

Nesting interactions of the social wasp *Dolichovespula saxonica* [F.] (*Hymenoptera: Vespinae*) in wooden nest boxes for birds in the forest reserve „Las Piwnicki” in the Chełmno Land (Northern Poland)

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Abstract. The aim of this research was to investigate the process of colonization in wooden nest boxes for birds by the wasp *Dolichovespula saxonica* [F.] in the forest reserve “Las Piwnicki” during 1986–1987. About 69% of 150 nest boxes were colonized (36% by *D. saxonica*) in 1986 and 35% (10% by *D. saxonica*) in 1987. Parasite *Shecophaga vesparum* Court was observed inside small cell nests (SC) and large cell nests (LC) in the ratio of 5(SC) : 3(LC). During the two seasons, the decrease in the number of parasitised nests followed with the ratio of 10(1986) : 1(1987). Competition of the „wasp – wasp” type (VV) compared to other competition types, such as „wasp – bird” (VA) and different types with wasps (DT), was the most frequent one among the interactions and followed with the ratio 1(VV) : 7(VA) : 5(DT). The number and proportions of construction types of nests during the studied growing seasons seem to prove the regular and irregular development of the *Dolichovespula saxonica* colony.

Key words: *Hymenoptera*, *Vespinae*, *Dolichovespula saxonica*, interactions, the Forest Reserve “Las Piwnicki”.

1. Introduction

Saxon wasp – *Dolichovespula saxonica* [F.] dominates in number among species of social wasps from the genus *Dolichovespula*. In Poland it takes place mainly in forest areas (unpublished data). Similarly to other social wasps, this species is one of the very active predators, hunting insects, including mainly imagines of dipterans (*Diptera*). Its successful development is attributed to habitual building of nests in hollows and other surface, wooden shelters (Edwards 1980; Kemper & Döhning 1967).

Introduction of wooden nest boxes for birds in forest areas provides the species with new nesting sites. Efficiency in colonising those nesting sites is a result of competition

for the sites by different species of birds, mammals and invertebrates, including wasps of the same species and other social wasps. Whereas, effectiveness of the development of wasp colonies remains under the influence of mechanisms of intrapopulation competition (Archer 1998) and the parasitoid *Shecophaga vesparum* Court (*Hymenoptera: Ichneumonidae*) (Edwards 1980; Matsuura & Yamane 1990).

In 1992–1994, the efficiency in colonising ca. 240 birds’ wooden nest boxes by the wasp *Dolichovespula saxonica* had been observed in typical forest environments of Borecka Forest (Pawlikowski & Pawlikowski 2003). The present paper aims at evaluating the effectiveness of settling in about 150 boxes by the wasp *Dolichovespula saxonica* in the forest reserve of northern Poland, taking

