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PHENOLOGY OF SOCIAL WASPS (*HYMENOPTERA: VESPINAE*) IN THE KUJAWY REGION (NORTHERN POLAND) UNDER THE INFLUENCE OF CLIMATIC CHANGES 1981–2000

Abstract: Duration of flight periods were determined for most numerous species of social wasps for two decades 1981–1990 and 1991–2000. The tendency to shorten the duration of wasps' flight periods by 12–18% was observed during 1990s. An attempt was undertaken to associate this phenomenon with observed climatic changes that shape nutritional resources of Vespinae.

Key words: Wasps (*Hymenoptera: Vespinae*), phenology, Kujawy region, climate change

Introduction

Wasps are predators of insects and they prefer anthropogenic habitats. They are the main reducers of dipterans in rural and urban areas (Edwards 1980; Matsura & Yamane 1984; Pawlikowski 1990). They also eat a variety of carbohydrate food. In their quest for food, they often visit flowers of *Umbelliferae*, *Scrophulariacae* and thickets of *Symphoricarpos albus*, as well as different rooms and places with products or food scraps subjected to ethyl fermentation. When visiting those places they become not only pollinators, but also a vectors of pathogenic micro-organisms. Thus they may constitute a sanitary threat (Nadolski et al. 2000). At the same time, because of their

activeness and aggressiveness, wasps pose a high allergological and toxicological threat for residents.

The biology of social wasps has been very well studied (Edwards 1980; Kemper and Döhring 1967; Matsura and Yamane 1984). For more than 20 years the research has been carried out on the nesting ecology of social wasps in relation to the cycle of colony development (Pawlikowski 1990). Within the scope of this research attempts have been made to define factors influencing their abundance dynamics as well as the duration of the development of colonies. In the 1980s and 1990s, monitoring studies were also conducted on social wasps in the urban and agricultural landscape of the Kujawy region. The results of most of this research have been published (Pawlikowski 1999; Pawlikowski and Osmański 1998; Pawlikowski and Przybylska 2001; Pawlikowski et al. 2005; Pawlikowski and Pawlikowski 2006).

The aim of this paper is to determine the phenology and the duration of wasps' flight periods under the influence of the observed climatic changes in the 1980s and 1990s.

Material and methods

The research on social wasps in the agricultural landscape of Kujawy was conducted ca. 20 km south of the town of Inowrocław from April to October in 1981–2000. The study involved observing and catching wasps along a transect running through the villages of Stodólno, Kraszyce, Stodoły, Książ and Strzelno Klasztorne. This area is located within the UTM square CD13 (Fig. 1). The march was undertaken on sunny days at intervals of 5–7 days during April, May, August and September, and at intervals of 7–10 days during the remaining months, at 8:00–15:00 GMT (depending on the occurrence of optimal conditions for wasps' flights). All wasps were registered along the transect while they were busy with their activities, i.e. searching for food, hunting, collecting nectar and honeydew (mainly on *Umbelliferae* plants and *Symphoricarpos albus* thickets), and collecting material for building nests (particularly on wooden constructions). Special attention was paid to miscellaneous places with carbohydrate food, like gardens, orchards, utility buildings, and service and trade buildings. Social wasps, with distinct and unquestionable species characteristics were recorded directly. Specimens with characteristics difficult for quick species identification were caught alive (by means of an entomological net or an exhauster) and after

