently been reported from Złotów in the Pomeranian Lakeland (CELARY 2005), this representing a confirmation of contemporary presence of this species along the River Noteć.

Parasitic species of rare hosts are extremely difficult to find, as is the case with *Dufourea dentiventris* and its parasite *Biastes trunctatus*. Three species of the genus *Nomada* represent similar examples and can hardly serve as a basis for conclusions about faunal change. Instead, they signify a need for more insightful studies.

Evident faunal change

Of the 358 bee species recorded from Wielkopolska-Kujawy Lowland to date, the presence of 41 species (11.4%) has not been confirmed in contemporary studies. Does this, however, furnish enough proof that more than 11% of wild-bee species have become extinct in the area under study over the last century? A detailed analysis of these species (see p. 398) certainly gives no ground for such conclusions, primarily because these species have an insular distribution in Poland and are rare by nature, e.g. as parasites of equally uncommon hosts. As a rule, they are also small-sized and thus difficult to spot.

At the same time, it can be assumed that the localities of three species (*Anthophora quadrifasciata* and *Megachile octosignata* or *Bombus confusus*) do not exist at present. *Colletes nasutus* and *Dasypoda thomsoni* have possibly shared their fate. However, only further studies can provide a definitive answer.

There has been a clear reduction of the population of *Anthophora parietina*, which was recorded quite numerously as late as the 1970's, with *Anthophora pubescens* possibly representing a similar pattern. In the 1970's, both species, and especially the former, were found in massive numbers in clay walls of old buildings. At present, as has already been noted, only one site is known from Wielkopolska, in a skansen in Dziekanowice near Gniezno (BANASZAK W.A. 2005).

In reference, or opposition, to the group of species currently not recorded, one can point to the large group of species 79 (22.0%) not recorded by TORKA, but identified in contemporary studies. This case, too, must not be used to draw a general conclusion about expanding populations or ranges. Instead, these facts point to better identification of the fauna owing to intensive searches. Furthermore, the use of coloured traps has generated data demonstrating unusual abundances of species previously believed to be rather not numerous or rare, such as *Evylaeus minutissimus*.

Evident examples of expanding ranges are provided by *Andrena fulva* and *Bombus semenoviellus*. *Andrena fulva* is actually a common species, especially in the towns of

Wielkopolska and Kujawy, e.g. in Poznań or Bydgoszcz. Over the last 20 years, it has expanded its range eastwards and now reaches the country's eastern borders. In turn, *Bombus semenoviellus*, recorded in Poland for the first time in the mid-1990's, is now reported throughout the country. It is already present in Germany, Czech Republic and Slovakia (PŘIDAL & TKALCU 2003, PŘIDAL & KOMZAKOVA 2009).

DISCUSSION AND CONCLUSIONS

The ample materials (20.883 individuals) collected from Wielkopolska-Kujawy Lowland between 2000 and 2010 contained 257 species, which, together with species identified by the present author in earlier studies (BANASZAK 1982, 2008, BANASZAK et al. 2004) gives a total of 317 species currently inhabiting the area of study.

Over the entire last century, studies in Wielkopolska-Kujawy Lowland have identified 358 species of Apiformes, accounting for 75.5% of the bee fauna of Poland. This is a record number of bee species to be reported from a single geographical region in Poland where such studies have been carried out. Wielkopolska is thus one of the best-documented areas in Poland. For comparison, let us state that similar numbers of species have so far been reported from the whole of Lithuania and Belgium (BANASZAK 2002).

Despite the identification of such a high number of species, contemporary studies have failed to confirm 41 bee species (11.4%) reported by Torka and other authors one hundred years ago. The present author is nevertheless far from concluding that these species have withdrawn from the area of study, which would be an overinterpretation, though, admittedly, this conclusion is justifiable in rare cases, such as *Anthophora quadrifasciata,* or that some species, such as *Anthophoras plagiata*, have at least experienced a drastic reduction in numbers. *Anthophora quadrifasciata* is one of our larger species and is easy to notice in the field; still, it was not found in Krzyż although that site was inspected three times. However, it should be immediately emphasised that at present *Anthophora quadrifasciata* has been confirmed in Mazovia, where it was documented as early as the 18th century, in a manuscript by de PERTÉES (1802).

