ATTEMPT TO USE SOUNDS IN COMMERCIAL BEEKEEPING

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Summary

The study was performed in the beekeeping seasons of 1996 and 1997 in a resident apiary of the Apiculture Division in Puławy. The colonies were raised in Danant beehives. The objective of the study was to develop a simple method which would allow the beekeepers to retain the bees on the combs and to prevent them from leaving the nest. Attempts were also made to establish whether exposing the colonies to sounds affects pollen foraging.

The sounds of 120 Hz, 450 Hz and 800 Hz frequency were emitted through 3 loudspeakers of the maximum output of 80 W each. The sounds were emitted as a rectangular wave in alternating cycles of 2 sec of sound and 2 sec of silence. The loudspeaker was placed either on the inner cover or on the inner cover and on the walls.

It was found that exposing the bees to an 800 Hz sound was effective in the immobilization of the majority of individuals on the combs which allowed the inspection of the colonies without resorting to the use of a smoker. It was also demonstrated that a sound of that frequency is effective in preventing the bees from taking foraging flights without at the same time irritating them. Arguably, the method can be recommended to prevent the bees from leaving the beehive during pesticide sprays as seventeen hours after the exposure to sounds was completed there was no difference in the amount of gathered pollen between sound-exposed and control colonies.

Keywords: honeybee colony, sounds, bee behaviour.

INTRODUCTION

During the beekeeping season there are many occasions on which bees have to be confined within the nest. The most important of such occasions is when entomophilous crops are treated with pesticides. Another occasion is when colonies have to be taken out to new pastures, especially when the transportation is taking place during the daytime. Because of that investigations have been conducted for many years aimed at developing a simple and efficient method to retain the bees in the beehive.

Attempts to close the beehives with different kinds of porches attached at the entrance were a failure (Zmarlicki, Pidek 1976). Encouraging results were obtained, though, when a colony was exposed to vibration. Tests performed both on a small colony placed in a plastic greenhouse and in open air commercial colonies gave evidence that vibrations prevent the foraging bees from leaving the nest (Spangler 1971, 1975, Spangler, Owens 1975, 1976). However, when applied to commercial colonies in large beehives the technique requires that the beehives be placed on special palettes which makes work in the apiary difficult and incurs additional costs. This is probably the reason why the use of floor vibration has not been universally accepted by beekeepers. So the research is continued into new methods to protect the bees from foraging on entomophilous crops during pesticide sprays (Salamon, Hooker 1989, Muszyńska 1999)

Alongside with occasional needs to prevent the bees from leaving the nest, a need to suppress bee activity on the combs occurs every time the nest is inspected. Until now, the bees have been retained on the combs by means of smoke. However, the technique, universally used by beekeepers, is not always safe. In regions of fire hazard (e.g. in dry climate woodland areas or in the periods of drought) smoking may start a fire. The use of a smoker may also start a fire in apiary buildings.

Beekeeping lore says of a possibility to stop a swarm with sounds produced by banging a wooden baton against a pot or a bowl (Bobrzecki 1984). It is now known that bees not only receive the vibrations of the ground but also are capable of receiving vibrations of the air (sounds). The latter are received by sensorial cells that form the aural organ localized on the anthenae (Kirchner et al. 1991, Kirchner 1994, Dreller, Kirchner 1995.) Therefore, there are grounds to accept as trustworthy accounts of escaping swarms that responded to sounds.

Investigations into the response of bees to simple sounds of a defined frequency were performed both under laboratory conditions and in apiaries (Frings, Little 1957, Little 1962, Rybak, Muszyńska 1998). Sounds falling within a frequency range of 500 Hz to 900 Hz cause a complete immobilization of the majority of bees present on the comb. It was also demonstrated that a sound of 600 Hz frequency and 120 dB intensity emitted from a distance of 1 m from the beehive caused the majority of bees to freeze on the combs of a commercial honeybee colony. As a result, inspection could be made without making use of a smoker (Frings, Little 1957, Little 1962). Those encouraging results notwithstanding, sounds are still not used in beekeeping. The only attempt to use sounds in the apiary was to calm down the bees flying outside the beehive but the results were not satisfactory. (Lord et al. 1985). It confirmed the results of earlier studies according to which both vibrations and sounds failed to elicit response from flying bees (Little 1962).

The results of the study reported here were meant as a contribution to the present knowledge about the possibilities to use sounds in apiaries. The objective was to develop a simple method to be used in apiaries that would allow beekeepers to make the bees stay on the combs and to prevent them from leaving the nest. An attempt was also made to find out if exposure to sounds affects honey producing performance. Account was also taken of the effect of sounds on gathering of pollen.