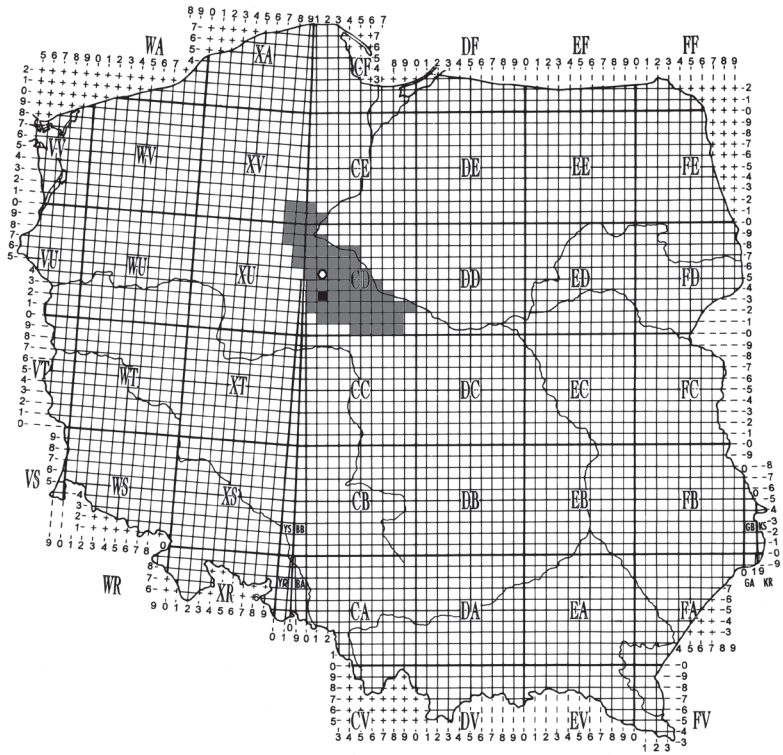

Fig. 1. Research area (black square) in the Kujawy region (gray squares) superimposed on a map of Poland in the UTM grid system. Location of the meteorological station in Inowrocław marked with white dot

thorough examination (through a x20 magnifying glass) were mostly identified in the field and then released. Only a few of them were poisoned for laboratory identification.

Occasional observations of the distribution *Vespinae* wasps were conducted in some agricultural environments near the towns of Inowrocław (CD15), Gniewkowo (CD26) and Aleksandrów Kujawski (CD46).

The characteristics of weather conditions in individual research years were based on the data from the meteorological station in Inowrocław, located close to the research area. Data for mean air temperature and total annual precipitation were taken into account (Fig. 2).

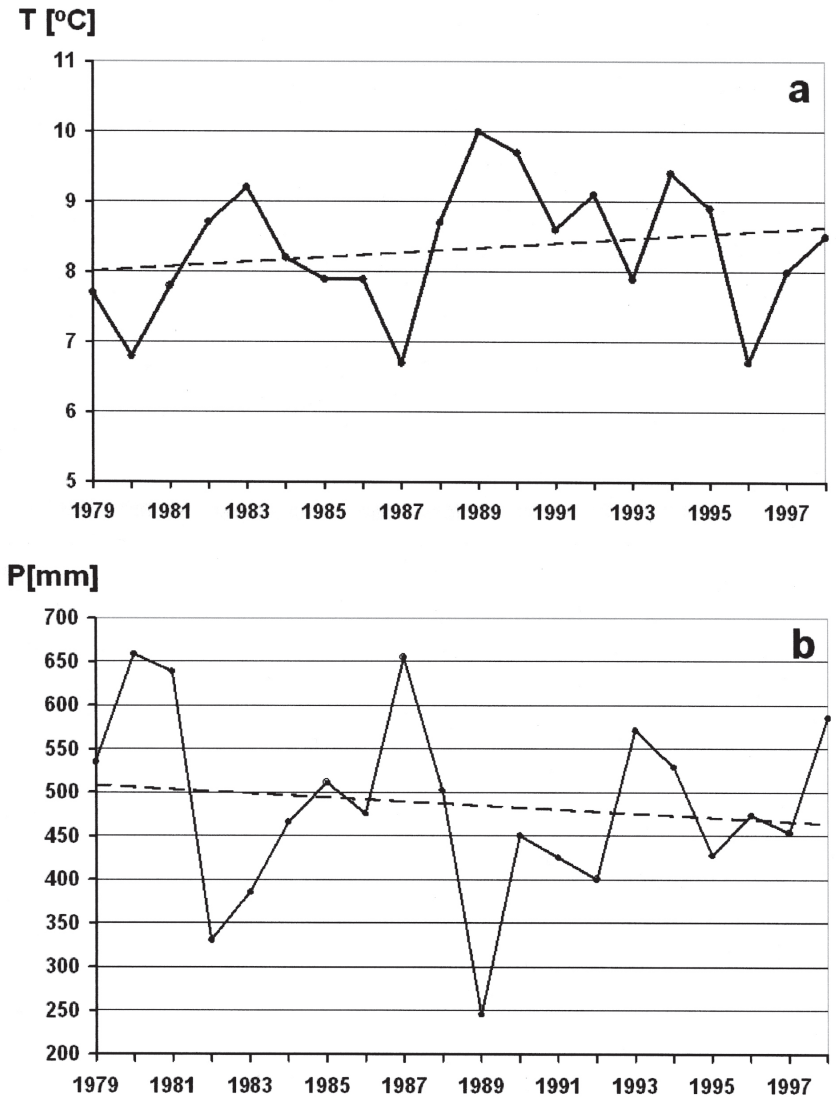

Fig. 2. Mean annual air temperature (a) and total rainfalls (b) for the Kujawy region according to data from the meteorological station in Inowrocław, 1979–1998 (Rogowski, unpublished). Dotted lines indicate trends