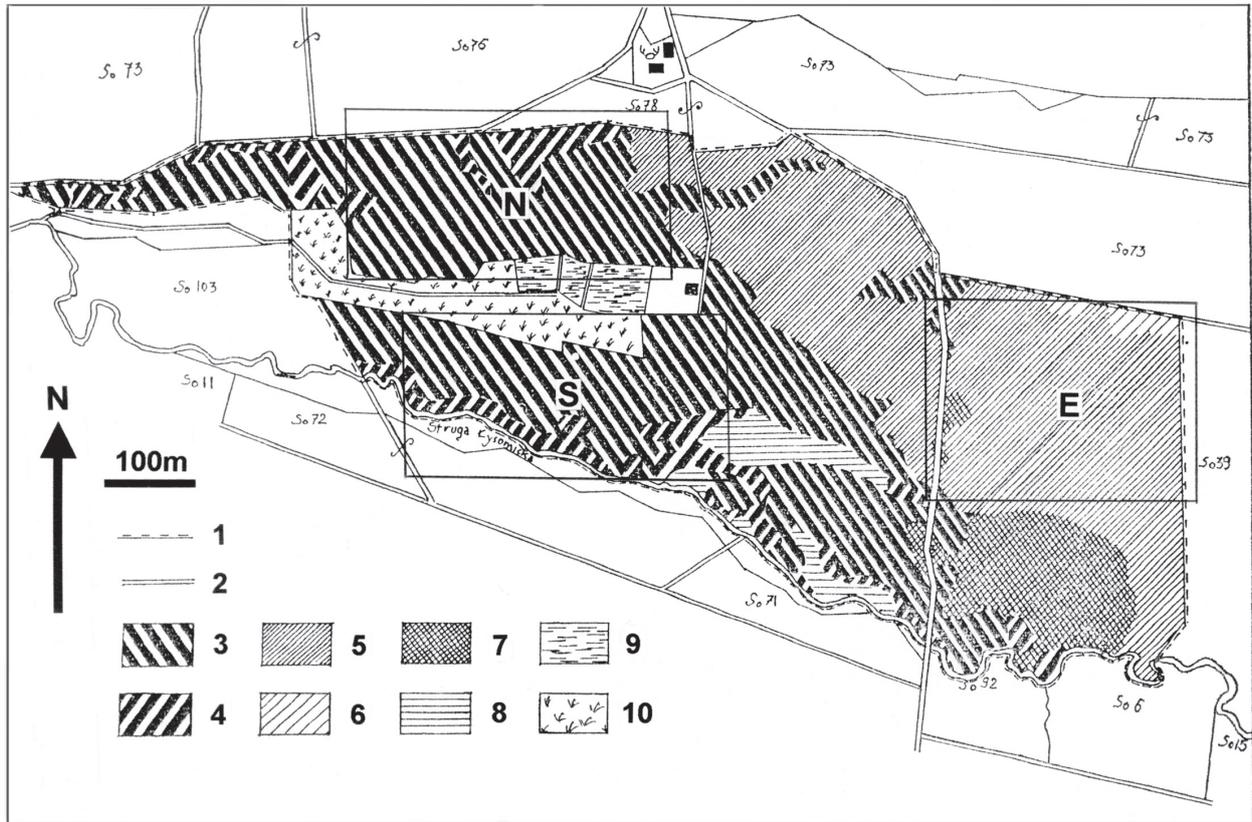


Figure 1. Location of areas with wasp settlements inside wooden nest boxes for birds (N, S, E) in the Reserve "Las Piwnicki": 1 – boundary, 2 – roads, 3 – *Tilio-Carpinetum typicum*, 4 – *Tilio-Carpinetum stachyetosum*, 5 – *Quercus-Pinetum*, 6 – *Quercus-Pinetum* strongly resembling a pine forest, 7 – *Quercus-Pinetum* mixed with *Tilio-Carpinetum*, 8 – *Circeo-Alnetum*, 9 – ponds, 10 – meadows (Gromadska 1977, after Rejewski 1977)

into account interactions of other species. At the same time, the development success of colonies was subject to evaluation, as well as the extent of their parasitization by *Shecophaga vesparum*.

2. Material and methods

The research was carried out in 1986–1987 in the Forest Reserve „Las Piwnicki” on the northern edge of the Toruń Basin within the lower Vistula valley (North Poland, UTM: CD38). The whole area is slightly inclined towards the west and diversified with two parallelly situated dune embankments of the relative height ranging from 3 to 5 m. Along the southern edge, a small rivulet, called the Łysomicka Stream flows (Fig. 1).

The dominating forest associations are mesotrophic mixed lime-oak-hornbeam forest – *Tilio-Carpinetum typicum*, fertile mixed lime-oak-hornbeam forest – *Tilio-Carpinetum stachyetosum* and mixed coniferous forest – *Pino Quercetum* (Rejewski 1977). Mesotrophic mixed lime-oak-

hornbeam forest is most developed in the central and north-western part of the reserve. This forest consists of a higher layer of trees composed of 300-year-old pedunculate oaks (*Quercus robur* L.) and a lower layer of undergrowth dominated by hornbeam (*Carpinus betulus* L.). In the herb layer, mainly species of mixed lime-oak-hornbeam forest occur, accompanied by pine forest species.