The disappearance of certain local sites from species' overall ranges is a fact. This trend was demonstrated on a large scale by W. BANASZAK (2005) for *Anthophora plagiata*. Shrinkage of the range of *Dasypoda argentata* is described by CELARY (2007). According to that latter author, the species inhabited southern Sweden in the early 20th century and now it has withdrawn from Brandenburg in Germany and from Pomerania and Mazury Lakeland in Poland. However, even if a species has actually become extinct at a site, we can never be absolutely certain that this is really the case, especially as most species not recorded in contemporary studies are rare by nature, being difficult to record on account of small body size or being nest parasites of equally rare host species. The authors of a comparison of bee fauna after 75 years in the state of Illinois (USA) also failed to identify radical changes, except presenting lists of rare species, which, however, cannot be used to draw

conclusions stipulating faunal change (MARLIN & LABERGE 2004). Furthermore, cases of re-emergence of species regarded as extinct have also been reported, e.g. *Xylocopa valga* GERSTAECKER and *X. violacea* (L.), which were not recorded in Poland for several dozen years but are now observed quite frequently.

The overall number of unconfirmed species accounts for approximately 11.5% of all previously identified bee fauna. Still, most of them have been present in neighbouring areas and their identification (with a few exceptions) in Wielkopolska may be a question of time. In this context, the catastrophic assessments of bee fauna persistence and changes in Belgium (25.2% described as decreasing) appear unconvincing (RASMONT et al. 2005).

It is easier to formulate conclusions in the case of the bumble bees, such as *Bombus muscorum, B. sylvarum*, etc. The observed decrease in their abundance has been ascribed to changes in the proportion of their host plants, especially *Fabaceae* (ELLIS et al. 2006, DARVILL et al. 2006, GOULSON et al. 2005, 2008). The dwindling food resources of the honey bee, and thus also of wild bees, in the last two decades are an actual problem. The replacement of Fabaceae with other crops as described above is also taking place in Poland. At least in the last two decades, there has been a noticeable trend towards simplified crop rotation in agriculture. The arable field landscape of today is dominated by cereals, corn and rape (spring rape is disappearing). In the orchards of today's rural households, fruit trees have been replaced by conifers and other ornamental plants. The assessment of the effect of a simplified food base is a challenge for bee scientists. However, it must still be remembered that also 100 years ago both in Poland and in other European countries many species of bumble bees were recorded as isolated individuals or were observed only locally (see p. 396).

This argument appears convincing also in Wielkopolska in view of a distinct fall in abundance or extreme rarity of *Bombus ruderatus*, *B. disinquendus,* or *B. pomorum*. While *Bombus distinquendes* and *Bombus confusus* were also uncommon before World War II, *Bombus ruderatus* occurred quite abundantly in plantations of red clover in Wielkopolska. A valuable contribution in our eyes is a manuscript by J. OLSZEWSKI of 1937 discussing bumble bees visiting plantations of red clover in Wielkopolska. The author listed 19 species and, most importantly, provided data on their abundance. Significantly, apart from the dominant *Bombus pascuorum* (23.2%), which is a ubiquitous common pollinator even today, *Bombus silvarum* was a subdominant at that time (18.4%). Of note was a high percentage (8.3%) of *Bombus ruderatus*. *B. distinquendus* (0.8%) *B. pomorum* (3.3%) and *B. confusus* (0.7%) were present, be it in small numbers, as single individuals (Fig. 7.). Let us add, that these species, rare today, were also observed in the 1970's in plantations of red clover around Bydgoszcz and Toruń (SOWA et al. 1991). In the same period BILIŃSKI & RUSZKOWSKI (1991) still found, though rarely, *Bombus humilis*, *B. distinguendus* and *B. pomorum* around Poznań. On the other hand, the presence of a species in an area depends primarily on the local environmental conditions rather than the changing policies regulating the proportion of plantations of entomogamous species in agricultural landscape.

It would also be an over-interpretation to state that the finding of as many as 79 (22.0%) species for the first time in the region under study is a sign of expanding ranges or increasing population abundance.

Evident beneficial changes include the appearance of *Bombus semenoviellus* (throughout Poland) or the geographical expansion of *Andrena fulva*, which can now be observed all across Poland, and in cities, at least in Poznań and Bydgoszcz, it is a common spring species.

It is worthwhile to quote, at this point, the regular observations by BANASZAK (1997, 2003) regarding local changes in bee faunas in different types of landscape carried out over 10 years, divided into 3-year periods, which mainly revealed beneficial changes. Quantitative and qualitative decreases are merely a consequence of natural processes of ecological succession, such as the overgrowing of the grassy area the author studied in Wielkopolska.