Table 1. Domination [%N] and distribution of species of *Vespinae* wasps in selected areas* (according to the UTM grid system) of the Kujawy region in 1981–2000

Species	1981–1990 (CD13)		1991–2000 (CD13)		1981–2000 (UTM)			
	n_i	%N	n_i	%N	CD13	CD15	CD26	CD46
Vespula germanica (F.)	11540	91.49	11352	85.57	+	+	+	+
Vespula vulgaris (L.)	713	5.65	1556	11.73	+	+	+	+
Vespa crabro L.	212	1.68	182	1.37	+	+	+	+
Dolichovespula saxonica (F.)	131	1.04	136	1.03	+	+	+	+
Dolichovespula sylvestris (Scop.)	11	0.09	6	0.05	+	–>	–>	+
Vespula rufa (L.)	8	0.06	23	0.17	+	+	+	+
Dolichovespula media (Ret.)	0	0.00	12	0.09	+	–	–	–
Total of *Vespinae* (= N)	12615	100.0	13267	100.0	+	+	+	+

* – Stodoły > Strzelno (CD13), Inowrocław (CD15), Gniewkowo (CD26), Aleksandrów Kujawski (CD46)

n_i – number of observed specimens, N – total number of specimens, –> – recorded during other investigations

Research results

The studies on wasps *Vespinae* in the area of Kujawy, during the distinguished ten-year intervals of the years 1981–2000, revealed the widespread presence of 6 species (Table 1). Whereas the species *Dolichovespula media* (Ret.) was observed only occasionally in 1990s. Among *Vespinae*, two species dominated: *Vespula germanica* (F.) (from 86% to more than 90% of the total specimens) and *Vespula vulgaris* (L.) (from 6% to nearly 12% of the total specimens). In each of ten-year periods, they comprised together 97% of the total number observed wasps. Quantitative distributions of social wasps recorded in the period 1981–1990 (12615 specimens) and 1991–2000 (13267 specimens), were very similar to each other. The set of species recorded in the twenty-year period as a whole, together with their

potential nest parasites, such as *Dolichovespula omissa* (Bishoff), *Dolichovespula adulteriana* (Buysson) and *Vespula austriaca* (Pz.), constitut almost a complete set of *Vespinae* recorded in Poland.

Based on the first flights of queen mothers (Table 2) and on the last observed flights of different castes of imagines, the phenology of *Vespinae* flights was determined in the study period (Table 3). The range of flights of the superdominant *V. germanica* was shorter in 1991–2000 by 18.5%, in comparison with the years 1981–1990. Also the range of *V. vulgaris,* the second dominating species, was shorter in the second ten-year period by 16.3%. For remaining species, the tendency for shorter flight ranges was also observed in the second decade. Only for the hornet – *Vespa crabro* L. – did the range of flights remain constant. However, it was revealed that in 1991–2000, the range of its flights began and ended, on average, one week earlier.

Discussion

In 1996 and 1997 (Pawlikowski and Osmański 1998), it was found that wasps were selecting more hygric locations for their nests. Those habitats, mostly covered with shrubs or shaded with the crowns of trees, remained humid more permanently in the twenty-four-hour cycle and stayed hygrophytic for longer in comparison with open areas. The maintenance of humidity in the environment was favourable to the development and attraction of hygrophilous insects, particularly dipterans – the main victims of predatory social wasps. Furthermore, it is a well-known fact that for species of *Vespula* from the moderate climate, which build underground nests, the increased humidity of habitats could be unfavourable for their societies (Kemper and Döhring 1967; Matsura and Yamane 1984). These wasps, however, having endothermic thermoregulation as well as the proper construction of cardboard nests (multilayered protection), effectively mitigate the increased humidity of underground nesting sites.