Fertile mixed lime-oak-hornbeam forest covers lower locations in the western and southwestern part of the reserve. Also there, the tree stand consists of two layers. In the upper layer, hornbeam is the most significant species and is accompanied by pedunculate oak and black alder (*Alnus glutinosa* L.). In the understory hornbeam dominates, and in some places hazel (*Corylus avellana* L.) and common elder (*Sambucus nigra* L.). The herb layer is highly diversified with some contribution of riparian forest vegetation.

Mixed coniferous forest occurs in the northeastern part of the reserve. The higher tree stand consists mainly of pine (*Pinus sylvestris* L.) and pedunculate oak, and the lower one is mainly dominated by the undergrowth of

Table 1. Wooden nest boxes settling status in research areas in the reserve "Las Piwnicki" (RLP): NA – north area in *Tilio-Carpinetum typicum* forest, SA – south area in *Tilio-Carpinetum typicum & stachyetosum* forest, EA – east area in *Quercus-Pinetum* forest, nb – number of boxes

| Settling | | 1986 | | | | | 1987 | | | | |
|-------------------------------------|------|-------|-------|-------|--------|------|-------|-------|-------|--------|------|
| | | NA | SA | EA | RLP | | NA | SA | EA | RLP | |
| | | nb=58 | nb=44 | nb=47 | nb=149 | % nb | nb=56 | nb=44 | nb=47 | nb=147 | % nb |
| Bird | | 19 | 14 | 11 | 44 | 29.5 | 17 | 9 | 9 | 35 | 23.8 |
| Bird + <i>Bombus</i> | | – | – | 1 | 1 | 0.6 | – | – | 1 | 1 | 0.6 |
| <i>Dolichovespula saxonica</i> [F.] | QN | 7 | 1 | – | 8 | 5.3 | 5 | 5 | – | 10 | 6.8 |
| | SC+P | 1 | – | 3 | 4 | 2.6 | 2 | – | 1 | 3 | 2.0 |
| | LC+P | – | 1 | 3 | 4 | 2.6 | – | – | – | – | – |
| <i>D.saxonica</i> + wasp | QN | 1 | – | 2 | 3 | 2.0 | – | – | – | – | – |
| | SC+P | 3 | – | – | 3 | 2.0 | – | – | – | – | – |
| <i>D.saxonica</i> + bird | QN | 8 | 7 | 6 | 21 | 14.1 | 1 | 1 | – | 2 | 1.3 |
| | SC+P | 1 | 1 | 3 | 5 | 3.3 | – | – | – | – | – |
| | LC+P | 1 | – | 4 | 5 | 3.3 | – | – | – | – | – |
| <i>Vespa crabro</i> L. | QN | 1 | – | 3 | 4 | 2.6 | 1 | – | – | 1 | 0.6 |
| | SC | – | – | 1 | 1 | 0.6 | – | – | – | – | – |
| Not settling | | 16 | 20 | 10 | 46 | 30.8 | 30 | 29 | 36 | 95 | 64.6 |

QN – queen nest

SC – nest with small cells

LC – nest with large cells

+P – nest parasitized by *Sphecoaphaga vesparum* Court

hornbeam, pedunculate oak and buckthorn (*Frangula alnus* Mill.). The herb layer is characterized by sparse contribution of species.

The Reserve remains under the influence of atlantic and continental climate. Mean annual temperature for this area oscillates around 6°C. Usual amplitudes of temperature are from –12 to 4°C in January and from 16 to 21°C in July. Precipitation oscillates from 300 mm to 800 mm per year (Barcikowski et al. 1990). Air temperature and total precipitation of growing seasons during the studied years were favourable for the development of the social wasps' colony.