MATERIAL AND METHODS

The study was run in the Apiculture Division apiary in Puławy in the years 1996 and 1997. The sounds applied had the frequency of 800 Hz, 450 Hz and 120 Hz. They were generated by a custom-made portable set made up of a generator and a three-channel amplifier. A sound of a given frequency could be emitted simultaneously by three dynamic loudspeakers, each having a diameter of 12 cm and an output of 80W. The sounds had a rectangular wave shape and were emitted in alternating cycles of 2 sec. of sound and 2 sec. of silence. The volume of the sound was set at a level that was not annoying to the surroundings (ca. 80 dB at 1m from the beehive)

Experiment I. Effect of sounds on the bees occupying the combs in the nest.

The study was performed on medium-strong queen right colonies occupying 5 - 6 combs in Danant hives. Caucasian or Carniolan queens were inseminated naturally. The colonies were investigated during the beekeeping seasons of 1996 and 1997 in the months of June and July. During each observation three loudspeakers were used. Two of them were fixed to the outside walls of a non-insulated hive, the third was placed directly on the inner cover. The loudspeakers hung outside remained there during the whole study. The loudspeaker placed on the inner cover was moved to different places, as the need arose, so that it did not stay in the way during inspecting the successive combs. There was a total of 15 observation events performed on 15 dates. On each date four treatments were applied: check treatment without sound, I - sound 800 Hz, II - sound 450 Hz, III - sound 120 Hz. Each treatment involved a total of 15 colonies.

Experiment II. Effect of sound on honey bee flight activity.

The tests were performed during one beekeeping season, in 1996, on medium strong 5-6 comb queen right colonies derived from nuclei started in the same year. Caucasian and Carniolan queens were inseminated naturally. At the end of July in experiment II apiary four groups were picked at random, each group comprised of three colonies. There were three test groups and a check group. Once a week each test group was exposed to a half-hour sound treatment: I - sound of 800 Hz frequency, II - sound 450 Hz, III - sound 120 Hz. The sound exposure was run on three dates at mid-day hours during sunshine weather. A loudspeaker was placed on the inner cover of each test beehive and covered with a cushion. Next the roof was closed and the sound generator was turned on. During the sound emission the bees outside the hive were observed for behaviour characteristics such as stinging mood and flight activity. During the last 5 minutes of the exposure outbound bees were counted in all colonies.

Experiment III. Effect of sound on pollen gathering in bee colonies

The tests were run in 1997 and involved medium strong queen right colonies with naturally inseminated Carniolan queens. The colonies were derived from nuclei started in 1997. The bees occupied 5 - 6 combs, 2- 3 combs having uncapped brood. The following sound treatments were tested: I - check treatment - no sound, II - sound 120 Hz, III - sound 800 Hz. Treatment II was at the same time a reference to the 800 Hz treatment inasmuch as earlier studies had shown that exposure to 120 Hz did not suppress flight activity. However, the question was whether type of simulate, by possibly modifying the situation in the nest without immobilizing the bees, did not affect pollen gathering. In treatments II and III one loudspeaker was placed on the inner cover, covered with a cushion and the roof was closed.

The test was run in two series. In series I the amount of gathered pollen was measured on the cessation of the 7-hour exposure to sound. In series II the sound treatment also lasted 7 hours but the pollen was measured 17 hours after the exposure was finished. On a given test date the effect of sound on pollen gathering was tested for one frequency only. A single treatment involved three colonies across all experiment series and dates. A rule was adopted that non-treated colonies of one date were exposed to treatment on the next. Pollen was gathered by means of pollen traps fixed at the beehive entrance. A total of 96 pollen samples were gathered (12 samples for each treatment in a given series). Each sample was a replication of a treatment.

All experiment data were subjected to Duncan test at the alpha level equal to or lower than 0.005.

RESULTS

1. Effect of sounds on bees that stayed on the combs in the nest (experiment I)

In each year and on every test date the majority of bees exposed to 800 and 450 Hz sounds remained motionless on the combs. It allowed the colony inspections to be performed without any use of smoke. It is noteworthy that the sound exposure-related immobilization of bees persisted for another 10 minutes after the cessation of the exposure. Another remarkable thing was that the effect produced by the 800 Hz sound was greater than that obtained with 450 Hz. On the other hand, bees exposed to 120 Hz sound remained active both during the exposure and thereafter. Smoke was necessary to inspect those colonies and the reference non-treated colony.