In summary, despite the alarming reports of some researchers (e.g., DYLEWSKA 1990, 1997, RASMONT et al. 2005), the example of Wielkopolska Lowland shows that there is no reason to raise the alarm in the case of wild bees. The reason for concern in Poland is the lack of understanding for environmental research, including studies of biodiversity, as reflected in the scarcity of funds allocated for that purpose both by the national government and by a lobby of geneticians and biochemists, a fact emphasised by the present author on a number of occasions (BANASZAK 2000, 2006, 2008).

The dearth of data is alarming as it often leads to hasty conclusions. There are still too many *terra incognita* on the apidological map of Poland, including poorly identified bee fauna of many national parks. However, the same problem is seen in other parts of Europe and the world. We do not know the causes of disappearance of certain species and emergence of others, neither can we determine the magnitude of these trends. We should not be confused by the fact that many reports represent minor additions to the knowledge base, or by the faunal extinction "craze". In the case of invertebrates, unlike large vertebrates, faunal change should best be viewed as faunal fluctuations, as suggested previously elsewhere by the present author (BANASZAK 2003).

Changes in the fauna of wild bees, their magnitude, rate and directions, are, in my opinion, the fundamental questions of contemporary apidology.

REFERENCES

ALFKEN J.D. 1911. Apidologische Studien. Deutsch. Entomol. Zeitschr., **1911**: 457-466.

ALFKEN J.D. 1912. Die Bienenfauna von Westpreussen. Ber. Westpreuss. Bot.-Zool.Ver., Danzig-Gdańsk, **34**: 1-96.

ALFKEN J.D. 1924. Beitrag zur kenntnis einiger Bienen Finlands. Natulae Ent., **4**: 33-40.

BANASZAK J. 1971. Nowe stanowiska porobnicy murarki (*Anthophors parietina* F) w okolicach Poznania. Przyr. Polski Zach., **9(1-4)**: 107-111.

BANASZAK J. 1973. Pszczołowate (Apoidea) okolic Poznania. Bad. Fizjograf. Pol. Zach., 26 (Ser. Biologia): 33-78.

BANASZAK J. 1976. Pszczoły (Hymenoptera: Apoidea) Ogrodu Botanicznego w Poznaniu. Bad. Fizjograf. Pol. Zach., C-Zoologia, **29**: 71-85.

BANASZAK J. 1977. Pszczoły (Hymenoptera; Apoidea) rezerwatu „Dębina" pod Wągrowcem. Bad. Fizjograf. Pol. Zach., Seria C-zoologia, **30**: 155-158.

BANASZAK J. 1982. Pszczoły (Apoidea, Hymenoptera) Niziny Wielkopolsko-Kujawskiej. Fragm. Faun., **27**: 75-92.

BANASZAK J. 1983. Ecology of bees (Apoidea) of agricultural landscape. Polish Ecological Studies 9, **4**: 421-505.

BANASZAK J. 1996. Wstępne wyniki badań nad zasobami naturalnymi owadów zapylających w Lednickim Parku Krajobrazowym. Studia Lednickie, Lednica-Poznań **4**: 495-498.

BANASZAK J. 1997. Local changes in the population of wild bees. I. Changes in the fauna ten years later. Ochrona Przyr., **54**: 119-130.

BANASZAK J. (ed.) 2003. Stepowienie Wielkopolski – pół wieku później. Wydawnictwo Akademii Bydgoskiej im. Kazimierza Wielkiego, Bydgoszcz, 266 pp.

BANASZAK J. 2003. Zagadnienia zmian fauny bezkręgowców. Prawda i mity na przykładzie owadów zapylających.[in:] J. BANASZAK (ed.) Stepowienie Wielkopolski – pół wieku później. Wyd. Akademii Bydgoskiej im. Kazimierza Wielkiego, pp.101-116.

BANASZAK J. 2004. Apidae. [in:] Fauna Polski, W: BOGDANOWICZ, E. CHUDZICKA, I. PILIPIUK, E. SKIBIŃSKA (eds). Muzeum i Instytut Zoologii PAN, Warszawa, 1, 509 pp.

BANASZAK J. 2004. Z badań nad owadami zapylającymi w Bydgoszczy (Hymenoptera, Apoidea).[in:] P. Indykiewicz, T. BARCZAK (eds). Fauna miast Europy Środkowej 21.wieku, Wyd. LOGO, Bydgoszcz, 225-233 pp.

