EXPERIENCES IN REARING OF *BOMBUS LUCORUM* L. (HYMENOPTERA, APOIDEA) IN CAPTIVITY

Zkušenosti s laboratorním chovem čmeláka hájového *Bombus lucorum* L. (Hymenoptera, Apoidea).

Bučánková A.[1,2], Ptáček V.[2,3]

[1]Výzkumný ústav pícninářský, spol s r. o. Troubsko

[2]Masarykova Univerzita, Přírodovědecká fakulta, Brno

[3]Zemědělský výzkum, spol s r. o. Troubsko

Abstrakt – Při aplikaci laboratorních metod chovu známých pro čmeláka zemního(*Bombus terrestris*) na čmeláka hájového (*Bombus lucorum*) bylo zjištěno, že jako stimul pro kladení vajíček matky bez problémů přijímají nejen kokony nebo dělnice vlastního druhu, ale i kokony *B. terrestris*. Většinou přijmou i jednu mladou dělnici *B. terrestris* jako pomoc s dochovem vlastních dělnic první generace. V rodinách chovaných v laboratoři dochází často k brzkému bodu zvratu (switch-point) a pohlavní potomstvo je produkováno již v druhé nebo třetí generaci, čímž se liší od druhu *B. terrestris*. Ve srovnání s uměle přezimovanými matkami zakládají matky odchycené v přírodě početnější rodiny, které produkují také více mladých matek.

Klíčová slova: *Bombus lucorum*, *Bombus terrestris*, chov, opylování, šlechtění

Abstract – Having applied the technique known for management of *Bombus terrestris* in rearing of *B. lucorum* it was found, that as the stimulus for oviposition queens of *B. lucorum* do adopt not only conspecific cocoons and/or workers but also the cocoons of *B. terrestris.* They accepted a callow worker of *B. terrestris* as the helper in the care of their own first worker brood. It was noted a rather early switch point in the laboratory bred colonies - queens were produced in the second or third generation of brood, what was different from *B. terrestris*. Colonies started by the artificially over wintered queens produced less young queens in comparison with those started by the queens brought from the nature.

Key words: *Bombus lucorum*, *Bombus terrestris*, rearing, management, pollination

Introduction

The white tailed bumble bee *Bombus lucorum* is a Euro-siberic species having the broad ecological valence. In the Czech Republic it occurs from lowlands also in the higher levels till the mountains. This presents its difference from *B. terrestris* (Pavelka and Smetana, 2003). Similarly to *B. terrestris* also *B. lucorum* natural colonies should be numerous – accumulating up to 200 workers (Goulson, 2005). From the systematic point of view both mentioned species are considered to be closely relatives. They belong to the most abundant species in Europe, what means – they play an important role in the pool of natural pollinators. Recently, bumblebees (mostly *B. terrestris* and other species in North America) have been used to pollinate crops of the primary production in greenhouses. More over bumblebees can be used also in the process of plant breeding, thus serving as the pollen vectors in the deliberate crossings under the cover from netting (Ptáček, 1987; Drobná and Ptáček, 2001). Regarding the recent trends in preferring the home- or endemic species, instead of importing *B. terrestris* all over the world, *B. lucorum* offers one of such measure. Its rearing can be implemented into the plant pollination and/or breeding processes especially in northern countries, where this species belongs among the dominants.

Whereas the technique of rearing *B. terrestris* for commercial purposes seems to be

generally known (Ptáček, 1985, 2003; Welthius and Van Doorn, 2006), data regarding the management of *B. lucorum* in the laboratory conditions have not been published. Hasselrot (1960), Friden (1965), Vale and Aaltonen (1969) were successful in starting colonies in confinement, but they were put outside, after the first workers had emerged. This article reports about our trials to rear *B. lucorum* by the same method which we had adopted for the production of *B. terrestris* colonies in laboratories of the Masaryk University of Brno and the Agricultural Research in Troubsko near Brno, Czech Republic.