2. Effect of sound on bee flight activity (experiment II)

Each sound frequency used in these experiments clearly induced the bees to leave the nest, all frequencies supressed flight activity. This is illustrated by the data in Table 1.

The effect of the 800 Hz sound was particularly conspicuous. It must be emphasized that during the experiments the bees showed no irritation symptoms.

3. Effect of sounds on pollen gathering by honeybee colonies

The results obtained in series I of the experiments are presented in Table 2.

It was found that under the test conditions a 7-hour exposure to sound of 800 Hz may have produced a certain negative effect on pollen gathering performance. However, the treatment-to-treatment differences, although verging on significance, were not proved conclusively. It was all the more interesting as flight intensity of was shown to be significantly reduced by the exposure to the sound of that frequency. The 120 Hz sound which was also demonstrated to have reduced flight activity to some extent did not significantly affect pollen gathering performance, either.

The results obtained in series II of the study are shown in Table 3.

It was found that seventeen hours after the cessation of the exposure to sounds of 800 Hz or 120 Hz the amount of pollen was not significantly different from that gathered from colonies that received no sound exposure.

Table 1

Number of bees leaving the beehive during the last five minutes of sound exposure

Date	Replication (colony)	Treatment - sound frequency			
		800 Hz I	450 Hz II	120 Hz III	Check
22.08.1996	1	8	3	8	35
	2	3	7	22	15
	3	3	6	3	15
29.08.1996	1	5	4	2	79
	2	8	13	5	26
	3	3	2	8	5
05.09.1996	1	2	15	22	98
	2	6	14	9	54
	3	1	7	2	63
Total		39	71	87	390
Mean		4.33a	7.88a	9.00a	43.33b

Means followed by different characters are significantly different.

Table 2

Pollen recovery from honeybee colonies within test groups immediately on the cessation of sound exposure (series I)

Gathering season and number of gathering dates	Treatment	Number of replications	Amount of pollen yielded by one colony on one gathering date (g)	
			mean	range
01.07 - 04.07.1997 (4)	Check	12	12.14	1.74 - 26.65
	800 Hz sound	12	9.49	1.18 - 25.70
20.07 - 01.08.1997 (4)	Check	12	3.92	0.42 - 10.13
	120 Hz sound	12	4.44	0.74 - 14.56

Table 3

Pollen recovery from honeybee colonies within test groups seventeen hours after the cessation of sound exposure (series II)

Gathering season and number of gathering dates	Treatment	Number of replications	Pollen weight recovered from one colony on one gathering date (g)	
			mean	range
10.07 - 16.07.1997 (4)	Check	12	6.52	0.81 - 13.06
	800 Hz sound	12	7.87	1.39 - 17.11
22.07 - 06.08.1997 (4)	Check	12	6.78	0.62 - 14.51
	120 Hz sound	12	7.27a	0.98 - 19.37

DISCUSSION AND CONCLUSIONS

The results bear out the observations of other investigators according to whom bees become motionless upon exposure to sounds of frequency range within 500 - 900 Hz. This is higher than sound frequency reportedly produced by bees in various circumstances (Ohtani, Kamada 1980; Pratt et al. 1996). It should be remembered that sounds produced by bees are of complex nature and the frequency ascribed to individual honeybee function groups is only a basic frequency (Ohtani, Kamada 1980; Michelsen et al. 1986).

The impulse to which the bees were exposed during the study was a complex one. Undoubtedly, the sound emitted from the loudspeaker on the inner cover (experiments 2 and 3) and simultaneously from three loudspekers on the inner cover and on outer walls (experiment 1) generated vibrations in the beehive. However, it must not be argued that the bee reaction described in this study is solely a response to vibration. The behaviour of bees as observed in this study and in another laboratory study (Rybak, Muszyńska 1998) largely departed from that described by an investigator who studied the effect of vibrations on a honeybee colony (Spangler 1969). According to that investigator vibrations caused bees to escape from the vibration source. Our observations indicate that bees become immobilized on the combs immediately upon receiving the sound stimulus. Whatever the mechanism involved, it is beyond doubt that by means of an 800 Hz frequency sound the majority of bees on the combs can be effectively immobilized. The treatment allows a safe colony inspection without resorting to smoke. Sounds of that frequency are also effective in suppressing, albeit not completely, honeybee foraging flights.