BANASZAK J. 2006. Badania entomologiczne i ochrona owadów w Polsce a obecna sytuacja prawna i organizacyjna. Wiad. Entomol. 25, Supl. **2**: 9-16.

BANASZAK J. 2006. Materiały do fauny pszczół (Hymenoptera: Apiformes) Polski. V. Wiad. Entomol., **25**(2): 97-103.

BANASZAK J. 2008. Fauna pszczół (Hymenoptera: Apoidea: Apiformes) Bydgoszczy [in:] P. INDYKIEWICZ, L. JERZAK, T. BARCZAK (eds). Ochronić różnorodność biotyczną w miastach, SAR „Pomorze", Bydgoszcz, 234-245pp.

BANASZAK J. 2008. Najważniejsze trendy oraz wyzwania entomologii XXI wieku w Polsce. Wiad. Entomol., Supl. **27**: 59-76.

BANASZAK 2008. Zróżnicowanie owadów zapylających w parku pałacowym w Lubostroniu. [in:] J. BANASZAK, H. RATYŃSKA (eds) Przyroda parku pałacowego w Lubostroniu. Oficyna wyd. „Branta", Bydgoszcz-Poznań, 113-121pp.

BANASZAK J., RASMONT P. 1994. Ocvurence and distriution of the subgenus Bombus Latreille sensu stricto in Poland (Hymenoptera, apoidea). Pol. Pismo ent., **63**: 337-356.

BANASZAK J., CIERZNIAK T. 2000. Pollinating insects (Apoidea) [in:] J. BANASZAK (ed.) Ecology of forest islands. Wyd. Uczelniane Akademii Bydgoskiej im Kazimierza Wielkiego (Bydgoszcz University Press), Bydgoszcz, 107-134.

BANASZAK J., CZECHOWSKA W., CZECHOWSKI W., GRABARCZYK H., SAWONIEWICZ J, WIŚNIOWSKI B. 2000. Zagrożenia i perspektrywy ochrony owadów błonkoskrzydłych (Hymenoptera). Wiad. Entomol. 18, Supl. **2**: 177-211.

BANASZAK J., CIERZNIAK T., RATYŃSKA H. 2003. Local changes in populations of wild bees (Hymenoptera: Apoidea): 20 years later. Pol. Pismo Ent., **72**: 261-282.

BANASZAK J., RATYŃSKA H., BANASZAK W.A. 2004. Proponowany rezerwat „Folusz" pod Szubinem jako ostoja termofilnej szaty roślinnej i fauny żądłówek (Hymenoptera: Aculeata: Apoidea,. Scolioidea). Bad. Fizjograf. Polski Zach., Seria C-Zoologia, **50**: 101-132.

BANASZAK W.A. 2004. Przegląd badań nad owadami zapylającymi Poznania. [in:] P. INDYKIEWICZ, T. BARCZAK (eds). Fauna miast Europy Środkowej 21.wieku, Wyd. LOGO, Bydgoszcz, 155-166 pp.

BANASZAK W.A. 2005. What has caused the decline of the solitary bee *Anthophora plagiata* (Illiger, 1806) (Hymenoptera: Apoidea) in the Wielkopolska-Kujawy Lowland in west Poland? Pol. Pismo Ent., **74**: 157-185.

BANASZAK-CIBICKA W.A. 2008. Wstępne informacje o zróżnicowaniu fauny pszczół Poznania (Hymenoptera: Apoidea: Apiformes). [in:] P. INDYKIEWICZ, L. JERZAK, T. BARCZAK (eds). Ochronić różnorodność biotyczną w miastach, SAR „Pomorze", Bydgoszcz, 260-264 pp.

BANASZAK-CIBICKA W.A. 2009. Specyfika fauny pszczół (Hymenoptera: Apoidea: Apiformes) miasta na przykładzie Poznania. Instytutu Zoologii Uniwersytetu Przyrodniczego, Poznań, mscr, 147 pp.

BILIŃSKI M., RUSZKOWSKI A. 1991. Trzmiele Wielkopolski. Pszczeln. Zeszyty Nauk., Puławy, **35**: 127-138

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

BLÜTHGEN P. 1920. Die deutschen Arten der Bienengattung Halictus Latr. Dt. Ent. Zeitschr., Berlin, 1920/21 (1/2): 81-132.