The recorded decreasing trend of the precipitation and at the same time the increasing trend of the air temperature in the vegetation season during the last 20 years (Fig. 2), as well as the significant ($p \leq 0.05$) tendency to shorten the duration of flight periods of *Vespinae* (Table 3), would indicate the general deterioration of habitat conditions for this group of insects. However, this deterioration would concern mainly the nutritional factors. Prob-

Table 2. Phenology of spring queens' flights of the majority of social wasp species in the Kujawy region during 1981–2000

Year	*Vespula germanica*			*Vespula vulgaris*			*Vespa crabro*			*Dolichovespula saxonica*		
	P	K	ND	P	K	ND	P	K	ND	P	K	ND
1981	13.04	19.06	68	15.05	15.06	30	09.05	14.06	35	-	-	-
1982	14.05	17.06	34	04.05	10.06	36	-	-	-	-	-	-
1983	20.04	04.06	46	-	-	-	01.05	09.06	40	-	-	-
1984	17.04	26.05	40	-	-	-	14.05	10.06	22	-	-	-
1985	20.04	22.05	33	13.05	15.06	27	14.05	21.05	8	09.05	21.05	13
1986	-	-	-	-	-	-	01.05	31.05	29	-	-	-
1987	30.04	11.06	43	27.05	04.06	9	11.05	08.06	29	-	-	-
1988	08.05	14.05	38	-	-	-	-	-	-	30.04	14.05	15
1989	15.04	19.05	35	15.05	17.06	33	-	-	-	22.04	10.05	19
1990	12.04	23.05	42	01.05	18.05	47	03.05	05.05	3	05.05	01.06	27
1981–1990	23.04*	02.06*	40	27.04*	27.05*	30	10.05*	02.06*	23	02.05*	20.05*	18
1991	21.04	21.06	62	-	-	-	-	-	-	28.04	05.05	8
1992	02.05	30.05	29	15.05	02.06	17	-	-	-	30.04	22.05	23
1993	26.04	03.06	39	-	-	-	03.05	23.05	19	24.04	01.05	8
1994	23.04	01.06	40	18.05	01.06	15	07.05	28.05	22	30.04	07.05	8
1995	21.04	31.05	41	-	-	-	06.05	27.05	22	25.05	31.05	7
1996	21.04	22.05	30	-	-	-	-	-	-	20.05	30.05	11
1997	12.05	12.06	32	-	-	-	12.05	30.05	17	06.05	28.05	23
1998	07.05	12.05	6	12.05	01.06	14	09.05	?	?	28.04	26.05	29
1999	01.05	02.06	33	10.05	04.06	26	07.05	?	?	-	-	-
2000	20.04	06.06	48	02.05	07.06	37	-	-	-	19.05	24.05	6
1991–2000	28.04*	03.06*	36	11.05*	02.06*	22	07.05*	27.05*	20	08.05*	22.05*	14

P – date (day.month) of the first spring queen observation; K – date (day.month) of the last spring queen observation
ND – number of days with spring queen flights; *) – an average date

Table 3. Phenology of *Vespinae* wasps' flights in the Kujawy region during 1981–2000

Species	MND	Years	Months and 7–8 day periods						
			A	M	J	J	A	S	O
1. Vespula *germanica* (F.)	168[a]	1981–1990	––●●	●●●●	●xxx	xxxx	xxxx	xxxx	xv––
	137[a]	1991–2000	–––●	●●●●	●xxx	xxxx	xxxx	xv––	–––––
2. *Vespula vulgaris* (L.)	141[b]	1981–1990	–––●	●●●●	vvxx	xxxx	xxxx	xxxv	vv––
	118[b]	1991–2000	–––––	–●●●	●vvx	xxxx	xxxx	xxv–	–––––
3. *Vespa crabro* L.	122	1981–1990	–––––	––●●	●vvv	xxxx	xxxx	xxv–	–––––
	122	1991–2000	–––––	–●●●	vvvx	xxxx	xxxx	xv––	–––––
4. *Dolichovespula saxonica* (F.)	113[c]	1981–1990	–––––	●●●v	vvxx	xxxx	xxxv	–––––	–––––
	99[c]	1991–2000	–––––	–●●v	vvvx	xxxx	xxv–	–––––	–––––
5. *Dolichovespula sylvestris* (Scop.)	113?	1981–1990	–––––	●●●●	●vxx	xxxx	xxx–	–––––	–––––
	96?	1991–2000	–––––	–●●●	●vxx	xxxx	xx––	–––––	–––––
6. *Vespula rufa* (L.)	91?	1981–1990	–––––	––●●	●vxx	xxxx	xx––	–––––	–––––
	90?	1991–2000	–––––	––●●	●vvx	xxxx	xx––	–––––	–––––
7. *Dolichovespula media* (Ret.)	89?	1981–1990	–––––	––●●	vvxx	xxxx	xx––	–––––	–––––
	82?	1991–2000	–––––	–––●	●vxx	xxxx	xx––	–––––	–––––
Number of *Vespinae* species		1981–1990	0012	4477	7777	7777	7754	3332	2200
		1991–2000	0001	1567	7777	7777	7743	3310	0000

