TECHNIQUES FOR YEAR-ROUND REARING OF *Bombus terrestris* L. (*Hymenoptera, Apoidea*) IN CHINA

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Summary

The effect of different temperature and different stimulation oviposition methods on the development of bumblebee colonies was examined. The experimental results showed that a climate room at 30°C±0.5 and RH 60%, queen with a plastic cocoon model and two honeybee workers were appropriate for rearing *Bombus terrestris* colonies in China. 36.42% of queens mated successfully when proportion of queens and drones was 1:5, the successful copulation was highest compared with other four proportions (1:1, 1:3, 1:8, 1:10), their successful copulation rate was 13.43%, 25.83%, 30.24%, 18.98% respectively. These techniques provide opportunities to rear *Bombus terrestris* colonies year-round in China.

Keywords: *Bombus terrestris*, bumblebee, colonies, techniques, temperature, stimulation methods, successful copulation, year-round rearing, proportion.

INTRODUCTION

Bumblebees are well-known important pollinators in their natural habitats. Recently, their use to pollinate various glasshouse crops has been developed widely and their industrial rearing techniques have been developed extensively in many countries (Pinchinat B. et al. 1979). If it can be performed on an economic scale, year-round laboratory culture appears to be the best long-term method for mass rearing (Abak et al. 1995). In China, several laboratories have been rearing bumblebees for scientific studies of social behaviour, biology, pollinating application and others since 1996, and have made remarkable progress (An et al. 2001, Peng et al. 2003; Guo et al. 2003). For all of these purposes it is desirable to be able to culture bumblebees throughout the year.

It is the key segment for year round rearing bumblebees to master the optimum ambient condition for growth and development of the bumblebee colonies, a method used to stimulate a queen to lay eggs. In the present paper these techniques are studied.

MATERIALS AND METHODS

Experimental queens and males were obtained from *B. terrestris* imported colonies reared to be utilized for fruit and vegetable pollination in greenhouses in China. The bumblebees were fed with sugar water (1:1, v/v) and pollen collected by pollen-traps from honeybees, only fresh pollen immediately deep frozen in small plastic bags after being collected was used. Mated queens were treated with CO_2 and reared in the nest wooden boxes (15 cm × × 10 cm × 10 cm), after emergence of all workers of the first brood, the small colonies were shifted into the breed boxes consisting of a feed chamber (19 cm × × 19 cm × 17 cm internal dimensions) and

a nest chamber (28 cm × 19 cm × 17 cm internal dimensions). Data were recorded for the shortest time of colony initiation, the longest time of colony initiation, proportion of queens that laid eggs, successful colony production (about 100 workers in a colony), the time of colony production.

Temperature

Colonies of *B. terrestris* were reared in a controlled climate room at 60% RH and submitted to five temperatures: (1) 24°C±0.5, (2) 26°C±0.5, (3) 28°C±0.5, (4) 30°C±0.5 (5) 32°C±0.5. Temperature treatments comprised 90, 202, 426, 183, 60 queens, respectively.

Stimulation methods

Queens were kept in climate rooms at the result of temperature experiment and submitted to five stimulation oviposition methods: single queens were confined together with two honeybee workers from the south of China, two bumblebee workers, young worker cocoon, a plastic cocoon model and one honeybee worker, a plastic cocoon model and two honeybee workers. Each method comprised 60, 124, 59, 176, 250 queens, respectively. No stimulation comprised 90 queens.

Mating experiment

Newly emerged queens were collected from the nests and maintained in boxes until the copulation experiments took place. Newly emerged males were taken directly from different nests before the experiment and introduced into the box. Corresponding to this developmental process, males prefer to mate at an age of 16±7 days (Duchateau and Marien 1995), readiness of queens to mate seems to be greatest at around six days of age (Gretenkord 1997).

Different proportion of 30 queens and males (1:1, 1:3, 1:5, 1:8, 1:10) were introduced into a mating cage, 100 cm × 100 cm × 80 cm. The experiments started at 08:00 h and end at 14:00 h, the temperature in the copulation room was maintained at 22°C, 60% RH and light intensity at 2000 lx (halogen lamp). The behaviour of the bees was observed for every other 20 min. Data were recorded for successful copulation.

RESULTS

Temperature

Table 1 shows that the shorter time of colony production and colony initiation was, the higher the temperature was. The proportion of queens that laid eggs and colony production were both highest at 30°C±0.5 and RH 60% compared with other four temperatures (24°C±0.5, 26°C±0.5, 28°C±0.5, 32°C±0.5). So we think a climate room at 30°C±0.5 and RH 60% was appropriate for rearing *B. terrestris* colonies in China.

