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Effect of mating nucs spacing and subspecies of honey bee (*Apis mellifera*) on the drifting of queens returning from mating flights

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Abstract: *Effect of mating nucs spacing and subspecies of honey bee (*Apis mellifera*) on the drifting of queens returning from mating flights.* The loss of honeybee queens during mating flights increases the cost of their production. The aim of the study was to examine if the spacing of nucs influences the drifting of queen honey bees, which return from mating flights. The study also compared the drifting of Carniolan (*A. m. carnica*) and Italian (*A. m. ligustica*) queens. We examined the total of 89 queens which were placed in mating nucs together with about 1,000 workers. Some of the mating nucs were arranged in rows spaced 30 cm apart, without any landmarks, and other nucs were spaced a few meters apart, next to trees or bushes. Each group of nucs included Carniolan and Italian queens. The results show that significantly more queens failed to return from mating flights to nucs placed in rows without any landmarks (51%) than from those placed next to trees or bushes (7%). The study also showed that there is no significant differences between level of drifting of Carniolan and Italian queens.

Key words: beekeeping, honey bee, mating flights, drifting of honeybee queens, *Apis mellifera*

INTRODUCTION

During the mating flights, some honey bee queens are lost (Ratnieks 1990, Schlüns et al. 2005, Perez-Sato et al. 2008, Gąbka 2009). Losses of queens may reach 20% (Palmer and Oldroyd 2000, Medina and Gonçalves 2001) but in the colonies standing in a row at a close distance from one another, without any trees or bushes in the vicinity, the losses can be as high as 40% (Gąbka 2009). Also in case of workers about 40% of them drift away from colonies arranged in rows (Pfeiffer and Crailsheim 1998). One factor that is considered important in queen loss is the drifting of returning queens to a foreign hive in the apiary. Such mistakes are almost always fatal because workers kill any alien queens that they detect (Ribbands 1953). On the contrary, foreign foragers carrying a load of honey are accepted in bee colonies. Also drones gain admittance into strange colonies very easily (Washington 1967). Queen loss during mating is disastrous for the colony, because at the time of the queen's mating flight there is no open brood in the nest to rear a new queen. Besides, in mass production of egg laying honeybee queens, losses of queens during mating flights increase the cost of their production. Most of the bees, which drift, do so during their orientation flights and before they become regular foragers (Free 1958). Also in the case of queens, drifting occurs on the maiden orientation flight. Queens on later flights do not drift (Perez-Sato et al. 2008).

Bees learn the colour of their hive in the close vicinity of the entrance, take little or no notice of colours above the lower brood chamber, and orient to a colour below the entrance more than to one above it. They do not learnt combinations of colours, but they distinguish between certain symbols placed immediately above the hive entrance. Moreover, foragers learn the height of their hive, and the height of its entrance above the ground (Free and Spencer-Booth 1961). Always more bees drift from a centre colony to the end colonies of a row than vice versa (Free 1958, Jay 1965, 1966a, b). There is no preference of drifting bees for related colonies (Pfeiffer and Crailsheim 1998). Neumann et al. (1997) found that drifters from neighbouring colonies prefer to go to other colonies rather than the neighbour. On the contrary, Pfeiffer and Crailsheim (1998) reported that most bees drift into the colony next to their original colony. According to Jay (1968, 1969a, b, 1971), three methods are effective in reducing drifting between hives: (i) the use of irregular or non-repetive layouts (patterns) of hives, and placing the hives within each layout to face different directions; (ii) the use of coloured hives, or coloured strips above or below the hive entrences (black, white, yellow, blue); (iii) the use of landmarks near hives (trees, bushes, fences etc.).

It is commonly believed that Italian bees are more prone to drift than the other subspecies. On the contrary, in Skowronek (1996) investigations level of drifting for Italian (*A. m. ligustica*) drones was less than 2%, whereas for middle European (*A. m. mellifera*) over 20%. Danka et al. (2006) found no differences in the drifting of yellow Italian bees and black Russian bees.

The aim of the study was to examine the influence of mating nucs spacing on the drifting of honeybee queens returning from mating flights. It also compares the drifting level of Carniolan and Italian queens.

MATERIAL AND METHODS

The experiment was performed in Apiculture Division at Warsaw University of Life Sciences – SGGW in 2012. Research was performed on 89 bee queens, including 46 Carniolan (*Apis mellifera carnica*) and 43 Italian (*Apis mellifera ligustica*) ones. Queens rearing was performed in two strong Carniolan nurse-colonies. First, the queens were taken away from these colonies, and after 9 days, when no more open brood was left, emergency queen cells were removed. This way the bees accepted more larvae introduced to be reared as queens (Gąbka et al. 2010). On the next day, 60 larvae from a purebred Carniolan queen and 60 larvae from a purebred Italian queen were grafted and introduced into the nurse-colonies. The larvae up to 1 day old were selected, as the age of brood used to rear queens affects their quality (Jordan 1960, Woyke 1971). After 10 days, queen cells were removed from the colonies and placed in three-comb trapezoidal mating nucs together with about one thousand of worker bees in each; 46 nucs had Carniolan queen cells, and 46 had Italian queen cells placed in them. For each subspecies, 25 nucs were arranged in rows, 5 nucs in each, spaced about 30 cm apart, and 21 nucs were placed next to various landmarks (bushes or trees) spaced several meters apart. Rows of nucs were situated in two parallel lines. The distance between neighbouring rows was about 10 m. All nucs were faced in the same direction and painted in the same colour. After 3 days, the nucs were examined to see if queens had emerged from queen cells. All queens were individually marked by number tags. After 10 days, following the queens' mating flights, their presence in the nucs was controlled.