MND – mean number of flight days (? = not completed data)
[a,b,c]) difference between means have significance level $p \leq 0.05$
● = spring queen flights
v = probably flights of queens and workers
x = workers and other castes flights

able cause would be the reduction of rainfalls followed by the decrease of humidity in habitats of open cultivations in the agricultural landscape. This factor most probably limits the abundance of dipterans, and consequently the essential nutritional resources of social wasps.

Conclusions

Of the 7 recorded species of social wasps in 1981–2000, *Vespula germanica* was the most commonly noted, amounting to from 86% to over 90% of all specimens.

The duration of flight periods during the vegetative season (= period of the development of colonies) *Vespula germanica* in decade 1991–2000 was shorter by more than 18% compared to previous decade 1981–1990.

For the majority of the remaining species of social wasps, a tendency to shorten the duration of flight periods in the last ten years of the 20th century was also observed.

References

Edwards R., 1980, Social wasps. Their biology and control. Rentokil Ltd., East Grinstead, 398 pp.

Kemper H., Döhring E., 1967, Die sozialen Faltenwespen Mitteleuropas. Verlag Paul Parey, Berlin-Hamburg, 180 pp.

Matsuura M., Yamane S., 1984, Biology of the vespine wasps. Springer-Verlag, Berlin-Hong Kong, 323 pp.

Nadolski J., Majczyna D., Loga B., Stańczyk-Lutz A., 2000, Szerszeń (*Vespa crabro*) w Łodzi – wstępna ocena epidemiologiczna. Acta Univ. Lodz., Folia Zoologica, 4, 47–56.

Pawlikowski T., 1990, Wasp communities (*Hymenoptera*, *Vespidae*) in the agricultural landscape of Chełmno Land (N Poland). Pol. Pismo Ent., 60, 115–128.

Pawlikowski T., 1999, Metodyka monitoringu pszczół i os społecznych (*Hymenoptera: Apidae, Vespidae*) na obszarze Torunia. Acta Univ. Nic. Copernici, Biol. 54, 102, 55–63.

Pawlikowski T., Osmański M., 1998, Atrakcyjność środowisk miejskich dla os społecznych (*Hymenoptera: Vespinae*) na obszarze Torunia. Wiad. Entomol., 17(2), 95–104.

Pawlikowski T., Przybylska E., 2001, Dynamika zmian struktury zespołu os społecznych (*Hymenoptera: Vespinae*) na obszarze miasta Torunia w latach 1979–1995. Bioróżnorodność i ekologia populacji zwierzęcych w środowiskach zurbanizowanych, Bydgoszcz-Myślęcinek, 94–101.

Pawlikowski K., Pawlikowski T., Szałaszewicz E., 2005, Fenologia lotów os społecznych (*Hymenoptera: Vespidae*) na obszarze miasta Torunia w latach 1981–2000. Biblioteka Monitoringu Środowiska, Poznań, 495–500.

Pawlikowski T., Pawlikowski K., 2006, Long-term dynamics of structure changes of the social wasp community (*Hymenoptera: Vespi*nae) in agricultural landscape of the Kujawy region, Ecol. Quest., 7, 21–28.

Ziembińska H., 1973, Uwagi o klimacie Torunia. [Some remarks about climate of Toruń]. Acta Univ. Nic. Copernici, Geogr. 10, 32, 93–106.