Bobowski M. 2007. Owady zapylające Ogrodu Botanicznego Uniwersytetu Kazimierza Wielkiego w Bydgoszczy. Instytut Biologii i Ochrony Środowiska Uniwersytetu Kazimierza Wielkiego, Bydgoszcz, mscr, 42 pp.

BOIŃSKI M. 1973. Lasy liściaste środkowej części Pojezierza Krajeńskiego. Stud. Soc. Scient. Torunensis, sec. D, vol. IX, nr 5, PWN, Warszawa – Poznań.

CELARY W., WIŚNIOWSKI B. 2002 *Megachile genalis* MORAWITZ, 1880 – a wild bee species (Hymenoptera: Apoidea: Megachilidae) new for the Polish fauna. Pol. Pismo Ent. **71**: 145-149.

CELARY W. 2005. Melittidae (Hymenoptera: Apoidea: Anthphila) of Polanf – their biodiversity and biology. Wyd. Inst. Systematyki i Ewolucji Zwierząt PAN, Kraków, 177 pp.

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

COLLINS N.M. 1987. Legislation to conserve insects in Europe. The Amateur Entomologist's Society **13**: 1-80.

COLLINS N.M., WEELS S.M. 1987. Invertebrates in need of special protection in Europe. Nature and Environment Series 35. Council of Europe. Strasburg, 162 pp.

DARVILL B., ELLIS J.S. LYE G.C., GOULSON D. 2006. Population structure and inbreeding in a rare and declining bumblebee, *Bombus muscorum* (Hymenoptcra: Apidae). Molceular Ecology **15**: 601-611.

DAY M.C. 1991. Towards the conscervation of aculcate Hymenoptera in Europe. Nature and Environment Series, N°51. Council of Europe Press 44 + XXXIII pp.

DELTOW D. 2004. Owady zapylające Apoidea Arboretum Akademii Bydgoskiej ze szczególnym udziałem rodziny Apidae. Instytut Biologii i Ochrony Środowiska Uniwersytetu Kazimierza Wielkiego, Bydgoszcz, mscr, 34 pp.

DITTRICH R. 1903. Verzeichnis der bisher Schlesien aufgefundenen Hymenopteren. I. Apidae. Zeit. Et., Breslau - Wrocław, **28**: 21-54.

DYLEWSKA M. 1987. Die Gattung Andrena Fabricius (Andrenidae, Apoidae) in Nord- und Mitteleuropa. Acta zool. Cracov., **30**(12): 359-708.

DYLEWSKA M. 2000. Klucze do oznaczania owadów Polski. Cz. XXIV Błonkówki – Hymenoptera, Z. 68d Pszczołowate – Apidae. Podrodzina – Andrenidae, Pol. Tow. Entomol., Toruń, 152 pp.

DZIĘCZKOWSKI A. 1987. TORKA Valentin (1867-1952). Słownik biologów polskich, PWN, Warszawa, 545-546 pp.

ELLIS J.S., KNIGHT E., Darvill B., GOULSON D. 2006. Extremely low effective population sizes, genetic structuring and reduced genetic diversity in a threatened bumblebee species, *Bombus sylvarum* (Hymenoptera: Apidae). Molecular Ecology **15**: 4375-4386.

EMBER A.W., SCHWAMMBERGER K.H. 1986. Die Bienengattung *Rophites* SPINOLA 1808 (Insecta: Hymenoptera: Apoidea: Halictidae: Dufoureinae). Illustrierte Bestimmungstabellen, Senckenbergiana biol., **66**(4/6): 271-304.

GAULD I. D., COLLINS N., FITTON M.G. 1990. L'importance biologique et la conservation des hymenopteres en Europe. Council of Europe, Strasburg 52 pp.

GIRUS J. 2006. Wykorzystanie pułapek gniazdowych do oceny występowania żądłówek na terenie miasta Wągrowca. Instytut Biologii i Ochrony Środowiska Uniwersytetu Kazimierza Wielkiego, Bydgoszcz, mscr, 57pp.

GOULSON D., HANLEY M.E., DARVILL B., ELLIS J.S., KNIGHT M. E. 2005. Causes of rarity in bumblebees. Biological Conservation 122: 1-8.

GOULSON D., Lye G.C., DARVILL B. 2008. Decline and conservation of bumble bees. Annual Review Entomology 53:191-208.