Material and methods

During the 5 years of experiments 97 queens were at disposal for the trials; 42 of them originated from the nature and 55 were "over wintered" in laboratory. Queens were placed into the kitchen plastic doses (14x19x7cm), equipped with the cardboard underlay at the bottom and several openings for ventilation in the walls. They were fed about 60% sugar solution and pollen. The sugar compound was made from 90% of sucrose and 10% of fructose. An addition of commonly used sodium benzoate prevented the fermentation. The pollen used was taken freshly from the honey bee colony pollen traps as soon in the season as it was possible. This was about the middle of April. Out of vegetation the deep frozen pollen or the dry pollen were used. Dry pollen was moistened to the natural stage before using. Rearing was performed in darkness under the temperature 27^{o} C and the humidity of air of 60-70%.

To activate the nesting behavior, queens were kept in pairs (Sladen, 1912; Ptáček et al., 2000) or they were given conspecific cocoons (Duchateau et al, 1994) or cocoons of *B. terrestris*. In some cases, when the queen had already her young larvae, it was given a conspecific worker from another colony or a callow worker of *B. terrestris* to help the queen with the care of brood. After the own workers had emerged, the worker of *B. terrestris* was taken away. The colonies having the first workers were let to develop in wooden hives (260x190x200mm). If the colony produced young queens, they were removed when they wanted to take their cleanings flights (4 days of age). The queens were collected in glass aquaria covered with a net. Each aquarium had a paper shell at the bottom to absorb feces. Similarly, young males were collected in other aquaria, when they wanted to leave the hive. Bumble bees in aquaria were supplied by both, sugar solution and pollen. When queens were about 6 days old, approximately 2 unrelated males for each queen were added. By the access of daylight the mating process was started up and watched. The connected pairs were removed from the aquarium and put several together into an empty rearing dose. After the copulation was over, males were released. Queens were then let for about 4 days in darkness in the dose equipped with sugar feeder to fill their honey stomachs. Then they were put individually into doses for the photography films. Finely, several doses gathered together into a larger tight plastic dose equipped with the moistened tampon they were they put into a cool room and stored under the temperature 4-5 ^{o}C. After 2 months as the earliest and 6 months as the latest term they were activated by the treatments described above.

Results and discussion

Starting colonies

As it can be seen from the Table 1, about 88% of the queens, which originated from nature, were able to lay eggs, 67% could produce the first workers and 52% of the queens established queen producing colonies. Four queens did produce the first generation of workers, and then their colonies produced males only.

In the group of the artificially over wintered queens 82% were able to establish the brood cell, 20% could nourish the first worker generation and 13% of queens established the

colonies that produced new queens. Two queens produced the first workers and then their colonies produced males only. 10 queens produced entirely males.

Table 1. Success in starting colonies

	Total number	Built brood cell	Produced workers	Produced new queens
Queens from nature	42	37 (88)	28 (67)	22 (52)
Over wintered queens	55	45 (82)	11 (20)	7 (13)

Production of new queens

As it can be seen from the table 2, colonies started by queens from nature produced significantly more new queens ($\bar{x}$=29) in comparison to those started by queens diapausing in the lab. ($\bar{x}$=4). No deference was found between the periods from emergence of the first worker and the first queen.

Table 2. Young queen production in the bread colonies

Origin of queen	Numbers of new queens produced
Natural queens	1,2,2,2,4,4,6,8,12,12,13,13,24,25,60,110
Laboratory stored	1,1,1,1,2,2,4,5,16

Comparison of *B. lucorum* and *B. terrestris*

The technique used to manage *B. terrestris* in confinement can be used well for rearing of *B. lucorum*. Queens of the white tailed bumble bee lay eggs regularly within three weeks. They even accept cocoons of *B. terrestris* as an egg laying stimulus. *B. lucorum* queens which have their brood in larval stage also accept one callow worker of *B. terrestris* which helps them by nutrition of the larvae. But it is better to take off the alien worker after *B. lucorum* queen has her cocoons, otherwise the *B. terrestris* worker may compete for the dominance and contribute to early switch point in *B. lucorum* colony. On the other hand, *B. lucorum* queens accept conspecific workers as helpers without any sign of the competition behavior from their site. We could find a significant difference between the two species in the period between the emergences of first workers to the time of emergence of queens. In *B. terrestris* this period was 48 days as an average, but in *B. lucorum* the first queens did emerge in 32 days.