For the studies on colonization of nest boxes, three sites with different forest communities were selected. A list of colonised boxes in particular years is presented in Table 1.

Altogether 149 birds' wooden nest boxes were used; type A1, B1 and C1 according to Sokołowski (1971). In the autumn 1986 about 50 boxes were installed at each site (each type proportionally represented), 2–3 m above the ground. Colonization status of boxes has been inspected at

the end of May, at the beginning, middle and end of July, in mid August, as well as at the beginning or mid September every research year. While inspecting the breeding boxes, their settlement status was recorded, and colonizing species were determined. Nests of wasps, in which the colonial development was completed, were collected for detailed analysis of settlement in cells. In total 67 nests were collected, including 53 in 1986 and 14 in 1987. During the last inspection in each research year, breeding boxes were cleaned up from all other remained nests (mainly birds'), as well as from organic remains.

3. Results

Effectiveness of settlement in nearly 150 wooden nest boxes for birds at 3 forest sites of the reserve "Las Piwnicki" in 1986–1987 is presented in Table 1. Their inhabitation level were 69% (including 36% by *Dolichovespula saxonica*) in 1986 and 35% (10%) in 1987. Saxon wasp colonized the breeding boxes independently (S), as well as together with

Table 2. Nests of the *Dolichovespula saxonica* in research areas in the reserve "Las Piwnicki" in 1986–1987; area marks as in Table 1

| Nest development types | Number of nests [n] in research areas | | | | | | | | | | | | | | | |
|------------------------|---------------------------------------|------|----|------|----|------|-----|------|------|------|----|-----|----|---|-----|------|
| | 1986 | | | | | | | | 1987 | | | | | | | |
| | NA | | SA | | EA | | RLP | | NA | | SA | | EA | | RLP | |
| | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| QN | 16 | 72.7 | 8 | 80.0 | 8 | 38.1 | 32 | 60.3 | 6 | 75.0 | 6 | 100 | – | – | 12 | 85.7 |
| SC+P | 5 | 22.7 | 1 | 10.0 | 4 | 19.0 | 10 | 18.9 | 2 | 25.0 | – | – | – | – | 2 | 14.3 |
| SCM+P | – | – | – | – | 2 | 9.5 | 2 | 3.8 | – | – | – | – | – | – | – | – |
| LCfQM+P | 1 | 4.5 | – | – | 4 | 19.0 | 5 | 9.4 | – | – | – | – | – | – | – | – |
| LCQM+P | – | – | 1 | 10.0 | 3 | 14.3 | 4 | 7.5 | – | – | – | – | – | – | – | – |
| All nests | 22 | 100 | 10 | 100 | 21 | 100 | 53 | 100 | 8 | 100 | 6 | 100 | – | – | 14 | 100 |

QN – nests built by founder queens

SC – nests with small cells produced

SCM – nests with small cells and males produced

LCfQM – nests with large cells males and a few queens produced

LCQM – nests with large cells and queens and males produced

+P – nests parasitized by *Sphecophaga vesparum*

other species (X). Moreover, also birds (A: mainly great tit – *Parus major* L. and pied flycatcher – *Ficedula hypoleuca* (Pall.) and hornet – *Vespa crabro* L. (C) participated in the settlement. Settlement contribution for A : S : X : C was represented in the following proportions 9 : 3 : 7 : 1 in 1986 and 7 : 2 : 0.4 : 0.2 in 1987.