GUSENLEITNER F., SCHARZ M. 2002. Weltweite checkliste der bienengattung Andrena mit Bemerkung und Ergänzungen za paläarktischen Arten (Hymoptera, Apidae, Andreninae, Andrena). Entomofauna Zeitsch. Entomol. Suppl. 12, 1280 pp.

KĘDZIORA N. 2006. Zastosowanie pułapek gniazdowych do oceny występowania żądłówek (Aculeata) w krajobrazie rolniczym. Instytut Biologii i Ochrony Środowiska Uniwersytetu Kazimierza Wielkiego, mscr.

KOMENDARCZYK A. 1993. Dokumentacja projektowanego rezerwatu krajobrazowego „Kruszyn" położonego w gminie Sicienko w woj. bydgoskim wg stanu na 1993-01-01. Biuro Usług Techniczno-Leśnych, Toruń, mscr, 29pp.

KONDRACKI J. 1998. Geografia regionalna Polski. Wyd. Naukowe PWN. Warszawa, 441 pp.

KOWALCZYK K., KURZAC T., SOSZYŃSKI B. 2009. Porobnica paskowana *Amegilla quadrifasciata* (VITTERS, 1789) (Hymenoptera, Apoidea) – nowe stanowisko polilektycznej pszczoły w Polsce. Chrońmy Przyr. Ojcz., **65**(3): 231-233.

KRASICKA-KORCZYŃSKA E., KORCZYŃSKI M. 2003. „Ostrów Małe Rudy" w dolinie Noteci. Flora i Fauna Pomorza i Kujaw, Bydgoszcz, **1**: 105-114.

KRYGOWSKI B. 1958. Krajobraz Wielkopolski i jego dzieje. Seria: „Wielkopolska w oczach przyrodnika:, Nr 2, PWN, Poznań, 164 pp.

ŁOZIŃSKI P. 1920. Błonkówki pszczołowate okolic Krakowa. Spraw. Kom. Fizjograf. Kraków, **53**: 125-137.

MARLIN J.G., LABERGE W.E. 2001. The native bee fauna of Carlinville, Illinois, revisited after 75 years: a case for persistence. Conservations Ecology 5(1): 9.[online] URL://www.consecol.org/vol5/iss1/art9.

MARQUARDT T. 2000. Owady zapylające wirydarza Wyższej Szkoły Pedagogicznej w Bydgoszczy. Instytut Biologii i Ochrony Środowiska, Bydgoszcz, mscr, 39 pp.

MARQUARDT T. 2002. Struktura zespołów pszczół (Hymenoptera, Apoidea) na terenie miasta Żnina. Pracownia Monitoringu Środowisk Lądowych UMK, Toruń, mscr, 77 pp.

MATUSZKIEWICZ J.M. 2010. Geobotaniczna analiza specyfiki regionu kujawsko-pomorskiego [w:] H. RATYŃSKA, B. WALDON (eds) Ciepłolubne murawy w Polsce – stan zachowania i perspektywy ochrony. Wyd. Uniwersytetu Kazimierza Wielkiego, Bydgoszcz, 11-43 pp.

MORZYŃSKA K. 2002. Udział Apidae na tle innych rodzin pszczół w środowiskach łęgowych doliny Wisły pod Bydgoszczą. Instytut Biologii i Ochrony Środowiska Akademii Bydgoskiej im. Kazimierza Wielkiego, Bydgoszcz, mscr, 48 pp.

NAWROT M. 1922. Plan urządzenia Gospodarstwa Rezerwatowego na okres od stycznia 1992 do 31 grudnia 2001r. Regionalna Dyrekcja Lasów Państwowych w Pile, Nadleśnictwo Kaczory, mscr.

NOWAK-KAŁUŻNA R. 2006. Pszczoły rezerwatu „Zielona Góra". Instytut Biologii i Ochrony Środowiska Uniwersytetu Kazimierza Wielkiego, Bydgoszcz, mscr, 40 pp.

OLSZEWSKI J. 1937. Gatunki trzmieli na ziemiach wielkopolskich; rola trzmiela w zapylaniu koniczyny czerwonej. Zakład Zoologii i Entomologii Uniwersytetu Poznańskiego, mscr, Poznań, 67 pp.

OSYTSHNJUK A.Z. 1977. Fauna Ukraini. Tom. 12 BdZolini. Bip. 5. Bdżoli – andrenidi, Naukova Dumka, Kiev, 328 pp.