The development of the brood was not as successful in *B. lucorum* as in *B. terrestris*. Especially artificially over wintered queens destroyed already based brood cells repeatedly. Probably the reason of that was the improper quality of pollen or the specific composition of pollen. Nevertheless, we could not find any difference between colonies fed with the fresh pollen on the one side and those fed with the frozen or dry and moistened pollen. The brood losses were in both of the groups. Maybe, also several short spells of dry air period, which occurred in the rearing room, could contribute to the loss of brood. The repeated starts in brood rearing could be the reason of the early switch point in the colonies. Commonly, after several generations of workers the colonies started to feed the diploid brood as queens. Those colonies had very small numbers of workers (5-15). We obtained colonies having more than 50 workers only in 5 cases. From them 1 originated from the laboratory over wintered queen. But also in those colonies the production of young queens started earlier than in *B. terrestris*. As a special event several colonies of *B. lucorum* produced a portion of the new queens after a long period of the mail production, what we never observed in *B. terrestris*.

Mating in laboratory condition is possible similarly as in *B. terrestri*s. But pairs of *B. lucorum* must have the access of the day light to instigate the copulation activity. *B. terrestris* is able to mate even under the working illumination in the laboratory. The time of copulation measured in 9 cases in *B. lucorum* was between 17 and 54 minutes ($\bar{x}$=28,8). *B. lucorum*

queens also do mate only once. Wintering of queens in *B. lucorum* is similar to that of *B. terrestris*.

Conclusion

Rearing of *B. lucorum* according to the technique used for *B. terrestris* is possible only partially. Queens in the solitary phase, as well as developing colonies need better quality and/or specific composition of pollen. Here the further research is necessary. Nevertheless 67 % of natural queens produced workers in laboratory what can be considered as a good base for such experiments.

Acknowledgement

We acknowledge the projects: NPV II 2B06007 and MSM2629608001 of the Czech Ministry of Education Youth and Sport, Czech Republic, which enabled the experiments with rearing the bumblebees.

References

Drobná, J., Ptáček, V. 2001: Genetic resources conservation in some forage legumes using bumble bee (*Bombus terrestris*) pollination. Acta Hort. číslo časopisu, 211-213.

Duchateau, M.J., Toshiba, H., Velthuis, H.H.W. 1994: Diploid males in the bumble bee Bombus terrsestris, Entomol. Exp. Appl. 71, 623-269.

Fridén, F. 1965: Preliminär redogörelse för försöken med humledomesticering. (Personal communication in Holm, 1966).

Hasselrot, T.B. 1960: Studies on swedish bumblebees (genus Bombus Latr.), their domestication and biology. Opusc. Entomol. 17, 1-192.

Holm, S.N. 1966: The utilization and management of bumble bees for red clover and alfalfa seed production, Ann. Rev. Ent. 11, 155-182.

Pavelka, M., Smetana, V. 2003: Čmeláci, Valašské Meziříčí: Český svaz ochránců přírody, Vyd. 2., 105 pp.

Ptáček, V. 1985: Zkoušky tří metod chovu čmeláků (Hymenoptera, Bombidae). (Testing three methods of rearing bumble bees.) – Sb. věd. prac., OSEVA, VŠÚP Troubsko 9, 56-57.

Ptáček, V. 1987: Technická izolace ve výzkumu a šlechtění jetelovin. (Technical isolation in research and breeding of legumes.) – Sb. věd. prac., OSEVA, VŠÚP Troubsko, 10, 117-128. Czech, En.sum. 1987.

Ptáček, V. 2003: Deliberate production of young queens in Bombus terrestris L. (Hymenoptera, Apoidea) colonies reared in Laboratory. J. Api. Sci. 47, 67-71.

Ptáček, V., Pernová, E., Borovec, R. 2000: The two-queen cascade method as an alternative technique for starting bumble bee (Bombus, Hymenoptera, Apidae) colonies in laboratory (Preliminary study). Pcel. zesz. nau. 44, 305-309.

Sladen, F. W. L. 1912: The Bumble–Bee. - London, Mac Milan Press.

Welthius, H. H. W., Van Doorn, A. 2006: A century of advances in bumblebee domestication and the economic and environmental aspects of its commercialization for pollination. Apidologie 37, 421–451.

Valle, O. Aaltonen, M. 1969: Domestication trials on bumblebees, Acta Agr. Fenn. 113. Pp.22.

Kontaktní adresa 1. autora.

Mgr. Alena Bučánková, Zemědělský výzkum, s r.o., Zahradní 1, Troubsko, 664 41, bucankova@vupt.cz