Contribution of saxon wasp in the settlement process in breeding boxes was clearly correlated to the two-year cyclical development of families according to the Archer's principle (1998). In accordance with the aforementioned principle, after a season with a high number of females (including mainly new queens in nests with large cells), a season with a small number of females follows. Research on the structural variability in communities of social wasps, in the Toruń Basin (Pawlikowski & Przybylska 2001) and in the Kujawy region (Pawlikowski & Pawlikowski 2006), proved the synchronization between seasons with a high number of females and even-number years. Assuming this as a regularity for populations of social wasps from Northern Poland, one can validate a higher contribution of nests in the reserve during a season of an even-number year. Contribution of nests, which completed their development at the stage of queens' nests (QN) or nests with small cells (SC), or nests with large cells (LC) was expressed in the ratio of 8 : 3 : 1 in 1986 and 6 : 1 : 0 in 1987.

Only nests with small (SC) and large (LC) cells, i.e. 14–62% of all nests of *Dolichovespula saxonica* were subject to parasitization by *Sphecophaga vesparum*. Nests with small cells were more parasitized than nests with large cells,

in the ratio of 5(SC) : 3(LC). The effect of parasitization was not high and included 3–5% of specimens in SC nests and 0.4–4% of specimens in LC nests. The number of parasitized nests was decreasing in particular years, following the numerical ratio of 10(1986) : 1(1987) (Tab. 3).

Competition for birds' wooden nest boxes at the studied sites of the Reserve comprised 7 interactive types with participation of wasps, bumblebees and birds (Tab. 4). The interactive types were basically revealed between wasps (VV), between wasps and birds (VA), as well as between other types (DT). Contribution of those types for VV : VA : DT in particular years was as follows: in 1986 – 1 : 6 : 3, in 1993, in 1987 – 0 : 1 : 6; whereas for the whole study period – 1 : 7 : 5.

4. Discussion

The balance of nests and types of interaction in the reserve and in the Borecka Forest (Pawlikowski & Pawlikowski 2003) was used in order to determine the nest development types in normal and abnormal development cycle. A cycle was regarded as normal when consisted of a sequence of organizational events with participation of a colony's founder queen and few generations of workers that walked out generations of males and young queens. A cycle was regarded as abnormal if an initial nest was orphaned during that cycle, as a consequence of competition between post-hibernation queens. Further development of an orphaned

Table 3. Competition (\leftrightarrow) for wooden nest boxes for birds with wasps of *Dolichovespula saxonica*. Number of interactions (ni) and percentages(% ni) within the research areas in the reserve “Las Piwnicki” in 1986–1987.

| Competition type | Subjects of interactions | 1986 | | 1987 | |
|------------------|------------------------------|-------|------|-------|------|
| | | ni=53 | %ni | ni=14 | %ni |
| VV | NDsx \leftrightarrow 2QDsx | 1 | 1.9 | – | – |
| | NDsx \leftrightarrow QDsx | 1 | 1.9 | – | – |
| | NDsx \leftrightarrow NDsx | 1 | 1.9 | – | – |
| | NDsx \leftrightarrow NVc | 2 | 3.7 | – | – |
| VA | NDsx \leftrightarrow NA | 1 | 1.9 | – | – |
| AV | InA \leftrightarrow NDsx | 32 | 58.5 | 2 | 14.3 |
| A?V | InA? \leftrightarrow NDsx | 15 | 28.3 | 12 | 85.7 |

N = nest, In = initial nesting, Q = queen, A = bird, A? = probably bird, V = *Vespinæ* wasp species, B = *Bombus sp.*, Dsx = *Dolichovespula saxonica*, Vc = *Vespa crabro*

Table 4. Parasitise effect of *Dolichovespula saxonica* nests by *Sphecophaga vesparum* in forest areas of the reserve “Las Piwnicki” in 1986–1987; nests types as in Tab. 2.

| Nests | | Number of individuals in nest | | | | |
|-------|--------|-------------------------------|-------|-----------|------|----------|
| Type | Number | all in cells | | parasited | | |
| | | range | mean | range | mean | % of all |
| SC | 12 | 16–206 | 48.7 | 1–8 | 2.3 | 4.7 |
| SCM | 2 | 106–244 | 175.0 | 1–9 | 5.0 | 2.9 |
| LCfQM | 5 | 222–376 | 288.6 | 1–22 | 11.6 | 4.0 |
| LCQM | 4 | 221–1262 | 889.3 | 1–8 | 3.3 | 0.4 |