Statistical comparisons were made using the Chi^2 test of independence. Calculations were performed using SPSS 21 software.

RESULTS AND DISCUSSION

Overall, 46 Carniolan queens and 43 Italian queens were obtained from 92 queen cells introduced into mating nucs. In the case of nucs arranged in rows without landmarks, 11 (44%) of the 25 Carniolan queens and 14 (58%) of the 24 Italian queens were lost, whereas in the case of nucs placed next to trees or bushes several meters apart, 1 (5%) of the 21 Carniolan queens and 2 (11%) of the 19 Italian queens were lost.

A significant influence of the arrangement of mating nucs was observed on the losses of queens returning from mating flights, both among Carniolan queens ($\chi^2 = 5.63$, $df = 1$, $P = 0.018$) and Italian queens ($\chi^2 = 5.107$, $df = 1$, $P = 0.024$). In total, in the case of nucs arranged in rows without any landmarks, highly significantly more queens were lost compared to nucs placed next to trees or bushes ($\chi^2 = 10.736$, $df = 1$, $P = 0.001$) – Table 1. This confirms the results previously obtained by Gąbka (2009). In his studies, 40% of queens were lost from colonies arranged in rows without any landmarks, compared to 12.3% of queens from colonies arranged in rows next to trees or bushes, and to as few as 2.6% of queens from hives randomly placed close to trees or bushes. Perez-Sato et al. (2008) reported no significant differences in the drifting of queens from mating nucs spaced at various distances from one another: 5% of queens from colonies spaced 2 m apart and 4% of queens, from colonies spaced 5 m apart, were lost. Similarly, in our studies the losses of queens from nucs arranged at distances of several meters away from one another amounted to 7%. Pfeiffer and Crailsheim (1998) reported that about 40% of bees drift away from colonies arranged in rows, and in Boylan-Pett et al. (1991) investigations, on average, only 42% of the total foragers in a colony originated from that colony. It confirms our results for queens.

TABLE 1. Queen loss during flights depending on mating nucs arrangement

Specification	Number of queens before flights	Number of lost queens	% of lost queens
Nucs in rows without landmarks	49	25	51 a
Nucs in no rows with landmarks	40	3	7 b
Total	89	28	31

Different letters indicate significant differences between the groups (Chi^2 test: $P < 0.05$).

No significant impact of honeybee subspecies on the drifting of queens was found either in the case of nucs arranged in rows ($\chi^2 = 0.327$, $df = 1$, $P = 0.567$) or those placed next to landmarks ($\chi^2 = 0.41$, $df = 1$, $P = 0.522$). In total, differences between losses of Carniolan and Italian queens were not significant ($\chi^2 = 0.664$, $df = 1$, $P = 0.415$) (Table 2). Also, Danka et al. (2006) did not find higher level of drifting for Italian workers and Skowronek (1996) stated even more drifting middle European than Italian drones. In contrast to these results, it is commonly believed that Italian bees are more prone to drift than the other subspecies.

TABLE 2. Queen loss during flights depending on honeybee subspecies

Specification	Number of queens before flights	Number of lost queens	% of lost queens
Apis mellifera carnica	46	12	26 a
Apis mellifera ligustica	43	16	37a
Total	89	28	31

The same letters indicate no significant differences between the groups (Chi^2 test: P >0.05).

CONCLUSION

Significantly more queen honey bees are lost during mating flights from nucs arranged in rows without landmarks compared to nucs placed next to trees or bushes.

The honeybee subspecies does not affect the drifting of queens returning from mating flights. Level of drifting for Italian and Carniolan queen honey bees do not differ.

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Streszczenie: *Wpływ ustawienia ulików weselnych oraz podgatunku pszczoły miodnej (*Apis mellifera*) na błądzenie matek powracających z lotów godowych.* Straty matek pszczelich podczas lotów weselnych zwiększają koszty ich produkcji. Celem pracy było zbadanie, czy sposób ustawienia ulików weselnych wpływa na błądzenie matek powracających z lotów godowych. Porównano również błądzenie matek kraińskich (*A. m. carnica*) i włoskich (*A. m. ligustica*). Ogółem zbadano 89 matek, które znajdowały się w ulikach weselnych, z około tysiącem robotnic. Część ulików ustawiono w rzędach w odległości około 30 cm od siebie, a część przy drzewach lub krzewach w odległości kilku metrów. W każdej grupie ulików były matki kraińskie i włoskie. Stwierdzono, że z ulików weselnych ustawionych w rzędzie, bez punktów orientacyjnych ginie podczas lotów godowych istotnie więcej matek (51%) niż z ulików ustawionych przy drzewach lub krzewach (7%). Nie stwierdzono istotnych różnic między błądzeniem matek kraińskich i włoskich.

Słowa kluczowe: pszczelarstwo, pszczoła miodna, loty godowe, błądzenie matek pszczelich, *Apis mellifera*

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