O'TOOLE C. 1993. Diversity of native bees and agroecosystcms. [in:] J. LA SALLE., I.D GAULD (eds), Hymenoptera and biodiversity, pp. 169-196. Natural History Museum London and CAB International, Wallingford, UK 348 pp.

O'TOOLE C. 1994. Who cares for solitary bees? [in:] A. MATHESON (ed.). Forage for Bees in an Agricultural Landscape. International Bee Research Association, Cardif, UK. pp. 47-55.

PEKKARINEN A. 1999. Oligoleclic bee species and their decline in Finland (Hymenoptera: Apoidea). [in:] K. ELBERG, M. MARTIN, A. PEKKARINEN (eds), Proceedings of the 24th Nordic Congress of Entomology, Tartu, Estonia, 1997, pp. 151-156. University of Tartu & Estonian Naturalists' Society.

Perthées K. 1802. Partie I. contenaut: Les Coléoptères – Hémiptères – Neuroptères – Hyménoptères – Diptères, mscr, p. 341. Library of the Institute of Systematics and Evolution of Animals PAS, Kraków.

PESENKO Yu.A., BANASZAK J., RADCHENKO V.G., Cierzniak T. 2000. Bees of the family Halictidae (excluding Sphecodes) of Poland: taxonomy, ecology, bionomics. Wydawnictwo Uczelniane Wyższej Szkoły Pedagogicznej, Bydgoszcz, 348 pp.

PŘIDAL A., TKALCŮ B. 2003. Records of two bumble bee species new for the Czech Republic and Slovakia (Hymenoptera: Apoidea: Bombini). Entomofauna. Zeitschr. Entomol., **24**(23): 317-332.

PŘIDAL A., KOMZÀKOVÀ O. 2009. Faunistic records from the Czech Republic - 276. Hymenoptera: Apoidea: Apidae. Klapalekiana, **45**: 119-120.

RADCHENKO V.G., PESENKO Yu.A. 1994. The biology of bees (Hymenoptera, Apoidea). Zool. Inst., St. Petersburg, 350pp.

RASMONT P. 1984. Les bourdons du genre Bombus Latreille sensu stricto en Europe occidentale et centrale, Spixiana, **7**: 135-160.

RASMONT P., LECLERCO J., JACOB-REMACLE A., PAULY A., GASPAR Ch. 1993. The faunistic drift of Apoidea in Belgium. [in:] E. BRUNEAU (ed.) Bees for pollination. Commision of the European Communities, Brussels, pp. 65-87.

RASMONT P., PAULY A., TERZO M., PATINY S., MICHEZ D., ISERBYT S., BARBIER Y., HAUBRUGE. 2005. The survey of wild bees (Hymenoptera, Apoidea) in Belgium and France. FAO – report. www.atlashymenoptera.net/biblio/144, pp.18.

RUHNKE H. 1998. Zur Verbreitung, Bionomie und Gefährdung der Blattschneiderbiene Megachile genalis MOR (Hymenoptera: Megachilidae). Martin-Luther-Universität Halle-Wirtenberg, mscr.; 2000. Mitt. Dtsch. Ges. allg. angew. Ent., **12**: 513-516.

SCHMIED-EGGER Ch., SCHEUCHL E. 1997. Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Östereichs. Bd. III: Andrenidae, Velden (Selbstrerlag), 180 pp.

SŁOMA I. 2005. Owady zapylające rezerwatu „Wąwelno" pod Bydgoszczą ze szczególnym uwzględnieniem trzmieli. Instytut Biologii i Ochrony Środowiska Akademii Bydgoskiej im. Kazimierza Wielkiego, Bydgoszcz, mscr, 49 pp.

SOWA S., DYLEWSKA M., BILINSKI M., RUSZKOWSKI A. 1991. Trzmiele bydgoskiego, pilskiego, toruńskiego i włocławskiego. Pszczeln. Zeszyty Nauk., Puławy, **35**: 113-125.

STOECKHERT E. 1919. Beiträge zur Kenntnis der Hymenopterenfauna Frankeus. Mitt. Müncher Entomol. Ges., e.v. (1-4, 5-6, 7-8): 1-36.

STOECKHERT F.K. 1933. Die Bienen Frankens (Hym. Apid.). Eine ökologisch-tiergeographische Untersuchung. Deutsch. Ent. Zeitsch. (Berlin), 1932; Beiheft: VIII+294pp.

SZAFRANÓWNA H. 1933. Przyczynki do historii badań flory poznańskiej. Biblioteka 'Kroniki Miasta Poznania", Poznań, nr 4, 43 pp.