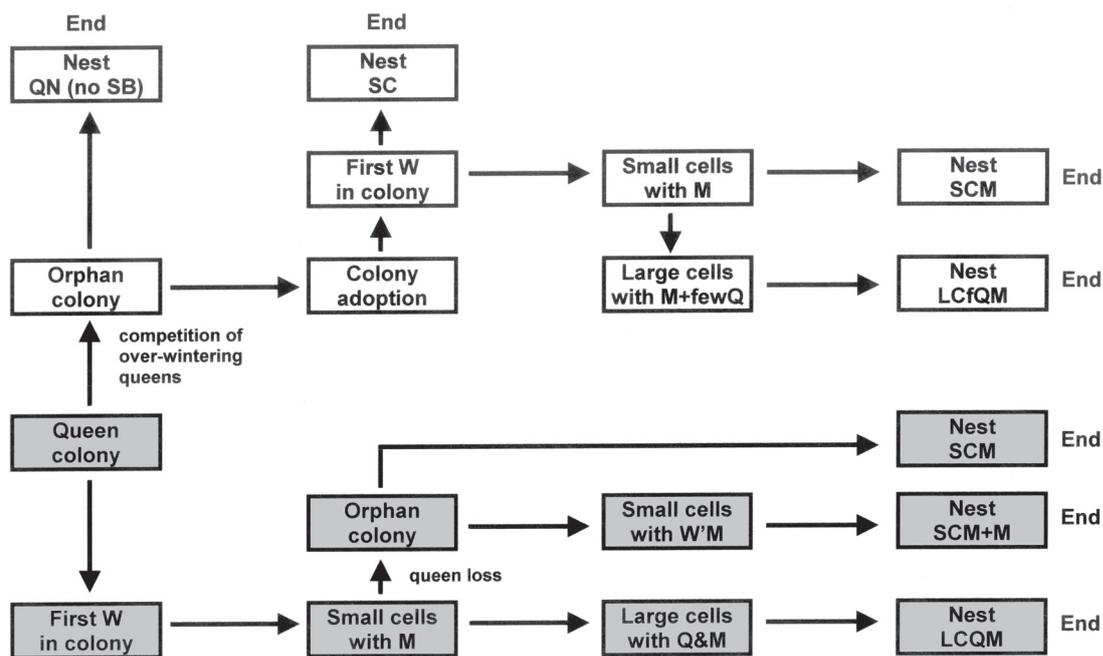


Figure 2. The normal and abnormal colonial development of *Dolichovespula saxonica* when founded queens are fertilized. Normal colonial development are shaded. Explanations: SB – siled brood, W – workers, M – males, W’M –worker’s males, Q – queens; types of nests explained in text

colony proceeded with the presence of a queen-usurper and few generations of workers, which produce scanty generations of males and young queens (Fig. 2).

The highest number of nests was recorded during the even-number years. During those years, queens' nests (QN) and nests with small cells (SC) dominated over nests with large cells (LC). Also then, interactions between queens were recorded always and quite frequently during nest founding. The number and proportions of nest development types of nests during the studied growing seasons seem to prove the regular and irregular development of the *Dolichovespula saxonica* colony. One should observe, that during the seasons with intensive competition between queens, all nest development types appear, developed through normal and abnormal development of the colony. Nevertheless, nests with abnormal development of the colony dominated among them. Also, during the years without intensive competition between queens, all nest development types occurred, but nests that originated as a result of regular development of the colony dominated than.

Parasitism by *Sphecohyga vesparum*, which accompanied particular developmental types of the colony, was not high. In the general balance of produced wasps, the observed parasitism did not significantly influence the course and the intensity of the life cycle of the wasp *Dolichovespula saxonica*.

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