The above conclusion is also encouraged by the results of the assessment of pollen gathering by colonies that received for 7 hours a sound of 800 Hz frequency. Within that time no significant effect of sound exposure on pollen gathering performance was recorded. However, it must not be overlooked that the tests were performed under the conditions of very poor pollen supply even though weather conditions favoured bee flights. It is very likely that under more abundant pollen supply the differences in colony productivity for each treatment would not have been so conspicuous and the effect of 800 Hz sound could have been stronger. However, it seems that there are grounds to suppose that keeping the bees confined to the nest for even as long as several hours will not have significant impact on colony productivity. It was demonstrated that following a period of adverse foraging conditions bees become mobilized for harder work (Fewel, Winston 1992; Rinderer, Hagstad 1984, Robinson et al. 1998). It seems that even if the sound treatment had some negative effect on colony productivity it was worth applying in order to keep down bee poisoning or to reduce fire hazard in the apiary.

It ought to be emphasized that the results from this study confirmed earlier observations (Spangler 1971; 1975) pointing to the presence of worker bees in the colony that not respond to vibrations and sounds. Consequently, not all the bees freeze on the combs. Also, not all of them quit foraging flights. Those bees are not numerous and do not display aggressive behaviour. However, conceded the very fact that they take flights in spite of the sound treatment, a certain number of bees may be exposed to poisoning when foraging on pesticide-sprayed crops. Bees that displayed a particularly low level of response to the sound treatment used in this study belong probable to a strictly defined function group. Worker bees of different function groups are known to vary in the way they respond to such stimuli as brood pheromone or the smell of bee venom (Breed et al. 1990). It is an open and interesting question what function group it is. However, from the standpoint of practical beekeeping the understanding of that problem is of little consequence. Tthe most important thing from the practical viewpoint is that the method discussed in this paper is easy to implement. It efficiently regulates bee behaviour, keeps the bees confined to the combs and suppresses bee flight activity without the need to close the entrance.

Based on the results of this study it can be argued that in the apiaries with bees living in Dadant beehives a sound of 800 Hz frequency used as described in the methods part of this paper can be used to regulate bee behaviour. The device used in the study allowed the emission of several frequencies and was of a prototype character. However, in normal beekeeping one frequency i.e. 800 Hz will be enough. With the current technological level the design of a portable device that would emit an alternating sound/silence cycle of a single frequency and volume (800 Hz, 80 dB) presents no problem. An open question is what the response to sound will be of commercial colonies that use beehives other than Dadant type or made of materials other than wood. Moreover, it must be found out if the sound treatment as described in this paper will be effective in suppressing the movement of bees in very strong colonies localized on a plentiful nectare pasture. If the relevant tests proved to be positive the technique should be more widely disseminated among beekeepers.

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PRÓBA ZASTOSOWANIA BODŹCÓW DŹWIĘKOWYCH W PRAKTYCE PSZCZELARSKIEJ

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Streszczenie

Badania prowadzono w latach 1996 i 1997 podczas sezonu produkcyjnego w pasiece złożonej z rodzin osadzonych w drewnianych ulach typu Dadant należących do Oddziału Pszczelnictwa ISK w Puławach. Ich celem było opracowanie dla warunków pasiecznych prostej metody, która pozwalałaby za pomocą dźwięków zatrzymać pszczoły na plastrach oraz powstrzymać je przed opuszczaniem gniazda. Starano się też ustalić czy traktowanie rodzin dźwiękiem ma wpływ na efekt pozyskiwania przez nie pyłku.

Pod uwagę wzięto dźwięki o następujących częstotliwościach 120 Hz, 450 Hz i 800 Hz, które emitowano przez 3 głośniki o średnicy 12 cm i maksymalnej mocy 80 W. Emitowane dźwięki miały kształt fali prostokątnej oraz cykliczny charakter na przemian 2 sek. dźwięk i 2 sek ciszy. Głośnik umieszczano na powałce ula lub na powałce i ścianach ula.

Stwierdzono, że działanie na pszczoły dźwiękiem o częstotliwości 800 Hz pozwala na skuteczne unieruchomienie przeważającej liczby osobników na plastrach co umożliwia przeprowadzenie przeglądu rodzin bez użycia podkurzacza. Wykazano ponadto, że dźwięk o tej częstotliwości skutecznie powstrzymuje pszczoły przed wykonywaniem lotów zbieraczych nie wywołując ich podrażnienia. Należy przyjąć, że stosowana metoda może być polecana do powstrzymania pszczół przed opuszczeniem ula w czasie prowadzenia oprysków pestycydami. Siedemnaście godzin po zakończeniu ekspozycji dźwiękiem nie stwierdzono bowiem różnic w ilości pyłku zebranego przez rodziny traktowane dźwiękiem i kontrolne.

Słowa kluczowe: rodzina pszczela, dźwięki, zachowanie pszczół.