The stimulation methods

Table 2 shows that 87.44% of the queens laid eggs, 54.24% of the queens produced a colony successfully when they were provided with young worker pupae. Proportion of queens that laid eggs and colony production were both highest when they were provided with young worker pupae compared with other five stimulation methods. Queens started egg laying and produced a successful colony very soon when they were provided with young worker pupae. But it is troublesome to acquire young worker pupae in China. The proportion of queens that laid eggs and colony production were both higher, queens started egg laying and produced a successful colony soon when they were provided a plastic pupae model and two honeybee workers. It is important that we acquire these materials easily.

Table 1

Colony characteristics relative to different temperatures

Colony characteristics	Temperature [°C]				
	24±0.5	26±0.5	28±0.5	30±0.5	32±0.5
Number of queens (n)	90	202	426	183	60
Shortest time of colony initiation (day)	3	3	2	2	2
Longest time of colony initiation (day)	21	24	19	19	20
Proportion of queens that laid eggs (%)	63.33	75.74	79.98	86.77	85.95
Successful colony production (%)	17.78	27.72	32.08	42.45	38.72
Time of colony production (day)	64	61	55	40	42

Note: successful colony production comprises of about 100 workers.

Table 2

Colony characteristics relative to the different stimulation methods (n=number of queens observed)

Stimulation methods	n	Colony characteristics				
		The shortest time of colony initiation (day)	The longest time of colony initiation (day)	Proportion of queens that laid eggs (%)	Colony production (%)	The time of colony production (day)
No stimulation	90	3	21	63.33	17.78	64
Two honeybee workers	60	4	18	71.67	20.00	55
Two bumblebee workers	124	1	18	87.10	30.65	40
Young worker pupae	59	1	14	87.44	54.24	40
A plastic pupae model + one honeybee workers	176	3	19	78.97	32.95	56
A plastic pupae model + two honeybee workers	250	2	16	80.80	31.20	55

Mating experiment

Figure 1 shows that 36.42% of queens mated successfully when the proportion of queens and drones was 1:5. The successful copulation was highest when the proportion of queens and drones was 1:5 compared with other four proportion (1:1, 1:3, 1:8, 1:10) and their successful copulation rate was 13.43%, 25.83%, 30.24%, 18.98%, respectively.

DISCUSSION

Several techniques have been described to rear *B. terrestris* colonies (Sladen 1912, Holm 1960, Holm 1964, Biliński

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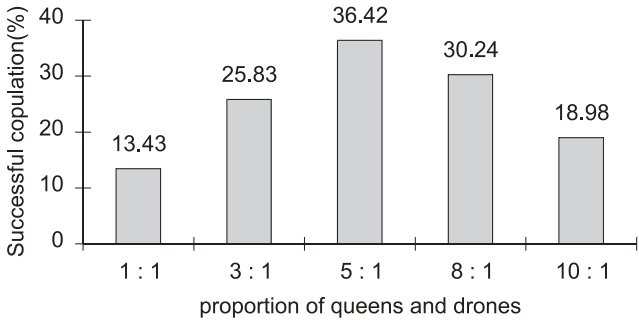

Fig. 1. Successful copulation relative to the proportion of queens and drones

1998, Plowright and Jay 1966, Ptaček 1983, Röseler 1985, Röseler and Röseler 1984). However, these methods seem ineffectivefor mass rearing in China. The methods need to be both effective and economical. Supplementing a queen with a plastic pupae model and two honeybee workers and at a climate room at 30°C±0.5 and RH 60% seem promising methods, because we have put our methods into practice successfully.

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TECHNIKI CAŁOROCZNEJ HODOWLI *Bombus terrestris* L. (*Hymenoptera, Apoidea*) W CHINACH

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S t r e s z c z e n i e

Badano wpływ różnych temperatur i różnych metod stymulacji czerwienia na rozwój rodzin trzmielich. Wyniki badań wskazują, że dla hodowli rodzin *Bombus terrestris* w warunkach chińskich odpowiednie warunki zapewnia komora klimatyzacyjna z temp. 30°C±0.5 i wilgotnością względną 60%, plastikowy model oprzędu i dwie pszczoły miodne – robotnice. 36,42% matek dokonało pomyślnego parowania, kiedy stosunek matek do trutniów wynosił 1:5, w tym przypadku odsetek zakończonych sukcesem kopulacji był najwyższy w porównaniu do pozostałych czterech badanych proporcji (1:1, 1:3, 1:8, 1:10) stanowiąc odpowiednio 13,43%, 25,83%, 30,24%, 18,98%. Techniki te pozwalają na całoroczną hodowlę rodzin *Bombus terrestris* w Chinach.

Słowa kluczowe: *Bombus terrestris*, trzmiel, rodziny, techniki, temperatura, metody stymulacji, pomyślna kopulacja, całoroczna hodowla, stosunek/proporcja.