SZCZEPIŃSKA A. 2005. Owady zapylające rezerwatu krajobrazowego „Kruszyn" pod Bydgoszczą ze szczególnym uwzględnieniem trzmieli. Instytut Biologii i Ochrony Środowiska Akademii Bydgoskiej im. Kazimierza Wielkiego, Bydgoszcz, mscr, 46 pp.

SZULCZEWSKI J.W. 1916. Ein Fall von Kreuzung zwischen zwei Hummelarten. Zeitschr.Naturwiss Abt., Posen-Poznań, **12**: 29-31.

SZULCZEWSKI J.W. 1922. Obecny stan badań nad fauna błonkówek wielkopolskich. Spraw. Kom. Fizjograf., Kraków, **55-56**: 98-101.

SZULCZEWSKI J.W. 1927. Rozmieszczenie niektórych przedstawicieli fauny na obszarze Wielkopolski. II Zjazd Słowiańskich Geografów i Etnografów w Polsce 1927, pp.1-2.

SZULCZEWSKI J.W. 1930. W sprawie ochrony owadów w Wielkopolsce. Wydawnictwo Okręgowego Kom. Ochr. Przyr. na Wielkopolskę i Pomorze w Poznaniu, Państw. Rada Ochr. Przyr., Poznań, **2**:57-58.

SZULCZEWSKI J.W. 1948. Błonkówki (Hymenoptera) Wielkopolskiego Parku Narodowego. Cześć III. Pszczołowate (Apidae). Prace Monograf. Przyr. WPN, PTPN, Poznań, **2(3)**: 70-89.

TOMASIK S. 2007. Różnorodność gatunkowa i bionomia żądłówek zasiedlonych w pułapkach gniazdowych. Instytut Biologii i Ochrony Środowiska Uniwersytetu Kazimierza Wielkiego, mscr.,126 pp.

TORKA V. 1910. Hymenopteren der Provinz Posen. Zeitschr.Naturwiss Abt., Posen-Poznań, **17**: 33-43.

TORKA V. 1913. Die Bieneu der Provinz Posen. Zeitschr.Naturwiss. Abt., Posen-Poznań, **20**(1-6): 97-181.

TORKA V. 1916. Einige seltene Hymenopteren Posens. Zeitschr.Naturwiss Abt., Posen-Poznań, **23**(3): 31-33.

TORKA V. 1933.Nachtrage zu meiner Veröffentlichung über „Bie Bienen der Provinz Posen" Deutsch. Wiss. Zeitschr., Polen, **26**: 83-94.

WILLAMS P.H. 1982. The distribution and decline of British bumblebee bees (*Bombus* Latr.). Journal of Apicultural Research **21**(4): 236-245.

WILLAMS P.H. 1986. Environmental change and the distributions of British bumble bees (*Bombus* Latr.). Bee World **67**(2): 50-61.

WILKANIEC Z., WÓJTOWSKI F., SZYMAŚ B. 1985. Some investigations on solitary bee Rhophitoides canus Ev. (Apoidea, Halictidae) nesting in alfalfa deed plantations. Zoll. Poloniae, **32**(3-4): 139-151.

WODZICZKO A. (ed.) 1947. Stepowienie Wielkopolski. Prace Kom. Mat.-Przyr. PTPN, Ser. B, **10**(4): 137-234.

WOŚ A. 1994. Klimat Niziny Wielkopolskiej. Wyd. Naukowe UAM, Poznań, 192 pp.

WÓJTOWSKI F., SZYMAŚ B. 1973. Dziko żyjące pszczołowate (Hym. Apoidea) terenów zieleni miejskiej Poznania. Roczniki AR, Poznań, **66**: 163-169.

WÓJTOWSKI F., FELISZEK H. 1977. Apidofauna zapylającą drzewa owocowe w pracowniczych ogródkach działkowych Poznania. Roczniki AR, Poznań, **94**: 235-241.

WÓJTOWSKI F., WILKANIEC Z. 1979. Pszczołowate (Apoidea) upraw nasiennych lucerny województwa poznańskiego. Roczniki AR, Poznań, **111**: 215-220.

WÓJTOWSKI F., SZYMAŚ B., WILKANIEC Z. 1979. Błonkówki (Hymenoptera) i muchówki (Diptera) odwiedzające kwiatostany marchwi nasiennej. Roczniki AR, Poznań **111**: 209-214.

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